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Preface

After the upheavals of 1989, it was to be expected that 1990 would not just quietly usher in the last decade of the twentieth century. The hectic pace of change continued in the Soviet Union and Eastern Europe as they tried to cope with the transition to political democracy and economic liberalism. In Western Asia the low level of endemic conflict flared up into a war involving both developed and developing countries. The winds of political change that originated in Europe also affected Africa, where doctrines of one-party rule as well as of apartheid suffered defeat.

The world industrial economy coped with these changes to the best of its ability. The fact remains, however, that in the economic sphere the pace of change is painfully slow. Developing countries still have a very low share in total manufacturing output. The economic climate in developed countries, recessionary during 1990 and only slightly better in 1991, still dictates the context in which developing countries can pursue their industrial growth. There is a growing trend towards large regional blocs with free trade among those within and a protective wall against foreign trade with those without. At present, these regional blocs span the developed countries which are markets for developing country manufactures. The success of the GATT talks will be a necessary but insufficient condition for improving the developing countries' prospects in the industrial sphere.

In its response to the transition in Eastern Europe as well as to the Gulf crisis, the world economy has shown that it can mobilize resources when it wishes to. Though arguably less dramatic, the plight of Africa, the continent that suffered major losses in the economic bonanza of the 1980s, remains urgent. The revival of the economies of Latin America is still painfully slow and continues to be hampered by financial constraints. The success of East Asian and South-East Asian economies shows that industrial growth depends crucially on unhampered cross-border flows of goods, services, capital, technologies, management and marketing skills and the like—in short, it hinges on opening up and freer trade. Above all, the access those countries enjoy to industrialized country markets, such as the United States, stands out as a powerful driving force. This lesson bears great significance for other developing countries as their access to industrialized country markets would appear even more essential to economic survival—especially for those countries with heavy debt burdens. This awareness is fortunately spreading quickly to countries in Eastern Europe, the USSR, China, Mongolia and Viet Nam, as well as to many countries in Africa which had been essentially "closed" for decades. The momentous systemic reform, however, requires a commensurate sum of aid to help minimize the time and pain of transition—not only for the reforming countries themselves, but also to the ultimate benefit of trading partners as amply proven by the Marshall Plan after the Second World War. What is needed is information and analyses that will further the transmission of industrial growth across the globe. The *Global Report* is designed to be part of that process.

It is rarely the case in history that one or two years can bring about a fundamental break with the past. Yet, between the summers of 1989 and 1991 the world seems to have settled a question that had been debated for two centuries and more. Contention started almost as soon as the 'dark satanic mills' sprang up in England in the eighteenth century. It was debated whether capitalism or socialism ensured faster industrial growth. The debate has since taken many different twists and turns. In the 50 years following the end of the First World War, the answer could honestly be said to have lain in either direction, while many countries sought a third way, an amalgam of the two stark alternatives.

In the 1980s, but increasingly so within the past two years, opinion has swung decisively in favour of an open, market-oriented economy, for the greater part privately owned and managed, as a way of achieving sustained industrial growth. In this environment, the State still has a role to play: an enabling role, guiding, helping and furthering rapid change. None the less, it will be difficult to argue henceforth with much conviction that industrial growth offers much scope for comprehensive State ownership.

The reason for this abrupt reversal seems to lie in the constant need for an industrial economy to adapt to change, demonstrate flexibility and be innovative. Well-established industrial giants in the most developed market economies fear sclerosis no less than the fledgling industrial infant in a developing country. As research and development speed up, new products and new processes are being constantly introduced. The pressure to reduce labour costs, economize on energy, save on raw materials or substitute one source for a cheaper source, be it for marketing, finance or maintenance—these are the constant challenges of an industrial environment.

Settling the debate does not end the difficulties of achieving sustained industrial growth. On the contrary, it points up the need for information and for intelligent planning as a part of industrial enterprise. The global trends in income and employment, the course of interest rates and exchange rates impinge on the prospects of everyone, no matter how small or large. Information becomes an economic mainstay.

It is with this knowledge that the *Global Report* focuses once again on providing detailed, concrete and up-to-date information on the global prospects for industrial growth. This year, special attention is devoted to the issues of efficiency in the use of energy and to the new financial instruments available for manufacturing industries in the global financial markets. The forecast for the global economy is of slow growth in the short-term. The prospects for industrial growth in developing countries offer no room for being sanguine. But the universal need for industrial growth and restructuring could not be more obvious. Furthermore, for the health of the world's industrial economy in both the long and short term, enhanced aid flows and generous market access, especially for the countries of Eastern Europe and Africa, could not be more urgent.

DOMINGO L. SIAZON, Jr.
Director-General

تمهيد

بعد أحداث عام ١٩٨٩ الجباشة ، كان من المتوقع الا يعبر بنا عام ١٩٩٠ الى العقد الأخير من القرن العشرين هكذا بهدوء . فقد استمر التغيير في الاتحاد السوفياتي وأوروبا الشرقية بسرعة محمومة ، اذ حاولت هذه البلدان معالجة مشاكل الانتقال الى الديمقراطية السياسية والليبرالية الاقتصادية . وفي غرب آسيا ، انفجر النزاع المستوطن الخافت في حرب شاركت فيها بلدان متقدمة وبلدان نامية . كما أن رياح التغيير التي هبت من أوروبا تركت آثاره أيضا في افريقيا ، حيث منيت نظم حكم الحزب الواحد ، وكذلك نظام الفصل العنصري ، بالهزيمة .

وقد تجاوب الاقتصاد الصناعي العالمي مع هذه التغيرات قدر المستطاع . بيد أن الحقيقة التي تظل قائمة هي أن التغير في المجال الاقتصادي كان بطيئا الى حد مؤلم . ولا تزال حصة البلدان النامية من اجمالي الناتج الصناعي متدنية جدا . كما أن المناخ الاقتصادي في البلدان المتقدمة ، الذي كان يتسم بالركود في عام ١٩٩٠ ثم تحسن تحسنا ضئيلا فحسب في عام ١٩٩١ ، لا يزال هو الذي يملي على البلدان النامية النهج الذي يمكن أن تتبعه في سعيها الى النمو صناعيا . وثمة اتجاه متنام نحو انشاء تكتلات اقليمية ضخمة مع جعل التبادل التجاري حرا فيما بين البلدان المنضوية فيها واقامة حواجز حمائية ضد التجارة الخارجية مع البلدان الأخرى . وفي الوقت الحاضر تنتشر هذه التكتلات الاقليمية في البلدان المتقدمة التي تمثل سوقا لمصنوعات البلدان النامية . ونجاح المحادثات الدائرة في اطار "الغات" سيكون شرطا لازما ، ولكن غير كاف ، لتحسين آفاق البلدان النامية في الميدان الصناعي .

وقد أثبت الاقتصاد العالمي ، في تجاوبه مع التحول في أوروبا الشرقية وكذلك مع أزمة الخليج ، انه قادر على حشد الموارد عندما يريد ذلك . أما محنة افريقيا ، القارة التي منيت بخسائر ضخمة في أجواء الرخاء الاقتصادي التي سادت في الثمانينات ، فانها تظل أمرا له صفة الاستعجال ، وان كان البعض يحاج بأنها أقل شدة من سواها . ولا يزال انتعاش اقتصادات أمريكا اللاتينية بطيئا بصورة مؤلمة ، وتظل المعوقات المالية هي حجر العثرة في طريقه . ويدل نجاح اقتصادات شرق آسيا وجنوب شرق آسيا على أن النجاح الاقتصادي يتوقف بصورة حاسمة على تدفق البضائع والخدمات ورؤوس الأموال والتكنولوجيات والمهارات الادارية والتسويقية ، وما الى ذلك ، عبر الحدود دون عوائق - أي يتوقف باختصار على الانفتاح وتحرير التبادل التجاري . وقبل كل شيء ، يبرز ما تتمتع به هذه البلدان من امكانية الوصول الى أسواق البلدان الصناعية ، كالولايات المتحدة مثلا ، باعتباره قوة دافعة شديدة . ويمثل هذا النجاح عبرة كبيرة لسائر البلدان النامية ، إذ يبدو أن امكانية وصولها

الى أسواق البلدان الصناعية هي أشد ضرورة للبقاء الاقتصادي - وخصوصا بالنسبة للبلدان التي ترزح تحت أعباء ثقيلة من الديون . ولحسن الحظ ، ينتشر هذا الوعي بسرعة الى بلدان أوروبا الشرقية والاتحاد السوفياتي والصين ومنغوليا وفييت نام ، وكذلك الى بلدان كثيرة في افريقيا كانت "مغلقة" أساسا لعقود طويلة . بيد أن اصلاح الانظمة الاقتصادية اصلاحا جذريا يتطلب قدرا مناسبا من المعونة ، للمساعدة على تقصير أمد الفترة الانتقالية وتقليل آلامها الى أدنى حد ممكن - لا بالنسبة للبلدان القائمة بالاصلاح ذاتها فحسب وانما لمنفعة الشركاء التجاريين أيضا في نهاية المطاف ، مثلما ثبت بجلاء من خطة مارشال بعد الحرب العالمية الثانية . وما يلزم الآن هو المعلومات والتحليلات التي من شأنها أن تعزز انتشار النمو الصناعي عبر أنحاء الكرة الارضية . والمراد من التقرير العالمي أن يكون جزءا من هذه العملية .

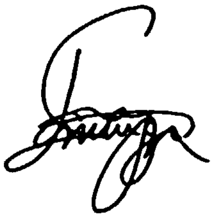
ويندر في التاريخ أن تفضي سنة أو سنتان الى إحداث تحولات جوهرية عن الماضي . ولكن بين صيف ١٩٨٩ وصيف ١٩٩١ يبدو أن العالم قد وجد الحل لمسألة ظلت موضع جدل مدة قرنين ونيف . فقد بدأ الصراع فور ظهور "الطواحين الشيطانية القاتمة" في بريطانيا تقريبا في القرن الثامن عشر . ونشأ الجدل حول ما اذا كانت الرأسمالية أم الاشتراكية هي التي تكفل نموا صناعيا أسرع . واتخذ الجدال ، منذ ذلك الحين ، انثناءات وانعطافات مختلفة عديدة . وفي السنوات الخمسين التي أعقبت الحرب العالمية الاولى ، كان يمكن للجواب أن يأخذ بأمانة أيا من الاتجاهين ، بينما سارت بلدان كثيرة في طريق ثالث ، هو مزيج من ذينك البلدين المتطرفين .

وفي الثمانينات ، وخصوصا في السنتين المنصرمتين ، مال الرأي ميلا حاسما لصالح اقتصاد مفتوح ذي توجه سوقي ، يمتلك القطاع الخاص الجانب الاكبر منه ويتولى ادارته ، كسبيل لتحقيق النمو الصناعي المستديم . وفي هذا المناخ ، يظل للدولة دور تؤديه : دور يمكّن من إحداث التغيير السريع ويوجهه ويساعده ويعززه . بيد أنه سوف يصعب على المرء من الآن فصاعدا أن يحاجج ، بكثير من الاقتناع ، بأن النمو الصناعي يتيح متسعا لملكية حكومية شاملة .

ويبدو أن السبب في هذا الارتداد المفاجئ يكمن في حاجة الاقتصاد الصناعي الدائمة الى التواؤم مع التغيرات والى اظهار المرونة والتجدد والابتكار . فالعمالقة الصناعيون الراسخو القدم في أشد الاقتصادات السوقية تقدما يخشون تصلب الانسجة لا أقل من أي وليد صناعي غِر في بلد نام . فمع تسارع وتيرة البحث والتطوير ، يجري استحداث منتجات جديدة وعمليات جديدة بصورة مستمرة . والتحديات الثابتة في أي بيئة صناعية هي الضغوط في اتجاه خفض تكاليف اليد العاملة ، وتقليل استهلاك الطاقة ، والاقتصاد في المواد الخام أو الاستعاضة عن مصدر ما بمصدر أرخص ، سواء فيما يتعلق بالتسويق أو بالتمويل أو بالصيانة .

وحسم الجدل لا ينهي مصاعب تحقيق النمو الصناعي المستديم ، وانما هو يدل على الحاجة الى المعلومات والتخطيط البارع كجزء من المشروع الصناعي . فالاتجاهات العالمية في مجالي الدخل والعمالة ، ومنحى أسعار الفائدة وأسعار الصرف ، تؤثر في آفاق الكل ، الصغار منهم والكبار . ومن ثم ، تصبح المعلومات دعامة أساسية للاقتصاد .

ومن هذا المنطلق ، يركز التقرير العالمي مجددا على تقديم معلومات مفصلة ومحددة وحديثة عن آفاق النمو الصناعي في العالم . ويولي في هذه السنة اهتمام خاص لمسائل كفاءة استخدام الطاقة ولأدوات التمويل الجديدة المتاحة للصناعات التحويلية في الأسواق المالية العالمية . وتشير التوقعات الى أن الاقتصاد العالمي سيكون بطيء النمو في المدى القصير . كما أن آفاق النمو الصناعي في البلدان النامية لا تثير التفاؤل . لكن حاجة العالم الى النمو الصناعي واعادة هيكلة الصناعة لا يمكن أن تكون أكثر جلاء مما هي عليه الآن . وعلاوة على ذلك ، فإن عافية الاقتصاد الصناعي العالمي في المديين الطويل والقصير ، هي أحوج ما تكون الآن الى زيادة في تدفقات المعونة وسخاء في تيسير سبل الوصول الى الأسواق ، خصوصا لصالح بلدان أوروبا الشرقية وافريقيا .



دومينغو ل . سيازون ، الابن

المدير العام

序 言

经过1989年的动荡，有理由认为，1990年在迎来二十世纪最后一个十年的过程中将不会仅仅是风平浪静的。 努力解决着政治民主和经济自由化这一过渡问题的苏联和东欧，它们的变革继续迈着巨大的步伐。 西亚地区小范围的地方性冲突引发了一场卷入了发达国家和发展中国家的战争。 以欧洲为发源地的政治变革风暴也吹到了非洲，使那里的一党制和种族隔离主义大受其挫。

世界工业经济竭尽全力地应付这些变革。 但实际情况仍然是，在经济领域中，变革的步伐过于缓慢。 发展中国家在制造业总产值中所占比重仍然很低。 发展中国家经济1990年呈现衰退，到1991年也只是略有好转，这种经济环境仍然制约着发展中国家争取工业增长的幅度。 正在出现一种组成大区域集团的趋势，这些集团对内实行自由贸易，对同外部的对外贸易则实行保护壁垒政策。 目前，这些区域集团已遍布各发达国家，而发达国家正是发展中国家制成品的市场。 要改善发展中国家在工业领域的前景，关贸总协定谈判的成功固然是个不可或缺的条件，但光有这个条件还是不够的。

世界经济针对东欧的变革以及海湾危机所做反应的过程表明，世界经济在希望调集资源时是有能力做到这一点的。 在八十年代的经济繁荣时期，非洲大陆受到了重大的损失。非洲的境况虽然可以说不那么具有戏剧性，但仍然是十分紧迫的。 拉丁美洲经济复苏的步伐仍然是恼人地缓慢，并且继续受到种种经济制约因素的阻碍。 东亚和东南亚经济的成功表明，工业的增长在很大程度上取决于货物、服务、资本、技术、管理和销售技巧等的不受限制的跨境流动，简而言之，取决于开放和贸易自由。 这些国家能够进入美国等工业化国家市场，应当说是一种强大的驱动力。 这一经验对于其他发展中国家有着重大的意义，因为进入工业化国家市场对这些国家的经济生存尤为关键，特别是那些债务沉重的国家。 令人庆幸的是，这一认识已迅速扩及到东欧、苏联、中国、蒙古和越南等国，以及非洲的许多几十年来基本上“封闭的”国家。 但是，有系统的重大改革需要有与之相称的援助，以便帮助它们尽量缩短过渡的时间和减少过渡的痛苦——不仅对进行改革的国家本身来说应当如此，而且就贸易伙伴的最终利益来说也应当如此，第二次世界大战后的马歇尔计划便是明证。所需要的是各种有关信息资料和分析，以促进全球范围内工业增长影响力的传播。 《全球报告》正是为了作为这一过程的一部分而问世的。

一两年的时间取得与过去迥然不同的根本突破，这在历史上说是十分罕见的事情。 可是，在1989年夏天至1991年夏天的这段时间里，世界看来已解决了一个两百多年来一直争执不休的问题。 这一争论几乎是早在十八世纪英国出现“撒旦式黑色磨坊”时便已开始。争论的焦点是：究竟是资本主义还是社会主义能确保更迅速的工业增长。 争论后来经过了许许多多的曲折。 在第一次世界大战后的五十年中，坦率地讲，应当说答案是二者参半，不过也有许多国家寻求第三条道路，希望能对两种极端办法加以综合。

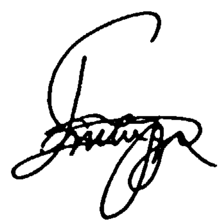
到了八十年代，特别是在过去两年的时间里，舆论决定性地倾向于开放的、市场导向的经济，主张更大范围的私人所有和私人管理，以作为争取持续增长的途径。 在这种环境里，

国家仍可发挥自己的作用，这是一种保证作用，即指导、协助和促进迅速的变革。 不过，也很难因此便很有说服力地说工业增长为全面国家所有制提供了很大的发展余地。

之所以出现如此急剧的转向，是因为工业经济始终需要适应变革、显示灵活性和具有创新性。 最发达市场经济中老牌工业泰斗对硬化症的恐惧，并不亚于发展中国家羽翼未丰的工业新秀的恐惧。 随着研究与开发的加速，新产品和新工艺不断推出。 削减劳力成本、节约能源、节省原料或以某一廉价来源取代现有来源，所有这些都是压力，无论是从销售、筹资还是从保养的角度看——这些正是工业环境中永久性的挑战。

辩论的解决并不意味着争取持续工业增长方面的困难的消失。 恰恰相反，却更加突出了作为工业企业的一个组成部分的资料信息和情报规划的必要性。 收入和就业的全球趋势，利率和汇率的变化情况，所有这些都对每个企业的前景产生着影响，而且对大小企业都不例外。 信息已成为主要的经济支柱。

正是基于这一认识，所以《全球报告》的重点再次放到了提供与工业增长全球展望有关的详尽、具体而新颖的信息方面。 今年，我们特别注意到了能源利用效率的问题以及世界金融市场为制造业提供的新的金融手段。 从全球经济预测情况看，短期内的增长将是缓慢的。 发展中国家工业增长的前景并不令人乐观。 但普遍需要取得经济增长，需要进行结构改革，这一点已是再清楚不过的了。 而且，为了世界工业经济长期和短期内的健康发展，现在比任何时候都更迫切需要扩大援助流量，更慷慨地提供市场进入机会，尤其是对东欧和非洲国家。



总干事

小多明哥·L ·夏松

Préface

Après les bouleversements de 1989, on ne pouvait attendre de l'année 1990 qu'elle inaugurât dans le calme la dernière décennie du XXe siècle. Et, de fait, le rythme effréné du changement ne s'est pas ralenti en Union soviétique et en Europe de l'Est, où l'on s'est efforcé de gérer la transition vers la démocratie politique et le libéralisme économique. Quant à l'Asie occidentale, le conflit larvé qui y régnait a fini par éclater et s'est mué en une guerre à laquelle ont pris part pays développés et pays en développement. La vague de réforme politique partie d'Europe a déferlé sur l'Afrique, où la doctrine du parti unique ainsi que l'apartheid ont été battus en brèche.

L'économie industrielle mondiale a fait face à ces changements du mieux qu'elle a pu; il n'en reste pas moins que dans la sphère économique le rythme du changement est demeuré dramatiquement lent. Ainsi, la part des pays en développement dans la production industrielle totale est aujourd'hui encore très faible. Le climat économique dans les pays développés, marqué par une récession en 1990 et une légère amélioration en 1991, continue de définir le cadre dans lequel les pays en développement peuvent inscrire leur industrialisation. On observe une tendance de plus en plus marquée à la formation de grands blocs régionaux pratiquant le libre-échange en leur sein, mais érigeant des protections à leur périphérie. Or, ces blocs régionaux rassemblent les pays développés qui sont les débouchés des produits manufacturés des pays en développement. Pour que ces derniers voient s'améliorer leurs perspectives industrielles, il faudra, condition nécessaire mais non suffisante, que les négociations du GATT soient couronnées de succès.

L'économie mondiale a montré par la manière dont elle a réagi à l'évolution en Europe de l'Est et à la crise du Golfe qu'elle pouvait mobiliser des ressources en cas de nécessité. Bien qu'apparemment moins spectaculaire, la situation critique dans laquelle se trouve l'Afrique, continent qui a subi des revers considérables en dépit de l'euphorie économique des années 80, appelle des mesures urgentes. Le redressement des économies d'Amérique latine est encore trop hésitant et reste freiné par des contraintes financières. Les succès économiques rencontrés par les pays d'Asie de l'Est et d'Asie du Sud-Est montrent que la croissance industrielle passe obligatoirement par la libre circulation des biens, des services, des capitaux, des technologies, des compétences — en gestion ou commercialisation, etc.; en d'autres termes, qu'elle dépend de l'ouverture et de la libéralisation des échanges. Avant toute chose, le libre accès aux marchés des pays industrialisés, tels que les Etats-Unis, dont jouissent ces pays est le moteur de cette croissance. Cet exemple est riche d'enseignements pour les autres pays en développement, car le libre accès aux marchés des pays industrialisés apparaît comme un facteur fondamental de leur survie économique — en particulier celle des pays fortement endettés. Fort heureusement, les pays d'Europe de l'Est, l'URSS, la Chine, la Mongolie et le Viet Nam en sont de plus en plus conscients, ainsi que de nombreux pays d'Afrique qui étaient restés quasiment "fermés" pendant des décennies. Or, toute réforme radicale du système économique nécessite une aide à la mesure de la tâche entreprise si l'on veut réduire au minimum la durée de la période de transition et les difficultés qu'elle engendre non seulement pour les pays engagés dans cette réforme, mais aussi pour leurs partenaires commerciaux, comme l'a amplement démontré le plan Marshall après la seconde guerre mondiale. Pour que l'industrialisation progresse partout dans le monde, des informations et des analyses sont nécessaires et c'est dans ce cadre que s'inscrit le présent rapport.

Historiquement, il est rare qu'une rupture brutale avec le passé puisse intervenir en l'espace d'un ou deux ans. Or, entre l'été 1989 et l'été 1991, le monde semble avoir trouvé la réponse à une question débattue depuis plus de deux siècles. La controverse est née peu après que furent créées en Angleterre, au XVIIIe siècle, les premières "usines démoniaques". On s'est demandé lequel des deux systèmes, du capitalisme ou du socialisme, pouvait assurer la croissance industrielle la plus rapide. Depuis lors, ce débat a connu de nombreux avatars. Au cours des cinquante années qui ont suivi la fin de la première guerre mondiale, on pouvait, en toute honnêteté, se prononcer en faveur de l'un ou de l'autre système, tandis que de nombreux pays s'efforçaient de trouver une troisième voie, à mi-chemin de ces deux pôles.

Dans les années 80, et tout particulièrement au cours des deux dernières années, l'opinion s'est prononcée de manière décisive en faveur d'une économie de marché ouverte, animée pour l'essentiel par le secteur privé et garante d'une croissance industrielle soutenue. Dans ce contexte, l'Etat aura toujours un rôle à jouer : celui d'un catalyseur qui oriente, aide et facilite un changement rapide. Il n'en reste pas moins qu'il sera difficile désormais d'affirmer avec une quelconque conviction que la croissance industrielle doive faire une grande place à la propriété étatique généralisée.

Ce changement brutal semble s'expliquer par le besoin constant qu'a l'industrie de s'adapter au changement, de faire preuve de souplesse et d'être capable d'innovation. La hantise de la sclérose habite aussi bien les géants industriels en place dans les pays les plus développés que les entreprises industrielles naissantes des pays en développement. Au fur et à mesure que s'accélère le rythme de la recherche-développement apparaissent régulièrement de nouveaux produits et procédés. La nécessité d'abaisser les coûts de main-d'œuvre, l'obligation d'économiser l'énergie, le souci d'utiliser rationnellement les matières premières ou de remplacer une source par une autre, plus économique, que ce soit pour la commercialisation, le financement ou la maintenance, sont autant de défis que doit relever l'industrie.

Pour autant, le fait que le débat soit clos désormais ne signifie pas que les difficultés inhérentes à une croissance industrielle soutenue soient aplanies. Au contraire, les entreprises industrielles ont plus que jamais besoin d'information et de planification rationnelle. Les tendances mondiales en matière de revenus et d'emplois et l'évolution des taux d'intérêt et des taux de change influent sur les perspectives de tous les agents économiques, quelle qu'en soit la taille. L'information est devenue l'un des pivots de l'activité économique.

Forts de cette analyse, les auteurs du rapport ont voulu qu'y figurent des informations détaillées, concrètes et à jour sur les perspectives mondiales de la croissance industrielle. Cette année, ils ont privilégié la question de l'utilisation rationnelle de l'énergie et les nouveaux instruments financiers dont peuvent disposer les industries manufacturières sur les marchés financiers mondiaux. A court terme, l'économie mondiale devrait connaître une croissance ralentie, et les perspectives de croissance industrielle dans les pays en développement n'incitent guère à l'optimisme. Il n'en reste pas moins que la croissance et la restructuration industrielles sont plus que jamais des nécessités universelles et que la bonne santé de l'économie industrielle mondiale passe, à long terme comme à court terme, par une intensification de l'aide et une plus large ouverture des marchés, en particulier pour les pays d'Europe de l'Est et d'Afrique.

Le Directeur général,

DOMINGO L. SIAZON, Jr

Предисловие

После потрясений 1989 года следовало ожидать, что 1990 год будет не просто первым годом последнего десятилетия двадцатого века. В Советском Союзе и странах Восточной Европы, которые стремились решать проблемы, связанные с переходом к политической демократии и либерализации экономики, продолжался бурный процесс преобразований. Мелкомасштабный местный конфликт в Западной Азии перерос в настоящую войну, в которую оказались втянутыми как развитые, так и развивающиеся страны. Ветры политических перемен, зародившиеся в Европе, затронули и Африку, где потерпели крушение доктрины однопартийного правления и апартеида.

Мировая промышленность настойчиво стремилась решать проблемы, вызванные этими преобразованиями. Однако в области экономики реформы продолжают осуществляться чрезвычайно медленно. На долю развивающихся стран по-прежнему приходится очень незначительная часть общего объема производства обрабатывающей промышленности. Состояние экономики развитых стран, в которой наблюдался спад в 1990 году и лишь незначительное оживление в 1991 году, по-прежнему определяет условия промышленного развития развивающихся стран. Наблюдается усиление тенденции создания крупных региональных блоков, в рамках которых осуществляется свободная торговля между ее членами и в то же время воздвигается стена протекционизма в отношении внешней торговли со странами, не входящими в эти блоки. В настоящее время эти региональные блоки включают развитые страны, которые являются рынками сбыта для производителей из развивающихся стран. Успешное проведение переговоров в системе ГАТТ является важным, но недостаточным условием для улучшения перспектив промышленного развития развивающихся стран.

Принимая меры в связи с переходным периодом в странах Восточной Европы, а также в связи с кризисом в Персидском заливе, мировая экономика продемонстрировала, что она может мобилизовать необходимые ресурсы, если она этого захочет. Хотя положение Африки является менее критическим (правда, об этом можно спорить), этот континент, понесший огромные потери в период стремительного экономического роста 80-х годов, по-прежнему требует принятия неотложных мер. Оживление экономики стран Латинской Америки продолжает осуществляться чрезвычайно медленно и сдерживается финансовыми проблемами. Успешное развитие экономики стран Восточной и Юго-Восточной Азии свидетельствует о том, что промышленный рост зависит прежде всего от свободного трансграничного потока товаров, услуг, капитала, технологии, опыта в области управления и сбыта и т.д.; иными словами, он зависит от выхода на международный рынок и создания более свободных условий торговли. Кроме того, доступ этих стран к рынкам промышленно развитых стран, таких как Соединенные Штаты Америки, выступает в качестве мощного рычага их развития. Этот вывод имеет огромное значение для других развивающихся стран, поскольку их выход на рынки промышленно развитых стран будет иметь еще более важное значение для их экономического выживания, что особенно актуально для стран с большой задолженностью. К счастью, понимание этого растёт в странах Восточной Европы, СССР, Китае, Монголии и Вьетнаме, а также во многих странах Африки, которые в течение многих десятилетий были в значительной степени „закрытыми". Однако проведение этой чрезвычайно важной фундаментальной реформы требует значительных средств для сведения к минимуму продолжительности и болезненности переходного периода. Это необходимо не только для самих стран, осуществляющих реформы, но в конечном счете выгодно и для их торговых партнеров, что совершенно очевидно показало осуществление Плана Маршалла после второй мировой войны. Насущной необходимостью является информационное обеспечение и проведение анализов, что будет способствовать дальнейшему промышленному развитию во всем мире. Подготовка *Глобального доклада* рассматривается как часть этого процесса.

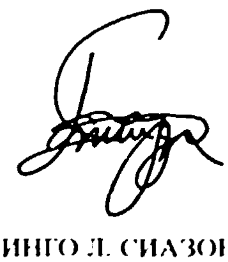
В истории крайне редки случаи, когда в течение одного года или двух лет удавалось решительно порвать с прошлым. Тем не менее, в период между летом 1989 и летом 1991 годов мир, очевидно, решил вопрос, по которому велись горячие споры на протяжении более двух столетий. Разногласия возникли почти сразу же после того, как в Англии в восемнадцатом веке возникли „зловещие сатанинские фабрики". Спор заключался в том, что обеспечит более быстрый промышленный рост – капитализм или социализм. С тех пор этот спор принимал весьма различные формы. В течение 50 лет после первой мировой войны ответ на этот вопрос вполне мог быть найден в обоих направлениях, хотя многие страны искали третий путь, который сочетал в себе оба этих антипода.

В 80-е годы, и особенно явно в течение последних двух лет, решительно возобладало мнение в пользу открытой экономики рыночной ориентации, в значительной степени опирающейся на частную собственность и частное управление, как пути достижения устойчивого промышленного развития. Но и в этих условиях государство все же должно выполнять определенные функции: оно должно создавать возможности для дальнейшего развития, осуществлять общее руководство, оказывать помощь и содействовать оперативному проведению необходимых изменений. Тем не менее, в дальнейшем будет трудно достаточно убедительно утверждать, что промышленное развитие создает огромные возможности для всеобъемлющей государственной собственности.

Причина этого неожиданного поворота, по всей видимости, заключается в том, что промышленное производство должно постоянно приспосабливаться к происходящим изменениям, проявлять гибкость и способность находить новые решения. Признанные промышленные гиганты в наиболее развитых странах с рыночной экономикой опасаются утраты динамизма в не меньшей степени, чем возникающие промышленные предприятия в развивающихся странах. По мере ускорения процесса НИОКР постоянно появляются новые виды продукции и новые процессы. Необходимость снижения расходов на рабочую силу, экономии энергии и сырья или замены одного источника более дешевыми источниками, касается ли это сбыта, финансирования или технического обслуживания, – эти задачи неизменно возникают в ходе промышленного развития.

Решение спора не устраняет проблем, стоящих на пути достижения устойчивого промышленного развития. Напротив, с особой остротой проявляется необходимость в информационном обеспечении и разумном планировании как элементов деятельности промышленных предприятий. Общемировые тенденции в вопросах доходов и занятости, динамики процентных ставок и валютных курсов оказывают серьезное влияние на перспективы развития любого предприятия независимо от его размеров. Информация становится основой экономической деятельности.

Учитывая это, основное внимание в *Глобальном докладе*, как и прежде, уделяется подробной, конкретной и современной информации о перспективах общемирового промышленного развития. В этом году особое внимание обращается на вопросы эффективного использования энергии и новых механизмов финансирования, которыми располагают обрабатывающие отрасли на мировых финансовых рынках. Согласно прогнозам, в ближайшем будущем мировая экономика будет развиваться низкими темпами. Перспективы промышленного развития развивающихся стран не дают поводов для большого оптимизма. Однако всеобщая потребность в промышленном развитии и перестройке является совершенно очевидной. Кроме того, для обеспечения нормального мирового промышленного производства как в долгосрочной, так и в краткосрочной перспективе крайне необходимо увеличить объем предоставляемой помощи и создать широкие возможности для доступа на мировые рынки, особенно стран Восточной Европы и Африки.



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Генеральный директор

Prefacio

Después de la agitación que caracterizó al año 1989, era de suponer que 1990 no se limitaría a anunciar tranquilamente el comienzo del último decenio del siglo XX. Los cambios prosiguieron a un ritmo acelerado en la Unión Soviética y en los países de Europa oriental, que luchaban por conseguir la transición a la democracia política y al liberalismo económico. En Asia occidental, los conflictos endémicos de alcance relativamente limitado se convirtieron en una guerra abierta con intervención de países desarrollados y de países en desarrollo. El viento de cambio político proveniente de Europa afectó también a África, continente en el que las doctrinas del monopartidismo y del *apartheid* se vieron derrotadas.

La economía industrial mundial ha hecho todo lo que ha podido para hacer frente a esos cambios, pero no queda más remedio que reconocer que en la esfera económica el ritmo del cambio ha sido lamentablemente lento. Los países en desarrollo siguen teniendo una proporción bajísima de la producción manufacturera total. El clima económico de los países desarrollados, que era recesionario durante 1990 y apenas mejor en 1991, sigue delimitando el contexto en el cual los paíes en desarrollo tienen que buscar la continuación de su crecimiento industrial. Hay una creciente tendencia hacia la formación de grandes bloques regionales con libertad de comercio para los países que los componen y con un muro de protección contra el comercio exterior de los demás países. En la actualidad, esos bloques regionales incluyen a países desarrollados que son los mercados de las manufacturas de los países en desarrollo. El éxito de las conversaciones del GATT es una condición necesaria, pero insuficiente, para mejorar las perspectivas industriales de los países en desarrollo.

En su respuesta a la transición en Europa oriental y a la crisis del Golfo, la economía mundial ha demostrado que puede movilizar recursos si lo desea. Aunque puede alegarse que las circunstancias son menos dramáticas, sigue revistiendo urgencia la penosa situación de África, continente que sufrió importantes pérdidas en el período de auge económico del decenio de 1980. El resurgimiento de las economías de América Latina sigue siendo demasiado lento, y sigue tropezando con limitaciones financieras. El éxito de las economías de los países de Asia oriental y del Sudeste de Asia demuestra que el crecimiento industrial depende fundamentalmente de que la corriente de mercancías, servicios, capitales, tecnologías, conocimientos de gestión y aptitudes de comercialización, etc., pueda cruzar sin dificultades las fronteras; o sea, depende de que se establezca y funcione un mercado más libre. Sobre todo, el acceso de dichos países a los mercados de los países industrializados, como por ejemplo los Estados Unidos, ha demostrado ser un poderoso impulso. Esta lección reviste gran importancia para otros países en desarrollo cuyo acceso a los mercados de los países industrializados parece ser aún más esencial para su supervivencia económica, especialmente los países que están muy endeudados. Afortunadamente, estas ideas se están extendiendo rápidamente a países de Europa oriental, la URSS, China, Mongolia y Viet Nam, así como a muchos países de África que durante decenios y decenios han permanecido fundamentalmente "cerrados al exterior". Ahora bien, una reforma sistemática tan trascendental requiere un volumen proporcional de ayuda que contribuya a reducir al mínimo la duración y las dificultades del proceso de transición, no solamente para los propios países en vías de reforma, sino también para beneficio de los copartícipes comerciales, según ha quedado suficientemente probado por el Plan Marshall después de la Segunda Guerra Mundial. Lo que se necesita son informaciones y análisis que promuevan la transmisión del crecimiento industrial a través del mundo. La finalidad del *Informe Mundial* consiste en formar parte de dicho proceso.

Es muy raro que en solamente uno o dos años pueda tener lugar un cambio histórico que representa una desviación tan fundamental del pasado, y sin embargo, entre los veranos de 1989 y de 1991, el mundo parece haber dado por resuelta una controversia que se venía suscitando desde hace más de dos siglos. Dicha controversia comenzó casi al mismo tiempo que las "fábricas de tejidos movidas por oscuras fuerzas satánicas" empezaran a diseminarse por la Inglaterra del siglo XVIII: se trataba de determinar si era el capitalismo o el socialismo el que promovía el crecimiento industrial con mayor rapidez. Desde entonces, el debate ha venido experimentando muchos altibajos y muchos cambios de dirección. En los 50 años que siguieron al final de la Primera Guerra Mundial, una respuesta franca hubiera podido inclinarse a favor de cualquiera de las dos tendencias contradictorias, mientras que muchos países procuraban encontrar un tercer camino, una nueva vía en la que se amalgamasen las dos poderosas alternativas que se discutían.

Durante el decenio de 1980, y aún más durante los dos últimos años, la opinión ha ido perfilándose definitivamente en favor de una economía libre y orientada al mercado, en su mayor parte de propiedad y gestión privadas, como sistema para conseguir un crecimiento industrial sostenido. En este contexto, el Estado sigue teniendo una función que desempeñar: una función de habilitación, de orientación, de ayuda y de fomento de un rápido cambio. De todos modos, sería difícil sostener en la actualidad con profunda convicción que el crecimiento industrial puede tener lugar en un entorno caracterizado por un sistema amplio de propiedad estatal.

La razón de este abrupto cambio de dirección parece estribar en la necesidad constante de que las economías industriales se adapten a los cambios, demuestren su flexibilidad y sean innovadoras. Los gigantes industriales bien asentados en la mayor parte de las economías de mercado desarrolladas temen tanto a la esclerosis como las bisoñas empresas industriales de los países en desarrollo. A medida que la labor de investigación y desarrollo recibe mayor impulso, el mercado recibe constantemente nuevos productos y nuevos procesos. La necesidad de reducir los gastos laborales de economizar la energía, de ahorrar materias primas o de sustituir una fuente de suministro determinada por otra más barata, tanto si es a efectos de comercialización como si es a efectos de financiación o de mantenimiento, constituye un problema constante para el entorno industrial.

Con concluir el debate ahora no se pondrá término a las dificultades que plantea la consecución de un crecimiento industrial sostenido; por el contrario, se destacará la necesidad de información y de planificación inteligente como parte de la empresa industrial. Las tendencias mundiales de los ingresos y del empleo, el curso de las tasas de interés y de los tipos de cambio actúan sobre las perspectivas de todos y de cada uno, sea grande o pequeña la empresa industrial de que se trate. La información se convierte en uno de los cimientos de la economía.

El *Informe Mundial* se basa en esta convicción para acometer una vez más la empresa de proporcionar informaciones detalladas, concretas y actualizadas acerca de las perspectivas mundiales de crecimiento industrial. Este año se presta especial atención a la cuestión de la utilización eficiente de la energía y a los nuevos instrumentos financieros disponibles para las industrias manufactureras en los mercados financieros mundiales. Las previsiones para la economía mundial indican un crecimiento lento a corto plazo. Las perspectivas de crecimiento industrial en los países en desarrollo no ofrecen ningún motivo de optimismo, pero la necesidad universal de reestructuración y crecimiento industrial no puede manifestarse con mayor claridad. Además, la prosperidad de la economía industrial mundial tanto a corto plazo como a largo plazo requiere con la máxima urgencia mayores corrientes de ayuda y un acceso más generoso a los mercados, especialmente por lo que se refiere a los países de Europa oriental y de África.

DOMINGO L. SIAZON, Jr.
Director General

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EXPLANATORY NOTES

Reference to dollars ($) are to United States dollars, unless otherwise stated.

References to tonnes are to metric tonnes, unless otherwise specified.

A slash (1980/1981) indicates a crop year or a financial year.

Industry categories referred to in this publication are based on Revision 2 of the International Standard Industrial Classification (ISIC)

References to ISIC codes are accompanied by a descriptive title (for example, ISIC 323-"Manufacturing of leather and products of leather, leather substitutes and fur, except footwear and wearing apparel"). Consideration of space, however, require a shortening of this description (for example, ISIC 323 may be referred to simply as "Leather and fur products"). In some cases, ISIC categories have been aggregated and the descriptive titles adjusted accordingly.

The term "billion" signifies a thousand million.

Figures in square brackets [ ] refer to source material listed after chapter V.

The following symbols have been used in tables:

Two dots (. .) indicate that data are not available or are not separately reported.

A dash (—) indicates that the amount is nil or negligible.

Totals may not add precisely because of rounding.

The following abbreviations and acronyms appear in this publication.

AIDS	acquired immunodeficiency syndrome
ASEAN	Association of South-East Asian Nations
BOT	build-operate-transfer
B.t.u.	British thermal units
CAD	computer-aided design
CAE	computer-aided engineering
CMEA	Council for Mutual Economic Assistance
DES	debt-equity swaps
DRAM	dynamic random access memory
ECU	European currency units
EEC	European Economic Community
GATT	General Agreement on Tariffs and Trade
GCC	Gulf Co-operation Council
GDP	gross domestic product
GNP	gross national product
IFC	International Finance Corporation
IMF	International Monetary Fund
ISIC	International Standard Industrial Classification of all Economic Activities
MITI	Ministry of International Trade and Industry
MMC	metal matrix composite
MVA	manufacturing value added
nbsc	northern bleached softwood kraft
NIC	newly industrializing country
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
PTA	Preferential Trade Area for Eastern and Southern Africa
R+D	research and development
SABIC	Saudi Basic Industries Corporation
SSP	single superphosphate
TFP	total factor productivity
TPA	tissue plasminogen activator
TSP	Trisodium phosphate

This report is based on information available as of March 1991.

Introduction

In the past year or so, the world has been convulsed by a series of conflicts and problems of both natural and human origin. The ravages of war were accompanied by a succession of natural disasters that added to the terrible toll of human tragedies around the world. Politically, the world acquired a new topography through the removal of the ideological divide between East and West, raising hopes and problems alike. Nevertheless, in the midst of unprecedented change, certain basic continuities remained in the pattern of international economic relationships.

Thus, the world, remaining placid in a context of upheaval, has become more resistant to economic shocks. The long-dreaded economic recession in the United States and its antecedents in some other industrialized countries have lowered the projected short-term path of world economic growth, but have so far failed to shift it to any significant extent. Growth prospects, though much subdued, remain more or less intact. Japan and the newly unified Germany, through their own internal dynamics, should be able to sustain their growth until the United States economy recovers. But more importantly, there has been a definite improvement in the investment climate for developing countries, especially some Latin American and South-East Asian countries. Despite its recent political tragedy, India seems to be well on the road to success in its industrial modernization process. Unfortunately, however, the economic hardships experienced by the least developed countries, especially in Africa, will probably continue.

In high-income countries manufacturing has clearly become relatively unimportant compared with service industries. In this connection, it is perhaps unique in the annals of corporate history that some of the largest United States and Japanese manufacturers are reporting larger returns on their non-traditional and non-manufacturing activities than on their manufacturing activities. However, the historically high real interest rates and the uncertainty surrounding their movements in the 1980s have considerably shortened investment time horizons, thus discouraging long-term investments, especially in the capital-intensive manufacturing sector and in industries essential for building and maintaining the infrastructure. In chapter I of *Global Report 1991/92*, the problem of high interest rates is therefore discussed in describing the medium-term prospects of the global economy.

The compulsion to modernize the industrial structure, to grow faster, to sustain the growth process longer, and to better the prospects for the future are as strong as ever for the majority of the world's economies. Chapter II surveys the recent experience of industrial growth in the major regions of the world industrial economy. Once again, regardless of the size or the maturity of the industrial structure, the overriding need is to innovate, adapt and restructure. Research and development, a supportive industrial strategy, a skilled labour force and a willingness to learn from others are important ingredients for East as for West, for North as for South. Perhaps the one region which emerges as requiring special attention is that of Tropical Africa, where the newborn industrial structure has been hit by the ill winds of debt financing problems.

Twice in the last 20 years it has seemed as if energy resource constraints would prove to be the barrier to sustained growth. If the threat has passed, it is still important to inquire into the efficacy of better energy utilization for industrial growth. The subject of energy use is thus dealt with in chapter III. While the level of energy consumption is higher in developed countries, it is now clear that the growth of energy consumption in those countries has slowed down to a trickle. Growth is no longer dependent on energy as much as it used to be, nor as much as it still is in the case of developing countries. It is the energy-intensive industrial structure of developing countries as well as those of Eastern Europe and the USSR which account for the growth in energy consumption. To transfer the energy-efficient technology of one part of the world to another is an urgent task, but it demands a great deal of detailed information, as chapter III demonstrates. Flows of capital are required to facilitate this transfer. Therein lies the problem.

UNIDO is a specialized agency particularly concerned with industry, including the performance of already existing industries in both developed and developing countries, as well as of those yet to be born. One of the victims of international financial crises always seems to be the manufacturing sector. The marginalization of the economies of most Tropical African countries today basically represents the marginalization of their infant industries rather than a shrinkage in their cash crop acreage. The problem of international capital shortages *vis-à-vis* industry in general, and manufacturing in particular, thus seems to be becoming universal.

In chapter IV, UNIDO surveys the recent developments in financial markets, including debt-equity swaps, country funds, venture capital companies, lease financing and build-operate-transfer operations, which have been innovative in their impact on the supply of funds for industries in developing countries. These innovations, while welcome, still leave the problem of a shortage of capital as acute as ever. It is a problem that requires a global perspective.

Finally, in chapter V, *Global Report 1991/92* continues the practice of previous years with expert surveys of 13 manufacturing industries as an aid to industrial policy-making in all countries.

I. World industrial economy: present situation and medium-term outlook

A. Present situation

The year 1990 was indeed an eventful one for the world. The longest peacetime expansion of the United States economy ended in the second half of the year. Peace itself lasted a bit longer, before being interrupted by a brief but tragic war in the Gulf. Previously antagonistic, the Federal Republic of Germany and the German Democratic Republic declared political union and began to devote their energies to the task of unifying their country economically. Most of the countries of Eastern Europe, after disavowing communism, initiated the painful process of readjustment. The USSR, torn by nationalistic sentiment within, suffered a paralysing blow to its economy as a functioning system. The list can go on, but the most significant development in 1990 and thereafter has to be the surprisingly limited impact of these dramatic events on the world economy. World output expanded by 1.7 per cent in 1990, less than the rate forecast by UNIDO, but definitely more than a global recession would have entailed.

Looking ahead and projecting world output in 1991 (see box: UNIDO forecasts for 1991-1992), UNIDO has again taken a position that might seem over-optimistic in the light of the fears of a global recession. In table I.1, world economic growth for 1991 is projected to reach 1.5 per cent, a forecast that exceeds by a wide margin the predictions of other international agencies, and that rules out a further worldwide economic contraction in 1991. For UNIDO, this sanguine outlook for the world economy is influenced by the forecasts of steady regional and country growth made by collaborating regional institutes. Most of the institutes forecast growth in the countries of their respective regions to be more internally generated in 1991 than usual, and often sufficient to arrest any serious contraction that might be caused by external factors. Indeed, the feared consequences of the United States recession for the world economy have been limited so far. This might have something to do with the moderateness of the United States recession, but more importantly it implies less reliance on the United States economy to provide the traditional stimulis for world economic growth.* At the same time, events in Eastern Europe and the USSR have had no adverse impact on the rest of the world, which has thus far chosen to follow them largely as an interested spectator. And except for the active participants, the Gulf war had no grave or immediate economic consequences—especially since world oil prices have remained low and seem unlikely to rise in the near future.

Taking a more detached stance from global events, many countries have chosen to explore opportunities at home or with their neighbours. The building of a single European market continues with unwavering enthusiasm within the countries concerned, but with mixed feelings outside. During 1991, the trade agreement between the United States and Canada will probably be extended to include Mexico, thus forming a North American common market. Mexico itself is planning to establish a free trade zone with its two southern neighbours, Colombia and Venezuela. And further south, Argentina, Brazil, Paraguay and Uruguay have signed an accord to create a common market that will be known as Mercosul with a population of some 190 million. The latest initiative by the Organization of African Unity to launch a new round of negotiations for establishing an African common market thus reflects a worldwide trend. The already extensive economic cooperation between the Association of South-East Asian Nations (ASEAN) and East Asian countries makes it look as if at least half the task of Asian regional economic integration has been accomplished. China and India clearly form regions unto themselves. In Eastern Europe, political changes have triggered increasing economic integration with Western European markets, although some countries are contending, at least for the time being, with powerful centrifugal forces.

To a certain extent, the world economy anticipated the current recession in the United States a long time before it actually arrived. Many countries, therefore, had sufficient time to shift their attention to internal markets. Thus, Japan managed a 5.3 per cent growth in 1990, and despite dire warnings, a similar rate of growth is expected in 1991. For the same reason, the Republic of Korea and Taiwan Province will maintain their annual pace of 9 per cent and 7 per cent respectively. Other Asian newly industrializing countries* (NICs), or countries that may soon be classified as such, will strengthen regional ties by means of cross-border investments which have sustained their growth in recent years.

*See *Industry and Development: Global Report 1988/89* (United Nations publication, Sales No. 88.III.E.6), chap. I, appendix, pp. 27-38.

*The term "NICs" is used extensively to describe developing economies, be they countries, provinces or areas, where there has been particularly rapid industrial growth. It does not imply any political division within the ranks of developing countries and is not officially endorsed by UNIDO.

UNIDO Forecasts for 1991-1992

The UNIDO 1991-1992 forecast is for world economic growth to slow down from the 1.7 per cent recorded in 1990 to 1.5 per cent in 1991, and to recover to 2.3 per cent in 1992. For developed countries UNIDO expects growth to decrease from 1.3 per cent in 1990 to 0.9 per cent in 1991, and to increase to 1.6 per cent in 1992. UNIDO forecasts growth in developing countries to increase from 2.8 per cent in 1990 to 3.3 per cent in 1991, and further to 4.1 per cent in 1992.

UNIDO believes that the recession in North America will end in late 1991. If this turns out to be the case, it will have been milder than the last recession. One consequence is that the recovery will be weak as well. The 2.8 per cent growth rate forecast by UNIDO for 1992 compares with 3.85 per cent GDP growth in 1983 and 7.1 per cent growth in 1984, following the much deeper recession of 1982. In the United States, inflation has been slow to respond to reduced aggregate demand, and with the fiscal deficit remaining a persistent problem, the monetary authorities will probably be reluctant to significantly relax monetary policy through the third quarter of 1991. As the fourth quarter of 1991 approaches, however, the monetary authorities will come under pressure to avoid any action that would jeopardize the recovery during the 1992 presidential election campaign.

Growth in Western Europe is expected to improve gradually to 1.8 per cent in 1991, and to 2.8 in 1992. Most of the countries in the region will follow the regional pattern of recovery. The major exceptions are to be found in Germany. The eastern part of the country, the former German Democratic Republic, is expected to experience another very difficult year in 1991, with GDP falling a further 10 per cent following the 20 per cent decline estimated in 1990. In 1992 the situation is forecast to stabilize with growth of 1 per cent. The situation in the rest of Germany is forecast to mirror that in the eastern part of the country, with growth reaching 4.9 per cent in 1991, and falling to 3.5 per cent in 1992. Recovery in Yugoslavia is also likely to remain elusive as long as internal conflicts there remain unresolved. The economic unification to be completed in 1992 by the countries of the European Economic Community (EEC) will give a boost to the economies of the region as a result of gains in efficiency, reduced costs of transactions associated with intra-EEC trade, and increased competition. These benefits, to the extent that they translate into lower prices, may also enable the monetary authorities to pursue less restrictive monetary and fiscal policies than would otherwise be the case. The direct economic impact of the unified market on the rest of the world is not expected to be large, although the neighbouring non-EEC countries of Western Europe will be affected. On the one hand, increased income will spur growth, but, on the other hand, the non-member countries will be at a disadvantage in exporting their goods to the EEC. The response of Austria and Sweden has been to apply for EEC membership, while that of the European Free Trade Association (EFTA), of which Austria and Sweden are also members, has been to work for an agreement with the EEC that would go far toward incorporating the EFTA countries into the unified market.

Economic growth in Japan is expected to continue at a rapid pace through 1992. From 5.3 per cent in 1990 it will fall to 5 per cent in 1991, before rebounding to 5.5 in 1992. There are, however, indications that the productive capacity of the Japanese economy is becoming strained as the length of the current boom increases. Inflation as measured by the consumer price index has increased every year since 1987, and while at 3.1 per cent it remains low in comparison with other industrial countries, it is a matter of sufficient concern to the Japanese authorities to have resulted in a generally restrictive policy stance. In the first instance this has most strongly affected the real estate and securities markets, but if it continues it will eventually slow investment and economic growth.

UNIDO continues to believe that in the medium term the economic and political changes taking place in the countries of Eastern Europe will result in rapid economic growth. However, in the short-run, the extent of the required transformation has certainly been underestimated. In both Poland and the former German Democratic Republic, which are pursuing accelerated programmes of transformation, GDP declined by 20 per cent in 1990. The difficulties facing these economies in transition over the next two years will continue to result in low or negative growth rates. The USSR, which has effected sweeping political reforms, has yet to decide on and implement systematic economic reforms. The shape of the economic reform package and the degree to which it will be supported by the developed market economies of Western Europe and North America remain unknown.

Several countries in the Latin America and Caribbean region, notably Argentina, Brazil, Nicaragua and Peru, have instituted policies to stabilize their economies afflicted by hyperinflation. In the short term, growth is likely to be slow, until the positive effects of the programmes have had time to work. For the region as a whole, UNIDO forecasts growth of 2.3 per cent in 1991 and 2.6 per cent in 1992. Slow growth in North America, especially in 1991, will be a factor holding down growth in the region, particularly in Mexico.

The stabilization of commodity prices will allow growth in Africa to pick up slightly in 1991-1992. Further progress on debt reduction combined with the positive effects of stabilization and restructuring programmes that are already in an advanced stage of implementation will also contribute to recovery. Despite these positive factors, UNIDO does not foresee strong recovery in the region as a whole over the next two years. For 1991, UNIDO forecasts GDP growth in Tropical Africa of 2.9 per cent, rising to 3.2 per cent in 1992.

In the Indian Subcontinent, growth of 3.6 per cent and of 4.7 per cent are expected in 1991 and 1992, respectively. One factor constraining growth in the region is the need to deal with increasing, though still moderate, rates of inflation and persistent problems in balancing federal expenditures and revenues. As a result of trade liberalization and export incentives, India has greatly expanded its exports, however the current account deficit has grown as a result of high levels of imports. In the generally depressed world economy of 1990, India's export growth slowed slightly, and the Government adopted measures to reduce imports. The need to deal with the balance of current account deficit, inflation and the budget deficit will probably lead to a moderately restrictive policy stance in India over the short-run.

Growth in East and South-East Asia is forecast to remain strong through 1992. Growing at 3 per cent in 1989 and 4.2 per cent in 1990, exports were not the motive force behind the remarkable 9.0 per cent growth recorded by the Republic of Korea in 1990. The reduction in exports was probably more the result of the recession in the United States and of the appreciation of the won against the yen, than of an erosion in the competitive position of the country following recent large wage increases. Indeed, exports from the Republic of Korea to countries other than Japan and the United States increased at the double-digit rates that have become normal for the Republic of Korea. High consumer spending, rapid money supply growth and a stimulative fiscal policy contributed to a large increase in domestic demand. Despite an increase in inflation to nearly 10 per cent and a projected slow growth in the North American market, UNIDO forecasts growth in the Republic of Korea to continue at about the same rate in 1991 and 1992 as in 1990.

Indonesia. Malaysia and Thailand are expected over the medium term to continue to experience high growth rates in GDP and in manufacturing. but lower growth is forecast in the short-run UNIDO forecasts falling growth in Indonesia. from 7 per cent in 1990 to 5 per cent in 1991. followed by an increase to 5 6 per cent in 1992 In Thailand. growth is expected to fall sharply from 10 per cent in 1990 to 5.2 per cent in 1991. before climbing to 6 7 per cent in 1992 Malaysia is also expected to experience a decline in its growth rate from 9 4 per cent in 1990 to 7.1 per cent in 1991 and 6 8 per cent in 1992

The austerity programme initiated by China in 1989 has succeeded in bringing down inflation from over 18.5 per cent in 1988 and 17.8 per cent in 1989 to 2.1 per cent in 1990. Economic pressure exerted by Governments of developed countries have added to the problems of the Chinese economy. So far the taming of inflation and lifting of the austerity programme do not seem to have set the stage for recovery of growth to pre-1989 levels None the less. a somewhat higher growth rate seems likely. unless economic sanctions are strengthened to include. for example. loss of most-favoured-nation treatment by the United States. UNIDO forecasts growth of 5 5 per cent in 1991. with a higher rate of 7.2 per cent in 1992.

The 1990 decline in GDP growth in developed countries was accompanied by an even sharper decline in manufacturing value added (see figure I.1). World growth in manufacturing value added (MVA) was a meagre 1.0 per cent in 1990. with 3.5 per cent growth in developing countries and 0.6 per cent in developed countries In fact the combined MVA growth of developed countries excluding Japan was negative Western Europe and North America experienced weak positive growth. while the countries of Eastern Europe and the USSR suffered a 3.3 per cent decline in MVA The United Kingdom. Italy and Sweden all experienced actual declines in manufacturing output. with MVA growth of 0.3 per cent. 1.1 per cent and 2.7 per cent. respectively. But the major contributors to overall slow growth in Western Europe were the former German Democratic Republic and Yugoslavia. with MVA growth of. respectively. 13.4 per cent and 10.5 per cent. Austria and the rest of unified Germany ran strongly against this trend. with MVA growth of 8.6 per cent and 5 5 per cent. respectively. largely as a result of their close involvement in the reconstruction of the economies of Eastern Europe and the USSR In North America. MVA growth in 1990 stagnated at just 0 6 per cent. while in Japan. MVA growth was 4 6 per cent. which was weaker than the average of over 7 per cent that it had experienced during the previous three years.

MVA in developing countries grew at the same rate in 1990. 3 5 per cent. as in 1989 In *Global Report 1990 91*. UNIDO forecast 1990 MVA growth in developing countries at 5.3 per cent. reflecting a much more optimistic view of overall global economic conditions. The situation in Africa and Latin America continued to reflect the problems confronting a number of countries in servicing their external debt With the slowdown in the markets of developed countries and higher oil import costs. many countries experienced difficulties in earning the foreign exchange needed to avoid bottlenecks in the supply of imported inputs in the manufacturing sector. In 1990 Latin America registered a decline of 0.6 per cent in MVA. compared with growth of 2 per cent in 1989. The overall picture in Latin America was dominated by the 8.3 per cent decline in MVA in Brazil. The Brazilian economy faced the disruptive effects of both hyperinflation and the stabilization policies implemented in order to bring inflation under control. Only three of the larger Latin American countries registered MVA growth in excess of 5 per cent in 1990. namely Colombia (5.2 per cent). Ecuador (5.5 per cent) and Venezuela (12.3 per cent). In Venezuela. rapid MVA growth in 1990 comes after a fall of 11.2 per cent in 1989

MVA growth in Tropical Africa in 1990 was 3.0 per cent. compared with 0.8 per cent in 1989. Cameroon and Côte d'Ivoire continued to experience negative MVA growth rates. both for the fourth straight year. With a fall of 4 per cent in 1990. the cumulative decline in MVA in Cameroon since 1987 totalled 38 per cent In Côte d'Ivoire over the same period. MVA fell by 18 per cent. with the 1990 decline being 5.7 per cent Thirteen African countries achieved MVA growth rates averaging above 5 per cent during the period 1985-1990

The subregions of Asia largely escaped the economic downturn that gripped the rest of the world. as is clearly reflected in the available MVA data for those regions MVA data are not available for the centrally planned economies of Asia. but for each of the other developing subregions. MVA growth was higher in 1990 than in 1989 In Western Asia. MVA growth rose from 2 8 per cent in 1989 to 9 per cent in 1990. for the Indian Subcontinent the jump was from 3.7 per cent in 1989 to 7 9 per cent in 1990. and for East and South-East Asia the increase was from 6.3 to 7 2 per cent

The 28-sector disaggregation of MVA growth rates broken down by all developed and all developing countries* for the 10-year period 1975-1985 and for the seven-year period 1985-1992 are shown in table I 2 This table also shows the share of developing countries in disaggregated and total manufacturing for the years 1975. 1990 and. as forecast by UNIDO. 1992.

As a result of the recession in North America. the slow-down in Western Europe and the sharp fall in MVA in Eastern Europe. the rate of growth of MVA in developing countries in 1990 was significantly higher than that in developed countries. UNIDO forecasts that this differential will increase in the short-run. with the share of developing countries in world MVA rising from 13 8 per cent in 1990 to 14.9 per cent in 1992 (see figure I.2). That this is the largest two-year gain in the MVA share of developing countries since the signing of the Lima Declaration and Plan of Action on Industrial Development and Co-operation would be more welcome if it reflected stronger growth in developing countries. rather than slow growth in many developed countries. Furthermore. rapid MVA growth is confined to the Asian subregions. with growth in Africa and Latin America remaining far below their potential

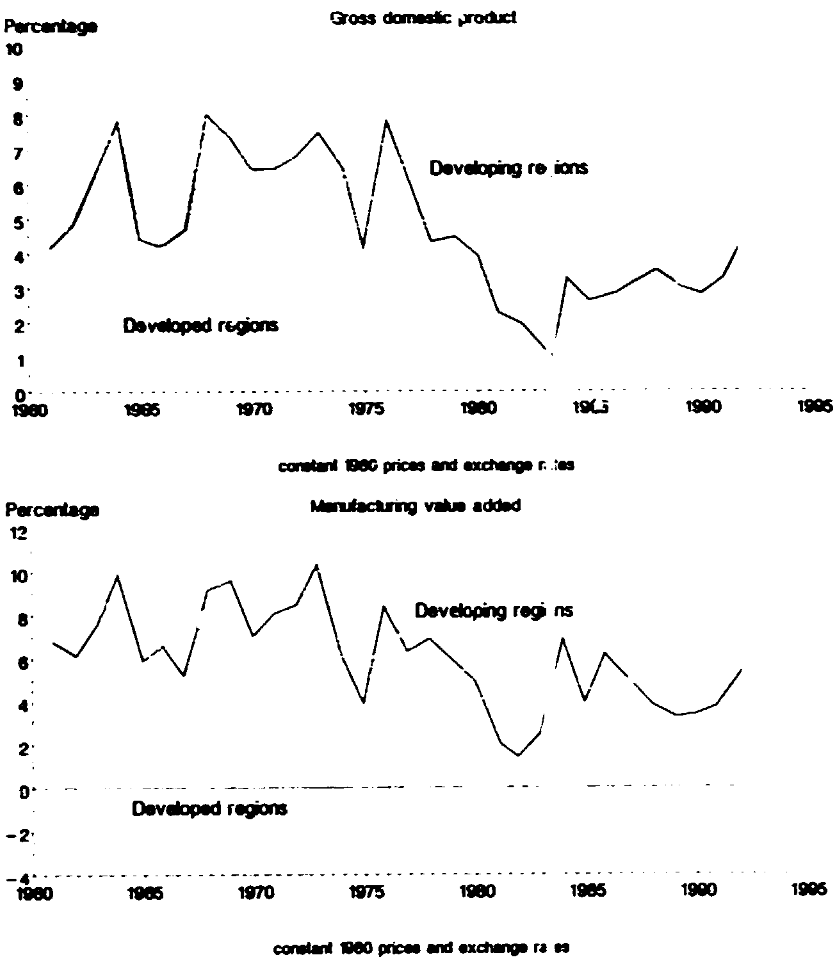
On the basis of UNIDO forecasts for 1992. the industries in which developing countries will have a 25 per cent share of world MVA are tobacco manufactures (ISIC 314). textiles (ISIC 321). leather and fur products (ISIC 323). footwear. excluding rubber or plastic (ISIC 324). and petroleum refineries (ISIC 353) The share of developing countries in 1992 is forecast to be over 20 per cent in beverages (ISIC 313). rubber products (ISIC 355) and iron and steel (371) (see figure 1.3).

The growth of MVA in developing countries between 1985 and 1992 is expected to be slightly lower. at 4.6 per cent. than the 4.9 per cent recorded for the 10-year period from 1975 to 1985 In developed countries. MVA growth for the two periods is expected to be unchanged at 2 4 per cent.

The industries that are expected to show rapid growth over the 1985-1992 period are professional and scientific goods (ISIC 385). electrical machinery (ISIC 383). other manufactures (ISIC 390). other chemical products (ISIC 352). non-ferrous metals (ISIC 372) and industrial chemicals (ISIC 351) The slower-growing industries are footwear. excluding rubber or plastic (ISIC 324). furniture and fixtures (ISIC 332). wood and wood products (ISIC 331). and textiles (ISIC 321).

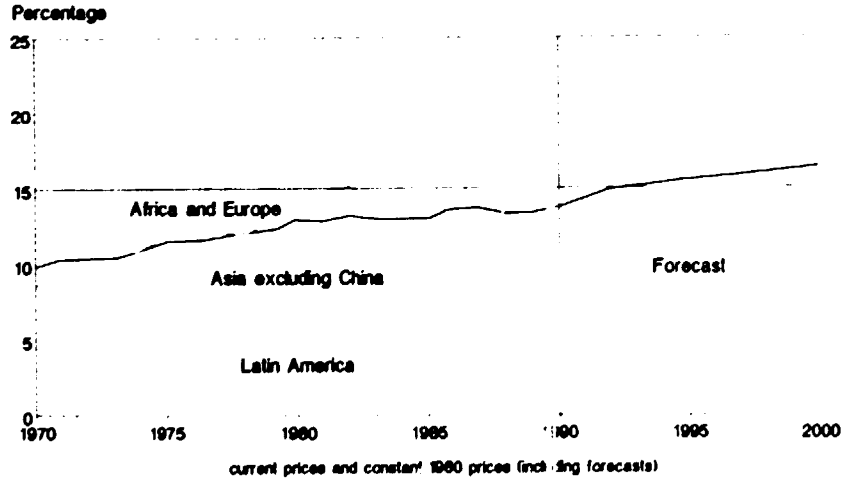
*The estimates shown in table I 2 are based on a sample of countries for which reliable data is available for the years included The sample includes 32 developed countries and 85 developing countries The sample does not reflect the situation in the centrally planned economies of Asia since MVA data is not available for these countries for the periods considered

Figure I.1. Growth rates of GDP and MVA in developed and developing regions, 1961-1992



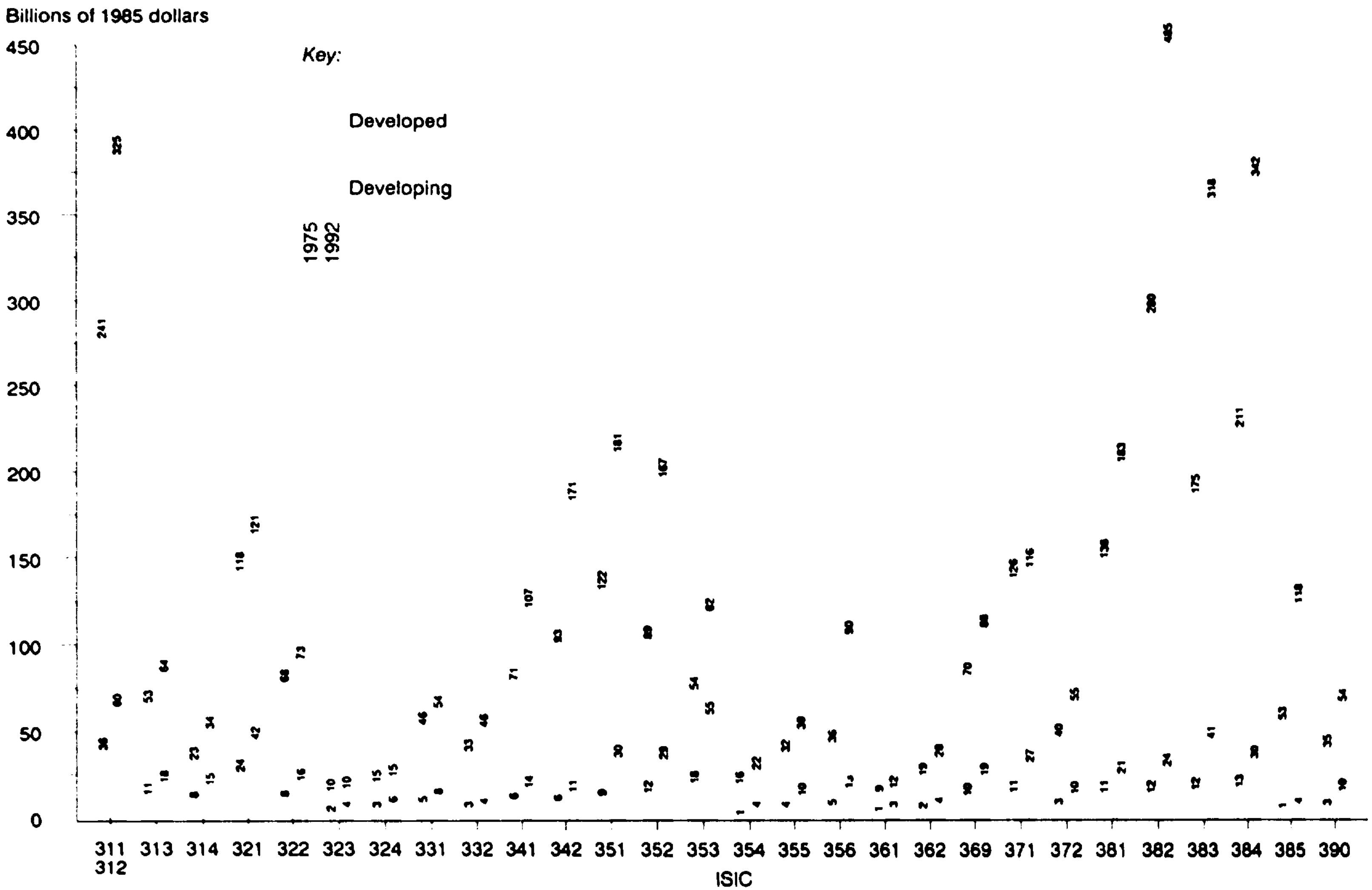
Sources: United Nations National Accounts Statistics and forecasts by UNIDO/PPD/IPP/GLO

Figure I.2. Share of developing countries in world manufacturing production, excluding China



Source United Nations National Accounts Statistics and forecasts by UNIDO PPD IPP GLO

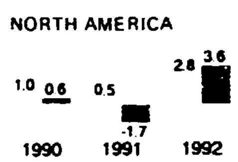
Figure I.3. Manufacturing value added of North and South, 1975 and 1992

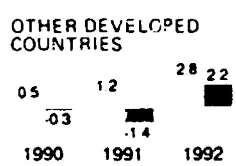


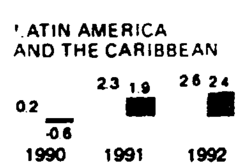
Source United Nations Industrial Statistics and forecasts by UNIDO PPD IPP GLO

Table I.1. Regional and country estimates of GDP and MVA

Regions, countries and areas	GDP growth rates (percentage) 1990	1991	1992	MVA growth rates (percentage) 1990	1991	1992
World	1.7	1.5	2.3	1.0	0.0	1.3
Developing countries excluding China	2.8	3.3	4.1	3.5	4.0	5.5
Developed countries	1.3	0.9	1.6	0.6	0.6	0.6
China	5.0	5.5	7.2			
North America	1.0	0.5	2.8	0.6	-1.7	3.6
Bermuda	1.3	1.5	1.9	2.8	2.8	2.9
Canada	1.4	1.0	3.1	-4.1	3.9	2.0
United States	0.9	0.4	2.8	0.9	1.6	3.7
Western Europe	1.8	1.8	2.8	0.7	1.6	2.7
Austria	4.6	3.5	3.4	8.6	5.3	4.7
Belgium	3.8	3.1	2.5	4.4	3.4	3.1
Denmark	2.1	0.8	2.1	0.6	0.3	1.8
Finland	0.0	1.0	4.0	-1.5	-0.4	4.5
France	2.8	2.0	3.1	1.2	1.5	1.8
Germany, Eastern Part	-20.0	-10.0	-1.0	-13.4	-5.8	1.0
Germany, Western Part	4.7	4.9	3.5	5.5	6.0	3.5
Greece	0.7	1.3	1.7	-2.5	-0.6	0.5
Iceland	-0.1	1.5	6.5	-2.4	-1.2	6.0
Ireland	5.0	3.0	5.2	4.8	3.1	7.2
Israel	5.1	3.2	3.0	6.6	2.5	1.6
Italy	2.0	3.5	4.2	-1.1	4.3	6.0
Luxembourg	1.8	0.5	1.8	-0.8	-2.3	0.7
Malta	8.1	5.3	5.5	4.8	2.0	5.1
Netherlands	3.5	3.2	3.0	3.6	3.1	2.9
Norway	1.8	1.5	2.1	0.9	0.6	0.9
Portugal	4.1	3.5	4.7	7.4	2.7	5.0
Spain	3.7	3.2	3.3	0.0	1.9	2.8
Sweden	0.5	-0.5	1.0	-2.7	-2.9	0.4
Switzerland	2.6	0.8	0.8	2.7	-2.4	0.3
United Kingdom	0.7	-1.4	2.0	-0.3	-3.2	1.2
Yugoslavia	[illegible]	-12.0	-4.0	-10.5	-21.0	-12.4
Eastern Europe including USSR	4.2	-6.5	-12.7	-3.3	-8.4	15.4
Albania	2.7	2.2	5.2	1.9	3.7	5.1
Bulgaria	-12.0	-1.5	10.3	..	..	..
Czechoslovakia	-3.0	-3.8	3.4	-4.0	-4.6	-4.0
Hungary	-5.0	-4.0	-12.1	8.5	-6.0	-14.1
Poland	-20.0	-8.0	-5.0	27.5	-4.4	6.1
Romania	12.0	-1.0	6.1	-4.5	6.4	4.0
USSR	-3.0	-7.0	-14.4	-2.0	-9.3	18.1
Japan	5.3	5.0	5.5	4.6	4.6	7.5
Other developed countries	0.5	1.2	2.8	-0.3	1.4	2.2
Australia	1.2	0.9	2.7	0.4	1.5	1.8
New Zealand	0.4	1.7	1.9	0.4	2.1	2.4
South Africa	0.9	1.7	3.1	1.6	2.3	3.0
Latin America and the Caribbean	0.2	2.3	2.6	0.6	1.9	2.4
Argentina	0.8	2.3	0.7	1.5	3.4	2.3
Bahamas	2.0	3.0	4.0			
Barbados	3.0	2.1	4.6	5.1	1.7	3.4
Belize	3.2	0.1	0.2	4.4	1.3	0.1
Bolivia	2.6	1.7	1.6	2.4	1.3	1.3
Brazil	4.5	1.2	2.0	8.3	0.3	0.7
Chile	2.0	4.1	3.8	0.8	2.1	3.3
Colombia	4.2	2.5	3.4	5.2	1.4	2.9
Costa Rica	3.8	3.0	3.2	3.7	3.2	3.7
Cuba	0.0	1.0	3.5	0.1	1.3	4.2
Dominican Republic	5.1	0.6	0.4	9.8	0.5	1.9
Ecuador	2.3	2.0	2.4	5.5	0.0	1.1
El Salvador	3.4	4.5	4.0	3.6	4.7	4.7
French Guiana	0.8	1.9	2.1	2.8	3.0	2.9
Guadeloupe	2.3	1.1	1.5	1.2	2.1	1.9
Guatemala	3.5	2.6	3.5	2.9	2.2	3.4
Guyana	6.2	1.5	2.0	6.8	3.9	2.7
Haiti*	0.1	1.4	1.3	1.5	1.4	1.1
Honduras	0.1	0.2	2.2	0.3	0.7	2.7
Jamaica	3.3	1.3	1.2	4.1	1.6	1.5
Martinique	2.9	4.3	4.5	2.9	2.8	2.8
Mexico	3.9	3.5	2.9	5.3	4.4	3.4
Montserrat	1.3	1.6	3.0	4.9	4.8	5.4
Netherlands Antilles and Aruba	5.0	0.4	1.0	2.6	2.8	2.9
Nicaragua	5.5	2.2	2.2	8.0	3.3	2.5
Panama	3.4	4.5	0.4	2.0	3.1	1.0
Paraguay	3.5	3.2	4.0	2.7	2.5	3.4
Peru	4.3	0.5	6.0	7.3	0.3	7.4
Puerto Rico	2.3	3.5	4.0	4.9	6.3	6.5
Suriname	1.0	1.7	1.4	1.6	1.2	1.3
Trinidad and Tobago	0.1	1.5	1.1	0.0	1.6	0.6
Uruguay	0.5	1.2	2.1	0.1	0.9	2.1
Venezuela	5.7	3.1	3.5	12.3	2.6	5.1
Tropical Africa (Sub-Sahara)	2.6	2.9	3.2	3.0	3.8	4.8
Benin*	2.1	1.6	1.8	2.7	2.4	2.6
Botswana*	1.6	2.4	4.0			
Burkina Faso*	1.8	2.2	5.0	3.8	4.3	3.9
Burundi*	3.9	3.8	3.5	3.7	3.7	3.6
Cameroon	1.0	3.5	4.8	-4.0	4.3	8.0
Cape Verde*	4.5	4.5	4.3			
Central African Rep.*	6.3	1.0	0.2	1.5	1.5	1.5
Chad*	3.0	2.7	0.4	2.9	2.6	0.4
Comoros*	1.5	0.3	0.2	0.6	1.0	0.2
Congo	3.1	2.5	3.2	2.8	4.4	4.4







growth for 1990 and projections for 1991 and 1992

Regions, countries and areas	GDP growth rates percentage			MVA growth rates percentage		
	1990	1991	1992	1990	1991	1992
Côte d'Ivoire	4 0	2 3	1 1	5 7	5 6	1 9
Djibouti*	1 1	2 0	1 4	5 2	4 0	3 7
Equatorial Guinea*	3 9	4 2	2 5	4 6	5 0	3 7
Ethiopia*	2 5	2 4	2 1	5 6	3 1	3 0
Gabon	5 5	4 0	4 5			
Gambia*	5 4	4 0	1 9	0 9	1 0	1 5
Ghana	2 7	3 5	3 8	4 9	6 9	7 7
Guinea*	4 0	1 6	2 2	3 7	1 1	1 8
Guinea-Bissau*	5 0	2 8	3 3	0 9	0 1	0 4
Kenya	3 5	5 7	7 4	6 0	8 1	9 6
Lesotho*	6 2	5 4	6 0			
Liberia*	-2 0	-0 1	0 3	1 8	0 6	1 7
Madagascar	4 0	0 7	0 2	3 9	3 3	3 3
Malawi*	4 8	4 5	4 4	8 6	8 0	7 9
Mali*	2 2	3 8	1 7	2 4	2 0	4 5
Mauritania*	4 0	3 6	2 6	6 6	6 5	6 6
Mauritius	6 6	2 0	5 7	10 3	5 9	9 5
Mozambique*	3 2	1 0	2 0	5 9	2 2	3 9
Namibia	0 3	0 9	0 4			
Niger*	2 5	1 6	2 4	0 1	2 0	2 0
Nigeria	5 2	5 1	2 9	5 7	4 2	2 3
Reunion	3 6	4 6	5 2	2 4	2 5	2 5
Rwanda*	0 9	0 5	0 7			
Sao Tome and Principe*	4 6	0 6	0 8	3 6	0 7	0 8
Senegal	1 0	5 5	3 3	5 8	2 2	3 7
Seychelles	2 5	0 9	2 1	8 4	7 7	8 2
Sierra Leone*	2 5	2 6	2 7	1 8	1 9	2 1
Somalia*	2 0	1 0	1 5			
Swaziland	3 2	5 7	5 7	4 9	5 9	6 0
Togo*	2 6	1 4	0 6	2 2	1 1	0 4
United Republic of Tanzania	3 6	3 4	3 4	4 5	4 0	4 1
Uganda*	4 0	1 6	3 0	4 1	0 8	2 6
Zaire	0 5	3 3	2 9	1 6	1 5	0 3
Zambia	0 0	2 0	3 0	0 7	1 2	3 6
Zimbabwe	4 7	5 3	4 0	5 8	6 5	5 0
North Africa	2 7	3 6	4 3	5 6	5 5	6 1
Algeria	2 4	3 5	3 0	6 5	7 2	6 9
Egypt	2 1	4 0	6 0	3 0	4 0	5 1
Libyan Arab Jamahiriya	7 0	4 4	3 6	13 4	10 3	10 6
Morocco	2 4	3 0	4 6	4 8	3 4	4 2
Sudan*	7 0	1 6	5 5	4 7	1 5	4 3
Tunisia	7 4	3 9	4 1	11 1	6 8	7 0

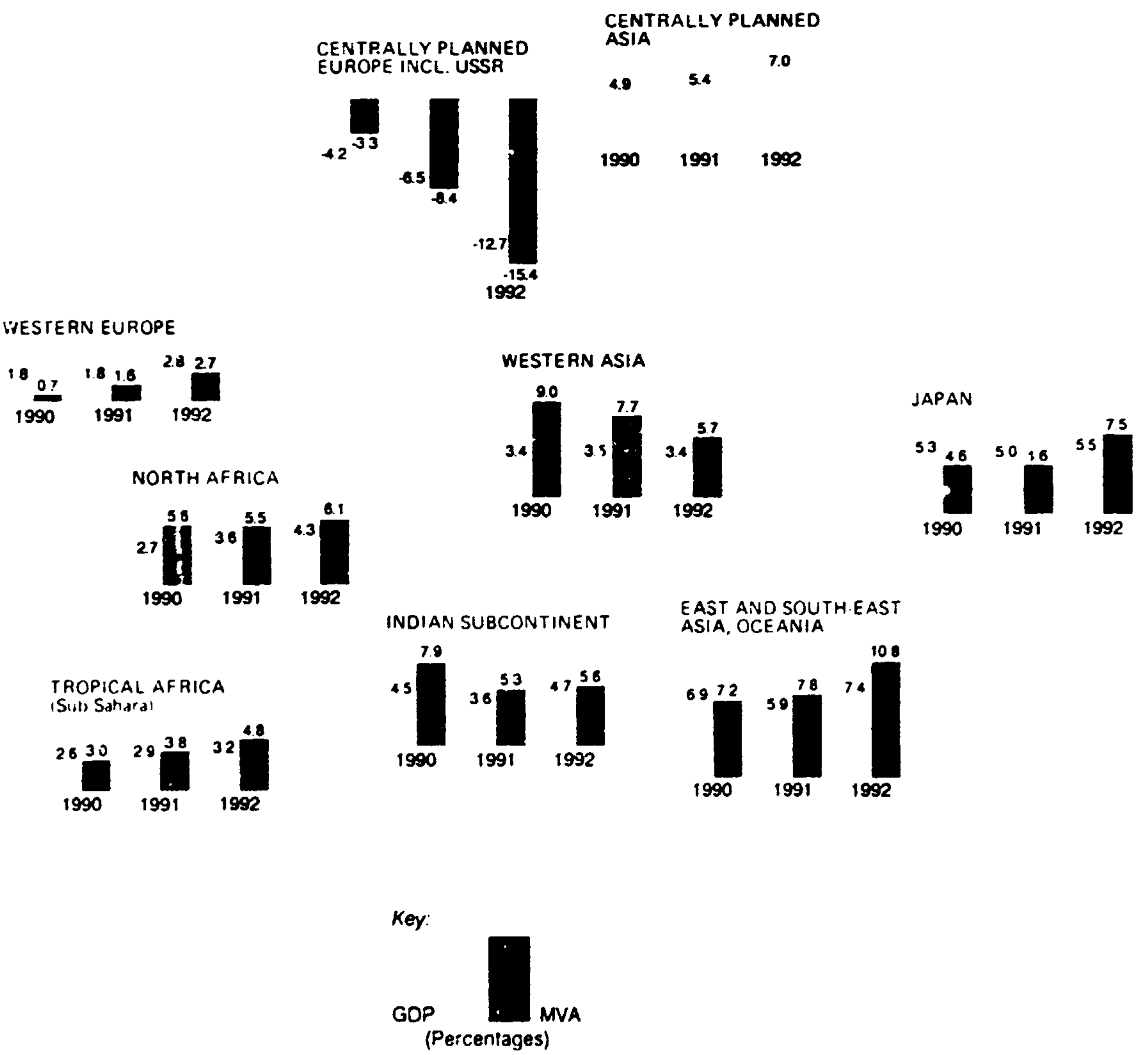


Table I.1. Regional and country estimates of GDP and MVA growth for 1990 and projectio.is for 1991 and 1992

(continued)

	GDP growth rates (percentage)			MVA growth rates (percentage)		
Regions, countries and areas	*1990*	*1991*	*1992*	*1990*	*1991*	*1992*
Western Asia	3.4	3.5	3.4	9.0	7.7	5.7
Cyprus	5.7	5.5	5.0	6.0	6.1	5.8
Iran (Islamic Rep. of)	3.0	2.9	2.1	5.7	5.6	5.0
Iraq	-8.0	25.0	-2.0	8.0	-11.5	4.0
Jordan	-5.6	-10.0	-5.0	-5.0	7.6	7.3
Kuwait	40.0	5.0	9.2	3.7	5.2	6.1
Oman	4.7	5.0	7.0	. .	. .	. .
Qatar	5.7	3.5	-1.1	9.5	9.1	8.6
Saudi Arabia	9.5	3.0	3.2	8.2	5.6	5.7
Syrian Arab Republic	6.0	7.8	4.9	. .	. .	. .
Turkey	10.5	8.1	4.2	14.0	10.7	5.4
United Arab Emirates	7.0	4.6	5.1	8.4	10.1	9.5
Yemen*	7.5	9.5	3.0	10.0	9.4	12.0
Indian Subcontinent	4.5	3.6	4.7	7.9	5.3	5.6
Afghanistan*	3.8	3.5	1.3	2.8	3.2	3.2
Bangladesh*	5.8	1.5	3.3	1.8	. .	. .
Bhutan*	7.0	8.0	7.1	10.4	10.5	12.7
India	4.5	3.6	5.0	8.8	5.5	5.8
Myanmar*	-6.0	6.0	-1.0	-6.8	5.7	-1.6
Nepal*	3.5	3.0	3.6	5.9	3.9	4.2
Pakistan	5.3	3.5	4.7	4.9	3.9	5.4
Sri Lanka	6.2	6.2	6.7	5.2	5.0	5.3
East and South-East Asia, Oceania	6.9	5.9	7.4	7.2	7.8	10.8
Brunei Darussalam	3.4	0.3	2.7	1.2	-2.4	0.4
Fiji	3.9	4.0	2.1	6.1	4.3	1.5
French Polynesia	7.7	7.2	5.8	9.5	9.7	9.9
Hong Kong	2.4	3.0	8.5	0.1	0.3	7.2
Indonesia	7.0	5.0	6.6	10.5	9.4	11.7
Malaysia	9.4	7.1	6.8	15.8	11.0	10.2
New Caledonia	1.0	0.8	0.3	-0.3	-0.9	1.8
Papua New Guinea	2.0	1.0	1.0	2.0	1.5	1.5
Philippines	2.2	1.4	1.9	1.5	1.0	1.6
Republic of Korea	9.0	8.7	8.3	8.3	10.0	12.0
Samoa*	0.8	-0.6	1.9	0.3	1.3	0.6
Singapore	8.3	6.7	7.7	7.4	6.1	8.3
Taiwan Province	5.1	7.0	10.6	1.7	7.6	14.3
Thailand	10.0	5.2	6.7	13.8	6.5	8.4
Tonga	5.8	5.3	7.4	. .	. .	. .
Vanuatu*	3.2	3.0	1.9	. .	. .	. .
Centrally planned Asia	4.9	5.4	7.0			
China	5.0	5.5	7.2	. .	. .	. .
Democratic People's Republic of Korea	4.7	3.2	2.5	. .	. .	. .
Lao People's Democratic Republic*	3.3	2.9	3.6	6.9	7.9	2.7
Mongolia	4.5	4.0	5.3	6.7	2.9	3.0
Viet Nam	-2.2	2.2	5.7	. .	. .	. .

*Least developed country

Note: Calculations are based on 1980—United States dollars figures.

Table I.2. Estimated share of industrial value added of developing countries in world total in 1975 projected shares for 1990 and 1992

(Percentage)

		Share of developing countries in world total			Average annual growth rates			
			Projected		Developed countries		Developing countries	
ISIC	*Branch of industry*	*1975*	*1990*	*1992*	*1975-1985*	*1985-1992*	*1975-1985*	*1985-1992*
3	Manufacturing	11.6	13.8	14.9	2.4	2.4	4.9	4.6
311	Food manufacturing	14.6	15.6	17.1	1.9	1.6	3.2	2.9
313	Beverages	19.3	22.8	24.1	0.8	1.4	2.9	3.5
314	Tobacco manufactures	31.9	33.2	34.4	2.1	2.4	4.4	3.1
321	Textiles	18.7	25.4	28.4	0.2	0.0	2.8	3.9
322	Wearing apparel	11.8	17.5	19.5	0.8	0.0	4.2	4.1
323	Leather and fur products	18.2	30.5	34.3	0.3	0.2	4.4	5.3
324	Footwear, excl. rubber or plastic	18.9	27.3	29.5	0.6	0.1	5.2	2.2
331	Wood and cork products	12.5	12.9	13.8	0.3	1.7	2.1	2.8
332	Furniture and fixtures	10.1	8.3	8.5	1.7	2.6	2.8	0.6
341	Paper and paper products	10.0	11.3	12.4	1.7	3.4	5.0	5.1
342	Printing and publishing	8.8	6.4	6.6	4.0	3.3	2.8	3.9
351	Industrial chemicals	8.8	13.9	15.5	1.6	3.5	6.7	7.4
352	Other chemical products	15.7	15.3	16.2	3.6	4.1	5.1	5.2
353	Petroleum refineries	30.5	48.3	51.5	0.7	1.2	7.8	5.3
354	Miscellaneous petroleum and coal products	6.9	13.2	15.0	2.0	1.7	8,1	4.1
355	Rubber products	13.0	21.2	23.3	1.2	1.0	5.9	6.2
356	Plastic products n.e.c.	14.6	13.9	13.9	5.8	5.3	7.5	4.9
361	Pottery, china and earthenware	14.1	17.7	19.2	0.9	1.8	2.4	5.9
362	Glass and glass products	11.4	13.8	14.7	1.5	3.2	4.6	4.8
369	Other non-metallic mineral products	13.9	18.1	19.7	1.0	1.9	4.6	3.5
371	Iron and steel	9.8	19.1	20.9	1.5	1.0	6.4	4.2
372	Non-ferrous metals	9.5	14.8	16.6	0.9	3.2	7.2	5.4
381	Metal products, excl. machinery	9.7	10.7	11.5	1.6	1.8	4.2	3.7
382	Non-electrical machinery	5.0	4.8	5.2	3.7	2.6	4.8	4.0
383	Electrical machinery	7.9	11.6	12.6	5.0	1.6	7.7	7.5
384	Transport equipment	7.7	8.4	8.9	3.2	2.4	5.2	4.3
385	P.ofessional and scientific goods	2.6	3.7	3.9	3.7	6.5	8.9	7.6
390	Other manufactures	10.5	15.6	17.5	2.7	2.4	6.7	7.7

Source: UNIDO statistical Data Base, estimates and forecasts by UNIDO/PPD/IPP/GLO. Calculations are based on deflated national currency converted into 1985-United States dollars figures.

Growth rates are derived from 117 sample countries: 32 "developed" and 85 "developing" (Industrial Statistics consolidated by UNIDO).

China and other centrally planned Asian economies are not included in the sample.

ISIC: International Standard Industrial Classification of all Economic Activities (Revision 2).

Although stricken by natural disasters of immense proportions, and by the tragic loss of a political leader of great stature, the peoples of the Indian Subcontinent have once again displayed a fierce determination to survive, and have made progress without massive inflows of foreign capital. Because of India's past exclusiveness, it took a long time to seed the modern industrial base in that country, and it will take even longer in Pakistan. Nevertheless, the economic growth rates achieved by those two countries in the recent past are not only high, but, more importantly, show no signs of flagging. Bangladesh, however, is an entirely different case, one which strains both the imagination and the conscience in view of the lack of an international effort on the scale required to prevent the flooding of the Ganges and the Brahmaputra, now so predictable, and the misery and economic loss that it brings in its train both to Bangladesh and to the world.

Latin American countries lost a whole decade of growth in the 1980s. The lesson has been severe and the toll just as great. Countries that made a new start have become much stronger and more resilient Chile did so successfully, at an early stage, followed by Mexico. Others have been joining the ranks in increasing numbers, including Costa Rica, Dominican Republic, Ecuador, Paraguay and, with much more difficulty, Peru. The outlook for the whole region, however, depends on the four largest countries—Argentina, Brazil, Mexico and Venezuela, and the biggest hurdle they have faced so far, namely the international credit embargo, is definitely easing. Not only is flight capital returning, but all four countries, especially Mexico, seem to be attracting new capital from abroad, sure signs that their economic prospects have improved.

If Latin America lost a decade of growth, Tropical Africa unfortunately never had one. Sustained economic growth in this region would be possible, but only after it acquires a much broader economic base than traditional agriculture and a few primary-commodity-exporting industries. In the mid-1970s, industrial investment surged, especially in new import-substitution industries, supported by high commodity export earnings and cheap credits and grants from abroad. The ensuing worldwide recession of the early 1980s brought this promising start to an abrupt halt. There was a brief spell of investment activity again in 1985-1986 which was dissipated completely by 1987. These "investment misadventures" cost Tropical African countries dearly, and most of them now carry enormous external debts. The marginalization of the countries of sub-Saharan Africa in the global economy will continue unless industrialization is allowed to resume. In the meantime, they have become extremely vulnerable to global economic slow-downs. The 1991 UNIDO projections for the sub-Saharan countries, therefore, are largely contingent upon the correctness of the optimistic UNIDO forecasts for the world economy in 1991.

A quick and strong recovery of the United States economy is a condition for continuous growth of the world economy. This is not only because the United States has an overpowering presence in the world economy by its sheer size, but because its domestic anti-recessionary policies, once adopted, will affect and shape the major macroeconomic parameters guiding the global economy. This means that the speed of recovery in the United States itself, as well as the policy package needed to bring about recovery, both deserve close observation. Government tax and spending programmes in the United States, unlike Japan and Germany, do not include fiscal measures to smooth cyclical fluctuations, because enacting and introducing changes in such programmes in the United States involves long delays that prevent them from making a significant contribution during a particular downturn. None the less, it is still an unfortunate time for the United States, with a recession under way, to be forced to curtail government spending and increase taxes. With United States fiscal policy actually fuelling the recession, and the monetary policy still powerless to help, the country has very limited policy options. One of the dangers is that United States policy makers may be forced to take a more protectionist stance—at least until enough domestic demand is generated for both domestic and foreign suppliers alike.

Economic recessions invariably kindle public sentiment for protectionism. The current forecast is that the recession in the United States will be over by the second half of 1991. There are, however, reasons to believe that the United States recovery, when it comes, might not be as strong or as sharp as in the past. A weak recovery will probably prompt the United States to press on for more active growth policies and possibly lower interest rates than those of other major industrialized countries. An active growth policy is, however, something most of these countries have come to regard as an irresponsible act. Yet the unification of Germany necessarily alters the traditional German predilection for strict fiscal and monetary discipline—at least to the extent that Germany has to finance the cost of unification through domestic economic expansion. When the Central Bank of Japan raised its discount rate from 2.5 per cent in mid-1989 to 6 per cent in August 1990, it did so to control financial speculation and bring stock prices and property values down. As this has happened, economic growth has nevertheless continued. With the "assets inflation" now largely being contained, Japanese economic expansion is likely to proceed without inviting further disciplinary action from the Central Bank.

Besides the United States, Japan and Germany, other developed countries are equally under pressure to expand, especially those caught in the midst of a prolonged recession. Most of them are expected to make headway in 1991, or at the latest by 1992. One of the basic problems facing these countries is, however, that the discretionary power to undertake expansionary policies unilaterally has become extremely limited. European countries that have joined the exchange rate mechanism cannot lower their interest rates to stimulate domestic investment without breaching their commitments to uphold the relative value of their currencies within a fixed limit. Even for countries outside such fixed exchange-rate agreements, any attempt to reflate the economy to put growth in a high gear will have to be tempered by the overwhelming concern for international capital flow.

B. Medium-term outlook

As far as the world economy is concerned, there are two systemic challenges to be overcome before continuous growth can be ensured. The first is to remove the basic deflationary bias inherent in the current arrangements for reconciling differences in macroeconomic policies between major industrialized countries. This has been the idea behind the position recently adopted by the United States, which, in meetings of the Group of Seven major industrialized countries, has argued for low interest rates and concerted reflation. But these measures help developing countries only indirectly. The second challenge pertains to the task of redirecting international capital flows more towards exploiting the world's current production opportunities, rather than being engrossed with paper assets and currency transactions. If this can be done by changing the practices and widening the 'culture' of global financial markets, some of these investments will flow automatically to developing countries. To a large extent, however, these two challenges go hand in hand, because one of the difficulties in achieving macroeconomic policy coordination among countries is the fear that international financial markets might react unfavourably to policies designed to promote growth. But while the crucial task of mobilizing "current" world savings and apportioning it among different investment opportunities and needs worldwide is left largely in the hands of private financial institutions, the task of reconciling growth and financial stability remains a challenging one.

1. External imbalance and lowered growth path

When the United States economy finally slipped into a recession, the world was somewhat taken by surprise, not because the recession was unexpected, but because the slide into it was gentle and gradual. No sudden tightening of monetary policy which often presages a recession was evident, nor did the economy warrant it. Output growth was slow and decelerated for some time before the recession arrived, with relatively high unemployment and low capacity-utilization rates. Despite this lull in the productive sector, consumer prices kept rising, giving a mixed signal to the monetary authorities in the United States.

Traditional thinking tends to liken recession in an economy to a passage through purgatory. It is regarded as a temporary and transitory state, while the economy sheds all past excesses and moves on to a much more prosperous state. There are, however, reasons to suspect that the recession in the United States and those which have preceded it in other developed countries are ordinary events. For instance, although many have predicted a shorter-than-average duration of 11 months for the current downswing phase in the United States, there has been no suggestion of a strong recovery exceeding the 6 per cent average initial growth rate experienced during previous cyclical upturns. In fact, the prevailing sentiment appears to be that the United States economy will emerge from the current recession with no more vigour than that which existed immediately before the contraction started. Thus, the Organisation for Economic Co-operation and Development (OECD), projecting a recovery, expects the United States economy to grow at 2.7 per cent in the second half of 1991 after falling at an annual rate of 1.8 per cent in the first. The uniqueness of this recession, therefore, lies in the absence of the characteristically exaggerated gyration in the output of the country before and after a recession.

To be sure, the muting of business cycles in developed countries has been noticed for some time. During the past three decades, government spending in OECD countries increased from an average of 28 per cent of gross domestic product (GDP) to 41 per cent. Since public sector spending has the tendency to increase during recessions, the large public sector presence has been used to help stabilize the economy. Furthermore, in developed countries, a typical household spends more than 60 per cent of its income on services. Demand for services is much less sensitive to changes in income than demand for goods, partly because services are not storable. A service-oriented economy such as that of the United States, therefore, becomes less vulnerable to a sudden change in income.

However, the biggest reason for expecting a recession to be milder and shorter today is the difference in the timing of the same business cycle in different countries. When the current recession started in the United States, the economies of both Germany and Japan remained strong enough to provide a helping hand. Even when the economies of the three countries showed synchronized patterns of behaviour, one of the three could be induced to serve as the engine of growth for the rest of the world by deliberately reflating domestic demand—as was done by the United States and Japan in 1982 and 1987, respectively. While in earlier decades a recession in the United States affected all OECD countries adversely and simultaneously, nowadays the effects are dispersed and disjointed. Yet another factor has been the importance of developing countries as sources of demand. During the 1970s, however, expanding import demand from developing countries provided an important counter-cyclical influence on the economies of developed countries. Thus, the closer countries become integrated into the world economy, the less the chance for any single country having to suffer from domestic recession of any significance or for any significant period. Admittedly, such a pooling of resources to contain recession in any one country might backfire, inviting a global recession instead, which was what actually happened in 1982. As mentioned before, in the current recession the world has been especially fortunate in this regard.

There are many economists who see a silver lining in the current recessionary cloud. Specifically, they argue that the recession will compel Governments to cut spending and reduce budget deficits which are thought to be responsible for the crowding-out of private investment. At the same time, whether accidentally or not, the recession seems to have brought about drastic improvements in current account imbalances. This being the case, the real question is how to resume growth without losing these improvements.

Today, if a country expands output unilaterally and faster than others, the imbalance in its balance of payment increases. Therefore, a joint decision by all major industrialized countries to expand output simultaneously becomes an attractive proposition in overcoming the problem of growth causing the current account imbalance. Growth so obtained will increase domestic saving, and could in turn be used either to invest abroad or to reduce foreign borrowing. The expectation is that the resulting increase in the supply of international saving will bring down the international interest rate, the real rate of which has reached such a high level as to discourage investment. A brief simulation exercise is presented below as a means of exploring and analysing the opportunities and problems likely to be encountered by such a concerted growth-oriented strategy.

Let it first be assumed that the 24 major developed market economies in the world, the currencies of which are freely convertible, decide to put their international payment problems firmly aside and to pursue a concerted full-employment policy that will reduce their 1990 unemployment rates to a uniform 3 per cent. International differences in the definition of unemployment make a single target number problematic. In 1990, for example, the rate of unemployment in Japan, at 2.1 per cent, was below the above-mentioned figure. But the emphasis here is on the qualitative impression rather than on quantitative precision. It is further assumed that the resulting increases in GDP are initially due to higher employment of labour alone, and do not require investment. The resulting output increase evidently varies from country to country, depending on both the actual level of unemployment and the size of the labour contribution to GDP in each country. Thus, the additional GDP increase in Japan is set at zero, because its unemployment rate in 1990 was below the target rate. In 1990, three other countries besides Japan (Luxembourg at 2.1 per cent, Sweden at 1.4 per cent and Switzerland at 0.6 per cent) had unemployment figures below the reference rate of 3 per cent. In addition, five countries (Greece, Iceland, Netherlands, New Zealand and Portugal) in fact had "excess employment", despite their apparently high unemployment ratios, which means that their growth rates are currently constrained by capital and other factors of production rather than by labour. Thus nine out of 24 OECD countries for one reason or another have to be excluded from consideration. The remaining 15 can increase their output primarily through the extra labour input and, in a second round of effects, through the induced increase in investment. There will be additional effects, but these are ignored for the time being. As the countries are reflating together, the effects of any inflationary upsurge are also mitigated in terms of international competitiveness, as the differential in relative rates of inflation will be marginal. The point of interest is the effect on trading balances *vis-à-vis* each other and in relation to non-OECD countries.

The sequence of effects is quantified in table I.3. The first effect is extra employment. Its effect on output is estimated from a time-series analysis of the

Table I.3. The potential source and size of additional international capital flow from OECD countries
(Million dollars)

Country	Increase in GDP: labour induced	Change in domestic saving	Change in trade balance with OECD countries	Change in trade balance with other countries	Change in domestic investment	Increase in GDP: investment induced	Total increase in GDP	1990 GDP growth rate: full employment (Percentage)	1990 GDP growth rate: actual (Percentage)
Australia	2 597	574	-97	45	626	60	2 657	2.26	1.36
Austria	140	36	-7	-	43	21	161	4.69	4.55
Belgium	8 257	1 594	212	-136	1 517	482	8 739	9.09	3.70
Canada	25 320	5 165	140	-99	5 124	561	25 881	5.33	0.90
Denmark	2 498	400	40	-6	366	69	2 567	4.39	2.10
Finland	379	90	-6	1	94	14	392	0.63	0.35
France	84 059	17 232	-1 838	288	18 782	3 889	87 948	9.81	2.39
Germany	13 253	3 260	767	31	2 462	1 284	14 537	5.68	4.71
Greece	-	-	-	-	-	-	-	-	0.67
Iceland	-	-	-	-	-	-	-	-	-
Ireland	1 767	318	149	23	146	21	1 788	9.96	5.00
Italy	14 448	2 991	-32	-115	3 138	1 501	15 950	3.93	2.21
Japan	-	-	-	-	-	-	-	-	5.60
Luxembourg	-	-	-	-	-	-	-	-	1.77
Netherlands	-	-	-	-	-	-	-	-	3.50
New Zealand	-	-	-	-	-	-	-	-	-0.43
Norway	327	79	23	-11	66	7	334	2.07	1.75
Portugal	-	-	-	-	-	-	-	-	4.20
Spain	32 657	7 413	-1 689	-648	9 750	2 650	35 307	10.80	3.56
Sweden	-	-	-	-	-	-	-	-	0.54
Switzerland	-	-	-	-	-	-	-	-	2.63
Turkey	5 649	1 480	-213	-1	1 694	573	6 222	18.26	10.50
United States	181 724	27 622	-2 735	-1 873	32 230	-	181 724	4.29	0.92
United Kingdom	4 668	766	-265	10	1 020	276	4 944	1.25	0.74
Total	377 744	69 018	-5 551	-2 489	77 058	11 407	389 151	4.57	2.12

aggregate production function for each country.* The extra output generates both extra imports and extra savings. Once again the tentative qualitative purpose of the exercise needs to be emphasized.

With that caveat, it may be seen that most countries could have improved their output performance: United Kingdom, by 0.5 per cent; Australia and Germany, each by 0.9 per cent; United States, by 3.4 per cent; France, by up to 7.1 per cent; and Canada, by 7.3 per cent. The combined total additional GDP for these OECD countries is thus, calculated to have amounted to some $389 billion, or 2.5 per cent of the actual total OECD figure for GDP attained in 1990 ($15,570 billion) The result is modest because only two thirds of the countries are expanding output, and in each case the contribution made by labour is obtained without the benefit of a commensurate increase in capital.

On the basis of the latest saving rates observed in the countries concerned, the combined gross domestic saving generated through the initial output increases amounts to $63.5 billion, a sum these countries will have at their disposal for investment, domestically or abroad. However, given the trend of the last 10 years, the likelihood is that, collectively, these countries will have a much larger sum for domestic investment, with their combined domestic saving being supplemented by international capital inflows arising from their bilateral and multilateral trade relationships.

Let is now be assumed that these countries, individually and collectively, had followed their established trade patterns, and exchanged goods and services among themselves and *vis-a-vis* the rest of the world, given the initial increase in GDP. Combined exports stemming from increased production would have amounted to $49.4 billion, of which $39.8 billion would have gone to OECD countries. The total additional imports of these countries from the world as a whole would turn out to be $56.5 billion, of which $44.8 billion would originate within OECD.** creating a net combined trade deficit of $7.2 billion. Of this amount, $5 billion would have to be supplied by Japan and other OECD countries that will not or cannot expand their output, and $2.1 billion would have to be financed through an additional reverse flow of resources from the rest of the world. The secondary effects on Japan and the other eight OECD countries that experience an increase in demand for their exports are ignored here.

In table I.3 the results for the 15 countries are presented. There is an initial increase in income and then a secondary one. Between these two stages are the induced effects on savings and on the trade balance. The latter effects have to be split into those involving, respectively, member countries and non-member countries of OECD. What, then, is the lesson imparted by such an exercise?

In the aggregate, the following results were achieved for all 15 countries:

Item	*Million dollars*
1. Primary (labour-induced) increase in GDP	377 744
2. Increase in domestic saving	69 018
3. Change in current trade balance (OECD)	−5 551
4. Change in current trade balance (non-OECD)	−2 489
5. Increase in domestic investment (2−(3+4))	77 058
6. Secondary (investment-induced) increase in GDP	11 407
7. Total increase in GDP (1 + 6)	389 151
8. Implied growth rate of GDP (percentage)	4.57
9. Actual 1990 growth rate of GDP (percentage)	2.12

The overall effects are thus obviously beneficial. There is some deterioration in the trade balances: hence the concerted strategy does not eliminate trade imbalances. But, as table I.3 shows, the problem in this respect is confined to the United States (extra deficit of $4.6 billion), and, to a lesser extent, France ($1.55 billion) and Spain ($2.34 billion). Of the rest, Belgium, Canada, Denmark, Germany, Ireland and Norway manage an improvement in their trade balances. Of the remaining six countries, Austria ($7 million) and Finland ($5 million) have only marginal deterioration, as does Australia ($52 million).

Thus, of the 15 OECD countries, six (France, Italy, Spain, Turkey, United Kingdom and United States) have worsening trade imbalances, six (Belgium, Canada, Denmark, Germany, Ireland and Norway) show some improvement, and three show negligible deterioration. But assuming that this deterioration is covered by capital flows without any substantial effect on interest rates, the effect on employment, investment and income are overwhelmingly positive. An extra output of nearly $400 billion is generated for an $8 billion increase in the trade deficit.

However, the argument here concerns the qualitative impression rather than quantitative details. There are many side-effects and omitted variables that would need to be taken into account to achieve quantitative precision. The purpose here is to demonstrate that while many countries have deliberately induced recessions to improve their trade balances, a more virtuous approach would involve a policy of positive growth with only mildly negative effects on the trade balance. A concerted policy aimed at high growth with some trade imbalance is more beneficial to industrial growth than uncoordinated unilateral policies of recession designed to achieve an improved trade balance.

Although the improvement in world current account imbalances seems to have been brought about largely at the cost of reduced trade and growth, a positive growth strategy would provide an opportunity to expand world trade once again, this time more extensively than intensively, by redirecting trade flows to developing countries and to Eastern Europe and the USSR, thus enabling them to participate more fully in the international exchange of goods and services, and broadening the productive base of the world economy. Of the $8 billion deterioration in the trade balance, $2.5 billion is thus directed to non-OECD countries. The extra $8 billion that have to be covered by capital

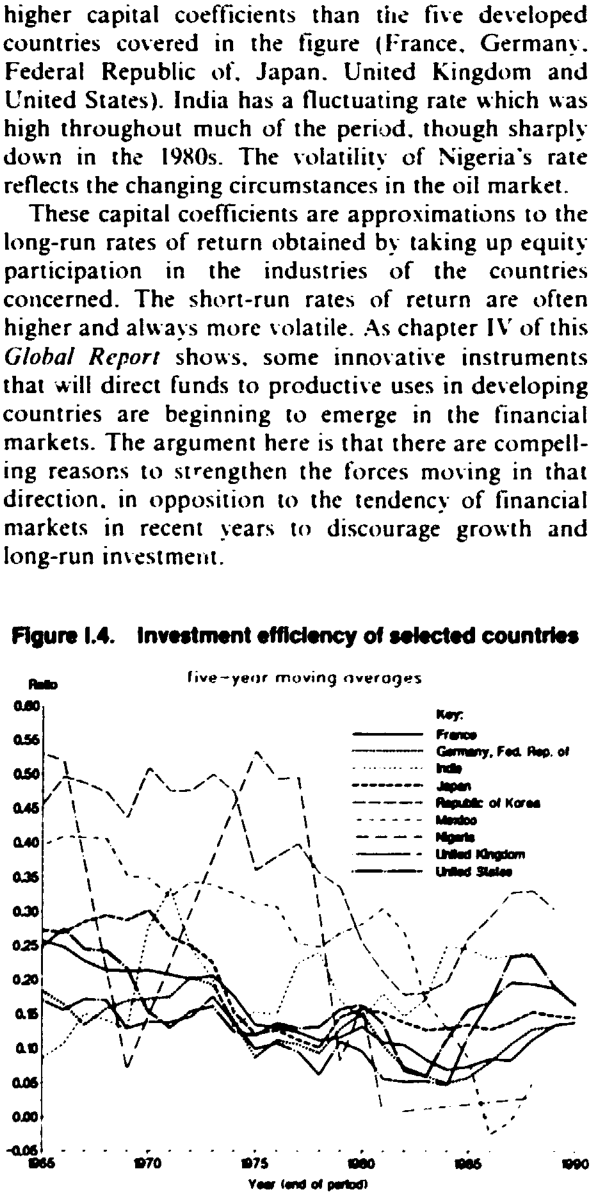
*Data were used for the years 1967-1989; details will be made available on request.

**Conceptually, total OECD exports to OECD countries should be equal to total OECD imports from OECD countries. The main reason for the divergence in this case is that, besides the usual statistical discrepancy, the exporting and importing countries are not the same, and are determined by the bilateral and multilateral trade relationships of 15 out of 24 OECD countries with expanding output inflows do not represent an excessive burden on the capital markets of the world, when compared with the enormous volume of financial resources traded daily. Much of that flow of resources is directed towards paper profits and governed by short-run, if not speculative, motives. There is an urgent need to consider whether some of this flood of money could be used to promote healthy and sustained growth.

It could be argued that the current pattern of international transfer of financial resources reflects the relative scarcity of capital in different countries. If scarcity of capital were to be measured by some measure of the "marginal productivity" of capital—for instance, by the extra output generated by a unit of investment—then it is easy to show that many developing countries have a high rate of return in this sense. Measurements of incremental income in relation to investment ratio—the so-called capital coefficient—are given in figure I.4, which presents five-year averages for nine countries during the period 1965-1990. The Republic of Korea and Mexico are shown to have higher capital coefficients than the five developed countries covered in the figure (France, Germany, Federal Republic of, Japan, United Kingdom and United States). India has a fluctuating rate which was high throughout much of the period, though sharply down in the 1980s. The volatility of Nigeria's rate reflects the changing circumstances in the oil market.

These capital coefficients are approximations to the long-run rates of return obtained by taking up equity participation in the industries of the countries concerned. The short-run rates of return are often higher and always more volatile. As chapter IV of this *Global Report* shows, some innovative instruments that will direct funds to productive uses in developing countries are beginning to emerge in the financial markets. The argument here is that there are compelling reasons to strengthen the forces moving in that direction, in opposition to the tendency of financial markets in recent years to discourage growth and long-run investment.

Figure I.4. Investment efficiency of selected countries



Sources: UNIDO statistical database and United Nations National Statistics

Note: Ratio of GDP growth to investment quota

2. *Competitive bidding for international capital and escalating interest rates*

One of the distinctive features of the 1980s was the continuing high real interest rate worldwide, a circumstance that discouraged investment and suppressed growth in developed and developing countries alike. In the process, the preference for quick-yielding short-term investment led to the widespread transformation of capital stocks through the neglect of physical infrastructures and the encouragement of large-scale diversion of investment from capital-intensive manufacturing to less-capital-intensive service industries. The overall result has been that the average rate of return on investment for the economy as a whole has decreased in most of the major industrialized countries. A disinclination to invest in any long-term project has affected the investment flow to developing countries, resulting in much longer average investment gestation periods in those countries. There is also a strong suspicion that high interest rates caused "asset inflation" — a worldwide phenomenon until only a year ago. The price of shares and real estate values increased excessively in most countries, while prices of goods and services currently produced remained more or less stable. Capital gains have therefore become an important investment consideration, rather than profits from current production. In the meantime, national saving rates have generally declined, reflecting the illusory increase in "wealth".

Throughout most of the 1970s, borrowing was facilitated by high liquidity in international capital markets caused by the huge volume of financial surpluses of the Organization of Petroleum Exporting Countries (OPEC). As a result of this glut of financial resources, money was frequently available at negative interest rates. Between 1978 and 1981, however, real interest rates turned sharply positive. By far the sharpest increase took place in the United States. In 1978, the short-term real interest rate in the United States was still negative (−0.4 per cent), but by 1981 it stood at a high of 8.9 per cent, while the increase in the long-term real interest rate, though smaller, was still impressive (from −0.2 per cent to 6.8 per cent in the same period, and 8.7 per cent in 1982). Foreigners took full advantage of the high interest rates in the United States by using substantial amounts of their own currencies to purchase dollars. This resulted in a sharp increase in exchange rates, which in turn adversely affected the current account deficit of the United States. In order to stem the outflow of financial resources to the United States caused by interest rate differentials in its favour, and to address their own growing budget and balance-of-payments deficits, many countries adjusted their interest rates upwards, thus setting the stage for competitive interest rate increases.

At the beginning of the 1980s, the perceived fear of inflation by monetary authorities in the major industrialized countries prompted the nominal increase in interest rates worldwide. By the end of 1986, however, most major industrialized countries were experiencing steadily declining output (and lower inflation) as a result of a year-long contraction in domestic demand. In early 1987, the Bank of Japan decided to stimulate the economy and reduced its discount rate to 2.5 per cent forcing market rates to below a 4 per cent average. Nominal rates in the Federal Republic of Germany came down as well (although the Central Bank in that country refused to lower its Lombard rates) Simultaneously, however, other major industrialized countries, including Canada, United Kingdom and United States toughened their monetary stance and increased interest rates to attract international capital inflows. Short-term interest rate differentials between loans denominated in dollars and pounds sterling against those denominated in yen and deutsche mark have become ever larger, and the actual interest rate spread between Japan and the United States surpassed the 5 per cent level in the first half of 1989, while the spread between the Federal Republic of Germany and the United States was above 3 per cent between mid-1987 and mid-1989. In the meantime, both Japan and the Federal Republic of Germany were compelled, on at least two occasions (the third quarters of 1987 and 1988), to raise their own interest rates to stem the excessive outflow of capital. The net result was that the short-term nominal interest rates of the seven major industrialized countries, combined and averaged, increased from 6.7 per cent in 1987 to 8.7 per cent in 1989.

During 1989 and early 1990, both Japan and the Federal Republic of Germany had to tighten their monetary policies because their domestic demand was growing excessively, which meant a substantial narrowing of interest differentials in favour of dollar-denominated loans. The short-term interest rate differential in favour of the United States was reduced to a mere 0.5 per cent against Japan, and actually became negative *vis-à-vis* the Federal Republic of Germany in 1990. In the meantime, the average short-term interest rate for the seven major industrialized countries went up to 9.1 per cent—this time owing to interest rate increases in the Federal Republic of Germany and Japan.

Such conflicting policies and frequent changes in interest rates in the major industrialized countries have also caused huge swings in foreign exchange markets. In the first half of 1989, the dollar appreciated significantly *vis-à-vis* the yen and deutsche mark, even though the United States still had a huge current account deficit. Central bank efforts to prevent further appreciation of the dollar by selling an unprecedented amount of the currency (according to some sources, as much as $2 billion a day at times in mid-1989) failed because of the favourable interest rate differential offered by dollar-denominated assets.

When the United States economy started to slow down in 1989, the economies of both Japan and the Federal Republic of Germany continued to grow strongly, improving the current account imbalance of the United States appreciably. Perversely, however, the dollar started to decline against the deutsche mark in mid-1989 and against the yen in early-1990, largely because of the disappearance of positive interest rate differentials offered by dollar assets. During the same period, official exchange market intervention remained tentative, and was limited to "teaching a lesson" to market speculators. The dollar continued to decline, and reached a new low against European currencies in mid-February 1991.

By mid-April 1991, however, the dollar had recovered remarkably, appreciating by 8 per cent against the yen and 21 per cent against the deutsche mark within a two-month period, in spite of the positive real interest rate differentials offered by deutsche-mark-denominated assets. Explanations for this unexpected dollar strength are many and often conflicting, thus any prediction involving future currency exchange rates entails a large element of gambling.

Whatever the reason for the historically high real interest rates during the 1980s might have been, it increased the so-called capital factor payments resulting from the ownership of foreign assets in the form of interest and dividend payments. According to the World Bank capital factor payments of developing countries increased from $5.8 billion in 1970 to $57.7 billion in 1983, which was equivalent to 14.4 per cent of their total exports of goods and services in the same year. For the group of severely indebted developing countries, however, capital factor payments constituted 21.4 per cent of their combined export earnings in 1983, forcing some of them to suspend interest payments, thus deepening the debt crisis of the developing world ([1], pp. 126 and 170).

In the meantime, the continuing need to service external debts with increased interest rates transformed many developing countries into net exporters of international capital. In 1981, there were only three non-OPEC developing countries with a current account surplus, namely Panama, Trinidad and Tobago and Uganda, the rest of them incurring trade as well as current account deficits. By 1983, however, their combined trade balance became positive, and their current account deficit, excluding debt service charges, virtually disappeared. But by 1985, almost 30 non-OPEC developing countries became trade surplus countries by virtue of simply cutting their average imports by 30 per cent from the pre-1981 level. The combined import bill for all developing countries dropped from $591 billion to $447 billion, or by 24 per cent in nominal value in that brief period. The ensuing economic retrenchment was especially severe for the highly indebted developing countries which have, even with continuous refinancing of old debt, been devoting substantial portions of their export earnings towards servicing their debt. The lack of imported parts and components have all but paralysed the manufacturing sector in Tropical African countries. Meanwhile, the reverse flow of resources from developing to developed countries continues.

High interest rates, which have forcibly reversed the normal flow of resources in the international arena, has also brought about a serious distortion in the domestic economies of developed countries as well. During the 1980s, the average GDP growth rate of major industrialized countries as a whole rarely exceeded 3 per cent per annum, making it an impossible task for these countries to pay a real interest rate of anything above 3 per cent without drastically altering the relative shares of income between wage earners and property owners. Although such a redistribution of income seems to have indeed taken place in some major industrialized countries, most of the extra money needed to pay the high interest seems to have come not from current income, but from the inflated valuation of existing physical and financial assets of these countries, especially in the form of highly priced financial stocks and a rise in real estate values.

In the mid-1980s, therefore, the price of land in Japan continued to increase to such an extent that by 1987 the total valuation of its land mass became bigger than the total estimated land value of the United States. Japanese stock prices kept advancing throughout the mid-1980s, thus ensuring investors of enough capital gains to pay for high nominal interest rates. Economists came to term this phenomenon as "stockerization of inflation", which became a common feature not only in Japan, but also in other major industrialized countries.

One often cited manifestation of this phenomenon in the United States was the "highly leveraged" buy-outs, involving the acquisition and recapitalization of industrial concerns. The total volume of leveraged buy-outs in the United States in the period 1984-1990 amounted to $216 billion [2]. The pricing of loans for these financial transactions were significantly higher than for conventional investment loans. While a prime corporate borrower might have paid 12.5 basis points or less above the London Inter-Bank Offered Rate (LIBOR), the average margin for merger-related Euro-currency loans in the first three quarters of 1989 was 112 basis points ([3], p. 75). For highly leveraged transactions, the rates have typically ranged between 200 and 300 basis points.

It seems, therefore, that these financial activities involving United States industrial firms have contributed substantially to the increase in interest rates in international capital markets. In the meantime, the United States corporate sector has become highly vulnerable to recession and declining profit. Between 1982 and 1989, the debt of non-financial firms in the United States rose by an annual rate of almost 12 per cent, and their net interest payments as a proportion of their cash flow increased from 16 per cent in 1980 to 20.3 per cent in 1989, causing many firms to experience liquidity problems later ([4], p. 71).

Today, speculative bubbles in stock and property markets which have caused asset inflation in developed countries seem to have been largely contained. In the meantime, competition for international capital to finance government fiscal deficits and merger and acquisition activities of private industrial firms in developed countries have largely diverted funds from real investment worldwide.

There are many hopeful signs that the credit restrictions directed against Latin American countries are easing. Flight capital from these countries is returning, and foreign direct investment is starting to put down new roots, especially in those countries which have made their economies more outward-looking and export-oriented. Offering official debt forgiveness to African countries remains a topic of discussion, albeit sporadically. Once their creditworthiness is restored, the reverse flow of resources from these countries should stop, and the normal course of development in the world economy may yet resume. The world has, however, yet to devise an effective international monetary system capable of creating enough international liquidity to ensure a normal flow of international capital without triggering another round of competitive interest rate increases.

After a severe recession at the beginning of the 1980s, world output grew at an average annual rate of 3.5 per cent between 1983 and 1989, while the volume of world trade in both goods and services increased at an average rate of 6.5 per cent in this period. There is no doubt that such growth in the "real" economy required an increase in the "symbolic" economy of money, credit and capital. The experience of the last few years, however, indicates that the growing flow of international financial resources has gone well above the volume required for the smooth conduct of international trade.

The global turnover in the international foreign exchange markets reached a staggering figure of $650 billion a day in 1989. This compares with a figure of just over $300 billion a day in 1986, and an estimated figure of less than $10 billion a day in 1973. International mergers and acquisitions, cross-border investments and asset holdings, as well as constant switching of one currency into another to avoid exchange losses, have all contributed to the phenomenal growth in international financial flows. At a yearly figure of $200,000 billion in 1989, such flows currently dwarf the 1989 total world trade figure of $3,300 billion by a wide margin.

In 1989, the total size of the international capital flow, representing the aggregate net claims arising from the exchange of goods and services among countries and held by trade surplus countries against deficit-incurring countries, amounted to no more than $220 billion (excluding capital service payments such as interest and dividends). The total international capital flow in 1989 therefore represented only 6.7 per cent of total international trade and 1.2 per cent of the world's combined GDP. Compared to this, the actual amount of new funds channelled through the international financial markets in 1989 amounted to $440 billion ($330 billion in net international bank lending, $6.9 billion in net Euronote placements, and $171.6 billion in net international bond financing, minus $68.5 billion for double counting) ([5], p. 124).

This growing gap between the "real" and the "symbolic" economy during the last decade indicates that international finance has been more preoccupied with shuffling already-existing world assets than with financing of current production and current trade. Needless to say, asset transaction is an essential element of a capitalist system of organizing world trade and production. The danger still exists, however, that international capital and resource flows will be increasingly affected by the legacy of the past rather than by what lies ahead.

II. Industrial performance, prospects and policy issues in major regions—global transition continues under increased uncertainties

As the euphoria generated by the ending of the cold war and the Gulf war has begun to fade, a new economic realism has been sobering policy makers in both developing and developed countries. Industrial reforms to meet the challenges of the new era seem to require thinking no less revolutionary than any recorded in the history of development. The process of transition from a centrally planned economy to a market-driven one represents one such requirement of new thinking. Perceived inadequacies of the existing (not idealized) market mechanism, with its imperfections and failures, represent another. Between these contrasting poles of thought, developing countries are faced with the imperative of redefining and rebuilding their own "market institutions". The signs of epoch-making transitions are conspicuous everywhere, along with the social and economic adjustment costs and uncertainties that the transitions entail.

In addition to reviewing short-run prospects for industrial growth in major regions, this chapter also focuses attention on institutional reforms. In recent years, virtually all major regions of the world have gone through industrial and institutional reforms. The successes and failures of these experiences have yielded important case material from which to glean valuable lessons.

The mix of market and non-market institutions differs among countries, ranging from the centrally planned type (as formerly in the USSR) to the *laissez-faire* type (as in Hong Kong). Each constitutes a system containing myriad component institutional arrangements and agents, such as banking systems, producers' associations, labour unions, researchers, merchants' associations, transport and communication networks, education and training systems, legal procedures, bureaucrats, and even the armed forces and police deployed to maintain law and order, all interacting under a set of formal rules and informal rules. Rewards for risk-taking are determined by the working of the whole system. The speed and efficiency of industrial restructuring depends on how these institutional components are organized. Studies have revealed that "the difference in economic performances stemming from different institutional contexts is much greater than the set of economic signals markets deliver" ([1], p. 126). This provides an important area which could be exploited by institution-building as a policy tool to create a new source of efficiency, based on what might be called "institutional or organizational technology".

Such considerations seem to provide the key to an understanding of recent events, including the reforms under way in Eastern Europe and the USSR, the projects marking the completion of the single EEC market in 1992 (particularly the technology aspects), and the factory contract responsibility system in China. In the past, factories under centrally planned systems, preoccupied with meeting quantity targets, tended to discourage the adoption of up-to-date technology, since there were few rewards for better-quality products that higher technology provides. In contrast, Japan, with formal and informal protection (though temporary), inter-enterprise cooperation in research and development under the Ministry of International Trade and Industry (MITI) guidance, *Zaibatsu*-owned banks for financing, and fierce oligopolistic competition for market share and quality (rather than price) improvements in the country and overseas, has fostered technological dynamism and prevented rent-seeking actions.

The quantitative indicators measuring industrial performance could be multifarious. Table II.1 presents gains and losses of manufacturing employment in major regions of the world for 1970, 1980 and 1990, along with a labour productivity index for the same years. It is noteworthy that for Japan, South-East Asia, and Eastern Europe and the USSR the labour productivity index in 1990 rose to over 200 (taking 1970=100). It is well-known, however, that the figures for Eastern Europe and the USSR are fictitious because of the distorted prices and mismatches of supply and demand (with inventory pile-ups of unsaleable goods). Superior labour productivity and employment growth in Japan and South-East Asia seem to reflect the success of efforts to upgrade the industrial base along with institutional reforms during the post-Second World War period.

Industrial performance continues to lag behind in Tropical Africa where labour productivity did not improve during the 1970s and 1980s, in spite of an injection of substantial foreign aid.

Developing countries have a valuable lesson to learn from observing carefully these "historical experiments". A careful analysis comparing the cases of success and failure may help to produce policy ideas for an improvement in industrial performance.

Table II.1. Manufacturing employment and index of labour productivity by major world regions, 1970, 1980 and 1990

Country, region, or grouping	Manufacturing employment 1970	1980 (millions)	1990	Labour productivity[a] Index 1980 (1970=100)	Index 1990 (1970=100)	Value 1990 (1985 dollars)
World	129.0	148.1	145.8	122.3	156.6	26 180
Developed regions	107.4	112.7	106.7	129.3	167.6	31 212
Eastern Europe and USSR	37.5	44.0	43.6	155.3	201.4	13 974
Japan	10.9	10.3	10.9	148.0	200.3	46 244
North America	19.9	21.1	19.4	124.6	160.1	64 376
Western Europe	37.8	36.7	32.8	125.7	164.6	28 667
Other	2.6	2.8	2.7	107.5	125.5	17 873
Developing regions	21.7	35.4	39.1	121.8	169.8	12 427
Indian Subcontinent	5.5	8.0	8.2	95.0	156.3	3 172
Latin America	7.5	11.2	10.1	127.1	176.9	20 651
North Africa	0.9	1.6	2.1	106 3	113.8	7 515
South-East Asia	4.7	9.3	12.1	148.1	240.0	12 089
Tropical Africa	0.8	1.5	1.6	99.7	99.7	6 264
Western Asia	1.0	1.8	2.3	96.9	139.3	25 853

Source: UNIDO data bank.
[a] MVA per employee in 1985 dollars.

A. North America

Analysts and forecasters debated whether the Gulf war would stimulate economic growth. One school argued that war expenditures would stimulate growth according to the usual Keynesian multiplier process. Others countered that the War would disrupt the normal process of production by raising oil prices, upsetting transport and communications, increasing uncertainties etc. But in the end, the War seems to have had little impact in North America.

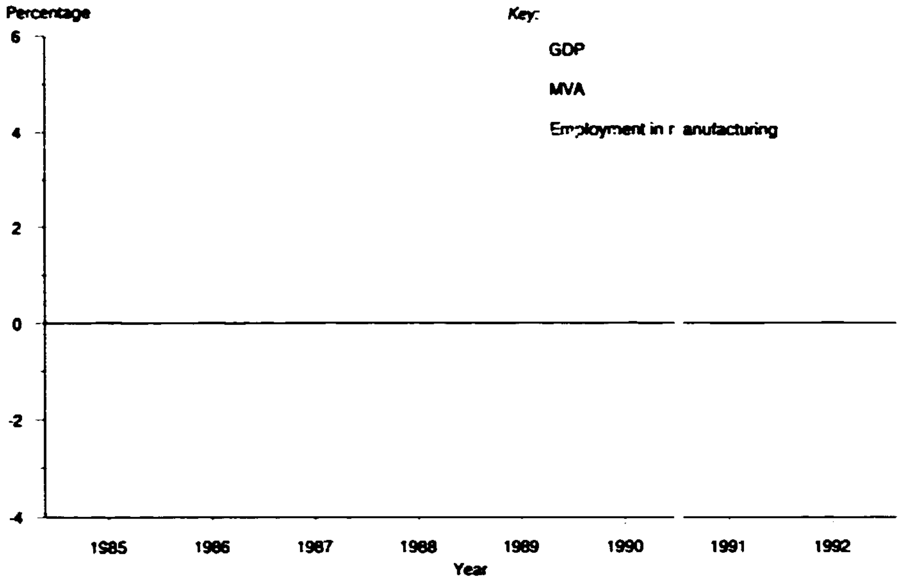
GDP in the region grew by a meagre 0.9 per cent in 1990, and is expected to slow down further to 0.5 per cent in 1991. The much-heralded soft landing of the current recession appears to have taken place, but the timing for take-off in the next phase of the cycle appears uncertain, as no strong stimulus for growth is in sight. Consumers have been constrained heavily by debt, especially by expanding credit-card debt ($215.8 billion in September 1989, compared with $137 billion in 1986 and $55 billion in 1980). The federal Government is burdened by increasing budget deficits ($165.4 billion in 1990 against $134.3 billion in 1989), and business sectors with highly leveraged financial structures and slow sales prospects do not seem ready to invest. Nevertheless, a lower interest rate may help to stimulate spending sensitive to the cost of capital, such as housing construction, automobile purchases etc. Only the export sectors may carry some hope to stimulate growth. United States exports grew by 8.5 per cent in 1990, offsetting recessionary forces in the domestic economy; but total world exports are projected to grow at a 4.1 per cent rate in 1991, compared with 5.6 per cent in 1990. However, merchandise exports account for only about 12 per cent of GDP (compared with over 60 per cent of GDP for consumption) in the United States. For these reasons, the recovery process is likely to be rather slow.

In spite of the slow pace of growth, some manufacturing industries are expected to perform well, notably the high-technology industries. In 1990, when the industrial production index registered only 1 per cent growth, output of information-processing equipment and related products grew by 4.5 per cent, among them office and computing machines, which grew by 9 per cent (see table II.2). Such sectoral performances seem to reflect the waves of ongoing technological innovation and also the shift in consumer preferences toward high-technology products. This trend is expected to continue in both the short- and the long-run (see figure II.1 for GDP and MVA patterns of growth in recent years and also for structural changes in industry).

A similar tendency can also be observed in United States export composition. While GDP in the United States grew only by about 1 per cent in 1990, its exports grew by 8.5 per cent. Consumer durables and capital goods exports led in export performance, growing at 18.8 per cent and 12.7 per cent, respectively (see table II.3). The 1990 high growth performance in the Federal Republic of Germany and Japan has obviously played a "locomotive" role in the world economy, with 25.4 per cent and 8.9 per cent import growth, respectively. United States exports in 1990 seem to have benefited from the trade boom in that year. World trade in high-technology products (computers, aircraft engines, scientific instruments, chemicals, pharmaceutical products etc.) will probably maintain its vigorous export growth in 1991, assisted by robust growth in Germany and Japan, though at a slightly slower pace.

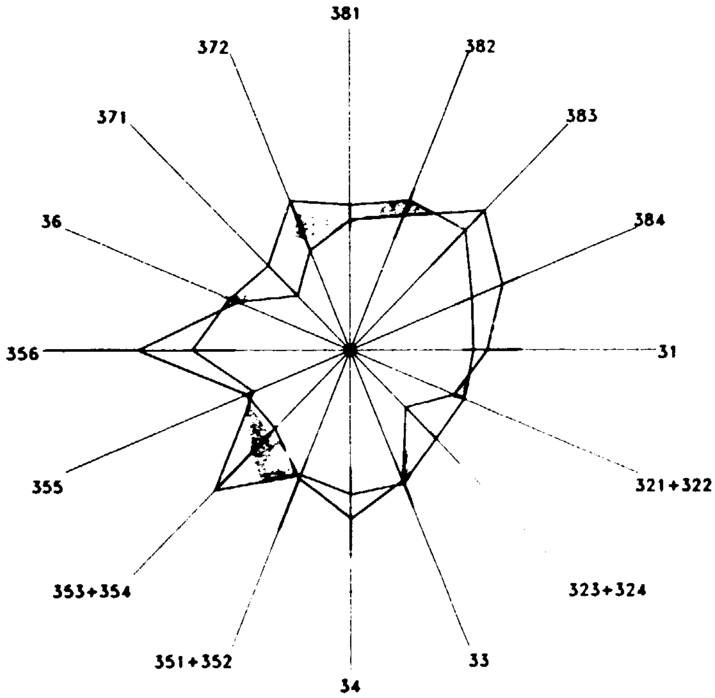
One of the most promising growth leaders in manufacturing is expected to come from the software industry. United States producers account for nearly 58 per cent of the world market (worth $110 billion) for software and related services. Its share compares with 13 per cent for Japan, 8 per cent for France, 7 per cent for Germany, 6 per cent for the United Kingdom, and 3 per cent for Canada. United States producers employ 1.4 million programmers and soft-

Figure II.1. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: North America



Industrial structural change

(Index of value added: 1975 = 100)



g = 2.16, θ = 9.45

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast

1980–1985

1975–1980

Sources: UNIDO database, estimates and forecasts by UNIDO PPD IPP GLO

Table II.2. Index of industrial production in the United States, 1989 and 1990
(1987=100, seasonally adjusted)

Products	1989	1990	Percentage change
Total index	108.1	109.2	1.0
Total products	108.6	110.1	1.4
Final products	109.1	110.8	1.6
Consumer goods	106.7	107.3	.6
Durable goods	107.9	106.1	-1.6
Automotive products	106.9	102.2	-4.4
Automobiles and trucks	105.7	97.2	-8
Other durable goods	108.8	109.3	-.5
Non-durable goods	106.4	107.6	1.1
Food and tobacco	104.2	105.9	1.6
Clothing	101.6	95.7	-5.8
Chemical products	109.5	113.2	3.4
Paper products	114.3	119.6	4.6
Energy products	106.7	105.9	-.7
Equipment total	112.3	115.5	2.9
Business equipment	119.1	123.0	3.3
Information-processing and related products	121.7	127.2	4.5
Office and computing machines	137.2	149.6	9.0
Industrial equipment	113.8	115.2	1.2
Transit equipment	123.8	130.0	1.2
Automobiles and trucks	103.9	96.7	-6.9
Defense and space equipment	97.4	97.3	-.9
Oil- and gas-well drilling equipment	93.7	109.3	16.7
Manufactured homes	92.3	90.6	-1.8
Intermediate products	106.8	107.7	.8
Construction supplies	106.1	105.2	.8
Business supplies	107.3	109.4	1.6
Materials	107.4	107.8	.4
Durable	111.6	111.8	.2
Non-durable	105.3	106.0	.7
Energy	101.3	102.1	.8

Source: Department of Commerce, *Survey of Current Business* (Washington, D.C., Government Printing Office, March 1991), pp. S1-2.

ware engineers, and the demand for them is growing faster than the supply. They are even sought after in India and China, where numeracy talent is cheap; otherwise, United States companies are establishing software subsidiaries in India and China to share programming work at fractional costs. The long-run importance of this industry cannot be overemphasized, as software product development is likely to determine the competitiveness of other industries by reducing costs, upgrading product quality and speeding up delivery and service time (see the section on Western Europe for details).

At the lower end of the performance spectrum lies the automobile industry. In 1990, domestic output fell, but the output of transplant cars rose.* The decade-long voluntary-export-restraint arrangements against Japanese automobiles do not seem to be helping United States producers to regain their competitiveness. Meanwhile, however, the sluggish market has forced General Motors to reduce costs by $13 billion (or 15 per cent) since 1987, for instance, by reducing management layers to four from six or more, and also by cutting back production capacity. Yet Toyota Motor Company announced for 1991 a second $800 million factory in Kentucky, raising its United States capacity to 1.5 million cars (950,000 in 1990) by the mid-1990s. Honda and Nissan motor companies are also planning to expand their capacities.

*"From 1985 to 1990, sales of transplant cars increased nearly threefold, and their share of total car sales increased from 2.5 per cent to 11 per cent … Sales of domestic nameplates fell 29 per cent in 1985-1990, and their share dropped from 73 per cent to 61 per cent" ([2], pp. 29-30)

1. *Long-run prospects for industrial growth*

The current recession seems to have reinforced the concern that the industry of the region has been losing competitiveness, and some therefore argue that a new (industrial) policy must be introduced to restore the supremacy that United States industry enjoyed during the post-Second World War era. They point out that in an increasing number of industries the relative position of the country, particularly *vis-à-vis* Germany and Japan, has deteriorated (with losses, for example,

Table II.3. United States: merchandise exports and imports by type of product in constant dollars, 1989 and 1990
(Billions of 1982 dollars)

Exports and imports	1989	1990	Percentage change
Merchandise exports	390.8	423.9	8.5
Foods, feeds and beverages	35.8	36.6	2.2
Industrial supplies and materials	92.2	97.7	5.0
Durable goods	32.8	34.6	5.5
Non-durable goods	59.4	63.1	6.2
Capital goods, excluding automobiles	176.4	198.8	12.7
Automobiles	28.9	29.6	2.4
Consumer goods	30.9	36.6	18.5
Durable goods	17.6	20.9	18.8
Non-durable goods	13.3	12.2	17.2
Merchandise imports	499.3	517.0	3.5
Foods, feeds and beverages	23.9	72.5	3.7
Industrial supplies and materials, excluding petroleum	72.3	72.5	0.3
Durable goods	39.2	37.1	5.3
Non-durable goods	33.1	35.4	7.0
Petroleum and petroleum products	93.8	95.5	1.8
Capital goods, excluding automobiles	134.7	156.4	8.8
Automobiles	63.8	63.3	0.8
Consumer goods	81.5	81.1	-0.5
Durable goods	46.1	44.8	-.2
Non-durable goods	35.4	36.3	2.5
Other			
Exports of agricultural products	39.6	40.1	1.3
Exports of non-agricultural products	351.2	383.8	9.3
Imports of non-petroleum products	405.5	421.5	4.0

Source: Department of Commerce, *Survey of Current Business* (Washington, D.C., Government Printing Office, March 1991), p.13.

in the share of the electronics and automobile markets). However, policy makers are divided on the issue of what should be done in the 1990s to strengthen industrial competitiveness.

One of the crucial long-run determinants of industrial competitiveness is productivity growth. Available evidence suggests that the growth of labour productivity in the United States and Canada has fluctuated widely, but without any downward trend since 1870 (see table II.4). But in some other countries, notably Austria, Germany and Japan, the growth in labour productivity seems to have accelerated. During the 1960s, labour productivity in Japan grew almost four times faster than in the United States. Furthermore, 14 out of 16 selected developed countries exceeded the United States in labour productivity growth in the 1950s and 1960s, and 13 countries did so in the 1970s. Analysts attribute the acceleration largely to the "technological catch-up process". The question remains, however, whether the existing pattern of labour productivity growth could be extrapolated into the long-run future, and whether a country such as Japan could surpass the United States after the catch-up process has been completed. This possibility appears to worry United States industrialists as well as policy makers in the region.

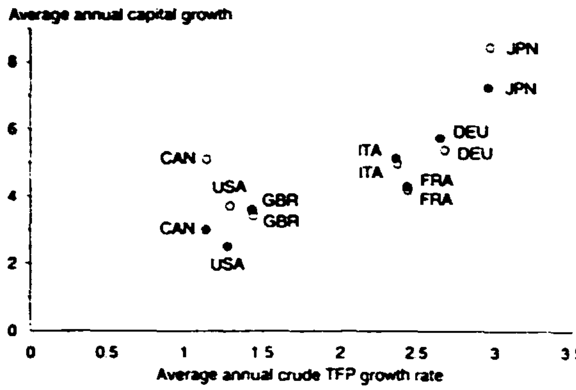
An additional piece of evidence concerns differences in total factor productivity (TFP) growth in manufacturing between industrialized countries (see table II.5). It is noteworthy that TFP growth in Japan has exceeded that of the United States and Canada since 1973, and also that Japanese TFP growth in machinery and equipment has been the highest since 1973. The machinery and equipment industry is the area in which global market competition for technological supremacy appears keenest.

There seems to be a broad consensus among researchers as to why the United States has fallen behind in TFP growth, particularly behind that of Japan. Notable factors include a relative slow-down in savings and capital accumulation and in skill formation (education and training), entrepreneurial quality differences (as a result, for example, of chasing "paper profit" and rent-seeking), and industry lags in research and development (especially in commercial applications of technology). To this list could be added various institutional differences between the two countries, relating to competition laws, industrial organization (*keiretsu* system), the banking system, the time horizon for decision-making etc. (see section B on Japan for further discussion of the institutional factor).

A high correlation between capital accumulation and TFP growth is commonly accepted as evidence of dynamic scale economies and learning by doing. Figure II.2 presents some revealing evidence with regard to industrialized countries during the period 1950-1979.

The change in capital stock accumulation as well as capital per unit of labour was highest for Japan, followed by the Federal Republic of Germany. The United States and Canada belong to the lower end of

Figure II.2 Growth rates of capital, and capital-labour ratio versus growth rate in TFP, seven industrial countries, 1950-1979



Key:

o Gross capital stock

• Gross capital per work-hour

CAN Canada
DEU Germany, Federal Republic of
FRA France
GBR United Kingdom
ITA Italy
JPN Japan
USA United States

Source: Jeffrey G. Williamson, "Productivity and American Leadership: A Review Article", *Journal of Economic Literature*, Vol XXIX, No 1 (March 1991), p 62

the diagram. Capital per unit of labour grew about three times faster in Japan than in the United States.

In skill formation also, indicators show a faster pace of growth in Japan than in the United States. For instance, the number of electrical and electronic engineering graduates in the United States grew from 11,375 in 1969 to 12,213 in 1979, compared with a growth of from 11,035 to 19,572 in Japan during the same period.* Under-investment in education in the United States has been recognized in recent years ([4], pp. 413-476).

Regarding entrepreneurial quality, it has been argued that United States entrepreneurs devote a greater amount of resources to mergers, litigations, financial manipulations and lobbying efforts than their competitors, often trying to meet a short-run (quarterly) profit-earning requirement.

> "... Between 1971 and 1981 the number of practicing attorneys increased by 68 per cent. The country now has more than 590,000 lawyers—one for every 400 citizens. ... Only about one of every 10,000 citizens in Japan is trained in law, while one out of 25 Japanese citizens is trained in engineering or science. More than 65 per cent of all seats on the boards of Japanese companies are occupied by people trained as engineers; roughly the same percentage of seats on American boards is taken by people trained in law, finance or accountancy. Thus, in Japan many problems that arise in business are viewed as problems of engineering or science, for which technical solutions can be found. In present-day America the same problems are apt to be viewed as problems of law or finance, to be dodged through clever manipulation of rules or numbers" ([5], pp. 159-160).

Expenditures on research and development are also regarded as an important variable affecting TFP growth. Evidence indicates that the private rate of return to research and development is high, often 20 to 30 per cent. Furthermore, the social rate of return has been reported to be far greater owing to high "spillover effects" on other firms. The following research results are worth noting:

> "For 1961-1981 the social rate was 1.5 to 2 times the private rate of return to research and development

*"... in electronic and electrical engineering by 1977 on a per capita basis Japan had almost three times as many as the United States and four times as many as the United Kingdom" ([3], p. 46).

Table II.4. Growth rates of GDP per worker-hour in 16 industrial countries, 1870-1979

Country	1870-1880	1880-1890	1890-1900	1900-1913	1913-1929	1929-1938	1938-1950	1950-1960	1960-1970	1970-1979
Australia	1.82	0.37	-0.80	1.01	1.49	0.88	2.20	2.76	2.22	2.83
Austria	1.50	1.98	1.93	1.50	0.72	0.21	1.61	5.69	5.90	4.32
Belgium	1.84	1.36	0.93	0.90	1.79	1.01	1.14	3.14	4.88	4.88
Canada	2.19	1.23	1.70	2.70	1.21	0.00	5.36	3.09	2.72	1.83
Denmark	1.47	1.95	1.90	2.21	2.57	0.43	1.23	2.97	4.90	3.06
Finland	1.29	1.14	3.36	2.42	1.95	1.89	2.10	3.96	6.37	2.60
France	2.32	0.90	2.02	1.82	2.34	2.83	0.75	4.39	5.38	4.09
Germany	1.50	2.15	2.42	1.41	1.40	2.3	-0.40	6.64	5.29	4.50
Italy	0.22	0.43	1.20	2.35	1.92	2.96	0.56	4.27	6.69	3.91
Japan	1.87	1.72	2.11	1.88	3.42	3.41	-3.20	5.57	9.96	5.03
Netherlands	1.44	1.26	0.98	1.07	2.44	-0.10	1.93	3.33	4.03	4.06
Norway	1.39	1.96	1.17	2.02	2.78	2.61	1.88	4.03	4.52	3.66
Sweden	1.76	1.95	2.70	2.26	2.40	2.66	2.43	3.43	4.79	2.55
Switzerland	1.59	1.37	1.47	1.26	3.18	1.01	1.52	2.98	3.69	1.91
United Kingdom	1.63	1.20	1.24	0.90	1.44	0.87	2.21	2.19	3.56	2.77
United States	2.28	1.86	1.96	1.98	2.39	0.74	4.03	2.41	2.51	1.92
Ratio (United States/average)	1.44	1.30	1.19	1.12	1.14	0.50	2.44	0.63	0.51	0.57
Number superior to United States	1	5	5	6	6	11	1	14	14	13

Source: Jeffrey G. Williamson, "Productivity and American leadership: a review article", *The Journal of Economic Literature*, vol.24, No.1 (March 1991).

Table II.5. TFP growth by industry in industrialized countries, 1970-1983
(Average percentage change per annum)

Country	Period	Total	Food	Textiles	Paper	Chemicals	Primary metals	Machinery and equipment	Other
United	1970-1973	5.6	5.8	4.3	5.1	6.2	6.8	5.4	3.2
States	1973-1979	0.4	-0.1	3.2	-0.5	0.2	-3.2	0.7	-0.7
	1979-1983	1.7	3.5	3.7	0.7	1.5	-4.5	2.4	-2.0
Japan	1970-1973	4.3	3.9	2.0	6.5	4.8	6.7	5.4	-10.6
	1973-1979	2.7	-0.4	4.4	-0.5	3.2	-0.2	5.5	2.2
	1979-1983	3.8	-2.1	8.8	3.4	2.9	-5.0	8.2	2.3
Germany,	1970-1973	2.9	0.5	1.4	2.8	4.8	1.2	2.6	0.3
Federal	1973-1979	2.4	1.9	3.5	2.0	1.8	2.1	2.4	0.4
Republic of	1979-1983	0.7	1.1	1.4	1.4	-0.2	-0.6	0.7	-3.4
France	1970-1973	3.7	3.9	3.9	-0.9	3.2	2.8	3.8	4.2
	1973-1979	3.0	2.2	1.6	2.0	2.8	0.9	3.6	3.3
	1979-1983	2.4	0.9	1.8	2.1	3.0	1.1	0.9	-1.9
United	1970-1973	4.9	2.3	5.0	4.0	6.0	1.7	4.1	3.9
Kingdom	1973-1979	-0.4	0.4	0.8	-0.5	0.6	-1.8	-0.6	..
	1979-1983	1.5	1.1	1.4	-2.9	1.2	1.3	1.9	-3.1
Italy	1970-1979	3.7	4.7	3.8	4.6	5.3	2.7	0.3	..
	1973-1979	2.1	2.0	3.7	1.8	3.0	0.2	0.9	..
	1979-1983	0.9	2.1	-1.7	1.5	2.7	-0.1	1.7	..
Canada	1970-1979	4.2	..	..	..	..	..	..	..
	1973-1979	0.7	..	..	..	..	..	..	..
	1979-1983	-1.3	..	..	..	..	..	..	..
Belgium	1970-1979	5.9	2.6	4.3	3.5	9.2	4.7	7.0	9.4
	1973-1979	3.7	1.7	3.3	3.2	6.1	2.9	3.5	3.2
	1979-1983	2.6	1.4	6.7	-2.5	4.5	0.8	2.5	0.7
Denmark	1970-1979	4.4	3.2	7.0	3.9	8.9	-6.6	3.4	7.1
	1973-1979	2.3	2.9	6.0	0.5	1.5	4.0	2.1	-2.4
	1979-1983	3.0	2.9	2.8	-0.6	7.7	7.9	2.3	4.3
Finland	1970-1973	2.6	..	..	..	..	..	..	..
	1973-1979	1.9	..	..	..	..	..	..	..
	1979-1983	2.9	..	..	..	..	..	..	..
Norway	1970-1973	3.5	0.4	1.9	1.9	7.0	5.9	1.8	4.5
	1973-1979	-0.3	-0.3	-0.6	-1.3	-1.7	1.1	-0.5	-2.2
	1979-1983	0.6	-4.0	2.9	0.6	3.0	0.8	0.0	-2.5
Sweden	1970-1973	2.9	-1.1	8.2	3.6	5.9	3.9	1.9	1.5
	1973-1979	0.4	-0.3	1.1	0.2	-1.0	1.6	0.7	3.9
	1979-1983	2.0	0.4	-0.7	0.3	3.3	6.4	3.2	-21.8
Australia	1970-1973	2.1	..	..	..	..	..	..	..
	1973-1979	1.7	..	..	..	..	..	..	..
	1979-1983	0.4	..	..	..	..	..	..	..
Average	1970-1973	4.5	4.0	3.7	5.1	5.5	4.6	4.5	-6.3
of 16	1973-1979	1.5	0.7	3.2	0.1	1.4	-0.5	2.2	1.7
countries	1979-1983	1.8	1.5	2.7	0.9	1.7	-2.1	3.4	1.0

Source: Steven Englander and Axel Mittelsstaedt, "Total factor productivity: macro-economics and structual aspects of the slow-down", *OECD Economic Studies*, No.10 (Spring 1988), p.23.

capital. The non-electrical machinery industry only generated a spill-over on the transportation equipment industry. However, the effect was quite large so that the social rate of return on R+D capital in the non-electrical machinery industry was 2 to 3 times the private rate of return. The R+D capital from electrical products and transportation equipment each affected the same industries as the chemical products industries. In both cases, the social rate was greater than the private rate, but only by about 10 to 20 per cent. The last industry is scientific instruments, which affected the chemical products and electrical products industries. The R+D capital from scientific instruments generated substantial spill-over effects on these two industries. In fact, the social rate of return was around 10 times the private rate" ([6], p. 433).

If the magnitude of spillover effects (or externalities) is indeed valid, the case for rethinking industrial policy becomes a strong one, contrary to the conventional skepticism about the strength of externalities and other market failures. In response to these and other findings, the old issue of the market versus State has re-emerged as a hot topic for debate. But, as usual, researchers as well as policy makers are divided—the market forces and gains-from-trade groups against the active industrial policy groups.* The latter school argues that the United States needs to redirect efforts and resources in order to meet challenges stemming from the globalization of industry and technological progress particularly in Japan. For instance, one recent statement reads:

"... there was still the suspicion that government could not pick winners and losers, and there was no understanding that this was *not* what the Japanese did. Japan had asked itself: Given the expanding technologies of tomorrow on which future industries will be built—microelectronics, biotechnology, telecommunications—where do we Japanese want to excel? And what is required for success? How do we build a climate that will allow us to achieve our goals? In the semiconductor example, the United States moved in the Japanese direction. It said, 'Yes, we want to preserve our capability in this all-important field. We are not prepared to let nature take its course. If other nations have strategies so must we'" ([7], p. 94).

These calls for strengthening industrial competitiveness were not unnoticed in policy action. Subsidies and favourable taxes have been among the major incentive measures. For instance, "of the $124.9 billion spent on private research and development in the United States in fiscal year 1988, 47 per cent came in the form of direct subsidies from the federal Government. ... The Tax Reform Act of 1986 extended the credit at a rate of 20 per cent, and later congressional action extended the credit through 1989" ([13], p. 140). Furthermore, the United States Congress passed the National Competitiveness Technology Transfer Act in November 1989. This law aims at establishing links between federal defence research-and-development programmes and private companies, with commercialization as a spin-off. This represents a sequel to the Omnibus Trade and Competitiveness Act of 1988, a powerful instrument designed to enhance the competitiveness of United States industry.

Summing up, industry in North America is faced with new challenges and opportunities coming from Asia and Europe. The challenges apply not only to low-technology production, but to high-technology products in which the United States used to dominate. Competition at all levels of technology is expected to intensify in the 1990s (involving, for example, low-technology goods from China, medium-technology goods from NICs, and high-technology goods from Japan). There seems to be a need to design new policy measures aimed at accelerating industrial productivity growth in the region, if it is to be prevented from falling behind. Meanwhile, it should be emphasized that, rather than competing for dominance or protection, cooperation to share markets, technology, risks and profits (for example, through joint ventures) has often proved to be a viable approach to solving numerous dilemmas caused by industrial disputes between the United States, Japan and Western Europe.*

*Examples of the latter group include [7], [8], [9] and [10]. Conservative views are expressed, for instance, in [11], p. 439-479; and [12], pp. 9-23.

B. Japan

Though the year 1991 is expected to see a mild dip in GDP growth to 5 per cent (from 5.3 per cent in 1990), the Japanese economy will lead virtually all other industrial economies in growth performance, and thus provide a much-needed stimulus to growth. Declining private investment will be partly offset by an increase in government investment. Implementation of the Japanese pledge, at the Structural Impediment Initiative meetings between the United States and Japan, to spend $3,200 billion over the next decade is likely to be accelerated in order to counteract the slow-down in growth. Basically, consumers appear to remain confident, though a higher interest rate could dampen their confidence somewhat.** The Japanese trade surplus will continue to pose problems leading to heightened political pressures from the United States and the EEC.

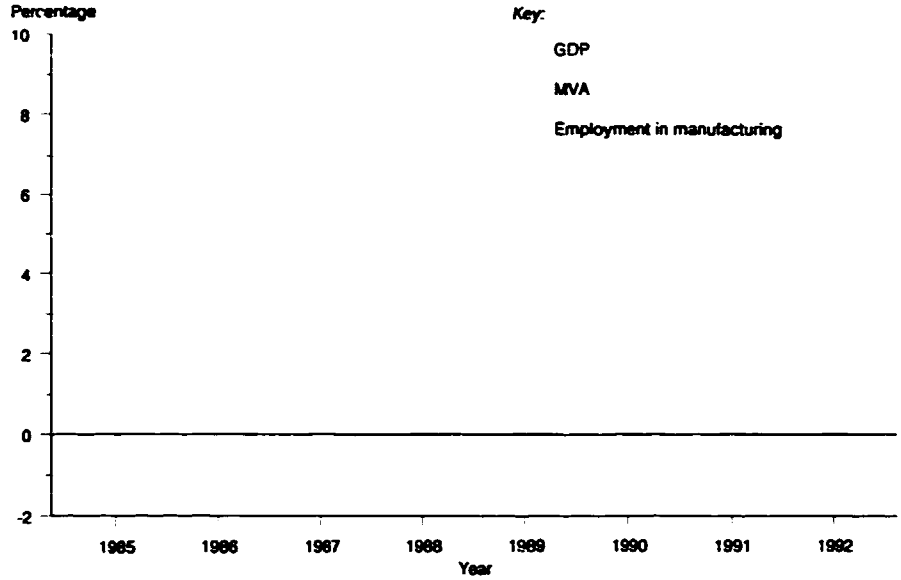
The major growth-constraining factor, private investment, is expected to slow to 1.1 per cent for all industries (−1.1 per cent for manufacturing in 1991) compared with 17 per cent growth in 1990 and 18 per cent in 1989. The 1991 figures come from the survey conducted by the Bank of Japan in February 1991 when the Gulf war was raging (see table II.6). The pessimism due to the war may be revised. Nevertheless, the negative rates of operating profits for fiscal year 1990, as reported in the table II.6, do not seem to augur well. However, engineering and capital goods industries (precision instruments, shipbuilding and heavy machinery, fabricated metal products, non-electrical machinery etc.) earned higher profits than resource-based industries (paper and pulp, steel, non-metallic mineral products, chemicals etc.).

The expected slack in private investment could be at least partly offset by government spending planned on building new airports, bridges, motorways, magnetic levitation trains, a science city, telecommunication systems, waterfront development etc. A 6 per cent increase in such spending for the fiscal year 1991 has passed the scrutiny of the highest legislative body of Japan, the Diet. This step will add a substantial demand for manufactured goods. In Japan, normal construction spending amounts to approximately 18 per cent of GDP, compared with about 9 per cent in the United States. As usual, Japanese policy makers are transforming adverse conditions into benefits; this time, the pressures of the Structural Impediment Initiative are leading to the modernization of infrastructure, with the promise of greater efficiency in the next century.

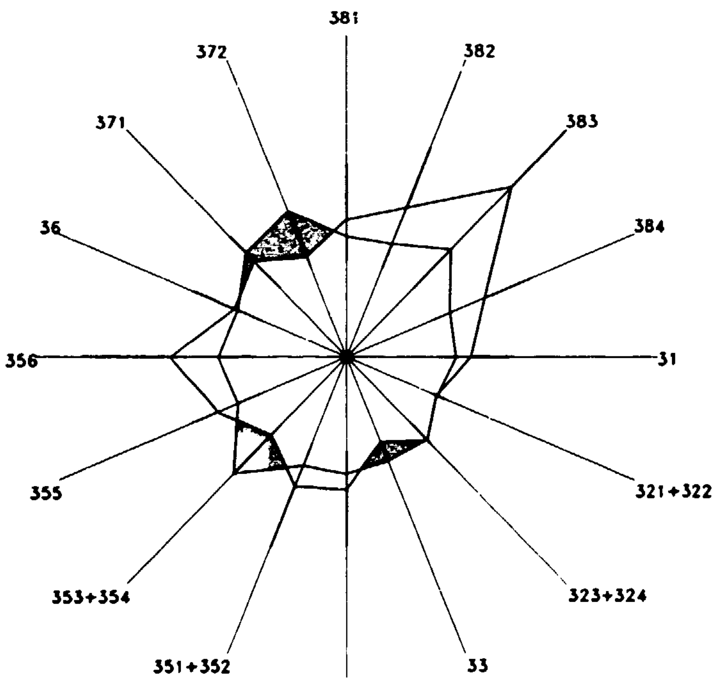
*"General Motors, for instance, entered into a joint venture with Toyota in part to learn a different conception of the corporation, one in which the authority of the managers derives from the managed. It turns out that employee motivation, productivity, and efficiency are greater when employees participate in decisions that affect their work and when they have enough of a sense of employment security to make a sacrifice today for gains tomorrow. ..." ([7], p. 41).

**The Bank of Japan raised the interest rate three times in 1989 and twice in 1990.

Figure II.3. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: Japan



Industrial structural change
(Index of value added: 1975 = 100)



g = 4.08, θ = 14.33

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast

1980–1985

1975–1980

Sources UNIDO database, estimates and forecasts by UNIDO/PPD/IPP/GLO

Table II.6. Japan: capital spending survey of large firms, fiscal year 1990 to fiscal year 1991
(Percentage change from previous fiscal year)

Industry	Fiscal year 1990 estimated		Fiscal year 1991 estimated	
	Operating profits	Capital spending	Operating profits	Capital spending
Manufacturing				
Food products	4.4	-1.8	0.8	-9.6
Textiles	-3.3	6.7	3.7	2.4
Paper and pulp	-49.8	-1.6	7.4	-43.5
Chemicals	-8.3	11.6	1.9	0.7
Petroleum products	42.6	31.1	1.9	0.8
Non-metallic mineral manufactures	-15.3	33.3	3.1	2.7
Steel	-15.2	34.2	-14.0	6.3
Non-ferrous metals	2.8	34.7	1.4	5.4
Fabricated metal products	11.1	53.5	4.9	2.8
Non-electrical machinery	8.9	44.9	2.1	-7.7
Electrical machinery	3.4	15.4	0.4	-2.3
Shipbuilding and heavy machinery	16.2	37.4	6.5	3.2
Motor vehicles	1.1	30.3	-2.2	4.5
Precision instruments	19.3	23.0	5.6	-6.0
Average manufacturing	-0.3	21.2	-0.1	-1.1
Non-manufacturing				
Construction	22.5	17.2	4.9	-7.7
Real estate	7.2	18.6	0.9	-0.8
Trading companies	3.3	8.5	4.5	-11.8
Retailing	6.2	8.2	5.2	10.3
Transport and communications	-2.4	11.1	0.7	4.7
Electric power	..	9.8	..	3.5
Gas supply	..	7.5	..	2.5
Electric power and gas supply	-36.8	..	-1.8	..
Services	6.1	35.5	7.5	-12.1
Leasing	-30.7	21.4	7.5	-12.1
Average non-manufacturing	-1.7	13.9	2.9	2.7
Average all industries	-0.8	16.9	1.0	1.1

Source: Bank of Japan.

Table II.7. Demand trends for selected products and services in Japan, 1985-1995
(Fiscal year 1985 = 100)

Category	Item	1985	1995
Export-dependent	Synthetic fibre production	88.8[a]	90.7[a]
	Crude steel production	104.2	105.8
	Automobile production	104.3	110.4
High-technology-related	Robot production	138.4[a]	283.5[a]
	Integrated circuits production	161.3[a]	241.1[a]
	Electronic computers and related equipment	167.4[a]	257.1[a]
Information-related	Contracts for car telephones	790.0	489.2
	Contracts for wireless call systems	197.0	508.0
	Publishing and printing	124.3	178.6
	Information service sales	278.6[a]	580.8[a]
Service-related	Leasing contracts	163.4	336.2
	Restaurant sales	122.1[a]	175.4[a]
	Fitness and gymnastic sales	180.0	580.0

Source: Japan Center for Economic Research.
[a] Indicates calendar year.

Much of the demand so created for manufactures would include high-technology varieties, such as fibre optics, intelligent buildings loaded with electronic gadgets and automatic office equipment, and nationwide telecommunication linkages. Table II.7 reflects the pace of changing demand composition for selected products and services (as estimated by the Japan Center for Economic Research). The growth leaders are expected to be the information-related products, such as car telephones, wireless call systems, information services, integrated circuits and computers. These represent high-value products per unit of material inputs. Such structural and compositional shifts in manufacturing are an important factor in the Japanese trade surplus, a factor which has been neglected in conventional analysis of Japan's balance of payments surplus problems (see figure II.3 for GDP and MVA pattern of growth in recent years and also for structural change in industry).

Energy-saving adjustments appear also to exemplify the structural approach embraced by Japanese decision makers. Oil imports declined from 2.4 per cent of gross national product (GNP) in 1978 to 0.8 per cent in 1989, largely as a result of changes in industrial structure. Thus, on the one hand, the vulnerability of the economy to oil price vagaries has been curtailed, while, on the other hand, energy-saving efforts have added to the trade surplus problem, especially when oil prices have fallen on the world market. The low oil prices in the post-Gulf war period seem to boost the trade surplus in 1991, reversing its recent slower growth trend.

The trade surplus seems certain to raise tension between Japan and its trading partners, particularly the United States and the EEC countries. The United States developed two strategies, namely the Structural Impediments Initiative and special article 301 of the Omnibus Trade and Competitiveness Act of 1988, to manage its trade deficit problems with Japan. The former targeted the following six major problem areas of Japanese markets for negotiation: the gap between savings and investment; urban and agricultural land policies; the multilayered, anti-competitive distribution system; business practices of collusion and exclusion; long-term *keiretsu* relationships in industrial organization; and slow changes in pricing mechanisms.* Special article 301 was not used in 1990, as its repetitive use was thought to be counter-productive. Many observers have at any rate judged these tools for negotiation to be ineffective as a means of quickly correcting trade imbalances, as well as being detrimental to the multilateral approach of the General Agreement on Tariffs and Trade (GATT) ([11], pp. 439-479).

The basic reasons for the chronic bilateral trade imbalances between Japan and the United States may stem from a variety of components of the two economic systems. The six United States targets for Structural Impediment Initiative negotiations could be an important set of components. However, it seems that the existing system has also been capable of generating superior competitiveness in Japanese products sold in the world market. The search for an explanation must take into account the rapid development of new products with higher value added, and new production processes cutting costs and eliminating defects. If the technical progress so observed were the real cause of Japanese competitiveness, then penetration of the closed Japanese market may be only a peripheral issue, not the real one ([14], pp. 21-45; and [3]).

Studies have revealed that over the past 30 years, the TFP growth of Japan has exceeded that of the United States by a wide margin (see table II.8). Table II.9 confirms this observation for a shorter period.

The gross value per hour worked in Japan reached 90.2 per cent of the United States level for total manufacturing in 1985, from 63.6 per cent in 1975 (measured in United States prices). Industry measurements of labour productivity are striking. In 1985, the electrical machinery and equipment industry reached 339.4 per cent of the United States level (83.5 per cent in 1975), machinery and transport reached 136.8 per cent (100.3 per cent in 1975), and basic and fabricated metal products reached 119.5 per cent (78.6 per cent in 1975). These are industries in which Japanese products have been beating similar United States products. The United States has insisted that Japan adopt voluntary export restraints on numerous items produced by these industries, including steel, automobiles, machine tools, semiconductors etc.

Behind these products and productivity figures lies the Japanese organizational and institutional edifice, providing information flows and incentive structures painstakingly crafted to facilitate technical progress and thereby enhance competitiveness (see box).

Table II.8. Growth of TFP in the United States and Japan, 1953-1974

Year	Annual rates of TFP change	
	United States	Japan
1953	2.0	7.2
1954	3.7	6.6
1955	3.7	6.4
1956	-0.9	5.9
1957	0.4	2.1
1958	0.3	-1.3
1959	2.6	6.9
1960	0.0	9.2
1961	1.3	10.3
1962	3.0	-3.7
1963	1.5	7.6
1964	2.4	8.6
1965	2.0	0.4
1966	1.4	4.9
1967	-0.6	5.3
1968	1.2	8.7
1969	-0.7	3.5
1970	-1.2	5.0
1971	1.8	1.6
1972	2.5	4.0
1973	1.4	1.8
1974	-4.1	-8.5

Source: D. W. Jorgenson and M. Nishimizu, "United States and Japan economic growth, 1952-1974: an international comparison", *Economic Journal*, vol. 88 (December 1978), p.722.

*For a discussion of these issues, see *Industry and Development: Global Report 1990/91* (UNIDO publication, Sales No.: E.90.III.E.12), pp. 50-51.

Reasons for the high competitiveness of Japanese industry

Japanese industrial competitiveness and the shift from imitation to innovation in various industries have been mainly due to a number of factors, in particular the following:

(a) Selective concentration on generic technologies that are pervasive and usable in many industries (computer-aided design, micro-electronics etc.), thus helping Japanese firms to build up their technological capabilities;

(b) Promoting economies of scope (flexibility) apart from economies of scale by intensive use of flexible manufacturing systems, robots etc;

(c) Promoting economies of aggregation through highly diversified but vertically integrated firms;

(d) Promoting the conflict-reducing role of MITI, which is helping firms to monitor world technological trends and to evolve programmes specifically designed to produce future-oriented industrial technologies;

(e) Planning deliberately to take up risky projects and then reducing the risks through consensus decision-making;

(f) Intense human resource development efforts at the firm level;

(g) Existence of a large number of laboratories operated by corporations in specialized areas but with specific product development objectives;

(h) A low interest rate helping to sustain continuous upgrading of manufacturing facilities and to reduce obsolescence through regular large-scale investments;

(i) Strong links between research and development, manufacturing and marketing, through staff training in complementary functions;

(j) Establishment of future-oriented production facilities through technology development projects among manufacturing firms. An example is the development of the synchrotron as a basis for the high-density circuit needed to produce a 64-megabit dynamic random access memory (DRAM). The synchrotron was developed by a number of firms (including NTT, Toshiba and Hitachi) with an investment of 20 billion yen. The project shows that the future growth of electronics will be towards the 64-megabit DRAM in the 1990s and the 100-megabit circuit at the beginning of the next century. The foundation has already been laid in Japan for the future growth of a new generation of micro-electronics circuits. Simultaneous cooperation and competition among Japanese firms is another unique feature of their highly innovative system;

(k) Rapid diffusion of new technologies. For example, in 1975 the rate of application of the facsimile was only 4.4 per cent, whereas in 1987 it had reached 63.7 per cent. Similarly, personal computer use was only 1.1 per cent in 1975, but had reached 48.3 per cent by 1987. The proportion of continuous cast steel in total steel production in 1987 was 92.7 per cent in Japan, as compared with 90.1 per cent in France, 60.5 per cent in the United Kingdom, 55.2 per cent in the United States and 14.5 per cent in the USSR. Rapid diffusion of new technologies helps in improving industrial competitiveness by increasing productivity and reducing manufacturing costs.

(l) Intense interaction among operators and engineers and the operation of the quality-circle system in Japanese industries. In the steel industry, the quality-circle concept has contributed considerably to operational improvements and cost reduction. The system is operational in most steel firms: Kawasaki Steel has about 3,300 quality-circle groups; Kobe Steel, about 2,400; Nippon Kokan, 3,842; Nippon Steel Corporation, 7,000; and Sumitomo, about 4,100.

(m) The "perception effect" as the primary cause of the technological superiority of Japan in information-oriented technologies. People who are continuously exposed to new technologies help the quick diffusion of new technologies. Japan is planning about 15 technology cities ("technopolises"), in which information technologies will be the key factor integrating the various activities. The country has already introduced the concept of 'intelligent buildings' incorporating networking, office automation and environmental control.

To sum up, Japan's rapid technological growth and high industrial competitiveness are due to a combination of technological, economic and social factors. The way the Japanese react may be explained using the 'Le Chatlier-Braun principle', stated thus: whenever a system in equilibrium is subjected to a constraint, it reacts in such a way so as to minimize the effect of the constraint. The pursuit of micro-miniaturization, conservation of space and resources, high-density living, strong communication links, high team spirit, outstanding productivity, innovative skills, a craving for information, and the urge to keep abreast of technological advances throughout the world—all these are ways of responding to problems such as high population density, low natural resource endowments, heavy dependence on energy imports, and isolation from other countries.

Source: B. Bowonder and T. Miyake, "Technology development and Japanese industrial competitiveness", *Futures*, January-February 1990, pp. 40-41.

Table II.9. Japanese gross value per hour worked as a percentage of United States gross value, by major manufacturing branch, 1975-1985

	Major manufacturing branches	1975	1985
1	Food manufacturing	28.10	20.29
2	Beverages	38.30	35.71
3	Tobacco products	26.40	31.09
4	Textile mill products	50.97	39.89
5	Wearing apparel	52.62	27.75
6	Leather products and footwear	22.46	17.55
7	Wood products, furniture and fixtures	18.14	23.75
8	Paper products, printing and publishing	44.52	57.81
9	Chemicals, petroleum and coal products	49.26	77.91
10	Rubber and plastic products	101.02	66.55
11	Non-metallic mineral products	52.18	50.45
12	Basic and fabricated metal products	78.55	119.45
13	Machinery and transport equipment	100.33	136.76
14	Electrical machinery and equipment	83.47	339.37
15	Other manufacturing industries	42.16	125.07
	TOTAL	63.63	90.24

Source: A. Szirmai and D. Pilat, "Comparisons of purchasing power, real output and labour productivity in manufacturing in Japan, South Korea and the United States, 1975-1985", *Review of Income and Wealth*, Series 36, No. 1 (March 1990), p.25.

Note: Data based on United States prices. Using Japanese prices the difference between the two countries is greater, but the change is generally about the same.

Masahiko Aoki has compared Japanese firms with those of the United States. Some of his findings, listed below, are instructive, and provide "food for thought" for policy makers in both developing and developed countries:

(a) The decentralized internal information structure of the Japanese firm is shown to be effective in adapting the work process flexibly and swiftly to a continually changing market and technological environment;

(b) Lifetime employment, seniority pay, bonuses and retirement allowances, and enterprise unionism collectively yield an incentive structure for employee competition for faster promotion on the basis of their learning achievements (information-processing capabilities);

(c) A *de facto* coalition of employees and stockholders based on bargaining (involving, for example, the exchange of diligent work for job guarantees) is efficient in solving conflicts and harmonizing the interests of both parties;

(d) The *keiretsu* system appears to provide a risk-sharing arrangement and to reduce long-run transactions costs for technological risk-taking activities.

More recent evidence suggests that ". . . information and incentive problems in the capital market affect investment. We come to this conclusion by examining two sets of Japanese firms. The first set has close financial ties to large Japanese banks that serve as their primary source of external finance and are likely to be well informed about the firm. The second set of firms has weaker links to a main bank and presumably faces greater problems raising capital. Investment is more sensitive to liquidity for the second set of firms than for the first set. The results may also suggest that the institutional arrangements in Japan offer Japanese firms an important competitive advantage. While international cost-of-capital comparisons are generally quite difficult to make, the evidence here documents that Japanese institutions may enable firms to mitigate capital market imperfections. To the extent that the United States capital market has no analogous institutional arrangements, United States firms may operate at a disadvantage" ([15], p. 57).

In short, though a mild slow-down is expected in 1991, Japanese industrial growth will lead that of virtually all other industrial economies. Japanese industry is robust, considering its on-going technical progress (long-term TFP growth), and its capacity for quick restructuring and adjustment to changing economic conditions compared with other industrial countries. Its rapidity of adjustment appears to stem from institutional arrangements that support quick action by providing information, investment funds and incentive rewards for technological risk-taking. Thus, there seems to be little likelihood of the current North American recession being transmitted to Japan in full force in the short-run.

Developing countries could benefit from studying carefully the differences in industrial organization and intra-firm behaviour between the United States and Japan. The findings of comparative research have made a substantial impact on policy formulation relating to technology and business operations, such as burgeoning United States-Japan joint ventures aimed at sharing newly developed institutional skills. Examples of Japanese innovation abound, the following being particularly noteworthy: the multifunctionality of workers, an essential ingredient of the *kanban* (just-in-time) system; a multidisciplinary team approach in development projects, particularly in high-technology industry where various disciplines such as engineering, marketing, finance, supply and procurement interact in an integrated manner; a de facto coalition of employee and stockholder organizations; the *keiretsu* system, which functions on the basis of long-term trust rather than contract specifications or court enforcement proceedings; and a horizontal information flow system as opposed to the vertical system of United States firms.

Given these historical experiments, developing countries should re-examine their existing institutional systems to determine whether their information and incentive structures are conducive to industrial upgrading. The creativity of policy makers is obviously crucial in borrowing and adapting institutional techniques, taking into account the political and cultural realities of the countries concerned.

C. Western Europe

For the immediate future, a guarded optimism concerning industrial growth in Western Europe can be allowed for several reasons. Expenditures on German unification are providing a strong pull of (Keynesian) demand for goods and services supplied by German producers as well as other EEC producers. The former Federal Republic of Germany recorded a strong 4.6 per cent GDP growth rate in 1990, in spite of high interest rates. Such growth occurred not only in consumer goods, but also in investment goods. The basic impetus for construction and investment generated by projects relating to the single EEC market of 1992 seems to have been maintained, despite uncertainties occasioned by the Gulf war. Moreover, the recession in the United Kingdom appears to be bottoming out.

Countering the positive forces, negative factors include the economic collapse in the territory of the former German Democratic Republic, inflationary pressures threatening to push up interest rates in the rest of Germany, low consumer confidence in some countries of the region, and fundamental uncertainties associated with the systemic reforms in Eastern Europe and the USSR.

The region is expected to maintain at least a 1.8 per cent GDP growth rate in 1991 (as in 1990). The growth leaders will include Germany, Ireland, Italy, Portugal and Spain.

Among the major factors determining the industrial performance of the region, German unification figures prominently. To fight the collapse of the economy of the former German Democratic Republic, where GDP fell by 20 per cent in 1990, (see table II.10 for industry rates of decline), the Government announced a set of special reconstruction projects worth over 24 billion deutsche mark to be spent in the period 1991-1992. Considering the worse-than-expected unemployment situation (with a 50-per-cent idle workforce projected in the former German Democratic Republic by the end of 1991), more money may be spent for unemployment benefits. These expenditures, along with other commitments such as aid to the USSR, could cause the budget deficit to top 5 per cent of GNP in 1991. Fortuitously, however, German expenditures are providing a much-needed growth stimulus for Germany's trading partners, particularly France and the United Kingdom (see table II.11).*

Another major factor is the continuous investment demand, though with a slow-down in some countries, such as the United Kingdom. Expenditures on fixed investment in Germany are expected to maintain an 8 per cent growth in 1991, after 8.7 per cent in 1990. Strong consumer demand particularly from the former German Democratic Republic has been sustaining

*"Germany recorded its first deficit on visible trade for 10 years in April (1991), underlining how German unity has led to a surge of imports in a country which last year registered the world's highest current account surplus" ([16], p. 1).

Table II.10. Production trends in the former German Democratic Republic following monetary union

Industry	Index of production percentage change from previous year	
	Third quarter 1990	Fourth quarter 1990
Chemicals, petroleum refining, rubber, plastic products	-47	-39
Ferrous and non-ferrous metal production	-64	-71
Non-metallic mineral products	-54	-68
Mechanical engineering, means of transport	-34	-36
Electrical engineering, precision instruments	-42	-49
Textiles, clothing, leather, leather products	-54	-61
Food, beverages	-60	-58
All industries	-48	-51

Source: Gemeinsames Statistisches Amt für die neuen Bundesländer, as quoted in Cambridge Econometrics, et.al., *Europe in 1995* (Cambridge, 1991), p.156.

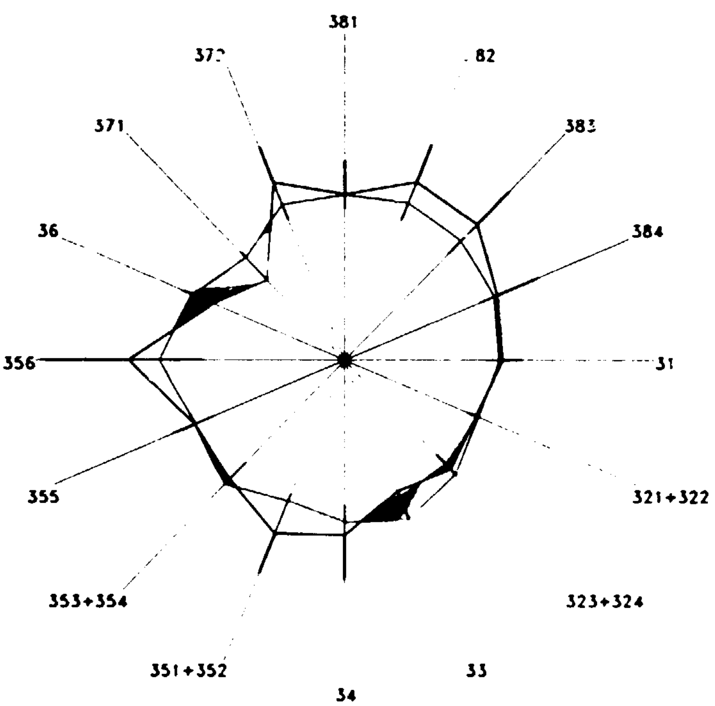
Table II.11. Exports of European OECD countries to the Federal Republic of Germany
(Billion deutsche mark)

Country or economic grouping	Annual rates			Percentage change from year-earlier period	
	1989	1990	1990 (fourth quarter)	1990	1990 (fourth quarter)
Austria	21.9	24.8	26.7	13	19
Belgium-Luxembourg	35.8	40.6	46.0	14	32
Denmark	9.5	11.2	13.0	19	26
France	53.2	58.9	64.0	11	12
Italy	48.2	50.4	60.8	16	21
Netherlands	52.9	59.1	64.7	12	19
Spain	10.1	12.1	15.5	12	20
Sweden	12.7	13.1	13.9	4	7
Switzerland	20.2	22.7	24.7	13	14
United Kingdom	34.5	37.8	43.2	10	17
OECD Europe	325.0	364.6	404.9	12	18

Source: Organization for Economic Co-operation and Development.

Figure II.4. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: Western Europe

Industrial structural change
(Index of value added: 1975 = 100)



g = 1.62, θ = 10.02

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast

1980–1985

1975–1980

Sources: UNIDO database, estimates and forecasts by UNIDO PPD IPP GLO high sales prospects, thanks to unemployment compensation, which is helping to maintain the purchasing power of the unemployed, though it will be unsustainable in the long-run.

Furthermore, the single European market still appears to be encouraging bullish behaviour among investors, as reflected in the levels of foreign direct investment (see table II.12). EEC countries as a group received the largest inflows ($72.2 billion) of foreign direct investment in 1990, even surpassing the United States. This trend is expected to continue in 1991 and 1992, providing growth benefits to the region in the form of both increased aggregate demand and greater production capacity, particularly in high-technology areas.

Although a breakdown of foreign direct investment by product categories is not available, it is well known that such investment, particularly from Asia, is targeted on the automobile, electronics, information and telecommunications industries. The obvious reason is to circumvent the protectionism, real or only feared, associated with the building of the single European market.* These industries are expected to grow faster than others (see table II.13). Whether indigenous producers in the high-technology areas could compete with foreign producers is a question that worries both policy makers and industrialists in the region (see figure II.4 for GDP and MVA growth in recent years and also for the pattern of structural change in industry).

1. Challenges to European industry and technology

Whether the single European market will lead to a "Fortress Europe" is everyone's concern and anybody's guess; however, the industrial and technological competition now raging does not seem to allow much room for optimism. Disputes over the definition of a "Japanese car" symbolize the basic issue of protectionism and its complexity.*

At the heart of the problem is the relative lag of European innovation compared with the United States and Japan, particularly in information and communication technology. In recent years, Japan has emerged as the leader in commercial applications of such technology in a variety of industries, making them formidable competitors in terms of the price and quality of their products. The case of automobile manufacturing is just one example of the Japanese challenge.

Table II.14 provides some details of the application of information and communication technology in a range of industries, comparing the EEC, the United States and Japan. It is worth noting that the number of inventions related to such technology as a share of total inventions in each industry is largest in Japan and smallest in the EEC, and this observation holds true in virtually all industries. On the demand side, table II.15 shows how applications of information and communication technology are spreading throughout various industries. For instance, computer-aided design (CAD) and computer-aided engineering (CAE) have spread through almost the whole of the mechanical engineering, data-processing equipment, electrical equipment, telecommunications equipment, consumer electronics, semiconductors, motor vehicles, and aerospace industries. CAD and CAE are spreading at an accelerated pace in the textiles and clothing industry, and starting to spread into the food and drink industry. The information and communication tech-

*Some analysts argue that German unification carries an inherent tendency to move toward protectionism (see for instance, [17], pp. 11-18).

*Whether a car imported into Europe from a Japanese-affiliated car maker in the United States should be regarded as a Japanese car or a United States car is an issue yet to be settled.

Table II.12. Capital movements of major industrialized countries, 1975-1990
(Billion dollars)

Country or economic grouping	1975-1979	1980-1984	1985	1986	1987	1988	1989	1990
Outward portfolio flows (movements of share capital and other securities)								
Total outflows	17.0	45.7	119.6	180.3	122.7	197.0	266.7	157.6
United States	5.8	5.8	7.5	4.3	5.3	7.9	21.9	26.7
Japan	2.6	13.8	59.8	102.0	87.7	87.0	113.1	39.7
EEC	3.8	18.7	43.8	62.9	20.8	85.6	116.0	83.0
France	0.9	1.2	2.5	6.0	3.3	4.2	6.7	6.8
Germany	1.5	4.3	11.0	9.7	13.5	41.4	26.7	14.6
United Kingdom	0.8	10.8	24.7	34.0	-6.7	17.8	58.8	28.5
Direct inward investment								
Total investment	18.4	34.2	33.4	58.7	92.0	120.5	155.0	114.9
United States	6.1	18.6	19.0	34.1	46.9	58.4	72.2	25.7
Japan	0.1	0.3	0.6	0.2	1.2	-0.5	-1.1	1.8
EEC	10.6	13.3	12.2	17.1	34.0	49.5	69.8	72.2
France	1.9	2.2	2.2	2.8	4.7	7.2	9.7	8.1
Germany	1.3	0.8	0.5	1.1	1.9	1.0	6.8	1.5
United Kingdom	4.2	5.3	4.7	7.3	14.1	18.3	28.8	31.6

Source: *Financial Times*, 11 June 1991, p.3

Table II.13. Production and employment in selected industries in Western Europe, 1982-1989 and projections to 1995

Industry	Average annual percentage growth rate			
	Production volume		Employment	
	1982-1989	1989-1995	1982-1989	1989-1995
Food and drink	1.3	1.6	-0.5	-0.5
Textiles and clothing	1.1	0.8	-1.6	-2.0
Pharmaceuticals	5.5	4.3	1.6	1.2
Automobiles	4.8	2.8	-0.8	0.0
Mechanical engineering	2.7	3.4	-1.4	0.9
Telecommunications equipment	5.2	8.2	..	-0.7
Aerospace	4.0	5.5	-	1.0
Coal	-3.2	-2.5	-5.7	-6.5
Oil and gas	0.7	0.6	-2.8	-1.0
Electricity	3.3	2.5	-0.5	-0.5
Crude steel	1.6	-0.5	-5.5	-2.3
Glass	3.6	2.9	-2.7	-1.6
Aluminium	0.2	1.2	..	1.1
Chemicals	4.3	2.9	-0.4	1.3
Transport	3.2	3.1	1.0	1.0
Telecommunication services	6.3	6.5	1.1	0.6
Data processing services	18.6	15.0	..	13.0
Audiovisual services	13.4	8.5	2.2	1.1
Retail distribution	2.6	2.5	0.7	0.4

Source: Gemeinsames Statistisches Amt für die neuen Bundesländer, as quoted in Cambridge Econometrics, et.al., *Europe in 1995* (Cambridge, 1991), pp.163-165.

Table II.14. Share of information- and communication-technology in the inventions of science-based industries [a]: EEC, United States and Japan, 1986-1988

Industry	EEC		United States		Japan	
	Rank[b]	Percentage	Rank[b]	Percentage	Rank[b]	Percentage
Office and data-processing machinery	1	100.0	1	100.0	1	100.0
Radios, television sets and similar equipment	2	100.0	2	100.0	2	100.0
Telecommunications equipment	3	100.0	3	100.0	3	100.0
Optical precision instruments	4	65.0	4	60.4	5	51.5
Photographic and video equipment	5	37.7	5	56.7	4	60.3
Aerospace equipment	6	20.1	7	21.8	7	39.6
Measurement, monitoring and precision equipment	7	18.2	6	38.0	6	45.9
Electrical machinery, wires and cables	8	14.9	10	18.1	9	23.3
Paper, printing and bookbinding machinery	9	14.5	9	18.1	8	31.9
Robotics	10	9.6	8	21.8	18	13.4
Medical and surgical equipment	11	7.3	16	5.9	10	23.3
Miscellaneous chemical products for industrial use	12	6.9	17	4.1	24	11.5
Chemicals	13	5.5	18	3.9	16	14.4
Processing of plastics	14	5.3	14	6.1	22	12.3
Rubber and plastics processing machinery	15	5.3	15	6.1	23	12.3
Motor vehicles	16	4.1	13	6.6	20	13.3
Mechanical lifting and handling equipment	17	3.7	11	10.1	12	18.4
Construction and civil engineering equipment	18	3.1	21	3.5	11	19.5
Metalworking machine tools	19	2.5	12	7.9	15	15.0
Hydraulic and pneumatic machinery	20	2.4	27	2.2	25	10.9
Space heat, ventilation, air-conditioning equipment	21	2.3	29	1.7	17	13.5
Iron, steel and metallurgical machinery	22	2.0	25	2.4	26	10.4
Internal combustion engines	23	1.9	32	1.4	29	10.0
Spectacles, equipment for use by opticians	24	1.7	26	2.4	19	13.3
Textile machinery and accessories	25	1.7	28	2.0	32	7.7
Transmission equipment for motive power	26	1.7	23	2.6	21	13.2
Iron and steel industry	27	1.6	19	3.7	31	8.2
Foundries	28	1.3	24	2.5	33	6.6
Machinery for food and related industries	29	1.2	20	3.6	28	10.2
Machinery for working wood and similar materials	30	1.2	22	3.5	13	18.1

Table II.14. (continued)

Industry	EEC		United States		Japan	
	Rank[b]	Percentage	Rank[b]	Percentage	Rank[b]	Percentage
Mining machinery	31	1.1	34	0.0	14	16.7
Compressors, pumps	32	0.9	31	1.4	27	10.2
Agricultural machinery	33	0.6	30	1.5	30	8.4
Pharmaceuticals	34	0.4	33	0.3	34	0.7

Source: Gemeinsames Statistisches Amt für die neuen Bundesländer, as quoted in Cambridge Econometrics, et.al., *Europe in 1995* (Cambridge, 1991), p.97.

[a] Measured by the number of inventions with patent applications in at least two countries.

[b] Within the country or grouping.

Table II.15. Status of application of selected information-and-communication-technology systems by industry

Industry	Distribution procurement/transport						Production			R+D/management/ administration				
	SSF	MIS	IMS	EDI	JIT	BRS	CNC	CAM	CAD	CAR	DB	EM	TCS	MS
Coal							••	••			•	•		
Oil and gas								••			••	•	•	••
Electricity								•••			••	•	•	••
Steel industry			••	•	•			••	••		•	•	•	••
Cement			•					••	•			•		•
Glass			••	•	•			••	•			•		•
Basic chemicals			••	•				•••		•	••	•	•	••
Plastics			•	•				•••		•	••	•	•	••
Pharmaceuticals			••	•			•	••		•	••	•	•	••
Food and drink	•	•	••	•				••	•			•		•
Mechanical engineering			•	•			••	•	•••		•	•	•	•
Data processing equipment			•••	••	•		•••	••	•••	••	••	••	••	••
Electric equipment			•	•			••	•	•••		•	•	•	•
Telecommunications equipment			•	•	•		•••	••	•••	•	••	•	•	•
Consumer electronics			••	•	•		•••	••	•••		•	•	•	•
Semiconductors				••	•		•••	•••	•••	••	•••	•	••	••
Motor vehicles industry		•	••	••	••		•••	••	•••	••	•	••	•	••
Aerospace industry			•	••	•		•••	••	•••	•	••	••	••	••
Textiles, clothing			•	•			••	•	••		•	•	•	•
Building, civil engineering									••		•	•	•	•
Wholesale trade		••	•	•	•	•					•	•	•	•
Retail trade	•	••	•	•		•					•	•	•	•
Rail transport	•		•	•		••					•	•	•	•
Road transport			•	•	•	•						•		•
Air transport	•		•	•		••					••	•	•	•
Transport services			•	•	•	•					•	•	•	•
Banking	••			••							••	••	•	•
Insurance				••							•	••	•	•

Source: Gemeinsames Statistisches Amt für die neuen Bundesländer, as quoted in Cambridge Econometrics, et.al., *Europe in 1995* (Cambridge, 1991), p.94.

Note: * Starting; ** accelerated spread; *** nearly complete spread.

SSF = Self-service facilities.
MIS = Merchandise information systems.
IMS = Inventory management systems.
EDI = Electronic data interchange.
JIT = Just-in-time procurement systems.
BRS = Booking and reservation systems.
CNC = Computer numerically controlled.
CAM = Computer-aided manufacturing.
CAD = Computer-aided design.
CAR = Computer-aided research.
DB = Databases.
EM = Electronic mailing.
TC = Teleconferencing.
MS = Management systems.

nology industry is expected to generate 10 per cent of world GDP in the year 2000 (compared with 5 per cent in 1989). European producers and policy makers are anxious to win a sizeable share in this fast-growing market. Currently, European consumption represents one third of the world total, while European production accounts for only 25 per cent of world output. In components production, Europe's share amounts to 17 per cent of output, compared with 41 per cent for Japan and 31 per cent for the United States. Among several factors explaining why Europe trails behind those countries, the shortage of scientists and managers appears to stand out. EEC countries train 39 science students per 1,000 inhabitants, compared with 88 in Japan and 79 in the United States.

Japanese prowess in information and communication technology also seems to have arisen from its early start. Information and communication technology is known to require huge lump-sum research and development costs with high risks. Furthermore, once the technology is commercialized, the learning-curve effect reduces the unit cost rapidly with increasing production experience (dynamic increasing return). Under these circumstances, the early starter wins. Japan identified information and communication technology as a "strategic sector" as early as the mid-1960s.

The most serious European response to the challenge has come rather late. Projects designed for the single European market started only in the mid-1980s, in particular the technology projects such as BRITE and ESPRIT. As latecomers, European producers have a choice to make. According to one scenario, the European market should be protected until such future time as the indigenous producers are able to compete. Under another scenario, European producers would cooperate with Japanese and United States companies through joint ventures in order to share the market, the technology and the profits.

The current signals appear mixed. On the one hand, Europe's top 10 companies in the field of information and communication technology have formed a group called the "Information Technology Roundtable". The group has made various recommendations of a strategic nature for action by the EEC. First, a transition period is needed during which imports of electronic goods should be restricted until "reciprocal market access" is obtained in countries or regions of trading partners. Secondly, EEC countries should exercise restraint in providing incentives to attract foreign direct investment. Thirdly, anti-trust policy should be "pragmatic" (meaning "lenient") so long as cooperation among European enterprises gives them a competitive edge in the global market.

On the other hand, some major companies have been searching for opportunities to form partnerships with Japanese companies, and some have succeeded. For instance, 15 per cent of Bull's United States subsidiary is owned by NEC, and Bull is buying a number of mainframe computers from NEC. Olivetti is producing some photocopier and fax machines under a joint venture with Canon and Sanyo. Siemens holds shares of Fuji Electric, which holds shares of Fujitsu, and Siemens buys mainframe computers from Fujitsu, and so on. Yet the Roundtable decided to exclude ICL (International Computers Limited) from membership because Fujitsu's take-over (with an 80 per cent holding) of ICL went against the aim of the group to promote the competitive position of Europe in relation to its Japanese and United States rivals.*

Another policy development characterizing the new attitudes associated with the emergence of the single European market concerns a recent decision relating to Japanese automobiles. The EEC Commission plans to help make the European automobile industry competitive by taking the following steps:

(a) Existing national quotas will be replaced by an EEC-wide arrangement for voluntary export restraint with Japan on 1 January 1993;

(b) The voluntary export restraints will be enforced from 1993 to 1999, during which time the share of Japanese cars will double to up to 16 per cent of the market, or approximately 2.5 million cars, including Japanese cars made in Europe;

(c) New country quotas for maximum sales of Japanese cars will be negotiated.

These moves were thought to be too lenient by the newborn European automobile association, the *Association des constructeurs européens d'automobile* (ACEA). The ACEA and the Commission have not yet settled their differences. United States experience with the application of voluntary export restraints by Japanese automobile manufacturers does not provide convincing evidence that such arrangements are an effective tool for sharpening the competitiveness of protected products.

The Information Technology Roundtable and the ACEA represent a new institution-building process that promises to play an important role in defining the market mechanism in the region. In July 1989, the first European Economic Interest Grouping was initiated. During the subsequent 18-month period, 114 such groupings were inaugurated throughout the EEC. Essentially these are producers' associations freely formed across national boundaries in order to exchange information, conduct joint buying and selling if it is economical to do so, and formulate joint opinions and recommendations to be conveyed to the Commission on EEC-wide policy matters. These groupings could become either politically powerful lobbying agencies against competition, especially from outside the region, or essential components of the single European market, helping to correct market imperfections relating, for example, to information generation and dissemination, and undertaking joint action to reduce risks and uncertainties, particularly those associated with cross-cultural transactions.

The region still has a wide range of agenda items to tackle before and after 1992. As of January 1991, the Council of Europe had before it 87 proposals relating to the single market (out of a total 285). The remaining items include such difficult issues as harmonizing value added tax, export controls relating to article 223 of GATT (which allows member States to take unilateral action in the fields of defence and security), accounting rules, and product quality stand-

*The expulsion disqualifies ICL from participating in some research projects sponsored by ESPRIT, although ICL was a founding member of ESPRIT.

Impact of the single EEC market of 1992 on Developing Countries*

An attempt has been made to quantify the simple gains-from-trade effects for developing countries of the single European market of 1992 (see table II.16). The single European market will result in trade creation (additional imports from non-EEC countries) and trade diversion (replacement of imports from non-EEC countries by production from within the EEC), and the increased efficiency expected from the single market will mean lower prices for EEC exports, providing a gain to importers. The total effect shown in table II.16 combines the gains for developing countries from trade creation and the price effect, less the loss due to trade diversion, which is assumed to affect manufactures only, since primary products from developing countries (tropical foodstuffs, oil etc.) do not generally face competition from EEC producers.

The following points should be noted with regard to the estimated gains-from-trade effects:

(a) The calculated total effect will be small (2.8 billion European currency units (ECUs)), less than 3 per cent of developing country exports to the EEC;

(b) For manufactures, trade diversion will be greater than trade creation, hence countries with a high percentage of manufactures in their exports to the EEC will tend to do less well than others, and opportunities for exporting manufactures to the EEC will be reduced;

(c) Trade creation in primary products will result in a net positive trade effect, which will be somewhat greater than the price effect (manufactured imports from the EEC will become cheaper);

(d) For countries specializing in the export of certain products subject to special import restrictions in the EEC (for example, bananas, coffee, cocoa, tobacco, footwear and wearing apparel), the effects may be considerable;

(e) The total effect will be negative (1.3 billion ECUs) for Asian NICs (which, being highly adaptable suppliers, will probably alter their export structures accordingly) and slightly negative for China, whereas the largest gains (due to higher demand for oil) will accrue to OPEC countries (1.5 billion ECUs about 5 per cent of their exports to the EEC);

(f) The estimated effects, apart from inherent difficulties such as uncertainty regarding trade elasticities and the static, partial-equilibrium nature of the methodology, do not reflect the many regulatory and institutional changes that the single market will bring, the effects of which are as yet impossible to quantify, but which may be of greater significance for developing countries than the simple gains-from-trade effects shown;

(g) There will be interactions, which cannot be quantified at present but which will undoubtedly affect the outcome for developing countries, between the single European market of 1992, the changes taking place in Eastern Europe and the USSR, the results of the GATT Uruguay Round of multilateral trade negotiations, and any modifications of the Multifibre Arrangement.

Based on Sheila Page, "Some implications of Europe 1992 for developing countries", mimeograph (December 1990), for the OECD Development Centre.

Table II.16. Estimated gains-from-trade effects for developing countries of the single European market
(Million ECUs and percentages)

Country, region or economic grouping	Trade creation: Primary	Trade creation: Manufactures	Trade diversion: Manufactures	Combined trade effect	Combined effect as percentage of exports to EEC	Price effect	Total effect	Percentage share of manufactures in exports to EEC
ACP	543	315	477	361	2.3	231	592	49.2
ASEAN[a]	446	102	464	-18	-0.3	44	26	..
Asian NICs	12	2 574	4 077	-1 491	-6.1	197	-1 294	95.5
China	56	529	689	-104	-1.5	58	-46	..
Latin America	502	495	751	246	1.3	208	454	52.6
Maghreb	244	370	534	80	0.9	90	170	..
Mediterranean	733	1 434	1 918	250	0.8	474	724	59.2
OPEC	1 556	515	847	1 224	3.8	312	1 535	9.3
South Asia	30	391	436	-15	-0.3	80	65	80.4
All developing countries	2 804	4 434	5 655	1 582	1.5	1 196	2 778	52.9

Source: Sheila Page, "Some implications of Europe 1992 for developing countries", mimeograph (December 1990), for OECD Development Centre.

Note: Based on 1987 trade values, or 1988 values in the case of ASEAN, Asian NICs, China, OPEC and South Asia, and assumed trade elasticities.

[a] Association of South-East Asian Nations.

ards. These are sensitive matters having to do with security, sovereignty and cultural traditions. Agenda items to be dealt with after 1992 include relationships with the countries of Eastern Europe and the USSR and also with EFTA, and the establishment of a European economic area and European monetary union.

D. Eastern Europe and the USSR

The systemic reforms taking place in Eastern Europe and the USSR brought negative growth in national output and industrial production in 1990 (see table II.17 for growth performance by country). A further deterioration of undetermined magnitude is expected in 1991 and 1992. The conversion of a centrally planned system into a market-driven system requires replacing the practice of fixing targets at the national level for the quantity of goods to be bought and sold with that of allowing individual decision-making by every member of a society to determine such matters. But the latter practice presupposes, among other things (see the roadblocks to economic reform in Eastern Europe and the USSR, listed below) a workable system of information and communication technology, transport, rules for transactions and competition (legal and non-legal institutions), banking and accounting, as well as a skilled workforce to operate and manage the whole system. One of the basic reasons for the negative growth common to all the countries in the region is the virtual absence of such a system.

Externally, the collapse of the Council for Mutual Economic Assistance (CMEA) has severely disrupted production and trade. Under the CMEA arrange-

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Roadblocks to economic reform in Eastern Europe and the USSR*

1. *Price reform and free-market pricing*

   Eliminate central allocation and rationing
   Raise prices on necessities
   Free competitive sectors
   Privatize and regulate natural monopolies

2. *International conditions*

   Remove quantitative restrictions and substitute tariffs
   Align different exchange rates
   Allow foreign investment
   Establish convertibility of currency

3. *Capital market changes*

   Free interest rates
   Introduce commercial (retail) banking separated from central bank
   Control money supply

4. *Labour markets*

   Free firms to lay off workers
   Introduce unemployment insurance and welfare reforms
   Introduce housing reforms for mobility

5. *Hard budget constraints*

   Reform accounting
   Remove profit constraints
   Remove credit constraints
   End tax and regulatory haggling

6. *Stabilization*

   Reduce budget deficits
   Raise interest rates
   Introduce anti-inflation policies (tax-based incomes policies, foreign competition)

7. *Budget reform*

   Remove redistributional pricing and substitute income-tested transfers
   Remove subsidies to failing firms

8. *Decentralization of economic decisions*

   Allow private property
   Separate firms from Government
   Privatize firms and production

9. *Competition*

   Break up monopolistic state firms
   Introduce antitrust laws and regulations
   Allow entry of foreign firms
   Encourage small enterprises

10. *Institutions of the market*

   Establish contract and bankruptcy law
   Train managers
   Nurture *homo economicus*
   Change anti-market sentiments

*See ([19], p. 296)

Table II.17. Eastern Europe and the USSR: indicators of growth performance in 1990
(Percentage)

Country	National product	Industrial production	Rate of inflation
Bulgaria	-10.0(GNP)	-10.0	50-60
Czechoslovakia	-3.0(NMP)	-3.7	18.4
Hungary	-4.5(GDP)	-10.2	31
Poland	-12.0(GDP)	23.3	250
Romania	-15.0(GDP)	-20.0	200
	-10 to -11(NMP)		
USSR	-2.0(GNP)	-1.2	14
	-4.0(NMP)		
Yugoslavia	-10.0(GNP)	-10.0	122

Source: Institute for Economics, Market Research and Informatics, Budapest.
Note: GNP = gross national product;
NMP = net material product.

ments, manufacturing industries in different countries were linked together as input suppliers and assemblers. For instance, the USSR supplied engine parts to be assembled in Bulgaria under a coordinated scheme to meet the needs of the five-year plans of different member countries.* Furthermore, the USSR used to be the main energy provider at subsidized prices or under barter deals. But now the USSR wants hard currency for all trade transactions, including those involving oil. Redirecting trade flows from CMEA partners to others, most likely in Western Europe, will take time and require changes in terms of trade because of the low-quality output produced by non-competitive industries.

Conditions in individual countries are briefly reviewed below, with a description of short-run performance, policy responses and future prospects, followed by a discussion of long-run structural policy issues (see figure II.5 for GDP and MVA growth in recent years and also for the pattern of structural change in industry).

1. USSR

Given the lack of a coherent reform programme**, economic performance in the USSR is expected to worsen significantly in 1991, with GNP declining by 7 per cent. To finance the budget deficit, which is running at 10 per cent of GNP, the USSR desperately needs to attract $15 billion in foreign capital.

The dramatic deterioration in the current account of the USSR is mainly due to the failure of the country's main export earner, oil, which accounts for 60 per cent of its revenues. The use of outdated technology (pumping oil to the surface by injecting water) has not only caused a massive waste of oil, but has also corroded the pipeline system, leading to a fall in output. Moreover, strikes in Azerbaijan, the main producer of oil equipment for the USSR, have resulted in a shortage of spare parts for the oil industry. Consequently, crude oil production fell to 11.4 million barrels per day in 1990, from 12.5 million in 1988 and 1989, and is predicted to fall further in 1991.

The reforms initiated so far by USSR policy makers—increased retail prices and wages, and encouragement of workers to participate in the management of State-owned enterprises—fell apart almost as soon as they began to be implemented. Prices are still government-controlled. Price changes have originated in government orders, with retail prices being raised in order to manage the rise in wholesale prices in 1990. An across-the-board increase in wages by less than the rise in prices did not remedy the distorted wage structure (in the USSR, surgeons are paid about a third of the wages of bus drivers). Worker participation in management was tried and failed in Eastern Europe in the 1980s. Under State ownership and with a lack of incentives, workers tended to put their own short-term interests above the long-term interests of the firm.

The logic behind the USSR policy of raising retail prices relative to the rise in wages was to give firms an incentive to produce more. However, industrial output fell by an annualized rate of 30 per cent in the first two months of 1991, indicating a fall in supply as well as demand. The firms cannot respond to higher prices because input supplies remain firmly under government control.

The State firms thus look to the government for finance, but revenue is falling at an alarming rate in the USSR because of the reluctance of the republics to hand in taxes. Remittances from the republics fell by as much as 72 per cent in just the first two months of 1991. State expenditure, on the other hand, keeps rising—subsidies on food alone cost the Government of the USSR 120 billion roubles in 1990.

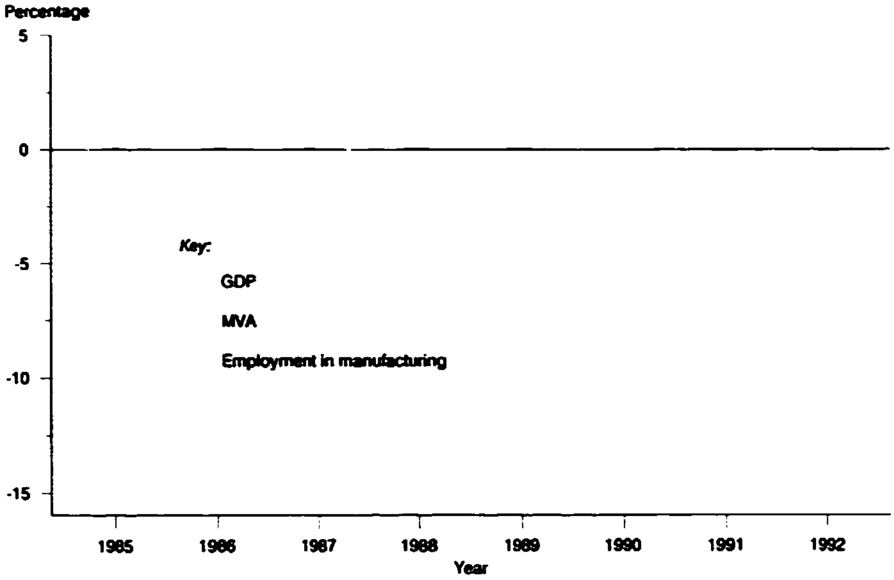
The declaration of intent signed in April 1991 by the Presidents of 10 Soviet Republics provides some evidence of a willingness to compromise on the part of the central authorities. However, the initial effect of the agreement will be to worsen the economic situation. Its pledge to repeal a 5 per cent sales tax and revoke part of recent price increases will reduce government revenues, while its indexation of wages will boost spending, and thus increase inflation. The Government desperately needs to raise funds to support its economic reforms (see below for list of possible funding sources).

Although agreements have been signed for 3,000 joint ventures in the USSR, including a $10 billion project with the American Trade Consortium (Chevron, Johnson and Johnson, RJR Nabsico, Eastman Kodak, and Archer Daniels Midland) to produce oil, food, cigarettes, film and other products, Fiat's $5.5 billion project to build car factories, Alcatel's $2.8 billion digital telephone switch venture, Combustion Engineering's $2.2 billion proposal to build a petrochemical complex, and a $2 billion plan of the American Medical Consortium (Pfizer, Hewlett-Packard, and Colgate Palmolive) to provide medical equipment and consumer goods, only about one third of the joint ventures have become operational, because of fears that the USSR economy may not improve.

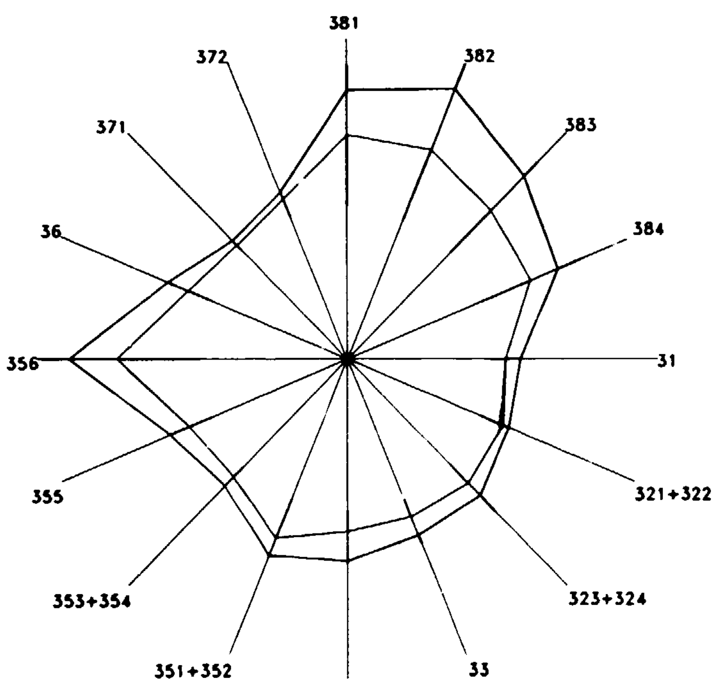
*"In 1990, 84 per cent of Bulgaria's exports were to other CMEA partners. In the first half of the last year Hungary delivered 34 per cent of its exports to CMEA members, Czechoslovakia 46 per cent, Poland 67 per cent and the USSR 54 per cent" ([18], p. 32).

**For a concise history of successive reform plans, see [20], pp. 146-167.

Figure II.5. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: Eastern Europe and the USSR



Industrial structural change
(Index of value added: 1975 = 100)



g = 2.07, θ = 17.37

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast
1980–1985
1975–1980

Sources: UNIDO database, estimates and forecasts by UNIDO/PPD/IPP/GLO

Possible sources of finance for economic reforms in the USSR

1. Domestic resources for conversion

   (a) Conversion of the defence industry to the production of civilian goods

   (b) Raising billions of roubles through the sale of houses and apartments to citizens seeking to purchase homes, preferably on an instalment plan (and, at the same time, siphoning off money overhang)

   (c) Selling land to farmers, with the same effect as in *(b)*

   (d) Natural resource development through joint ventures with foreign enterprises for the export of such items as mineral ores, oil, gas, and forest and marine products

   (e) Establishment of a manufacturing export zone or free trade zone

   (f) Joint ventures for the utilization of USSR capital assets in science and technology

2. External resources to be tapped

   (a) Development loans (for the construction of warehouses, roads, bridges, railways etc.) provided by the World Bank, the European Bank for Reconstruction and Development, the International Monetary Fund (for trade financing), and a North-East Asian Development Bank, which could be created through the pooling of resources for regional development in the North-East Asian region (including China, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea, and USSR), where resource complementarity appears to be robust

   (b) Official development assistance from the Group of Seven major industrialized countries

   (c) Foreign direct investment (through transnational corporations, joint ventures etc.)

3. Access to major markets

   (a) North America

   (b) EEC

   (c) Asia—Pacific region

4. Technical assistance from UNIDO and other international organizations to support reforms in specific areas

   (a) Privatization

   (b) Wage policy

   (c) Manager training

   (d) Development of the financial sector

   (e) Enterprise rehabilitation programme

For example, after the Deutsche Bank made losses on half of its USSR loans, German banks are refusing to lend any more money without 100 per cent government guarantees. The USSR still offers the prospect of a potentially lucrative market of 280 million consumers (for recent data on foreign direct investment, see tables II.18 and II.19).

Prospects of converting military into civilian industries

Around 60 per cent of engineering output and 25 per cent of GNP is taken up by military production in the USSR. The announced goal of converting at least 60 per cent of the production of military industries to civilian goods by 1995 is beginning to look increasingly remote, mainly because of the lack of coherent planning. The conversion scheme, which ironically originated from the defence department of the State Planning Committee, was drawn up by the military central planners without any participation of the civilian sector. Consequently, a switch from defence to civilian industry without structural reforms would only result in increasing monopoly conditions and economic rigidity.

Although defence plants have been relatively successful in producing complicated medical equipment, electrical appliances, personal computers and radios, such progress is rare. Generally, plans for civilian production take no account of the nature of the plant or the skills of the employees. For example, aircraft

Table II.18. Eastern Europe: evolution of joint equity ventures
(Estimates of cumulative numbers registered)

Time	Czechoslovakia	Hungary	Poland	USSR
End 1970s	-	4	-	-
1984	-	32	-	-
1 January 1988	7	102	13	23
1 January 1989	16	270	55	191
1 June 1989	35	420	190	679
1 January 1990	60	1 000	918	1 261
1 March 1990	60	1 000	1 000	1 480
1 July 1990	85	1 600	1 550	1 734
1 October 1990	500	2 300	1 950	2 024
31 December 1990	..	5 000	2 500	2 800

Sources: United Nations Economic Commission for Europe, Geneva.

Table II.19. Eastern Europe: growth in value of foreign direct investment in joint ventures
(Million current dollars)

Time	Czechoslovakia	Hungary	Poland	USSR
1 January 1988	10	95.8	4.4	89.4
1 January 1989	16	259.8	8.2	416.7
15 October 1989	85	360	80	1 700
1 March 1990	98	443	110	2 440
1 July 1990	140	800	186	3 140
1 October 1990	340	1 080	340	3 208

Source: United Nations Economic Commission for Europe, Geneva.

and motor plants are being converted to provide facilities for light industry, medical products and the food and agricultural sector, rather than producing civilian planes, still scarce in the USSR. Not surprisingly, such mismanagement has resulted in drastically lower production levels. Output at the Tula defence plant, for example, is down by 72 per cent, leading to net losses after a profit level of a million roubles in 1990. Again, the remedy would entail full commitment to privatization, including the scrapping of the State industries.

The lack of a skilled labour force also constitutes a major obstacle to the conversion scheme. The Sovfinamtrans (a joint venture consisting of USSR State railways, Neftechiimexport, a USSR oil company, a Finnish construction company, and Transico Industries of the United States), a $15 million project that could potentially provide civilian employment for some 400 military-industrial factories, is now floundering because of a lack of finance and of skilled labour and equipment, according to official sources.

Foreign debt problem

To complete the dismal economic picture, there is the problem of mounting Soviet debt, which could rise from $65 billion to $75 billion by the end of 1991. Debt repayments are projected to rise to $11 billion (excluding $5 billion of unpaid trade debts), while the debt-service ratio has risen from 8 per cent in 1986 to more than 15 per cent in 1990.

With decreasing export earnings, the Government now faces a limited number of policy options to finance its external deficit. It has already agreed to sell 234 tonnes of gold in 1990, amounting to $1.6 billion. Foreign exchange reserves have already begun to dwindle at an alarming rate, falling by two thirds in 1990 to $5.1 billion. National income is predicted to fall by as much as 16 per cent in 1991; reducing demand further by cutting imports would plunge the country into a deep recession. Finally, if imports of capital goods are cut, industries dependent on capital imports would suffer, including chemicals, machine tools and electronics.

2. *Poland*

The first stage of the "shock therapy" reforms in Poland liberalized trade, stabilized markets and established an internally convertible zloty. While successful privatizations and a trade surplus (with a current account balance of $0.6 billion) were recorded in 1990, it came at the cost of a 25 per cent fall in GDP, a 527.3 per cent rise in the consumer price index, a 32 per cent fall in private consumption expenditure, and a 17 per cent unemployment figure. The outlook for 1991 shows an improvement in GDP (forecast to fall by only 8 per cent), the consumer price index (forecast to rise by 60 per cent) and private consumption expenditure (predicted to fall by 10 per cent). Although the figures are negative, they represent an improvement over the economic performance of 1990.

Public sector industrial output fell by 25 to 30 per cent in 1990 according to official statistics, and is expected to fall at a lower rate in 1991. Food processing and light industry suffered the most, while investment fell by 10 per cent. The switch to hard-currency trade with CMEA, combined with the recession in the USSR, is expected to have an adverse effect on Poland's terms of trade. The current account deficit is expected to reach $2.2 billion in 1991, with imports rising to $15.6 billion and exports falling to $14.5 billion.

However, public sector figures fail to take into account the expanding private sector. The GDP of the private sector increased by 17 per cent (26 per cent excluding agriculture) in 1990, while its share in exports tripled. Nevertheless, the private sector has a long way to go: its share of total Polish exports still amounted to only 5 per cent in 1990, while its share of imports was only 14.6 per cent.

With 67 per cent of Poland's foreign debt (amounting to $31 billion) forgiven by its donors, known as the Paris Club, in March 1991, and with lower oil prices, the prospects of attracting foreign investment to Poland have improved substantially. New laws have recently been drafted which allow for 100 per cent profit repatriation.

Poland has already made progress in privatization. The biggest foreign investments include an agreement by Fiat to invest 453 million pounds sterling to develop a new mini-car and to modernize the State-owned FSM assembly plant in Silesia. Of the 160,000 cars produced per year, 100,000 will be exported to Western Europe. There is a $140 million venture of Pilkington (United Kingdom) with HSO Sandomierz to manufacture glass, and a $50 million deal of ABB (Switzerland) with Zamech to produce turbines. General Motors is considering investing $100 million to build an assembly plant for 30,000 to 50,000 cars per year. By the end of 1990, approximately 2,800 licences had been granted for joint ventures, but only 954 were operational. The average capital investment, at $163,000, was modest and many of the companies are small import-exporting firms.

Another method pursued by Poland to hasten privatization is the free distribution (to between 20 million and 40 million people) of State-owned assets, giving its citizens up to 30 per cent of the value of privatized companies, while the Government is to retain, at least initially, a 40 per cent share. The 5,000 small firms are the main target; the Government has also announced privatization of the State-owned airlines and retail stores.

3. *Other Eastern European countries*

Czechoslovakia is going through a period of deep recession. According to the Budapest-based Institute for Economics, Market Research and Informatics, in 1990 its national income fell by 3 per cent, industrial production by 3.7 per cent, and GDP by 3 per cent, while consumer prices rose by 12 per cent. The outlook for 1991 looks bleak; output is expected to fall by 10 per cent and inflation will rise to 30 per cent.

The energy sector will be the worst hit. Czechoslovakia remains heavily dependent on Soviet oil suppliers, more so than the other Eastern European countries. In the event of disrupted supplies of 7.5 million tonnes of oil from the USSR (and, given the Soviet energy crisis, a fall in supplies cannot be ruled out), economic instability in Czechoslovakia will rise substantially.

After 100 per cent nationalization under communist rule, Czechoslovakia is structurally behind the other Eastern European countries such as Hungary and Poland. This is reflected in its balance of trade figures: while the trade of Hungary and Poland with developed market economies rose sharply (around 30 per cent) in 1990, the trade of Czechoslovakia with those economies increased by merely 4.5 per cent. However, with new laws designed to attract foreign investment (100 per cent profit repatriation, two-year tax holidays) and low labour costs, foreign capital flow is expected to increase. The private sector is surprisingly strong, accounting for 10 per cent of GNP in 1990, and as much as 40 per cent forecast for 1991.

Foreign investments in Czechoslovakia recorded a substantial increase in 1990. Volkswagen is the biggest investor, with its 31 per cent stake in Skoda, the Czechoslovak car maker. The $6.6 billion investment (which accounts for 10 per cent of Czechoslovakia's GNP) over a 10-year period is aimed at the production of 400,000 cars per year by 1997 to meet an expected boom in demand for cars in Eastern Europe's 100 million households. However, unless the economy of the region improves, putting more cash in consumer hands, the projected consumer demand will not be translated into effective demand. Other major agreements concluded are a $175 million joint venture between CBC (France) and Tourinvest to build hotels, a $106 million venture between Linde (Germany) and Technoplyn to expand the gas industry, and an $80 million agreement between United States West (in partnership with Bell Atlantic) and the Government of Czechoslovakia to build phones and switches. Czechoslovakia has also embarked on a voucher scheme designed to accelerate its privatization process. Under the scheme, 40 to 80 per cent of the equity in from 1,000 to 2,000 State-owned firms (70 per cent of the total State-owned sector) is to be distributed in a series of auctions beginning in January 1992. With 70 to 80 per cent of Czechoslovak companies technically bankrupt, government options are severely limited.

Hungary is the most "westernized" of the formerly centrally planned economies of Eastern Europe. It attracted more than half of the total $1.2 billion worth of foreign investment in the region in 1990. Hungarian exports (processed food, machinery and some consumer goods) mainly targeted for Western European markets yielded a $950 million surplus in 1990. The private sector is as large as that of Poland, accounting for 30 per cent of GNP in 1990, and forecast to reach 45 per cent in 1991.

However, the economic crisis in the USSR and the consequent slow-down in its trade with Hungary (exports to the USSR are predicted to fall from 30 per cent of Hungary's foreign trade in 1989 to 14 per cent in 1991) means difficult economic conditions ahead for Hungary in heavy industries such as automobiles and industrial machinery. Bankrupt State enterprises are estimated to account for 7 per cent of economic output, and industrial production is estimated to have fallen by 10 per cent in 1990.

In spite of the relatively large amounts of foreign investments in Hungary, GDP could still fall by 5 to 5.5 per cent in 1991, resulting in a 6 to 6.5 per cent fall in domestic consumption, and a 7.5 to 8 per cent fall in investments. Another major problem for Hungary is its foreign debt, the highest per capita in Europe. In an attempt to boost its privatization programme, Hungary has been actively promoting joint ventures. The country plans to privatize 500 to 600 firms by 1993, and to put 50 to 60 per cent of State-owned assets in private hands by 1996. However, unless institutional reforms are firmly in place, the prospects for economic reform in Hungary, as in the rest of Eastern Europe, seem blighted from the beginning.

4. *Transformation toward a competitive system*

One of the major aims of the reform movements is to introduce market competition into centrally planned economic systems as a means of rewarding efficient producers. But the reforms entail demonopolization, privatization, rationalization of prices, and, importantly, the acceptance of competitive outcomes as a way of life—tantamount to a rejection of traditional egalitarianism. While the fundamental direction of change appears to be set in the region, the societal debates continue to rage (except in the now-defunct German Democratic Republic) as to the timing, speed and extent of reform, the modalities and transformation techniques, and the final shape of the structural mix envisioned in each country.

With regard to the issue of demonopolization in the USSR, for instance, the seven decades of central planning resulted in the creation of oversized firms and monopolies in virtually all industries (see table II.20), which now have to be broken up and left to compete on their own. But precisely how is this to be done? One way to solve the problem would be to liberalize imports against which domestic producers must compete. But the problem with non-tradeable goods would still exist. In this case, high monopoly profits should send signals for new entrants (including foreign direct investment) to come in and compete. No barrier should hinder such movement. The whole process requires, on the one hand, the establishment of laws and regulations governing competition, and, on the other hand, sufficient time for actors (managers) to play their parts accordingly.

Privatization presents no less daunting problems. First, the extent of privatization in an industry (70 per cent? 100 per cent?) should be agreed.* Secondly, an equitable method of distributing shares should be devised. Thirdly, the speed of privatization should be determined (within one year or five years?). Fourthly, stock market operations should be determined through the forces of supply and demand. This process will also require the establishment of laws and regulations and the training of actors (security dealers).

Privatization must be followed by action to rationalize the enterprise, such as the following: the shedding of redundant labour (often in excess of 100 per cent); the closing of non-viable production lines; and the retraining not only of unskilled labour, but also of technicians, managers and even engineers, in order to "sensitize" them to the need for cost-cutting etc. Rationalization at the interindustry level would also involve shifting resources toward light industry and consumer goods, hitherto relatively neglected. In the process, large-scale unemployment and inflation would tend to accompany negative output growth. The requirement of a safety net for the unemployed would force the Government to print money to finance it, adding force to inflationary pressures. This mix of economic ills appears to be common to virtually all the centrally planned economies in transition.

Inflationary pressures make the necessary price reforms even more difficult. Distorted prices must be corrected if the true scarcity value is to be made the basic signal for resource allocation and for the valuation of goods and productive factors. But freeing prices, where the infrastructure of market mechanisms (for example, an information system) does not exist, would tend to make price changes extremely volatile, chaotic or hyper inflationary.

The combination of these costly side-effects of the reform movement seems to be causing some to question its worth. In such a situation, consensus-building becomes crucial and requires strong political leadership:

> "True, all agree that there is no alternative to the market in the long-run; that eventually even the poor will gain more by robust economies than by state-imposed policies of income redistribution; that denationalization, deregulation and even tax reductions are desirable instru-

*At the time of writing, full agreement had not been reached on the extent of privatization (for example, of land) in the USSR.

Table II.20. USSR: concentration of deliveries to State supply agencies, by product group, 1988

Bracket (number of producers)	Production in bracket as percentage of total				
	Machine-building	Metallurgy	Chemicals and wood	Construction	For the social sphere
1	87.0	27.9	46.7	30.0	44.9
2-3	7.8	28.4	27.6	28.9	20.7
4-6	2.7	20.7	13.1	12.2	12.9
7-10	1.0	9.6	5.1	17.8	9.0
11-20	0.7	7.2	4.3	5.6	8.6
21 or more	0.8	6.2	3.2	5.5	3.9
TOTAL	100.0	100.0	100.0	100.0	100.0

Source: IMF, World Bank, OECD and European Bank for Reconstruction and Development, *A Study of the Soviet Economy*, vol.III (Paris 1991), p.315.

Table II.21. USSR: total factor productivity, 1950-1985, compared with other countries and areas

Estimated TFP growth of the USSR			Selected comparator countries or areas (1950-1973)	
Period	High	Low	Country	TFP growth
1950-1960	1.6	1.4	Republic of Korea	2.8
1960-1970	1.5	0.9	Taiwan Province	3.5
1970-1980	..	1.5	France	3.7
1975-1980	-0.4	-0.8	Germany, Federal Republic of	4.2
1980-1985	-0.5	-1.2	Japan	5.5

Source: IMF, World Bank, OECD and European Bank for Reconstruction and Development, *A Study of the Soviet Economy*, vol.III (Paris 1991), p.370.

ments of economic policy. But there is a strong undercurrent of sentiment through East-Central Europe in favour of egalitarian ideals. Resourceful and successful businessmen are often accused of "profiteering". Paradoxically, but not surprisingly, most people still feel entitled to the costly benefits associated with socialism, such as free education, subsidized housing and paid maternity leave" ([21], p. 138).

The egalitarian sentiment, if it persists, will probably shape the final outcome of the reform movement into something more like the Scandinavian competitive market system than the United Kingdom or United States systems. The old problem of balancing egalitarian values with efficiency requirements seems to have re-emerged in a landscape swept by reform. How the countries of Eastern Europe and the USSR will approach this problem remains to be seen.

The experiences of Eastern Europe and the USSR, however, seem to have made it plain to policy makers in developing countries that the total central planning regime as a system lacks the incentive structure to reward competitiveness achieved through innovative activities (see table II.21). Furthermore, creating a new system is far more difficult and costly than dismantling an existing system,* particularly because any reform process entails losers and gainers, and their conflict cannot be solved by economics alone.

E. Latin America and the Caribbean

The immediate outlook for the resumption of industrial growth in Latin America and the Caribbean as a whole has improved little, though the long-term prospects appear far better. The region is still plagued by high rates of inflation (see table II.22), heavy debt service requirements, net resource outflows (see table II.23), generally depressed foreign demand for its exports, mainly because of the United States recession, and declining living standards. MVA is expected to grow at 2.1 per cent and 2.4 per cent in 1991 and 1992, respectively, an improvement from —0.3 per cent growth in 1990. This picture is matched by GDP growth of 2.3 per cent and 2.6 per cent expected in 1991 and 1992, respectively. Population growth of 2.1 per cent projected for 1991 and 1992 overshadows both GDP and MVA growth prospects.

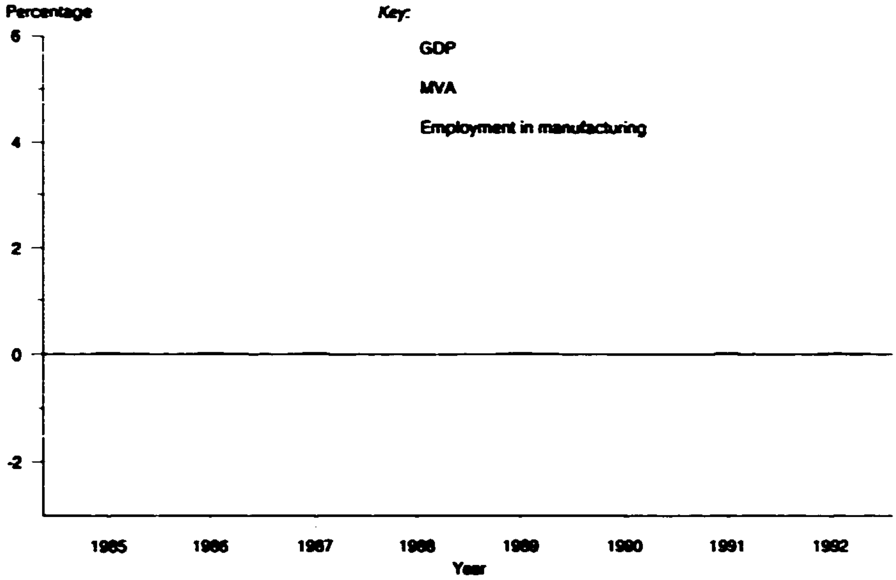
In the long-run, however, the region promises to achieve an improved industrial growth performance, especially because of the fundamental institutional changes taking place there. These changes include a strategic shift from an inward-looking to an outward-looking stance, from an emphasis on State-centred to private-centred industrial initiatives, and from protectionism towards a competitive orientation. Such steps would help to overcome the existing social and economic rigidities that have tended to block the adjustments needed for enhancing industrial competitiveness (see figure II.6 for GDP and MVA patterns of growth in recent years and also for the pattern of structural change in industry).

Counterbalancing the long-term positive factors are the legacies of the 1980s, in particular the reduction of investment levels in both physical and human capital (see table II.24) brought about by the heavy external debt burden. The loss of productive capacity therefrom will be felt during the decade ahead.

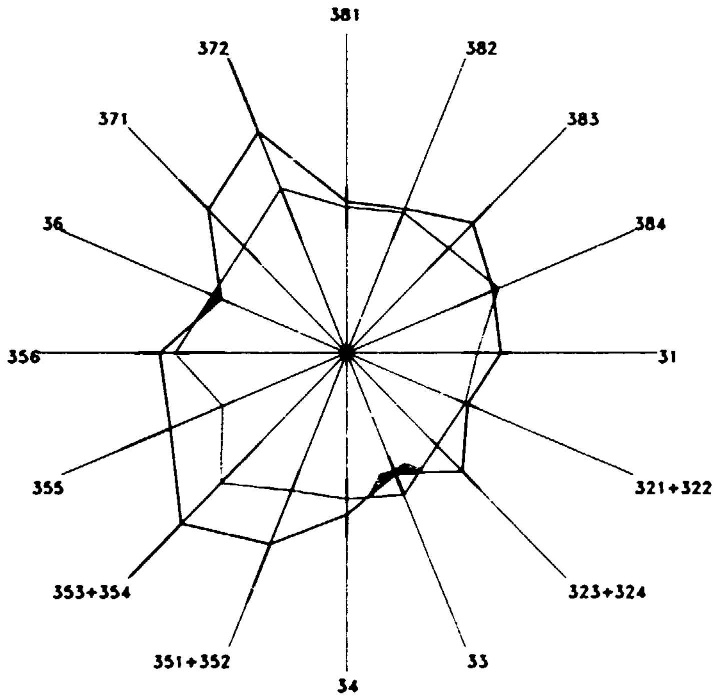
Growth performance in 1990 by individual countries in the region shows great diversity. Mexico has been more successful in implementing economic reforms partly because of its massive privatization campaign and the substantial influx of foreign capital. Its level of economic growth in 1990 was the highest in the past nine years. GDP grew by 3.9 per cent, with construction registering the greatest growth (7.7 per cent), followed by transport and communications (6.3 per cent) and manufacturing and utilities (5.2 per cent). Mining and agriculture also revived in 1990. MVA grew by 3.5 per cent, and is expected to grow by 4.3 per cent in 1991. However, if the United States recession continues, it could reduce Mexico's trade by one fifth in 1991 (62 per cent of the foreign investment in Mexico comes from the United States). The hardest hit would be the *maquiladora* (in-bond) industries along the United States border, which have so far recorded zero growth in 1991, compared with 15 per cent growth in 1990. All of Mexico's assembly industry is facing a downturn because of the United States recession: the car industry, electronics, television and household appliances, of which the main source of demand comes from the United States. Bilateral trade with the United States could be 15 to 20 per cent lower than the $50 billion figure recorded in 1990. This could have serious repercussions on the Mexican economy, which recorded a trade deficit of

*"The market system is complex, like a forest, a living organic thing. As the economists Kenneth Bounding and Joseph Berliner have noted, it is easy to chop down that forest, but it is very difficult and time-consuming to grow it again. It is not enough merely to replant several trees and call it a forest" ([22], p. 44).

Figure II.6. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: Latin America and the Caribbean



Industrial structural change
(Index of value added: 1975 = 100)



g = 2.60, θ = 13.76

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast

1980–1985

1975–1980

Sources: UNIDO database, estimates and forecasts by UNIDO PPD IPP GLO

Table II.22. Latin America: consumer price changes in selected countries, 1989, 1990 and forecast for June 1991
(Percentage)

Country	1989	1990	Forecast monthly rate for June 1991
Argentina	4 512.0	1 343.0	8.0
Bolivia	16.5	18.0	4.0
Brazil	1 764.8	1 794.0	10.15
Chile	21.4	27.3	1.0
Colombia	26.1	32.4	3.0
Costa Rica	9.9	27.2	2.0
Ecuador	54.2	44.1	3.0
El Salvador	17.5	24.2	10.0
Guatemala	20.2	60.2	4.0
Honduras	9.8	23.0	5.0
Mexico	19.7	29.9	2.5
Nicaragua	1 689.0	13 500.0	25.0
Paraguay	28.3	39.2	2.0
Peru	2 775.3	7 649.0	10.0
Uruguay	89.1	128.9	5.0
Venezuela	81.0	36.5	2.0

Source: *Latin American Economy and Business*, February 1991, p.14.

Table II.23. Latin America and the Caribbean: net capital inflow and transfer of resources
(Billion dollars)

Year	Net capital inflow (1)	Net payments of profits and interests (2)	Transfer of resources (3)[a]	Exports of goods and services (4)	Ratio of (3) to (4) (percentage)
1973	7.9	4.2	3.7	28.9	12.8
1974	11.4	5.0	6.4	43.6	14.7
1975	14.3	5.6	8.7	41.1	21.2
1976	17.9	6.8	11.1	47.3	23.5
1977	17.2	8.2	9.0	55.9	16.1
1978	26.2	10.2	16.0	61.3	26.1
1979	29.1	13.6	15.5	82.0	18.9
1980	29.7	18.1	11.6	82.0	10.8
1981	37.6	27.2	10.4	116.1	9.0
1982	20.2	38.8	-18.6	103.2	-18.0
1983	2.9	34.4	-31.5	102.4	-30.8
1984	10.0	36.7	-26.7	113.7	-23.5
1985	2.5	35.3	-32.8	109.3	-30.0
1986	8.7	32.2	-23.5	95.5	-24.6
1987	14.9	31.4	-16.5	108.2	-15.2
1988	5.3	34.2	-28.9	122.9	-23.5
1989[b]	13.7	38.3	-24.6	133.8	-18.4

Source: Economic Commission for Latin America and the Caribbean, on basis of official figures and figures supplied by the IMF.
[a] (3) = (1)-(2).
[b] Preliminary estimates.

$3 billion in 1990, a threefold increase over 1989. Investments in the oil industry also declined to only $2 billion in 1990. Privatization could be one way of dealing with the problem, but without the introduction of concomitant macroeconomic policies, it can hardly be regarded as a miracle medicine.

The industrial outlook for Venezuela, another country that has been relatively successful in attracting foreign capital, is also expected to improve in 1991-1992. A new drawback scheme is in effect for imported inputs used in manufacturing export goods. The scheme includes raw materials, semi-finished products, assembly parts, chemicals and other substances used in the manufacturing process. By reimbursing exporters for taxes regardless of whether the goods were imported or bought locally, the Government expects to offset the effects of the elimination of the export bond incentive, thus encouraging exports of manufactures. However, the 6 per cent bond incentive is still in effect for products with over 98 per cent of national value added.

The industrial outlook for Peru does not look promising. GDP growth is expected to increase gradually in the near future, as the Government struggles to comply with IMF stabilization policies and to control inflation. Although attracting foreign capital remains a top government priority, the overall economic crisis and guerrilla violence present major

Table II.24. Total government expenditures on education per person in Latin America, 1975-1985

Country	Expenditure per capita			Average annual growth rates		
	1975	1980	1985	1975-1980	1980-1985	1975-1985
	(1985 constant dollars)			(percentage)		
Argentina	63.37	93.60	39.28	8.11	-15.94	-4.67
Bolivia	24.07	28.75	1.88	3.62	-42.03	-22.50
Brazil	42.69	59.10	58.92	6.72	-0.06	3.27
Chile	43.98	65.28	51.98	8.22	-4.45	1.69
Colombia	22.01	22.33	..	0.29	..	..
Costa Rica	65.85	123.88	65.13	13.47	-12.07	-0.11
Dominican Republic	15.24	17.10	12.06	2.34	-6.75	-2.31
Ecuador	35.59	71.38	44.30	14.93	-9.10	2.21
El Salvador	34.28	36.31	22.87	1.16	-8.83	-3.97
Guatemala	19.24	27.12	21.19	7.11	-4.82	0.97
Haiti	3.62	6.19	4.48	11.31	-6.28	2.14
Honduras	26.83	27.34	33.14	0.37	3.93	2.13
Mexico	70.60	67.76	56.77	-0.82	-3.48	-2.16
Nicaragua	37.97	32.56	48.95	-3.03	8.49	2.57
Panama	103.35	101.69	108.72	-0.32	1.35	0.51
Paraguay	9.98	14.11	12.70	7.17	-2.08	2.44
Peru	35.16	31.54	23.32	-2.15	-5.86	-4.02
Uruguay	..	46.01	42.27	..	-1.68	..
Venezuela	206.25	193.73	185.66	-1.24	-0.85	-1.05
Unweighted average growth	-	-	-	4.29	-6.14	-1.34

Source: Fernando M. Reimers, "Education for all in Latin America in the Twenty-First Century: the challenges of Jomtien", Discussion Paper No. 358 (Cambridge, Massachusetts, Harvard Institute for International Development (September 1990), p.12.

obstacles to foreign investors. Industrial output is expected to fall by 4 per cent in 1991 (compared with 4.7 per cent in 1990), as import liberalization and an overvalued currency exert downward pressure on production. However, production with a high local content and large export markets, such as textiles, refined metals and processed fish, is expected to expand by about 5 per cent in 1991 (from 1.6 per cent in 1990) as a result of increased public spending on infrastructure.

Chile registered a sluggish 2 per cent economic growth in 1990, the lowest since the 1983 recession. This was mainly due to the tight monetary policies followed in an attempt to curb inflation, which was fuelled by the rise in oil prices in 1990. However, the monthly inflation rate has dropped to under 1 per cent since November 1990, and is expected to be low in 1991. Speculative capital attracted by high interest rates is pouring into Chile. The country's trade surplus is expected to increase in 1991 as a result of planned investments of $708 million in new mining projects over a five-year period by the State copper corporation Codelco. These new investments include joint ventures with domestic and foreign mining companies. Already the world's largest copper producer, Chile believes these investments will raise its annual output of copper to 1.28 million tonnes by the mid-1990s. In 1991, in an attempt to accelerate liberalization of the economy, the Central Bank of Chile has authorized commercial banks to invest up to 25 per cent of their dollar time deposits abroad.

The industrial sector in Colombia will face the rigours of privatization in 1991-1992, with the entry into force of a new foreign investment law that puts foreign investors on an equal footing with locals. The Government intends to sell its share in 26 companies over a four-year period. The various companies, operating in the fishing, paper, chemicals, salt mining, coal and finance industries, had a combined profit of $111 million in 1990 (12.1 per cent over 1989). In 1990, the automobile industry received an influx of $57 million in a joint venture between Mazda (Japan) and local banks.

Although the trade surplus of Argentina rose by 47 per cent in 1990 to a record $7.9 billion, the outlook for 1991 is grim. The strict monetary policies that led to a recession in Argentina contributed to the trade surplus by forcing companies to cut imports and boost exports. However, exports cannot continue to rise if the recession continues. Argentine industry grew by only 3.1 per cent in 1990, while motor vehicle and cement production fell by 23.4 per cent and 20 per cent, respectively, from 1989 levels. Machinery and equipment, however, performed better in 1990 than in 1989, with an 11 per cent increase.

Brazil has recently come out of its isolation by agreeing on a settlement of its $8 billion interest backlog, with a quarter of the arrears to be paid in 1991 and the rest in 10-year bonds. The shock methods of tight monetary policies and a savings freeze imposed by the Brazilian Government to cut inflation have led to a severe recession. Industrial growth has been sluggish as a result, exacerbated by the country's limited credit-worthiness. In 1990 Brazil received only $1 billion in foreign investment, and industrial production fell by 8.9 per cent, the lowest level since 1981.

Despite the diverse growth performances and prospects among the countries of the region, a remarkable consensus has emerged on the future direction of policy. Virtually all the countries have embarked upon a programme of privatization coupled with a process of opening up their economies. A new economic order seems to be taking shape in the region.

New trade relationships have sprung up, as policy makers attempt to achieve their dual objectives of attracting foreign investors and curbing inflation through cooperation. In addition to the free trade agreement between the United States and Mexico, a group of four countries, Argentina, Brazil, Paraguay and Uruguay, signed an accord on 26 March 1991 for the creation of a Southern Cone Common Market by the end of 1994. The goal is to create a market of 190 million consumers accounting for half the GDP of the Latin American and the Caribbean region. Export-led growth supported by a tariff reduction programme is expected not only to attract foreign investors, but also to strengthen policy coordination aimed at combating inflation.

The countries of the Andean Common Market with the exception of Ecuador, have also pursued policies designed to free trade by the end of 1991, and have given a mandate to the President of Venezuela to represent them in discussions with the President of the United States on the summoning of a meeting between the Andean Pact countries and the United States to consider joint trade liberalization within the framework of the programme of economic cooperation known as the Enterprise of the Americas. Simultaneously, in order to liberalize trade and move towards economic integration, a number of bilateral trade agreements have been signed, including, for example, one between Chile and Mexico to cut tariffs, and one between Argentina and Chile for the joint exploitation of their sea resources.

The swift move towards privatization throughout the region is another indicator of the extent of the economic change sweeping across Latin America. Mexico has been among the most successful to make such a move. Since the country embarked on its privatization programme in 1983, Mexico has made over $8 billion by selling more than 170 companies. The Government recently announced the sale of 18 State-run banks. The sale of three of them alone (Banco Mercantil, Banco Cremi and Banpais) is expected to bring in $4 billion in 1991.

Argentina has also moved strongly towards privatization, selling its telephone company, State airline, television and radio stations, and four petro-chemical plants, in addition to leasing 10,000 kilometres of roads and 5,000 kilometres of railway lines. The Government also announced plans to privatize all rail services in 1991, along with the State shipping line, ELMA.

Brazil, the other regional giant, plans in 1991 to privatize two big steel companies, Usiminas and Tubaro, which altogether account for well over $6.5 billion in assets. One of the biggest deregulations has taken place in 1991 in the computer and software industry in Brazil, with the Government dismantling a six-year policy banning the sale of most foreign computers and equipment in order to obtain the latest technology needed to update its heavily protected computer industry.

These measures of deregulation and privatization and the opening-up of the economy to neighbouring countries or to the world economy are expected to result in breaking up the existing rigidities and to make industry move toward greater efficiency. Such actions bring to mind similar movements taking place in Eastern Europe for similar purposes. The price, in terms of inflation, unemployment and declining standards of living, to be paid for the efficiency-based growth expected to arise from the reforms will be high. But in the long-run, the benefits of the reform will undoubtedly help to recover from the reverses suffered during the "lost decade of the 1980s".

Table II.25 shows the numbers of workers shed during the 1980s by manufacturing industries as compared with employment creation during the 1970s. It is noteworthy that, during the 1970s, over 3.69 million new jobs were created in manufacturing with every industry contributing significantly to the employment creation. Large contributions came from "modern strategic sectors", for instance, transport equipment, electrical and non-electrical machinery, metal products, iron and steel, non-metallic mineral products, and plastic products. However, the 1980s saw a large-scale shedding of workers in transport equipment, electrical machinery, metal products etc., which had grown under heavy protection and subsidies. The onset of the 1981-1982 recession and the ensuing debt crises obliged the State to cut subsidies.

The worker-shedding exercises, however, had the "salutary" effect of raising labour productivity as measured by MVA per workers. This partly reflects the laying-off of inefficient (marginal) workers and the elimination of sinecures, and partly greater restrictions on imports in response to balance of payments difficulties, thus raising local production through distorted prices. The Latin American pattern of improving labour productivity therefore appears to be qualitatively different from that of the East and South-East Asian region. In the latter, employment creation in manufacturing forged ahead in both the 1970s and 1980s, with labour productivity accelerating in both decades (see section I of this chapter for a detailed account of the East and South-East Asian region).

Though the reform efforts appear flourishing in virtually every country in the Latin America and the Caribbean region, the challenges also seem daunting. In the long-run, gains in labour productivity and efficiency-based growth depend crucially on, *inter alia*, technical progress and an institutional arrangement providing ample incentives and the information needed for technological risk-taking.

So far as technology is concerned, evidence suggests that regional policies need rethinking. A recent independent study concludes:

> "Over the course of the 1980s, policy attention in Latin America has in large measure shifted away from questions of technology, industrialization and productivity, and has instead focused on issues of debt, capital flows, macro-economic policy and trade liberalization. . . . Yet in our concern with macro-variables, we have perhaps overlooked the extent to which the accumulation of technological capabilities within productive enterprises remains central to Latin American economies in their attempts to expand output, improve export performance and raise standards of living.
>
> . . . periods of macro-economic instability increase the benefits of short-term, rent-seeking behavior, and reduce

Table II.25. Latin America: employment in manufacturing and labour productivity index, 1970, 1980 and 1990

Industry	Manufacturing employment			MVA per worker		
	1970	1980 (thousands)	1990	Index		Value[a]
				1980	1990	1990
				(1970=100)		(1985 dollars)
Food	1 436	2 002	1 894	117.6	150.0	15 049
Beverages	245	344	342	130.7	148.8	26 082
Tobacco	84	92	97	123.3	165.6	56 778
Textiles	810	953	885	123.7	154.3	14 524
Apparel	421	615	463	119.3	120.1	8 500
Leather and fur	101	139	111	95.5	146.2	13 362
Footwear	232	338	270	98.8	116.1	2 997
Wood and cork	237	433	391	110.3	103.3	2 544
Furniture	186	281	287	132.3	96.3	1 537
Paper	165	253	248	133.0	163.1	5 852
Printing	258	344	334	127.3	176.2	4 729
Industrial chemicals	144	221	241	145.9	277.6	13 360
Other chemicals	268	398	364	120.5	191.1	12 390
Petroleum refining	69	87	89	201.6	268.6	21 442
Petroleum and coal products	18	35	38	184.8	246.4	1 635
Rubber	92	143	134	104.3	184.9	3 844
Plastic products	114	279	313	106.7	124.9	4 315
Pottery	62	75	63	103.9	130.9	985
Glass	74	108	88	136.4	241.6	1 818
Non-metallic minerals	354	609	554	113.3	155.3	5 955
Iron and steel	213	387	321	118.1	190.3	11 514
Non-ferrous metals	71	117	119	86.9	111.8	5 243
Metal products	476	722	581	128.9	167.5	8 111
Non-electrical machinery	358	759	717	144.1	139.2	10 034
Electrical machinery	355	499	379	145.4	325.0	9 753
Transport equipment	502	700	584	143.2	165.1	10 707
Professional goods	33	59	53	205.1	531.9	1 483
Other	95	170	184	110.4	135.6	2 456
TOTAL	7 471	11 163	10 145	127.1	168.3	19 658

Source: UNIDO Consolidated Industrial Statistics.

[a] Estimated.

the pay-offs of the necessarily long-term process of accumulating technological capabilities" ([23], pp. 1465-1466).

At the institutional level, existing studies* suggest that many countries in the region show considerable support for Mancur Olson's hypothesis, summed up as follows:

> "The state is in this case seen as a passive arena of conflict, responding through institutional changes to pressures and inducements coming from organized lobbies. Rational choice here applies to the rent-seeking activities of groups and to the responses of politicians and bureaucrats. Dysfunctional institutions in terms of efficiency can thus be explained to exist for distributional or normative reasons" ([29], p.1397).

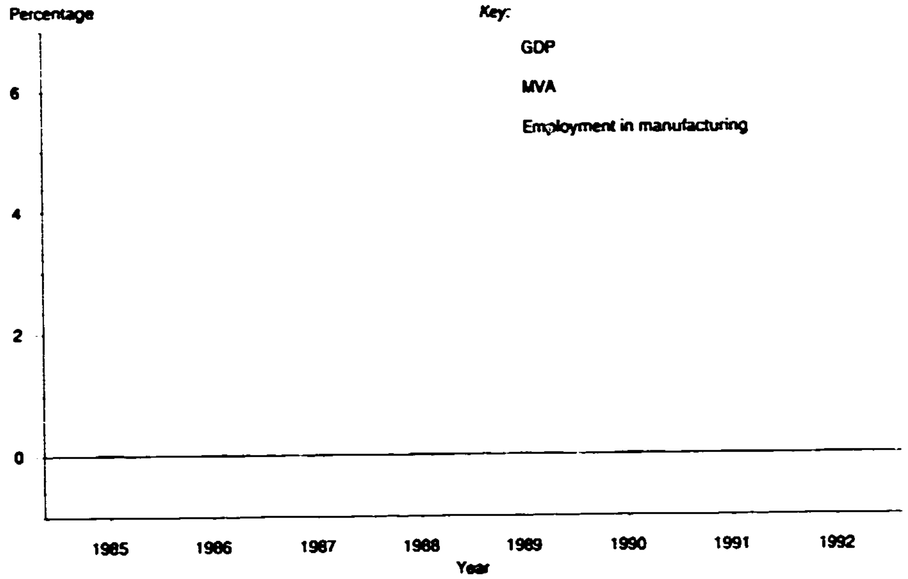
Nevertheless, the long-run prospects are encouraging, since the direction of reform efforts appears correct and bold measures are being taken. A good example is provided by Brazil's decision to repeal its Law of Similars (barring the import of products similar to those produced domestically) and to abolish the sanctuary of information technology hitherto strictly reserved for Brazilians.

*See, for instance, [24]-[28].

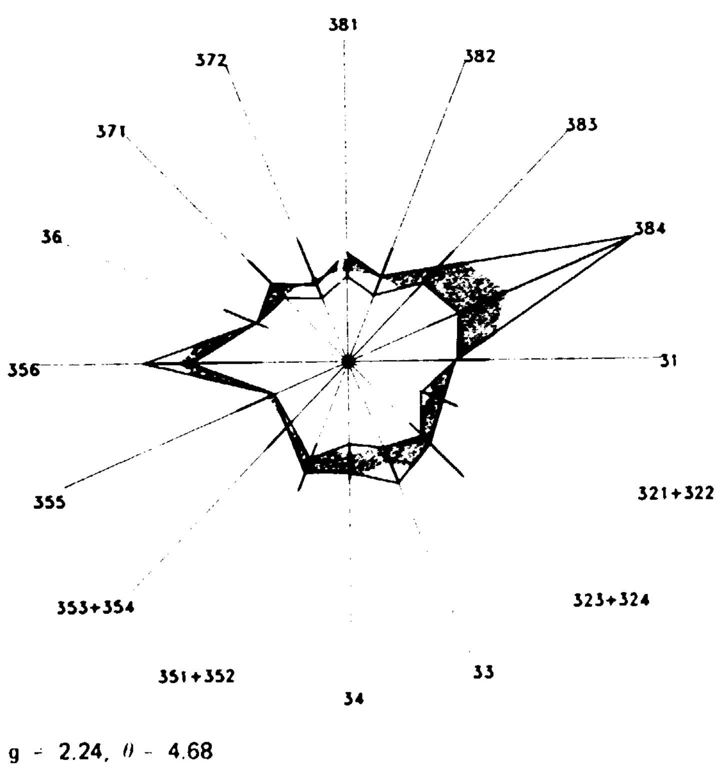
F. Tropical Africa

The prospects for industrial growth in Tropical Africa do not look promising in either the short- or the medium-run. The high oil prices of 1990 placed a strain on the balance of payments of most countries in the region by sharply increasing the oil import bill (with the notable exception of oil-exporting Nigeria). Moreover, there is widespread concern that the EEC, the main trading partner of Tropical Africa will continue to protect itself with an increasing number of bilateral agreements, which by definition erode the multilateralism of GATT, even if the single European market of 1992 does not raise its overall tariff barriers against imports. An African common market could be a counterpart of the EEC and at the same time serve to promote regional trade. However, the poor condition of the infrastructure in transport, communications, education, power, water and industrial services, as well as weak institutional capabilities, presents formidable obstacles to long-term prospects of growth in general and regional trade in particular. Moreover, in spite of recent efforts to liberalize trade and investment, foreign investors have been reluctant to invest in Tropical Africa because of political in-

Figure II.7. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: Tropical Africa



Industrial structural change
(Index of value added: 1975 = 100)



Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
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353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast
1980–1985
1975–1980

g = 2.24, θ = 4.68

Sources: UNIDO database; estimates and forecasts by UNIDO/PPD/IPP/GLO.

Table II.26. Tropical Africa: GDP growth rates by country, 1986-1990
(Percentage)

Countries	1986	1987	1988	1989	1990
Angola	5.9	13.3	6.6	1.3	1.3
Benin	-0.5	-3.6	2.5	1.3	2.1
Botswana	8.0	10.2	9.0	13.5	1.6
Burkina Faso	15.8	-1.8	8.5	-0.3	1.8
Burundi	3.8	4.1	3.5	1.5	0.9
Cameroon	7.5	-2.3	-7.7	-5.1	1.0
Cape Verde	2.9	10.2	3.2	5.5	4.5
Central African Republic	1.4	1.0	3.7	1.0	6.3
Comoros	3.1	2.1	1.4	-0.4	1.5
Congo	-7.2	-5.1	0.5	0.2	3.1
Côte d'Ivoire	3.6	-1.6	-2.0	-0.7	-4.0
Djibouti	1.8	3.7	0.9	-0.8	1.4
Equatorial Guinea	4.2	5.3	3.7	4.1	3.9
Ethiopia	7.2	9.5	2.0	3.0	2.5
Gabon	-5.6	-12	1.5	5.0	5.5
Gambia	5.2	5.5	5.1	4.9	5.4
Ghana	5.0	4.4	5.9	6.1	5.0
Guinea	2.5	-1.5	5.9	4.3	4.1
Guinea-Bissau	-0.5	5.6	4.4	5.0	5.0
Kenya	6.8	5.7	5.9	4.7	3.3
Lesotho	4.7	4.9	9.0	2.7	6.2
Liberia	-1.7	-1.0	-1.0	0.4	-2.0
Madagascar	2.0	1.2	3.8	4.9	4.0
Malawi	0.4	2.9	0.3	5.6	4.5
Mali	17.6	1.3	-1.0	11.9	2.2
Mauritania	15.4	2.7	3.6	3.6	5.2
Mauritius	8.9	9.4	5.9	4.3	6.0
Mozambique	2.0	10.9	5.6	3.2	3.2
Niger	6.5	-4.9	5.0	-3.5	2.5
Nigeria	2.3	-4.2	4.7	4.0	5.2
Rwanda	5.3	-0.8	-3.2	-6.3	0.9
Sao Tome and Principe	1.0	-1.4	2.0	2.5	4.6
Senegal	4.4	4.0	5.1	-1.7	4.5
Seychelles	1.1	4.4	7.4	7.5	2.5
Sierra Leone	-3.5	6.0	-0.1	-1.0	-0.9
Somalia	3.2	5.3	-1.3	2.9	3.6
Sudan	12.6	1.3	-1.7	7.4	-2.0
Swaziland	8.8	1.2	9.2	5.0	3.2
Togo	3.4	1.7	5.0	3.7	2.6
Uganda	0.9	8.4	7.0	6.3	4.0
United Republic of Tanzania	4.8	4.0	5.2	4.0	3.6
Zaire	2.7	2.7	3.2	-2.0	0.5
Zambia	0.9	2.3	3.1	-3.1	..
Zimbabwe	2.6	-1.5	5.8	5.6	4.7

Source: African Development Bank, *African Development Report 1991* (Abidjan 1991), p. A-4.

stability in the region. The above factors, coming on top of a heavy debt burden and high population growth rates (3.2 per cent per year), severely limit the options available to Tropical Africa for embarking on industrial growth (see figure II.7).

In 1990, MVA grew by 2.2 per cent and GDP by 2.6 per cent in Tropical Africa, while GDP per capita fell by 0.83 per cent (see table II.26 for individual country figures). In 1987, agriculture still accounted for 34 per cent of GDP and manufacturing for only 10 per cent.

1. Impact of the Gulf war

The Gulf war had a negative impact on economic growth throughout sub-Saharan Africa by increasing the oil import bill in 1990 and putting pressure on reform programmes as inflation soared. The prospects for economic growth suffered a further setback in 1990 owing to the generally poor performance of the agricultural sector in the region. The problems faced by Zambia as a result of the Gulf war, for example, are typical of the region. The IMF-supported three-year recovery programme to curb inflation, diversify the economy away from copper, and liberalize trade and investment suffered a major setback in Zambia. The increase in oil prices in 1990 forced the Government to divert its limited resources away from other sectors to meet the rising import costs, and the high domestic fuel prices served to fan inflation. Zambia's oil imports rose from $100 million in 1989 to $180 million in 1990, while the consumer price of petrol increased by 400 per cent.

Even in the comparatively healthy economies of the region, such as those of Kenya, Mauritius and Zimbabwe, the Gulf war exerted a significant negative effect. Zimbabwe's oil import bill nearly doubled to $382 million in 1990, and that of Kenya increased by between 30 and 50 per cent more than expected, while consumer prices for fuel increased by 45 per cent in Zimbabwe and between 30 and 40 per cent in Kenya. In Mauritius, as in Kenya, the high oil prices of 1990 had adversely affected the heavily import-dependent Export Processing Zones by increasing freight costs and input prices. Moreover, economies dependent on tourism (Kenya, Mauritius, Zimbabwe) lost significant amounts of revenues as a direct result of the Gulf war.

A few countries—Nigeria and, to a lesser extent, Cameroon and Gabon—profited from the Gulf war by increasing their oil revenues in 1991. However, even in these countries the long-term prospects for industrial growth are not overly optimistic, given their crucial dependence on the management of the formidable debt burden typical of the region, and on the ability to attract foreign investors. In Nigeria, oil production rose to 1.9 million barrels per day during the first half of 1990. The resultant expansion of the oil sector by 12.4 per cent contributed to a healthy economic growth at 5.2 per cent in 1990. Cameroon obtained an estimated $1,105 million in oil export revenues, while oil revenues contributed an estimated 59 per cent to Gabon's $50 million current account surplus in 1990.

2. The debt burden

In 1989 the total debt of Tropical Africa amounted to $147 billion, and in 1990 it was estimated to be $160.8 billion. The ratio of debt to GNP was 98.3 per cent in 1989 (GNP: $149,571 million) and an estimated 111.9 per cent in 1990, while the debt export ratio both to exports of goods and services was 370.5 per cent (total exports: $37,119 million) in 1989 and estimated to be 351.6 per cent in 1990 (total exports: $45,730 million). Added to this debt burden is the huge balance-of-payments deficit of the region. The cumulative deficit of Tropical Africa from 1983 to 1990 was $44,783 million. The deficit was $6,265 million in 1989 and fell to $5,515 million in 1990. Although the deficit in the region was lower in 1990, it was mostly due to the oil windfall revenues gathered by a few countries, for example, Nigeria. The overall outlook for growth in the region remains bleak.

Policy options are severely constrained by the crippling debt burden of most countries in Tropical Africa. Of the nine worst IMF debtors, five Tropical African countries account for 71 per cent of the arrears-to-export ratios of over 100 per cent.

Aid to the region actually increased in 1990, despite concern over diversion of available funds to Eastern Europe and Western Asia. The United States Congress raised African aid by $240 million, or 40 per cent over the $560 million originally intended, while about $8 billion in concessional aid was pledged in 1990 by a group of multilateral organizations under World Bank auspices to help 21 severely indebted sub-Saharan African countries to carry out their structural adjustment programmes.

3. *Industrial growth outlook in selected countries*

Economic performance has shown signs of improvement in some countries, such as Nigeria and Mauritius, and possibly Zimbabwe. However, most countries have shown disappointing rates of industrial growth, including Côte d'Ivoire, Kenya, Mozambique, Uganda and United Republic of Tanzania.

The export earnings of Nigeria rose to $11 million in 1990 (from $8 million in 1989) while GDP grew by 5.2 per cent (4 per cent in 1989). The oil sector grew by 12.4 per cent and manufacturing output rose by 7 per cent in 1990. Oil accounted for 90 per cent of the export revenues. In an effort to speed up economic growth, the Government embarked on an extensive economic liberalization programme including deregulation of the capital market and a programme to privatize 110 enterprises by mid-1992, including 32 parastatals. So far a total of 71 firms have been processed for privatization, and proceeds from the first 54 brought in 278 million naira, but the privatization programme remains behind schedule.

The latest survey of the Manufacturers Association of Nigeria has shown that manufacturing expanded by 7.3 per cent in 1990 mainly as a result of greater use of local raw materials in industries (breweries, textiles, synthetics and cement) and an increased allocation of foreign exchange for imports of raw materials, spare parts and machinery.

The motor assembly industry also registered growth mainly due to local sourcing (46 per cent of its inputs are now sourced locally). Generally, the proportion of local raw materials used in manufacturing rose from 30 per cent in 1986 to 50 per cent in 1990. Local sourcing is the highest in domestic-resource-based industries such as wood and furniture, textiles, food and beverages, and leather goods, and lowest in low-value-added activities such as the production of pharmaceuticals and electrical goods.

In Mauritius, a 6.6 per cent real GDP growth has been estimated by the Government for 1990, although the growth rate of gross fixed capital formation (domestic) has fallen considerably, from 24.7 per cent in 1987 to 12 per cent in 1989, and an estimated 11 per cent in 1990. However, sustained growth in tourism (estimated at 8 per cent in 1990) is expected to boost growth in transport, construction and financial services.

Employment in Export Processing Zones in Mauritius has continued to decline, falling to its lowest level in three years in the first six months of 1990, mainly because of a contraction of employment in large firms, and the increasing use of capital-intensive techniques in the clothing and textiles industry in an effort to cut labour and production costs. Recognizing the vulnerability of Export Processing Zones heavily dependent on low-value clothing and textile products, the Government has proposed diversification of the industrial base by promoting an electronics industry and stressed the need for human resource development.

In Zimbabwe, GDP grew by 4.7 per cent in 1990 (compared with 4.9 per cent in 1989), while growth in manufacturing output slowed, but is still growing. In the first quarter of 1990, the index of output by manufacturing industries increased by 3.8 per cent over the same period of 1989 to reach 133.0 (1980 = 100), compared with a 5.6 per cent rise for the whole of 1989. The following industries showed output improvements in 1990 compared with 1989: beverages and tobacco, 11.8 per cent higher; foodstuffs, 8 per cent higher; textiles, 3.3 per cent higher; and metal and metal products, 3 per cent higher. In Zimbabwe, the machine tool manufacturer, Linear Systems, has begun the first African production of spark eroders. Moreover, Garba Industries of Norton has started the export of machine tools to Zambia (heavy-duty grinding machines, bench grinders, abrasive cut-off machines, belt sanding machines and metal sheers), and plans to export soon to other countries of the Preferential Trade Area for Eastern and Southern Africa (PTA).

The prospects for industrial growth do not look optimistic for most of the other countries in the region, including Côte d'Ivoire, Kenya, Mozambique, Uganda and United Republic of Tanzania. In 1990, GDP grew by −4 per cent in Côte d'Ivoire, 3.5 per cent in Kenya, 3.2 per cent in Mozambique, 4 per cent in Uganda, and 3.6 per cent in the United Republic of Tanzania, generally registering a fall from the 1989 figures. Manufacturing growth slowed in 1990: manufacturing grew by 4.6 per cent in Kenya in 1990, compared with 5.9 per cent in 1989; industry grew by 3.4 per cent in the United Republic of Tanzania compared with 4 per cent in 1989; and industry performed badly in Côte d'Ivoire, Mozambique and Uganda. The manufacturing share of GDP in Mozambique was 17 per cent in 1990 (down from 23 per cent in 1980). Two thirds of production took place in three industries: food, beverages and tobacco (one third), clothing and textiles (18 per cent) and fisheries (12 per cent).

The manufacturing industry in the region typically suffers from high operating and capital costs and poor infrastructure in roads and communications. In Nigeria, for example, half the firms have their own boreholes, two thirds their own transport systems, and 37 per cent their own telecommunication equipment. In spite of substantial restructuring in Nigeria, only two industries—rubber products (mainly tyre manufactures), and chemicals and pharmaceuticals—are efficient in the long-run (that is, the industries can replace capital equipment through ploughback of projects under competitive conditions). However, there are some highly efficient firms within inefficient industries. For example, in the food and beverages industry, brewing and cocoa products is efficient while flour milling is not. This is partly due to low capacity utilization and mismanagement (lack of skilled management). Often, efficiency is a function of both size and ownership patterns in Tropical Africa: larger private-sector firms with transnational links tend to be more efficient than public-sector firms. In Nigeria, for instance, the predominantly government-owned pulp and paper and cement industries are highly inefficient.

The prospects for heavy industries in the region, especially the automobile industry, looks bleak. Capacity utilization is 15 per cent in the Nigerian automobile industry. The increasing economic and trade liberalization policies in the region seriously threaten the viability of these hitherto protected industries through increasing foreign imports (especially of used cars), and through the currency devaluation, which makes imported inputs more expensive. One way for the domestic car industry to deal with this would be to intensify local sourcing. Volkswagen Nigeria has formed a joint venture with local automobile part suppliers such as Chieme Motors for this purpose; the Government of Kenya is offering major incentives to both domestic and foreign investors in local component manufacture; and the new investment code in Cameroon gives substantial concessions to companies that source 25 per cent or more of their raw materials (excluding fuel) locally.

Another way for Tropical African countries to promote industrial growth would be to diversify their economies and promote foreign investments and joint ventures. The economic disadvantages of reliance on only one commodity is illustrated by the dependence of Côte d'Ivoire on cocoa. The sharp decrease in cocoa prices resulted in the collapse of the economy; its debt now trades at 10 per cent of face value. Also, in Uganda, for example, an attempt is being made to diversify exports from coffee. The declining price of coffee has led to falling export revenues and an increase in Uganda's debt-service ratio from 50 per cent in 1986 to 110 per cent in 1990.

Although the Tropical African countries are actively encouraging foreign investment, the response of foreign investors has so far been lukewarm. Even countries like Angola, Mozambique and United Republic of Tanzania, which formerly had planned economies, and staunchly nationalistic countries like Zimbabwe, have introduced new investment codes and set up investment agencies. Other African countries, including Cameroon, Kenya and Togo, have set up Export Processing Zones, and Malawi is drafting a new investment code.

The results are beginning to show in some cases. Botswana, Cameroon, Gabon, Mauritius, Nigeria and Swaziland have experienced inflows of foreign investment, ranging from $24 million per year in Botswana to $30 million per year in Nigeria, while Zimbabwe has received pledges of $40 million.

However, the overall picture does not look encouraging. The net inflow of foreign investment to Africa is estimated to be only $200 million to $300 million per annum, while some countries—for example, Togo—have been receiving only $10 million annually.

There are a number of obstacles to foreign investment in the region including the poor infrastructure, high production costs and a heavy tax regime. The average tax rate in Africa is between 45 to 50 per cent, with the exception of Lesotho (where company tax is only 15 per cent) and Botswana and Mauritius (35 per cent). Moreover, the contractionary monetary policies of the structural adjustment programmes often lead to a severe domestic credit squeeze. For example, foreign investors perceive investment costs in Nigeria (one country that is doing relatively well in Africa) to be twice as high as in East Asia, with 50 per cent less returns than those in the Pacific basin.

4. *Prospects for regional trade*

Regional cooperation in Africa could, if properly managed, promote economic growth in general and industrial growth in particular. For example, the Southern African Development Coordination Conference, has great potential, it has a modest, but feasible, programme, and it focuses on selected areas (transport, energy, industry and banking) in order to maximize mutual benefits. Moreover, economic integration should be outward-looking. That is, the ultimate aim should be to make African exports competitive in the global market by reducing domestic distortions and liberalizing markets.

Regional trade could be a major avenue to boosting exports. For example, the Government of Nigeria has decided to fully implement trade liberalization in raw materials, including goods ranging from minerals and tubers to textile fibres, in the area of the Economic Community of West African States. Regional trade ties have been strengthened in 1991 among many countries, including those between Gabon and Senegal, Senegal and Zimbabwe and Ghana and Zimbabwe. Cameroon has reported a 23.3 per cent increase in exports to other members of the central African customs organization, from 17 billion CFA francs in 1988 to 21 billion CFA francs in 1989. The Zimbabwean machine tools manufacturer Garva industries, plans to export to all PTA countries soon.

Another successful regional cooperation scheme has been the flexible credit systems designed for exporters and importers in PTA countries. Arranged by PTA commercial banks, the scheme serves as a link between businessmen and PTA financial institutions. Since the launching of operations in 1984, the scheme has decreased the amount of scarce foreign exchange used in intra-PTA trade from 80 per cent (1984) to 50 per cent (1988).

However, formidable constraints to regional trade remain in the form of poor road and communications infrastructure and inadequate policy coordination to liberalize regional trade, although significant progress has been made. At present, almost 25 per cent of all paved roads in Tropical Africa need complete or partial reconstruction, while another 25 per cent need immediate resurfacing.

5. *Impact of the single European market of 1992 on the region*

The EEC is the main trading partner of Tropical Africa. The impact of the single European market of

1992 could prove to be detrimental to African countries if the EEC persists in its highly discriminatory practices. According to GATT, the EEC, with its complex hierarchy of bilateral agreements, undermines the multilateral trading system. For example, the EEC textile and clothing manufactures are protected by 19 bilateral agreements under the Multifibre Arrangement, which expired in July 1991, which discriminates against textile imports from developing countries. Although overall EEC trade barriers against imports have remained stationary at 5.1 per cent (trade-weighted average) over the last three years, tariffs are generally higher on processed goods than on raw materials, which means that developing countries face a higher rate of effective protection in the markets of developed countries. Moreover, for manufactures in general, the incidence of non-tariff barriers in industrialized countries is estimated to be 50 per cent higher for exports of developing countries than for those of industrialized countries.

With regard to the prospects of long-term growth in manufacturing, there is little room for optimism. By necessity, long-term growth requires productivity improvement rather than a resource-intensive path. But the indicators of productivity for the region seem to suggest formidable constraints in both economic and non-economic areas.

Reliable statistics are hard to come by for a fruitful analysis. But the following information appears instructive. Table II.27 presents the level of manufacturing employment and value added per worker by industry in the region for 1970, 1980 and 1990. Though the average MVA per worker seems to have changed little during the 1970s and 1980s, there is a diverse and irregular pattern of change among individual industries, with a substantial increase in employment creation in virtually all industries during the 1970s. The latter seems to reflect the impetus given to the manufacturing sector by the generous inflow of capital resources, in the form of official development assistance and foreign direct investment, and growing world trade during the decade.

However, the favourable macroeconomic conditions concealed many micro-economic difficulties experienced by industrial enterprises, such as employment padding, chronic shut-downs due to electricity failures, shortage of spare parts, short-term demand fluctuations arising in part from the vagaries of commodity prices, interruptions in the supply of mostly imported input materials, and low capacity utilization. The

Table II.27. Tropical Africa: manufacturing employment and labour productivity index, 1970, 1980 and 1990[a]

Industry	Manufacturing employment (thousands)			MVA per worker		
				Index (1970=100)		Value[a] (1985 dollars)
	1970	1980	1990	1980	1990	1990
Food	176	285	355	91.3	90.8	5 404
Beverages	38	74	94	89.7	93.9	15 123
Tobacco	24	39	33	83.4	110.5	14 767
Textiles	153	264	285	88.5	76.5	3 470
Apparel	42	67	126	84.7	84.6	3 001
Leather	6	13	18	127.0	117.7	5 153
Footwear	15	25	31	98.1	106.3	5 248
Wood and cork	70	110	67	124.0	162.9	3 933
Furniture	22	45	35	114.3	103.4	3 146
Paper	10	25	35	91.0	69.3	5 534
Printing	28	51	51	101.3	85.3	4 456
Industrial chemicals	13	26	30	83.0	91.5	8 427
Other chemicals	23	56	71	118.8	100.2	8 242
Petroleum refining	5	9	14	68.2	56.1	31 341
Petroleum and coal products	0.2	0.7	1.1	34.7	26.5	17 984
Rubber	18	26	20	97.4	172.6	9 001
Plastics	6	42	29	81.1	95.3	5 322
Pottery, China	1	2	2	135.3	219.7	7 976
Glass	4	6	8	150.3	98.6	4 980
Non-metallic minerals	31	52	55	87.1	115.4	6 882
Iron and steel	11	22	36	142.5	101.2	7 284
Non-ferrous metals	3	7	6	57.5	96.4	22 372
Metal products	52	97	93	101.7	110.8	5 599
Non-electrical machinery	8	19	16	100.2	138.1	7 721
Electrical machinery	13	33	31	96.4	118.5	6 886
Transport equipment	29	65	59	263.4	155.4	7 423
Professional and scientific goods	0.3	1.4	2.4	77.9	130.4	6 164
Other	9	15	20	89.6	76.2	5 360
TOTAL	812	1 476	. 625	99.7	99.7	6 112

Source: UNIDO Consolidated Industrial Statistics.

[a] Estimated.

irregular pattern of labour productivity across the manufacturing sector seems to reflect those micro-economic problems. They have become worse during the 1980s owing to the recession and the debt crisis.

These problems are also apparently mirrored in the TFP measurement (see table II.28). For all four countries studied—Kenya, United Republic of Tanzania, Zambia and Zimbabwe—growth of employment and capital formation is impressive. But TFP growth is either negative or insignificant for the period from the mid-1960s to the early 1980s.

Though a number of competing hypothesis could help to explain the negative TFP growth, the emphasis will here be placed on two crucial constraints, namely technological capability* and the institutional set-up in Tropical Africa. Studies on these constraints are meagre, but those available already indicate the nature and magnitude of the long-term challenge facing the region. The improvement of technological capability in industry must ultimately come from indigenous corps of scientists, engineers and technicians. Tables II.29 and II.30 show how unfavourably the region compares with others in the number of scientists and engineers and in research and development expenditures. These figures do not say anything about "quality", another dimension crucial to technical progress in which the region is also probably lagging behind.

Nevertheless, the stock of scientists and engineers appears to be increasing rapidly in some countries of the region (see table II.31). This phenomenon seems encouraging, considering that the Republic of Korea had only about 40 engineers with college degrees in 1945 when the country was liberated from foreign occupation ([30], p. 21). Similarly, the number of science and technology policy-making bodies has been increasing rapidly in recent years (see table II.32). An important question remains: are these increases accompanied by a record of technical improvement?

The available studies tend to be discouraging, to a large extent because of the institutional aspects of the

*Sanjaya Lall and others define "technological capability" as a broad set of elements comprising "the entire complex of human skills (entrepreneurial, managerial and technical) needed to set up and operate industries efficiently over time. As with all skills, the acquisition of technological capabilities is necessarily a learning process. All learning proceeds at a certain pace given the complexity of the knowledge involved and the initial capabilities of the leaner . . .". Quoted in "Human resources and industrial development in Africa" (UNIDO/IPP/REG), p. 31.

Table II.28. Growth of manufacturing output, factor inputs and total factor productivity in Kenya, United Republic of Tanzania, Zambia and Zimbabwe
(Average annual growth rates[a/])

Country	Period	Growth of output (real terms)	Growth of employment	Growth of capital	Share of labour	TFP growth
Kenya	1964-1983	7.99	5.69	10.60	0.35	-0.89
United Republic of Tanzania	1966-1980	8.06	8.78	8.45	0.36	-0.51
Zambia	1965-1980	4.98	3.63	14.00	0.33	-5.60
Zimbabwe	1964-1981	5.28	4.76	5.55	0.39	0.03

Source: E. Shaaeldin, "Sources of Industrial Growth in Kenya, Tanzania, Zambia and Zimbabwe: some estimates", *African Development Review*, vol.1, No.1 (June 1989), p.27.

a/ The growth rates are estimated on the basis of regression estimates of logarithmic time trends.

Table II.29. Global distribution of research and development scientists and engineers, 1970, 1975 and 1980
(Percentage estimates)

Region	1970	1975	1980
Africa a/	0.3	0.4	0.4
Arab countries	0.6	0.7	0.9
Asia	17.4	18.6	18.5
Europe	22.0	22.6	22.3
Latin America	1.5	1.8	2.4
North America	21.8	17.3	18.0
Oceania	0.9	0.8	0.9
USSR	36.6	37.8	36.6
TOTAL	100.0	100.0	100.0

Source: UNESCO, *Statistics on Science and Technology* (Paris, 1986), p. V.11, as quoted in H.M. Bwisa, "Scientific cooperation for development in Africa", *African Development Review*, vol.2, No.1 (June 1990), pp. 8-9.

a/ Excluding Arab countries.

Table II.30. Global distribution of research and development expenditure by major areas for 1970, 1975 and 1980
(Percentage estimates)

Region	1970	1975	1980
Africa a/	0.2	0.3	0.3
Arab countries	0.2	0.3	0.5
Asia	7.3	10.8	14.8
Europe	25.3	32.0	34.0
Latin America	0.8	1.5	1.8
North America	44.5	33.7	32.1
Oceania	0.8	1.0	0.9
USSR	20.9	20.4	15.6
TOTAL	100.0	100.0	100.0

Source: UNESCO, *Statistics on Science and Technology* (Paris, 1986), p. V.11, as quoted in H.M. Bwisa, "Scientific cooperation [illegible] in Africa", *African Development Re*[illegible] (June 1990), pp. 8-9.

a/ Excluding Arab co

As part of their cooperation programme launched in August 1988, with the support of the French and Belgian authorities, UNIDO and the Centre for Industrial Development (CDI) of Brussels have identified 40 investment projects in the building materials industry in 10 French-speaking African countries: Benin, Burkina Faso, Cameroon, Chad, Congo, Djibouti, Gabon, Guinea, Senegal and Zambia.

The nature of the investment projects identified reflects the need for building products in these countries. The majority of their African promoters wish to exploit low-energy-consuming materials. Half of the investment projects concern the creation of units for the manufacture of stabilized clay bricks, while the others concern components made of wood (timberwork, doors, windows), of stone (tiles, rubble stone, kerbstone, paving, gravel etc.), of cement (tiles, joists, panels, roughcast etc.) and of plaster.

Project identification

In each of the countries visited on their mission, the UNIDO experts consulted some 30 entrepreneurs with investment projects in the building materials industry. Contacts were facilitated by UNIDO services on the spot and by public institutions such as the Ministry of Industry, Ministry of Town Planning and Housing, associations of entrepreneurs in the building industry, and chambers of commerce and industry. Of the total number of projects examined, three to five were selected for promotion.

Entrepreneurs who have opted for the manufacture of stabilized clay bricks and cement components basically want to produce for the local building market, with middle- and low-income households as the target customers; those who wish to engage in wood-processing and stoneworking are aiming also at the export market. In the case of the package of projects selected, UNIDO asked the entrepreneurs for in-depth studies of the target market, on the basis of an evaluation of current or future public and private building programmes in which the entrepreneurs could be involved.

Since few entrepreneurs have financial capital, their contributions are most often made in kind (land, buildings and infrastructure necessary for the project). In addition to contributions in kind, some of the local entrepreneurs take responsibility for the working capital of the project. In order to be promoted, contributions must represent some 20 to 30 per cent of the total investment envisaged. Finally, entrepreneurs must be prepared to pay a third of the cost of the pre-investment studies, the other two thirds being financed by UNIDO or CDI and the European partners.

Formulation of the investment project

The work involves assembling as much information as possible on the entrepreneur, the associates of the entrepreneur, the nature of projects to be developed, the size of the market, the amount of the investment and the means of financing the project.

In formulating the project, the kind of industrial cooperation that African entrepreneurs wish to set up with their European partners is also determined. The cooperation sought generally covers five areas: investment capital; provision of capital goods accompanied by training of operational and managerial personnel; assistance in management of the production units; assistance in the field of equipment maintenance; and marketing of products.

Promotion and search for partners

In Europe, the search for partners is carried out through the UNIDO investment promotion services. Industrial forums are also an opportunity to promote these projects. Almost all African entrepreneurs were invited either to the International Fair for Cooperation and Development Aid held at Montpellier in December 1988, or to the General Conference of Africabat held at Dakar in January 1989, or to the Investment Forum of the CACEU Countries held in December 1989.

In order to arouse the interest of European partners in investment projects in Africa, the UNIDO Industrial Investment Division is currently developing the concept of an institutional partnership. More specifically, this means sharing the costs of studies, travel of entrepreneurs, or training of the staff of enterprises between several of the partners involved in assisting the promotion of investment projects, in this case UNIDO, CDI, European and African industrialists, and regions with cooperation programmes in Africa. This approach has made it possible to put together a substantial budget for the setting-up of 10 medium-sized brickworks in Zaire.

Undertaking studies

A prerequisite for pre-investment studies is the commitment of European and African partners to develop industrial cooperation. Pre-investment studies focus on the promoter, the promoter's capacity to manage the project, the market, the products, the technology, the personnel employed, skill requirements, organization and management of work, profitability and financing of the project, and planning for start-up (factory design, staff training).

Fund raising

The request for funds for these investment projects is, in most cases, submitted to local banking institutions that handle lines of credit granted by international financing institutions (International Finance Corporation, African Enterprise Fund, Central Bank for Economic Cooperation, PROPARCO and West African Development Bank). The financing of the projects, totalling between $250,000 and $400,000, does not present any problem.

Assistance to plant start-up

It is at the start-up of their plants that entrepreneurs encounter difficulties which may place their investments at risk. That is why at this stage UNIDO provides them with assistance in training personnel and advice on managing the enterprise, monitoring production, marketing products and seeking markets.

building materials in Africa

Results

It is still too early to take stock fully of the joint UNIDO-CDI programme for the promotion of building materials in Africa, but it is possible to point to some interesting results.

In Zaire, for example, 10 entrepreneurs with an investment project in the manufacture of stabilized clay bricks have concluded industrial cooperation agreements with a European partner and, during 1989, acquired the necessary equipment. In order to support these entrepreneurs, in May 1990 UNIDO launched an assistance project entitled "Establishment of 10 Brickworks in Zaire", the aim of which is to train 10 supervisors for administration and management and 20 technicians for brick production and the construction of premises. This assistance project is also financed by CDI, the Walloon region and the industrial partner.

Five pre-investment studies related to the stabilized clay brick sector have been carried out (two in Cameroon, two in Guinea and one in Senegal). It is hoped that it will be possible to help with the start-up of these brickworks using the same approach as that adopted in Zaire.

In February 1989, the promotion of 15 investment projects in the wood sector was launched in Cameroon, Congo, Gabon and Zaire. As far as stone components and building site aggregates are concerned, eight investment projects included in the programme will be the subject of promotion at the next International Fair for Cooperation and Development Aid, to be held at Marseilles in January 1991.

UNIDO and CDI also plan to provide assistance for restarting the activities of the only fired brick plant in the countries concerned, located at Kakan in Guinea, for the training of managerial staff in management techniques, and for training the labour force. It should be pointed out that owing to measures taken by Governments for forest protection, projects for fired bricks will only have a future in Africa if the firing methods change or renewable energy sources are exploited.

In addition to the results presented above, the programme of promotion of industrial cooperation in the building materials industry in Africa has the following to its credit:

(a) Development of a methodology for identifying, formulating and promoting medium-sized investment projects appropriate to the economic environment in which small- and medium-scale enterprises evolve;

(b) Creation of a synergy between international agencies (UNIDO, CDI) and between these and the local investment promotion offices.

Experience acquired with this programme in Africa could, with appropriate modifications and adaptations, be utilized in other spheres of UNIDO activities and in other geographical regions. It should be pointed out, moreover, that countries in Latin America and Asia are already expressing interest in the idea.

Source: Industry in Africa, No. 4, pp. 25-27.

Table II.31. Total stock of scientists and engineers per million inhabitants in selected African countries, and percentage of GNP devoted to research and development

Country	Period	Scientists and engineers per million inhabitants: Beginning of period	Scientists and engineers per million inhabitants: End of period	Research and development as percentage of GNP: Beginning of period	Research and development as percentage of GNP: End of period
Central African Republic	1975-1984	37	78	0.1	0.3
Congo	1977-1984	197	509	0.4	..
Côte d'Ivoire	1970-1975	60	74	0.4	..
Egypt	1973-1982	299	446	0.8	0.2
Ghana	1970-1976	199	396	..	..
Kenya[a/]	1970-1982	282	543	..	..
Madagascar	1970-1980	24	13	0.9	0.2
Niger	1972-1976	7	20	..	0.1
Nigeria	1970-1977	25	30	0.1	0.3
Sudan	1971-1978	89	250	..	0.3
Zambia	1970-1976	18	49	0.2	..

Source: UNESCO, *Statistics on Science and Technology* (Paris, 1986), p. V.11, as quoted in H.M. Bwisa, "Scientific cooperation for development in Africa", *African Development Review*, vol.2, No.1 (June 1990), pp. 8-9.

a/ Figures for Kenya calculated from National Council for Science and Technology Report No.18 (Nairobi, 1985), table 1.

Table II.32. Trends in the formation of science and technology policy-making bodies in Africa, 1973-1986

Type of body	Numbers		
	1973	1979	1986
Ministry of Science or Ministerial science policy council	5	9	27
Science planning body in general	12	18	20
Multisector body for co-ordinating scientific research	18	24	28
Research bodies			
Natural science	2	16	25
Agricultural	15	30	32
Medical	6	20	21
Nuclear	3	4	4
Industrial	7	22	25
Environmental	1	14	15
TOTAL	69	157	197

Source: UNESCO, *Statistics on Science and Technology* (Paris, 1986), p. V.11, as quoted in H.M. Bwisa, "Scientific cooperation for development in Africa", *African Development Review*, vol.2, No.1 (June 1990), p.19.

societies concerned.* Invariably these studies converge to point out that the Leibenstein type of X-inefficiency, rent-seeking activities, lack of accountability, arbitrary decision-making, endorsement of "know-who" over "know-how", a personalized political culture etc. are largely a matter of institutional and organizational arrangements. The validity of these associations and their relative importance, however, demand further research, particularly in a country-specific and problem-specific context, if an operationally useful policy recommendation is to be made. The following conclusion deserves a lengthy quotation:

> "There are two basic obstacles to progress in technology policy in sub-Saharan Africa: first, the policies are implicit rather than explicit, and second, even if they were explicit, present institutions for managing them are inadequate to the task. To develop the needed policies, many studies are required the aim of which should be to illuminate Africa's development-related issues, reveal possible options, and propose preferable courses of action. Resource scarcities and other constraints already make this a difficult goal to achieve. However, the development of policies is made even more difficult by weaknesses and disincentives in existing arrangements for providing advice to policy makers" [31], p. 1479).

To sum up, the region faces both short-run and long-run challenges which demand herculean efforts in search of a solution. The challenges come from both external and domestic sources, and involve economic as well as non-economic variables, including the basic structure of socio-economic institutions. In this sense, the region seems to share with China, Eastern Europe and the USSR the need to be truly creative in crafting an efficient information-and-incentive system. Other regions (particularly developed regions) should share the work and the responsibility from altruism as well as from the need to avoid the undesirable side of interdependence, expressed thus by one observer: "So long as we do not succeed in this, as now for example, we shall find that they export violence and people instead of goods and services" ([37], p. 12).

*See for instance, ([31], pp. 1471-1480; [32]; [33]; [34], pp. 319-332; [35]; and [36], pp. 1147-11620).

G. North Africa and Western Asia

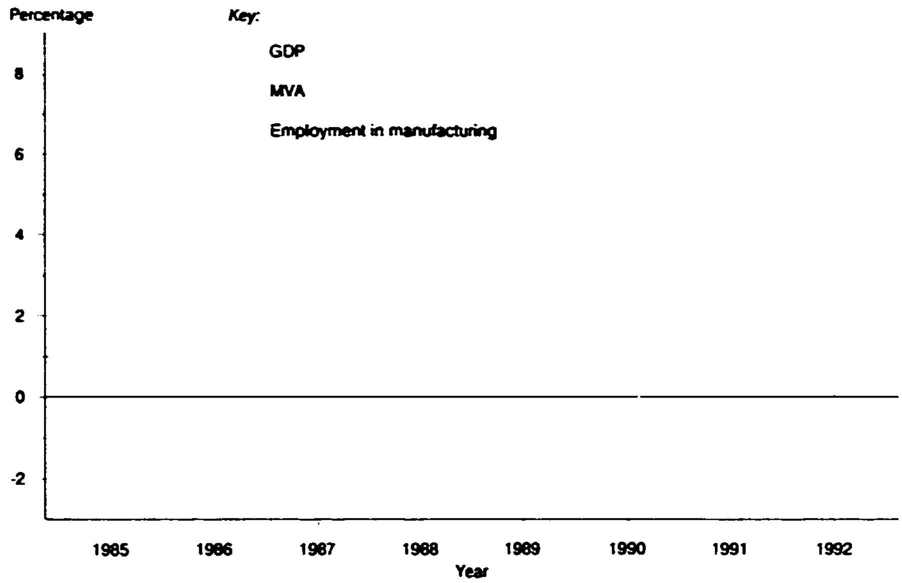
The economic growth of North Africa and Western Asia suffered in 1990 and 1991 as a result of uncertainties arising from the Gulf crisis and disruption caused by the war. The crisis had a significant damaging impact on the economies of Egypt, Iraq, Jordan, Kuwait, Morocco, Sudan, Tunisia and Yemen. The oil price rise during the crisis resulted in more income for big oil exporters in the region, but it was outweighed by the cost of war in some countries, such as Qatar and Saudi Arabia. Other countries, however, benefited from the higher oil prices, which helped push the current account into surplus in Algeria, Iran (Islamic Republic of), Syrian Arab Republic and United Arab Emirates. Private sector investment in the United Arab Emirates, rising gas and condensate sales in Algeria, and a more positive attitude towards foreign investment in Algeria, Iran (Islamic Republic of) and Syrian Arab Republic are also expected to provide a significant impetus to economic growth in 1991. The reconstruction of Kuwait is expected to boost the regional economy, as Kuwaitis buy goods and services from coalition partners such as Egypt, Morocco, Pakistan, Syrian Arab Republic and Turkey.

GDP per capita actually fell in the region from $3,191 in 1980 to $2,296 in 1989, while MVA per capita rose from $262 to $304; total GDP fell slightly from $423 billion to $413 billion during the same period. The data indicate that the relatively poor performance of the region in the 1980s compared with the 1970s is partly due to the lower oil prices in the 1980s, and partly to the high rate of population increase, from 98 million in 1970 to 132 million in 1980, 179 million in 1989, and 191 million expected in 1991. Table II.33 shows per capita GDP and MVA for countries of the region in 1989. A big gap in per capita income stands out: below $500 for Egypt, Sudan and Yemen, as compared with over $10,000 for Kuwait, Qatar and the United Arab Emirates. There is little sign of the gap being reduced in the long- or the short-run (see figure II.8 for GDP and MVA growth in recent years, and also for the pattern of structural change in industry).

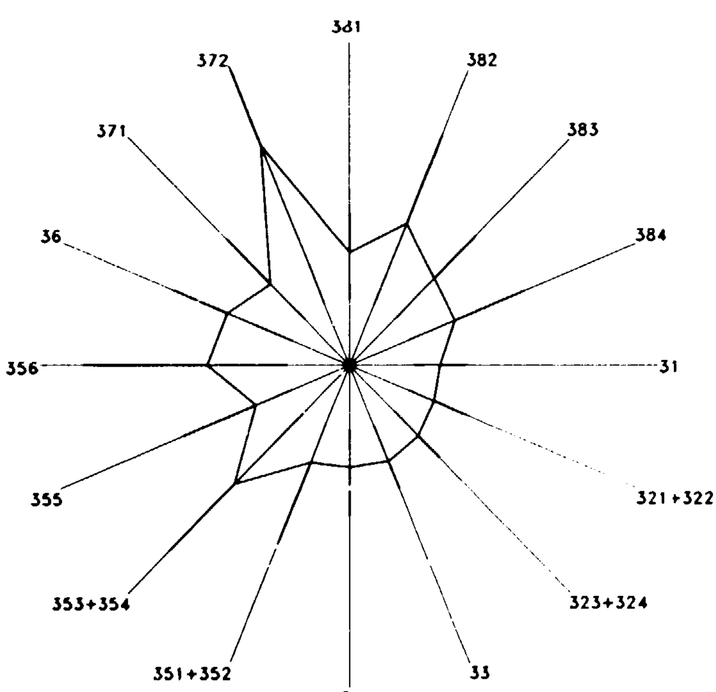
1. Reconstruction

The long-run costs of rebuilding the economy of Kuwait are estimated at between $100 billion and $200 billion. Estimates from United States and Kuwait sources has put the short-term bill at $50 billion (reconstruction: $10 billion; restoration of oil output and infrastructure: $40 billion). Added to this are pledges to the coalition military forces ($23.5 billion to the United States; $1.36 billion to the United Kingdom) worth $28.4 billion, and costs of exile estimated at $1.5 billion, which puts the short-term cost of the war close to a staggering $80 billion. This

Figure II.8. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: North Africa and Western Asia



Industrial structural change
(Index of value added: 1975 = 100)



g = 5.75, θ = 19.40

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast

1980–1985

1975–1980

Sources: UNIDO database; estimates and forecasts by UNIDO/PPD/IPP/GLO.

Table II.33. North Africa and Western Asia:
GDP, MVA and population in 1989

Country	GDP percentage change from 1988	GDP (million dollars)	MVA (million dollars)	MVA share in GDP	Population (thousands)	Per capita GDP (current dollars)	Per capita MVA (current dollars)
Saudi Arabia	9.1	79 231	6 480	0.08	13 316	5 957	487
Iraq	9.7	58 871	5 858	0.09	17 450	3 383	336
Algeria	-9.1	47 186	5 269	0.11	23 964	1 974	220
United Arab Emirates	15.2	27 281	2 355	0.08	1 530	18 187	1 570
Libyan Arab Jamahiriya	1.0	24 758	1 804	0.07	4 181	6 038	440
Egypt	3.2	24 290	3 671	0.15	50 257	483	73
Morocco	7.9	23 709	5 760	0.24	23 635	1 004	244
Kuwait	15.3	23 083	3 314	0.14	2 104	10 991	1 578
Syrian Arab Republic	10.6	17 879	3 332	0.18	11 712	1 528	284
Sudan	16.2	10 113	776	0.07	23 470	432	33
Tunisia	-0.3	9 998	1 442	0.14	7 804	1 281	184
Oman	12.4	8 532	362	0.04	2 160	4 062	172
Democratic Yemen	25.2	7 393	923	0.12	7 657	972	121
Qatar	13.3	6 475	775	0.11	371	17 452	2 088
Bahrain	7.2	3 872	471	0.10	483	8 016	863
Lebanon	-	3 600	-	-	2 818	1 285	-
Jordan	-29.0	3 221	331	0.10	3 939	825	84
Yemen	-4.3	1 128	105	0.09	2 585	451	42

Source: Economic Community of West African States.

will strain even Kuwait's substantial financial reserves, estimated at $100 billion.*

The reconstruction of Kuwait** is expected to provide a significant boost to the regional economy. The main beneficiary of the higher Kuwaiti demand for goods and services from the coalition partners will be Egypt. Exports to Kuwait of Egyptian goods, such as construction equipment and supplies (cement, steel and plastics), and the remittances of the estimated two million Egyptian workers who are expected to replace the Palestinians in Kuwait and Saudi Arabia, will definitely offset the $5 billion in hard currency earnings (mainly from tourism and remittances) lost as a result of the Gulf war. Moreover, debt forgiveness (over $14 billions from the United States and Saudi Arabia, which constitutes about 30 per cent of Egypt's foreign debt) and billions of dollars of aid from the Gulf States, including Kuwait and Saudi Arabia has given Egypt a "10-year extension of life". In 1989, before the war, the foreign debt of Egypt was a staggering $50 billion, debt service costs stood at $3 billion, and the ratio of debt to GNP was 159 per cent.

If Egypt is the biggest regional gainer from the Gulf war, then Jordan is definitely the biggest loser among the non-combatants. The loss of remittances alone as a result of the Gulf war is expected to cost Jordan about 50 per cent of its GDP in 1991. The loss of exports, remittances and tourism, and of the use of the Aqaba port cost Jordan around $2 billion in 1990, according to the Central Bank of Jordan. The prospects for 1991 look even bleaker, since the Kuwaitis and Saudi Arabians no longer want Jordanian goods and services, and the economy of Iraq, its main trading partner (which accounted for 23 per cent of its exports and 17 per cent of its imports in 1989), is in ruins. Loss of export earnings and the oil import bill will cost Jordan an estimated $2.9 billion, while an additional $150 million to $300 million will be lost in forgone remittances in 1991. Moreover, while aid worth close to $1 billion is expected mainly from the EEC, Japan and various other Western European countries, none will be forthcoming from Jordan's former Arab partners—Saudi Arabia, Kuwait and the other member States of the Gulf Co-operation Council (GCC).

2. *Oil and oil-related industries*

Regional reconstruction plans are inevitably tied to oil and oil-related industries. Resumed production by Iraq and Kuwait has begun with Iraq's request for permission to sell around $1,000 million worth of oil to buy essential goods and services. Kuwait's current daily production (with 80 per cent of its productive capacity destroyed) is estimated at only 75,000 barrels per day, compared with a pre-war OPEC quota of 1.5 million barrels per day. Both countries are expected to produce limited amounts by mid-1991.

A new post-war oil production plan is about to take shape in OPEC, which projects higher demand growth in the future, partly to meet the needs of South-East Asia, which will soon become a net importer of oil. According to OPEC sources, world demand is expected to rise to 54.83 million barrels per day in 1995, and 57.67 million barrels per day in the year 2000, while non-OPEC supplies are predicted to fall from 27.67 million barrels per day in 1995, to 26.9 million barrels per day in the year 2000. The projected increase in demand for OPEC supplies (including

*One source ([38], p. 5) estimates Kuwait funds held overseas at $100 billion while another source ([39], p. 2) estimates a level of between $120 billion and $200 billion.

**The bulk of the reconstruction contracts went to United States companies, including AT&T, Bechtel, Caterpillas, Dressner, Motorola, Raytheen, etc., currently estimated at more than $50 billion for all known contracts (see *Pakistan and Gulf Economics*, 16 March 1991, pp. 22-24).

natural gas) is expected to reach 27.76 million barrels per day in 1995, and 31.48 million barrels per day in 2000, compared with 24.53 million barrels per day in 1991. Official sources have calculated the required OPEC capacity at 33 million barrels per day in 2000 to allow for a safety margin.

Most Gulf producers are proceeding with plans to expand their oil and gas production and their oil-related industries such as petrochemicals, which would require an immediate reform of the current OPEC quota system. There has been speculation that Saudi Arabia's preference for vague, voluntary cuts are forerunners of a new set of ground rules. After showing itself quite capable of producing 8.5 million barrels per day (it produced nearly 40 per cent of total OPEC output during the Gulf crisis) and proceeding with a $36 billion plan to expand productive capacity to 10 million barrels per day by 1995, it is doubtful whether Saudi Arabia would agree to go back to the pre-war (mid-1990) quota of 5.38 million barrels per day.

The increased demand for oil and oil-products in South-East Asia, outstripping that of North America and Western Europe, has provided a renewed boost to the oil industry in North Africa and Western Asia. State-owned Saudi Aramco has moved full speed ahead to build a chain of refineries in East Asia (in Japan, which is the world's second-largest oil importer, in the Republic of Korea, where the consumption of oil products is rising by more than 20 per cent a year, and also in Singapore and Thailand) in order to secure access to markets. Not only is it cheaper to ship crude oil than refined, but the profit margins from oil product sales are also 20 per cent higher than those of crude oil sales. A $1.4 billion joint-venture refinery project (50:50) between Saudi Aramco and Ssangyong Oil Refining Co. of the Republic of Korea is projected to increase the existing plant's rated capacity to nearly 200,000 barrels per day. In addition, the joint venture would build new capacity, including a hydrocracker with a desulphurizing unit and a residuals cracker, which would enable the production of the more profitable diesel fuel from heavy fuel oils.

The main oil-producing countries of North Africa and Western Asia are also currently engaged in plans to expand their domestic refining capacities. The largest producer in the region, Saudi Arabia, with total refining capacity of 1.8 million barrels per day (2 per cent of world capacity and 10 per cent of international trade worldwide), is proceeding with a 10-year $1.5 billion plan to improve the poor profitability record of the industry by first commercializing and then increasing the refining of higher-value products, under the guidance of the Saudi Arabian Marketing and Refining Company (Samarec) created in 1988. The Samarec programme, due to start construction in late 1991, will be overseen by international engineering companies, and is intended to bring domestic refineries more in line with domestic demand, which is currently around 700,000 barrels per day.

Other major oil producers, such as Algeria, Iran (Islamic Republic of), and to some extent Syrian Arab Republic, have also begun a thorough upgrading of their oil and oil-related industries. The Islamic Republic of Iran has finally begun to come out of its isolation by inviting foreign firms to assist in rebuilding and expanding the oil industry. In its 1991 budget, the hydrocarbons industry received $5.3 billion, the highest allocation of foreign exchange resources. Techniq Bjou of France received a contract worth about $170 million to rebuild a 60,000-barrels-per-day liquified petroleum gas plant, and Daelim of the Republic of Korea has a contract worth $150 million to build a 300,000-tonnes-per-year ethylene plant at the $4,500 million Bandar Khomeini petrochemical complex. TLP, the Italian subsidiary of Techniq, has a $450 million contract from the National Petroleum Company of Iran (NPC), which controls the hydrocarbons industry, to build three units at the Tabriz petrochemical complex. NPC has also awarded a $270 million contract to Technimont of Italy and Salzgitter of Germany for an ethylene derivatives plant at the existing petrochemical complex at Arale. The overall plan is to make the Islamic Republic of Iran into a major world petrochemical producer.

In Algeria, higher oil prices during the Gulf crisis together with rising gas and condensate sales have pushed the current account surplus close to $1 billion in 1991, according to government sources (the current account is in surplus for the first time since the early 1980s). A market economy has been formally introduced as of 1 January 1991.

In spite of the recent reform package, substantial problems continue to obstruct the economic liberalization process in the Algerian economy. For example, the scantiness of information on local companies makes it difficult to identify joint venture partners for foreign firms, and a thorough streamlining of the State companies (clearing of debts, putting accounts in order) is needed (according to government estimates it will require $6.7 billion) before they can be put up for sale. Moreover, the Government remains fearful of too sharp a move towards big business capitalism after three decades of central planning.

The Syrian Arab Republic has also announced an economic liberalization package including a new investment law to be implemented in the latter half of 1991. The buoyant hydrocarbon industry is expected to contribute significantly to economic growth in 1991. Economic reform programmes in the Syrian Arab Republic are also expected to benefit greatly from the country's more favourable position in th international community and from increased flows of aid from the Gulf States, so far amounting to more than $1 billion. In 1990, the current account surplus reached $2,115 million (compared with $1,990 million in 1980), and economic growth was recorded at 6 per cent (up from −8.5 per cent in 1989).

Oil exports of the Syrian Arab Republic averaged about 100,000 barrels per day in 1990, and are expected to continue rising in 1991, thanks to expanded production of 480,000 barrels per day (early 1991) and higher demand. Recent foreign entrants in joint ventures in the hydrocarbons industry include British Petroleum and Elf Aquitaine. The expansion of the oil and gas industry of the Syrian Arab Republic will enhance the prospects for developing downstream facilities, which currently operate at low efficiency levels, and increase demand for supplies of equipment and expertise.

In spite of the rosy outlook for oil and oil-related industries, there remain some constraints in most of the above-mentioned countries. The war cost incurred by Saudi Arabia has created a financial constraint, while the lack of skilled personnel and wrecked physical infrastructure in the Islamic Republic of Iran may take years to develop. Saudi Arabia was forced to borrow $3,500 million on international markets for the first time in the country's history to help finance its war cost, estimated at more than $48,000 million, which was only partially offset by increased oil revenues of $13,000 million in 1990. The budget deficit is estimated to have amounted to $15,000 million in 1990.

Although real GDP in the Islamic Republic of Iran is projected to rise to 2.9 per cent in 1991, and the petroleum, gas and petrochemicals industry is projected to expand, structural problems, such as the 25 per cent inflation rate (which will remain as long as the rial remains overvalued at 20 times above the market rate) and, most importantly, shortages of skilled labour, remain to obstruct the development processes.

The industrial sector in the Islamic Republic of Iran is budgeted for a major expansion, including a 220,000-tonnes-per-year aluminum smelter in association with Dubai Aluminum, and the rebuilding of the steel industry and the expansion of the capacity of the Ahwaz unit to 1.5 million tonnes per year, with the cooperation of Kobe Steel of Japan. Renault of France is expected to help construct a 20,000-units-per-year assembly plant in the Islamic Republic of Iran by the end of 1991.

There is yet another constraint to economic development in the region, namely the enormous amount of funds that will be spent on defence. However little economic sense such government policy makes, the next few years will see rapid and massive increases in defence spending by the Gulf States for national security reasons. The United States has already proposed the sale of $18,000 million worth of military equipment to Egypt, Kuwait, Saudi Arabia and Turkey. Saudi Arabia's proposed purchases for 1989-1990 alone amounted to a staggering $24,194 million. It is profoundly ironic that the five permanent members of the United Nations Security Council provided 87 per cent of all major weapons bought by developing countries in the second half of the 1980s.

Summing up the short-run outlook, the region is set to recover from the aftermath of the Gulf war, though at a slow pace. The expenditures expected for reconstruction and rearmament will play a big part in sustaining aggregate demand for the region's industrial sector. But the extent to which the supply capacity of the region could meet increasing demand in the short-run is a moot point. Much of the demand may be met by imports from outside the region. Meanwhile, the region presents ample opportunities for industrialists to invest and trade in the long-run, thereby diversifying the output structure and sales markets.

3. *Long-run prospects for industrial growth*

The region has abundant energy resources, chemical feed-stocks, cheap capital, low taxes, modern infrastructure (water and electricity), and huge imports of industrial and manufactured consumer goods which can provide chances for import substitution. However, studies have revealed structural bottlenecks such as excessive dependence on imported professionals, skilled labour shortages, poorly developed industrial information systems (especially at regional level), and not least the lack of proper incentives designed to encourage market and product diversification.

The bottlenecks, however, provide challenges that can be exploited; that is to say, a systematic elimination of bottlenecks could help to improve and enhance factor productivity (particularly the productivity of labour, the most scarce resource). Such efforts could help to improve on the mediocre labour productivity gains of the 1970s and 1980s (see table II.34). For manufacturing as a whole, the labour productivity

Table II.34. North Africa and Western Asia: manufacturing employment and labour productivity index, 1970, 1980 and 1990[a/]

Industry	Manufacturing employment			MVA per worker		
	1970	1980	1990	Index		Value [a/]
	(thousands)			1980	1990	1990
				(1970=100)		(1985 dollars)
Food	327	525	686	96.7	93.0	9 502
Beverages	39	69	101	91.7	108.7	18 129
Tobacco	72	110	100	52.7	89.7	22 383
Textiles	556	747	801	124.4	154.0	8 941
Apparel	51	124	256	82.1	70.5	5 829
Leather	14	22	34	109.9	122.2	12 298
Footwear	32	57	72	64.8	64.8	9 040
Wood and cork	34	60	76	110.5	130.3	11 045
Furniture	25	41	58	119.8	108.6	8 203
Paper	39	67	90	117.6	156.8	15 956
Printing	39	61	75	94.5	129.8	12 507
Industrial chemicals	32	84	134	110.4	157.6	21 215
Other chemicals	75	107	149	123.2	205.6	23 134
Petroleum refining	20	60	58	54.5	131.4	348 800

Industry	Manufacturing employment			MVA per worker		
				Index		Value [a]
	1970	1980	1990	1980	1990	1990
	(thousands)			(1970=100)		(1985 dollars)
Miscellaneous petroleum and coal products	3	15	23	122.1	101.7	20 085
Rubber	20	28	40	138.1	187.3	18 944
Plastics	16	53	69	101.6	134.8	25 239
Pottery	9	20	32	114.4	177.0	14 168
Glass	22	37	46	119.7	185.7	15 341
Non-metallic minerals	118	273	389	110.4	125.7	15 369
Iron and steel	62	159	220	77.5	103.2	14 492
Non-ferrous metals	13	55	77	99.0	166.6	15 409
Metal products excluding machinery	107	170	221	95.1	126.9	13 496
Non-electrical machinery	42	106	159	115.5	169.7	15 911
Electrical machinery	47	112	165	89.8	133.5	19 754
Transport	35	146	213	73.9	119.6	16 687
Professional and scientific goods	3	7	16	117.9	126.9	13 109
Other	12	19	29	158.9	170.1	10 673
TOTAL	1 927	3 344	4 401	99.8	136.0	17 589

Source: UNIDO consolidated Industrial Statistics.
[a] Estimated.

Table II.35. Dependence of GCC countries on expatriate workforce, 1980 and 1985

Country	Total workforce		Expatriate workforce		Share of expatriate workforce	
	1980	1985	1980	1985	1980	1985
	(thousands)		(thousands)		(percentage)	
Saudi Arabia	3 212.7	4 342.1	1 694.0	2 721.0	52.7	62.7
Kuwait	501.1	671.5	392.6	541.2	78.3	80.6
United Arab Emirates	524.7	525.3	470.8	460.0	89.7	87.6
Bahrain	135.5	173.3	73.9	100.5	54.5	58.0
Qatar	95.6	102.0	79.0	78.0	82.6	76.5
Oman	280.0	369.0	112.0	191.0	40.0	51.8
TOTAL	4 749.6	6 183.2	2 777.3	4 091.7	58.5	66.2

Source: Central Statistics Organization, *Statistical Abstract 1987* (Bahrain, 1988).

index recorded 99.8 per cent in 1980 (1970 = 100), and 132.7 per cent in 1990. This compares with the average index for all developing countries of 121.8 per cent in 1980 and 169.8 per cent in 1990.

With regard to specific manufacturing industries, the index in heavy industries (such as other chemicals, rubber products, glass, non-ferrous metals and non-electrical machinery) led in labour productivity gains; while the light industries (such as food processing, tobacco, apparel and footwear) lagged far below the regional average. These results seem to reflect industrial planning with an emphasis on oil-related heavy industries, particularly in the GCC area. In order to correct the imbalance, small- and medium-scale light industries need to be encouraged and upgraded. Though the lack of data precludes a TFP analysis, it can be conjectured that TFP would most likely not have gained much, if at all, considering the massive investment carried out in the heavy industries of GCC countries.

The strategy of oil-related downstream industrialization, however, has created a dependence on expatriates because of the lack of a domestic pool of the required human resources available at short notice (see table II.35). Thus the United Arab Emirates imported 87.6 per cent of its total labour force in 1985, and Oman 51.8 per cent. The proportion of expatriate labour in other GCC countries fell between those two figures.

Table II.36 reflects the shortages of skilled labour in the GCC countries. Substantial labour productivity gains could be achieved if the local education and training systems focused their efforts on meeting those shortages.

Besides the shortages of skilled human resources, there exists a paucity of means of generation and

Table II.36. Numbers employed in the national workforce of GCC countries according to need and skill category

Skill category	Saudi Arabia	Kuwait	United Arab Emirates	Bahrain	Qatar	Oman
Lower technical						
1. Numbers required	18 822	3 514	2 533	582	1 100	533
2. National workforce	12 444	369	117	837	11	152
(2) as percentage of (1)	66.1	10.5	4.6	143.8	1.0	28.5
Skilled						
1. Numbers required	42 103	7 860	5 668	1 302	2 236	1 193
2. National workforce	27 835	825	261	1 873	25	340
(2) as percentage of (1)	66.1	10.5	4.6	143.8	1.1	28.5
Semi-skilled						
1. Numbers required	48 542	9 062	6 534	1 501	2 578	1 372
2. National workforce	32 092	950	301	2 159	29	392
(2) as percentage of (1)	66.1	10.5	4.6	143.8	1.1	28.6

Source: *Study on the development of manpower in manufacturing, oil, electricity and water desalination in GCC countries* (Riyadh, King Sand University, 1988).

dissemination of information needed for decision-making. An extensive UNIDO study concludes as follows:

> "A particular problem arises out of an apparent lack of awareness of markets among entrepreneurs in the Gulf and inadequate market information available within the GCC and even in respect of national markets. This has led to duplication of plants and excess capacity within the GCC and even within national markets, and exacerbated a tendency for entrepreneurs to focus narrowly on their own markets. It is important to correct this situation rather rapidly. This market information obstacle is likely to be even more problematic in respect of overseas markets, new types of manufactured activity (new to the Gulf) and small enterprises" ([40], pp. 134-135).

This is an area in which the Government or even a manufacturers' association could contribute, repairing market imperfections. Information is a necessary condition for the efficient functioning of the market, but the region seems to have far to go in developing its "infant market mechanism", in spite of an abundant supply of capital funds—oil money.

H. Indian Subcontinent

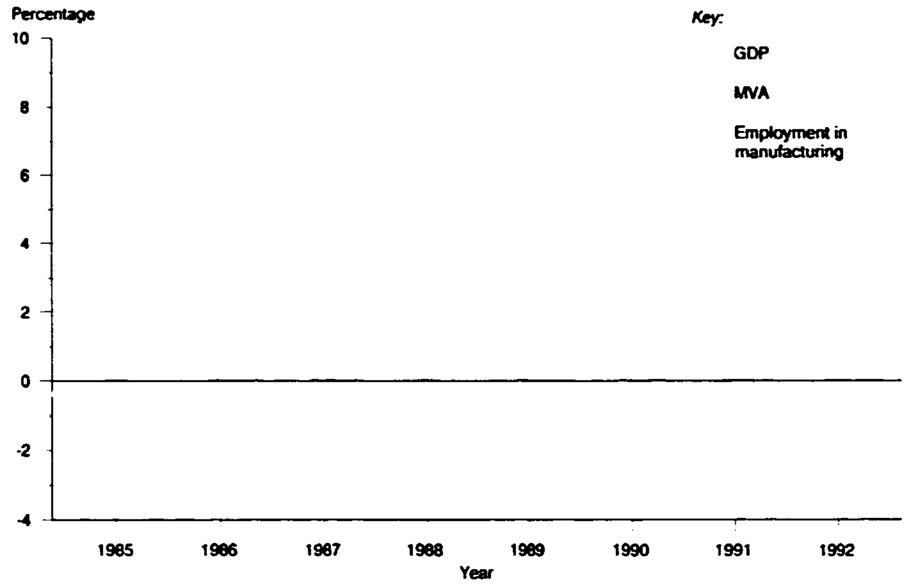
In spite of budget and balance-of-payments deficits, rapid population growth, high oil-import bills, and the loss of remittances and exports due to the Gulf war, industrial growth in the Indian Subcontinent improved in 1990. The long-term prospects for industrial growth in the Indian Subcontinent have undergone a dramatic change since the mid-1980s, with the shift (notably in India and Pakistan) towards deregulation and liberalization. India has indicated its readiness to undertake major changes in economic policy, including restructuring of the trading system, removal of excessive controls, and modification of the Foreign Exchange Regulation Act of India, which has been a major hindrance in attracting foreign investments. Streamlining and simplifying the rules and regulations could provide a powerful stimulus to growth, considering the vigourous development of entrepreneurial, scientific, and technological capabilities, particularly in India, over the last four decades.

MVA in the Indian Subcontinent grew by 8.1 per cent in 1990 from 4.2 per cent in 1989, a substantial improvement, due mainly to the performance of food manufacturing, footwear (excluding rubber), industrial chemicals and other chemical products, and non-electrical and electrical machinery. Regional MVA is expected to increase by 5.5 per cent in 1991, and with a further slight increase to 5.6 per cent in 1992. With regard to long-run MVA growth rates, the annual average for the region is expected to be below the 6.2 per cent achieved in the 1980s (see figure II.9. for GDP and MVA growth in recent years, and also for the pattern of structural change in industry).

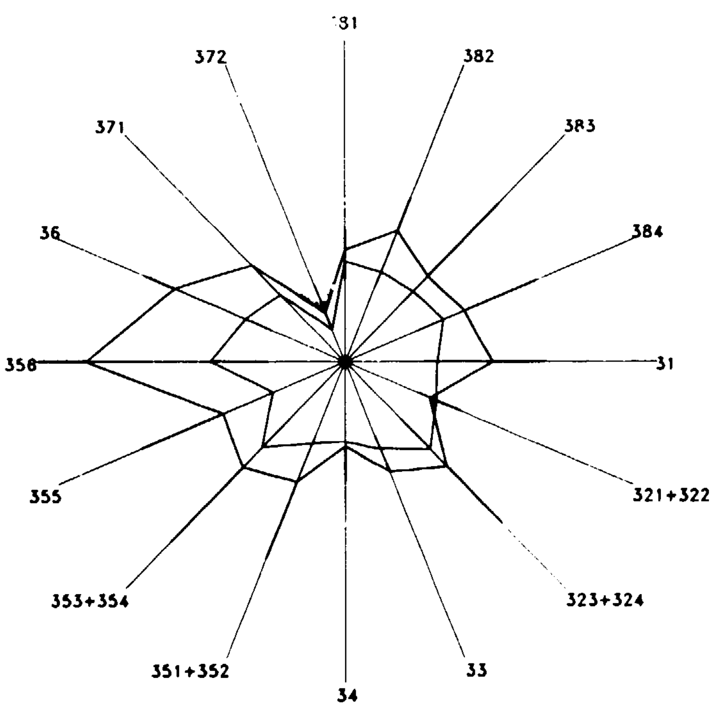
Growth in manufacturing employment has lagged behind MVA growth. In the 1980s, employment in the manufacturing sector recorded only a 0.4 per cent annual average growth rate (while MVA grew by 6.2 per cent), and from 1990 to 1992 it is expected to rise by an annual average rate of 2.09 per cent (compared with an MVA growth rate of 5.7 per cent). In 1990, employment in the manufacturing sector increased by only 1.69 per cent (from its 1989 growth rate of 1.57 per cent), while in 1991 and 1992, the employment rate is expected to rise slightly by 2.08 per cent and 2.51 per cent, respectively. This weak employment growth in the manufacturing sector is partly due to an emphasis on capital-intensive industries, such as industrial chemicals and non-electrical machinery.

GDP growth in the region fell in per capita terms in 1990. In India GDP growth fell in 1990 to 4.5 per cent for the first time in six years, while the population increased from 830 million to 850 million. In Pakistan, GDP growth fell from 6.2 per cent in 1988 to 5 per cent in 1989, and is expected to rise to 5.3 per cent in 1990 owing to the adverse effects of the Gulf war (loss of remittances and higher oil prices), as well as a fall in foreign aid levels. In Nepal, GDP growth declined from its 1989 rate of 2.3 per cent to 2 per cent in 1990. In Bangladesh, GDP grew by 5.8 per cent in 1990 from its 2.5 per cent rate in 1989, but the population rose from 113.5 million in 1989 to 115.3 million in

Figure II.9. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: India



Industrial structural change
(Index of value added: 1975 = 100)



g = 4.44, θ = 14.48

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast
1980–1985
1975–1980

Sources: UNIDO database, estimates and forecasts by UNIDO/PPD/IPP/GLO

1990. Sri Lanka recorded a surprising 6.3 per cent GDP growth in 1990, compared with 2.3 per cent in 1989, while the population rose from 16.8 million in 1989 to 17 million in 1990.

1. *Impact of the Gulf war*

The Gulf war had an adverse effect on the short-term economic outlook for the region. The economies of Bangladesh, India and Pakistan, were particularly hard hit by the fall in remittance levels and the higher price of oil during the Gulf crisis, which led to a widening of the balance-of-payments deficit and high inflation rates. Although the subsequent fall in the price of oil has eased some of the adverse effects, the current account deficit in India is estimated to be $8 billion, while inflation rose to 12 per cent in 1990-1991. North Africa and Western Asia, however, account for only a small proportion of Indian exports: in 1989-1990, the share of that region in Indian exports was only 6.7 per cent, with Kuwait and Iraq accounting for approximately $250 million out of total exports worth $16.5 billion.

The economy of Pakistan suffered more than that of India as a result of the Gulf war. The total loss was estimated to be $2 billion. According to official estimates, the foreign remittance level is expected to decline little from $1.9 billion in 1989-1990 to $1.8 billion in 1990-1991. Revised export forecasts are down by $300 million in 1990-1991. Added to this is the bill of 500 million Pakistan rupees for the repatriation of Pakistanis from Kuwait. While exports to North Africa and Western Asia form only a small percentage of total Pakistani trade (Saudi Arabia, the main trading partner in that region, accounted for only 2.5 per cent of total exports in 1989-1990), imports from the region are somewhat bigger (Kuwait accounted for 11.5 per cent, and Saudi Arabia for 4.4 per cent, of total imports in 1989-1990). From July to December 1990, imports from the Gulf fell by 8 per cent, but while exports to Kuwait and the Islamic Republic of Iran fell, exports to other Gulf countries, such as Saudi Arabia and United Arab Emirates, rose by 26 per cent.

In Bangladesh, remittances represent around 35 per cent of the country's total foreign exchange earnings on current account, with Kuwait and Iraq accounting for 13 per cent of the total remittances forgone as a result of the Gulf war. The high oil prices during the Gulf crisis placed a considerable strain on the ability of the government to finance the oil import bill. However, the subsequent fall in oil prices has eased the constraint on the balance of payments, with the oil import bill estimated to be around $425 million in fiscal year 1990/91. The current account deficit was $2,500 million and total imports were $1,485 million in 1990.

Sri Lanka's Gulf war losses (fall in remittances and exports as well as a higher oil import bill) were around $50 million. The rise in export earnings (from $1,558 million in 1989 to $1,850 million in 1990 mainly due to tea exports) has resulted in a considerable reduction in the current account deficit (from $361 million in 1989 to $230 million in 1990).

While analysing the impact of the Gulf war on the region, it should be noted that the massive reconstruction programme in Kuwait and Iraq should benefit the economies of the Indian Subcontinent, provided that the demand for foreign workers remains unabated. However, the intention stated by the Government of Kuwait to pursue an accelerated capital-intensive reconstruction programme indicates a desire to reduce dependence on foreign workers. Moreover, with firms from developed market economies (mostly United States, United Kingdom and Japanese) winning the bulk of the post-war reconstruction contracts in Kuwait, the prospects of Indian or Pakistani firms obtaining big contracts remain dim (except for providing cheap labour).

2. *Opening up the region: moves towards a market economy*

Privatization is being considered as a serious policy instrument in the region. The Government of India has announced its intention of selling part of the equity of selected public-sector firms valued at 25 billion Indian rupees ($1.32 billion). Further privatizations in Indian industry are being contemplated, especially in the banking sector. Pakistan's programme includes deregulation of the foreign capital market and privatizing 115 State-owned enterprises within a year. Sri Lanka has already privatized a number of companies and plans to modernize various public-sector consumer-goods firms in order to put them up for sale, helped by a $120 million loan from the International Development Association.

A number of privatizations have already taken place. The Industrial Credit and Investment Corporation of India raised holdings of private investors to 27 per cent from 2.8 per cent, while the Shipping Credit and Investment Corporation of India offered 250 million shares, or 30 per cent of its equity, to private investors.

At the recent change of Government, India indicated its readiness to undertake major reforms in economic policy, including restructuring of the trading system, removal of excessive controls, and modifications of the Foreign Exchange Regulation Act, which has been a major hinderance in attracting foreign investments.

In spite of recent privatization measures, Indian industry is still tightly regulated. State monopolies abound in energy, communications and services, and public sector enterprises dominate production of steel, non-ferrous metals, engineering goods (including machine tools and most capital goods), chemicals (including fertilizers), paper, and coal and minerals.

Protective walls in India are still among the highest in the world. Tariffs in India at 146.4 per cent for intermediate, 107.3 per cent for capital, 140.9 per cent for consumer, and 137.7 per cent for manufactured goods (on average) are the highest in the world. Moreover, strict controls on imports, such as classifying the bulk of capital goods as restricted and banning consumer goods altogether (with the exception of a few essential goods such as medicine), have the effect of discouraging trade growth. India has the lowest import-to-GDP ratio in Asia: in 1988 its import-to-GDP ratio was only 9 per cent, compared with 22 per cent for Pakistan, 35 per cent for Sri Lanka, and a high of 183 per cent (due to re-exports) for Singapore.

The recent announcements by the Government of India of two successive devaluations, which have depreciated the rupee by almost 20 per cent against the major currencies, is indicative of the country's transition in economic policy. However, the most important step marking a shift towards a market mechanism is the suspension of the cash compensatory scheme, abolition of supplementary licences, and enlargement of the replenishment licensing scheme to cover all non-essential imports. As a result of this, it would no longer be necessary to issue the 6,000 supplementary and 1,500 additional licences annually for imports. To that extent, trade would be freed of bureaucratic controls, and instead be guided by market forces.

Export performance was poor in 1988; exports of manufactures as a percentage of GDP were merely 4 per cent in India, compared with 9 per cent in Pakistan, 10 per cent in Sri Lanka, 11 per cent in Bangladesh, 33 per cent in the Republic of Korea and a high of 130 per cent in Hong Kong. India's average annual export growth rate from 1980 to 1985 was only 0.1 per cent, while for its Asian neighbours it was much higher: 2.6 per cent for Bangladesh, 6.4 per cent for Pakistan, 13 per cent for the Republic of Korea, 17.7 per cent for Malaysia and 21 per cent for Sri Lanka. India's new trade policy is expected to give a new impetus to Indian exports, while making them more competitive.

The privatization programme of Pakistan has also not been very successful. Although the Pakistan rupee has been made almost freely convertible, and foreign exchange controls and investment regulations have been eased, a number of key industries remain partly or wholly government-owned, including steel, automobiles, cement, fertilizers, vegetable ghee, and textile machinery. The privatization programme has also been bogged down with problems: the sale of 26 per cent of the profitable Muslim Commercial Bank, for example, has been entangled in a web of rules and court orders. Moreover, the Government of Pakistan needs to spend a substantial amount of money to streamline and modernize its loss-making public enterprises before they can be made ready for sale. In these days of dwindling foreign assistance, it is not going to be easy to find funds.

But privatization in Pakistan seems to be here to stay. Pakistan's heavy reliance on external assistance—debt service costs accounted for 40 per cent of the budget in 1990-1991—and United States aid policy towards Pakistan has made the country more dependent on the IMF and the World Bank, pushing the administration towards economic liberalization.

The economic liberalization policies of Sri Lanka seem to have met with more success. Ceylon Oxygen has recently sold 60 per cent of its shares to a Norwegian firm (Hydrogas Ltd.) for 60 million Sri Lanka rupees, and offers are pending from firms in Europe, Japan and the Republic of Korea for the other public enterprises scheduled to be sold. A series of concessions and tax holidays (mainly of five years duration) have also contributed to boosting the country's industrial production and exports. However, they have added to the plethora of bureaucratic rules and regulations, increasing both administrative costs and possibilities of evasion.

3. *Performance of the manufacturing sector–prospects for "sick industries"*

The bulk of manufacturing in the region is accounted for by India, where manufacturing was 26.9 per cent of GDP in 1989, compared with around 17 per cent in Pakistan and Sri Lanka and around 7 per cent in Bangladesh. The average annual increase of industrial output from 1960 to 1980 was 4.6 per cent in India, 5.3 per cent in Sri Lanka, 6.1 per cent in Bangladesh and 8 per cent in Pakistan. In the 1980s, industrial output in India improved owing to modest efforts at economic liberalization: from 1980 to 1988, the average annual increase in industrial output was 4.4 per cent in Bangladesh, 7.2 per cent in Pakistan and 7.6 per cent in India.

Bureaucratic rules and regulations, such as the capacity licensing system and the Monopolies and Restrictive Trade Practices Act (MRTP) of India, pose a formidable obstacle to industrial growth in the region. In an effort to promote new entrants, the capacity licensing system, with its complex rules, is biased against the expansion of existing firms, resulting in falling capacities. For example, unable to take advantage of scale economies because of existing regulations, the 11 firms in the nylon filament industry set up 11 separate plants with an average capacity of between 10 and 25 per cent of the international standard.

The MRTP ignores the existence of large and inefficient monopolies in the public sector in India. The public sector profits are mainly due to a handful of firms such as the three oil companies, which earned two thirds of the gross profits over the past few years. Moreover, in the private sector the complex regulations of MRTP actually lead to a division of markets by the largest firms. For example, in machine manufacturing for pulp and paper, earth-moving equipment, packaging, cement and printing, the four largest companies had 70 per cent of the market in the mid-1980s. Proposed modifications of the MRTP will go a long way toward making Indian industry more competitive.

Another policy that prevents efficient production in India is the complex cost-plus approach used by the Government to fix prices of intermediate industrial goods. This has resulted in erratic pricing. For example, some goods are priced uniformly, while others are priced depending on the age of the plant, and yet other goods are priced according to categories of consumers. The consequent high costs of production compared with world market costs serve as a major disincentive to the promotion of competitiveness both domestically and internationally.

India's poor energy conservation methods have also contributed to a higher cost structure in many industries. According to UNIDO estimates, energy consumption could be reduced and production cost cuts by 10 to 15 per cent for aluminium, fertilizers, cement, paper, caustic soda, calcium carbide and other products.

Moreover, India's policy of preventing firms from going bankrupt has swelled the number of "sick industries". In 1987 there were 160,000 sick firms. The restrictions imposed by the Government on take-overs and mergers makes asset sales difficult, while its policy of protecting the labour force makes it almost impossible to dismiss workers. Consequently, the sick industries are propped up by subsidies, tax reliefs and credits from the publicly owned Indian banks. The net result is to erode industrial competitiveness and the health of the financial system (almost 20 per cent of outstanding loans of Indian financial institutions are attributable to sick industries), as well as promoting inefficient industries, and raising production cost and prices.

Half-hearted as the economic liberalization efforts have been till now, they have still had a beneficial effect on the industrial sector: from 1984-1985 onwards industrial growth has averaged 8.5 per cent and manufacturing 9 per cent per year. Some industries, such as electronics and especially software, have shown much promise. Output in the electronics industry rose from 1.8 billion rupees (Rs) in 1970-1971 to Rs 8.1 billion in 1980-1981, and is expected to reach Rs 110 billion in 1990-1991. Electronics exports, mainly destined for Eastern European countries, increased from Rs 7.5 billion in 1989-1990 to Rs 12 billion in 1990-1991. However, the electronics industry is heavily reliant on imported parts, and will thus have to face greater difficulties as a result of the recent series of currency devaluations by the Government. Another industry that has been prevented from expanding by the restrictive government import policies (particularly those policies that restrict the flows of technology) is the engineering industry, which accounted for 8 per cent of Indian exports in 1990-1991.

Restrictive import and technology policies also threaten the long-term prospects of the motor vehicle industry, which has been expanding rapidly in recent years. In 1989-1990, 150,000 cars were produced, some of which were exported to markets in Eastern Europe. The two-wheeler industry (bicycles and motorbikes) with total output of 1.75 million units in 1989-1990, is the largest in the world.

Telecommunications have also expanded rapidly, with 4.2 million telephone lines added in 1988-1989 and annual additions of 375,000 connections. Plans to further develop India's C-dot system, however, needs a more open technology policy.

The textile industry has contracted substantially, and is now operating at 50 per cent of productive capacity with 150 textile mills in the sick industry list. Production in the steel industry has also been disappointing. It increased from 6.8 million tonnes in 1980-1981 to 11.5 million tonnes in 1988-1989, and the industry is currently operating at less than 75 per cent of its capacity. The outlook for the aluminum industry seems favourable because of the abundant bauxite and alumina smelting capacity, provided that the electricity supply constraint is overcome.

Import controls, higher duties on components and tax increases have already caused production in consumer durables (the leading growth industry in the 1980s) to slump. Production of colour television sets, for example, declined from 1.2 million in 1989 to 900,000 in 1990.

In Pakistan, the rate of growth of manufacturing reached, on average, 9 per cent in the mid-1960s, then fell to an average annual rate of 2.9 per cent for most of the 1970s, but revived in the 1980s to reach an annual average growth rate of 7.7 per cent (1982/83-1987/88). Manufacturing accounted for 17.2 per cent of GDP at current factor cost in 1989-1990, and 48 per cent of all exports by rupee value in 1988-1989. These exports, however, were concentrated in the relatively low-technology industries, such as cotton textiles and garments.

The manufacturing sector in Pakistan consists mainly of food processing and cotton textiles, which accounted for 35.4 per cent of the value added in 1985-1986. The textile industry, however, has been contracting in recent years, although it still accounted for 40 per cent of exports in 1984-1985. The steel industry is currently (1989-1990) operating at 72 per cent of its capacity, and has yet to achieve sustained profitability.

In Bangladesh, manufacturing was 7.5 per cent of GDP in 1989-1990, falling from 8.4 per cent in 1988-1989. Although the manufacturing sector grew by an estimated 9.9 per cent in 1990-1991, the average annual growth rate from 1977-1990 was only 3.5 per cent. Given the narrow base of the manufacturing sector, the natural disasters of 1991, and the consequent collapse of domestic demand (especially in export-oriented industries such as jute and textile milling, as well as food manufacturing and transport equipment), it seems unlikely that the high growth rate of 1990 can be maintained.

The jute milling industry is the largest industrial employer, accounting for 22.6 per cent of total export earnings in 1987-1988. However, heavy reliance on jute (Bangladesh is the world's largest exporter) has made the country vulnerable to fluctuating world prices and the threat of synthetic substitutes. The textile industry, which includes cotton spinning and fabric production, expanded rapidly in the 1980s owing to a proliferation of garment manufacturing firms, replacing jute manufactures in 1987-1988 as the largest export earner with 36 per cent of exports. There is considerable potential for the prawn and shrimp branch of the food processing industry in Bangladesh, but output suffers because of lack of resources for developing fish farming.

Until recently, the pace of economic liberalization policies had decelerated with adverse consequences in India, which accounts for the bulk of MVA in the region. Interest payments on India's short-term debts are expected to be around $500 million in 1991. At the same time, the region is going through a chronic budget and trade deficit, while the sick industries of India are showing no signs of improvement. However, the removal of export subsidies is expected to result in savings of nearly $150 million for India, and its computer and telecommunication industries are expected to realize their potential, with the Government liberalizing the economy and loosening up import restrictions.

An assessment of the impact of industrial policies in Bangladesh

Compared with the situation in India, the need for technological progress in Bangladesh industry appears even more urgent. Studies of the subject are scanty. Fortunately, a careful study has been made by a noted development economist. His conclusions are worth a lengthy quotation:

> One of the main preoccupations of countries in the postwar era has been economic development. While economists rarely agree on any issue, surprisingly a general consensus has emerged among them on development theory, namely that development depends critically on the achievement of rapid technical change.
>
> Bangladesh has made a serious effort at promoting growth through industrialization. The instruments of policy the country has used for industrialization consists mainly of fiscal and financial incentives. The New Industrial Policy of 1982 and the Revised Industrial Policy of 1986 simplified import and investment procedures; introduced a significant degree of liberalization, privatization, and decentralization; and provided about 30 per cent more effective assistance through fiscal, financial, and other incentives to industrial investment and production. Yet, according to an in-depth assessment of the impact of industrial policies at the Planning Commission, entrepreneurs have failed to respond to these policies.
>
> Various explanations have been advanced for the stagnation of industrialization in this country. Some of them mistake symptoms for real causes. When economic considerations are brought to bear upon the stated causes of sluggish investment and thereby hidden costs bared, two root causes of most industrial ills become transparent: (1) the side effects of high effective assistance have caused more harm to industrialization than direct benefits, if any; and (2) the critical factor of growth, namely technology, has been neglected in Bangladesh.
>
> The former result follows from the deceleration of the rates of investment, decline in total factor productivity, stagnant industrialization, and so forth. For the latter result, the analysis of technology was carried out both from the results side and the source side. From the results side, it was found that not only the levels of Bangladesh's productivity and technology are lower than those prevailing in its neighbouring countries, for example, Thailand, India, but relative rates of growth of productivity in numerous industries are also lagging behind. The productivity gap is increasing and Bangladesh is losing in international competitiveness in shrimp, fruit juices, textiles, sugar, coir, hospital services, communications and so forth.
>
> On the source (input) side of technology, Bangladesh lags far behind in research and development as a percentage of GDP, ratio of science and technology personnel with postgraduate degrees to total science and technology personnel, fiscal and financial support for technology, organization and institutes of technology transfer (from abroad), indigenous technology generation, creation and levels of diffusion of industrial innovations, development and standardization of spare parts and other equipment, advances and effort in various technology areas, and so forth.
>
> A widespread consensus prevails among local and expatriate analysts that anything short of a big leap in industrial technology is highly unlikely to enable Bangladesh to catch up with neighbouring countries like Thailand and India.
>
> In this regard, one may refer to the February 1986 National Science and Technology Policy (NSTP86). The NSTP86 was the result of several years of deliberations among policy makers, scientists, technologists, professional bodies and administrators on the ways and means to foster science and technology activities in the country so that economic development may be accelerated. One of the important national objectives set out in NSTP86 is the "attainment of a national capacity for the assessment, selection, acquisition, adoption and adaptation of foreign technology". It envisages development of national capacity for autonomous decision-making in technological matters and the establishment of institutional facilities for efficient absorption of imported technology.
>
> Efficient digestion of imported technology involves attaining the capacity to maintain the facilities, developing skills to replicate technology when necessary (thus avoiding repetitive imports) and adapting technology to suit local conditions. It is now widely recognized that countries which have benefited from large-scale import of technology did not stop at its adaptation but went ahead and introduced improvements and were able to go for innovation and creation of new technologies. This process of successful absorption of imported technology was possible through the establishment of appropriate institutions for transfer and development of technology. Keeping in mind the experience of such countries, the science and technology policy document recommended:
>
> > "A Technology Transfer Study Center to be instituted as a think tank for the NSTP. With further development of a policy regime for technology transfer and the institution of appropriate legal, fiscal and financial instruments for imported technology, a National Center for Technology Development and Transfer may be established in due course to serve as a focal point to provide information, training, consultancy and extension services in respect of technology transfer".
>
> Nearly four years have passed. No action is known to have been taken to develop this National Centre. In the meanwhile, industry has been stagnating. The longer the action on technology transfer is delayed, the bigger the cost and effort that will have to be made. A rectification of past neglect of the specified policy directives is urgently needed.

Source Gian S Sahota, *An Assessment of the Impact of Industrial Policy*, Discussion Paper No 333 (Cambridge, Massachusetts, Harvard Institute for International Development, 1990)

4. *Technology policy and long-run prospects*

The long-run outlook for industrial growth in the region seems promising, provided that the policy of gradual liberalization and deregulation continues, *inter alia*, to instil a healthy dose of competition and to encourage upgrading of the technological level of the industrial base. The scientific and technological resources appear plentiful compared with other developing countries. Greater linkages between research and development activities and commercialized efforts (including rural industries) could be enhanced by introducing a new incentive system, (for example, less regulation and licensing). Such action could help to reverse the negative TFP growth productivity of the 1970s and to ensure efficiency-based industrial growth in the 1990s.

Numerous studies have pointed out the anti-growth consequences of "over-regulation"* The technological aspect of the matter deserves special attention because of its crucial implications for a strategy aimed at efficiency-based industrial growth in the 1990s. The following summary represents typical research findings:

"In short, the compulsive requirement of government's interventionist policy led to an internal learning process that reduced the cost burden of technology import, but there were no adequate incentive structures for a continuous process of technology upgrading and cost-effective innovations to make the Indian industry technologically dynamic and competitive in production. Perhaps, the protected market within which the firms operated did not play any significant role in inducing the firms to modernize and to become competitive. Consequently, the direction of technological change was not adequate to enhance the rate of growth in factor productivity and industrial output comparable to the achievement made by other NICs which followed a more open and less-controlled policy regime" ([46], p. 42).

After extensive research, the following conclusion has also been reached:

"The dangers inherent in such policy interventions, however, are great, and have been a major theme of this study. Over-protection calls forth the wrong types of TC (technological capability) and perpetuates inefficiencies which should have been temporary. It breeds sloth in the exercise of existing TC, especially in world markets, and, by slowing down the growth of the whole industrial sector, retards the pace of learning. Other forms of intervention can also have deleterious effects in the development and exploitation of TC. In India, the setting up of a large science and technology infrastructure divorced from production, the imposition of price controls, the virtual halting of new direct foreign investments, tough regulation of licensing and so on, have all taken their toll on the process of healthy industrial growth" ([47], p. 240).

*See for instance, ([41]; [42]; [43], pp. M81-84; [44]; and [45], pp. M77-80).

Table II.37. Indian foreign technology collaboration and direct foreign investment, 1970-1988

Year	Number of approved FTC arrangements	FTC arrangements with foreign equity	Total DFI (million rupees)	Share of DFI by major countries: Germany Federal Republic of (percentage)	Japan (percentage)	United Kingdom (percentage)	United States (percentage)	Average DFI per case (thousand rupees)
1970	183	32	24.5	5	30	1	20	766.3
1971	245	46	58.4	20	8	28	26	1 269.1
1972	257	37	62.3	2	-	18	66	1 683.0
1973	205	34	28.2	25	12	4	42	828.5
1974	359	55	67.1	9	7	8	29	1 220.5
1975	271	40	32.1	22	4	4	37	801.2
1976	277	39	72.7	13	-	8	62	1 863.8
1977	267	27	40.0	19	-	17	46	1 482.6
1978	307	44	94.1	9	1	5	50	2 137.7
1979	267	32	56.9	8	-	26	39	1 777.2
1980	526	73	89.2	5	19	11	24	1 222.5
1981	389	57	108.7	50	6	7	21	1 907.2
1982	590	113	628.1	6	40	3	8	5 558.1
1983	673	129	618.7	8	26	2	22	4 796.4
1984	752	151	1 130.0	3	5	2	8	7 483.6
1985	1 024	238	1 260.0	9	12	3	32	5 296.9
1986	957	240	1 069.5	19	5	7	27	4 456.3
1987	852	242	1 077.1	9	6	8	27	4 450.6
1988	930	134 a/	2 395.0	17 a/	3 a/	6 a/	47 a/	9 086.7 a/
TOTAL	9 331	1 763 a/	8 912.6	11	11	6	26	4 387.9 a/

Source: Ministry of Industry and Indian Investment Center, as quoted in Hiroshi Kakazu, *Industrial Technology Capabilities and Policies in Selected Asian Developing Countries* (Manila, Asian Development Bank, 1990), p. 33.

Note: FTC = foreign technology collaboration;
DFI = direct foreign investment.

a/ These figures cover the period January to June.

Table II.38. Indian Subcontinent: manufacturing employment and labour productivity index, 1970, 1980 and 1990[a]

Industry	Manufacturing employment (thousands) 1970	1980	1990	MVA per worker Index 1980 (1970=100)	Index 1990 (1970=100)	Value[a] 1990 (1985 dollars)
Food	740	1 429	1 111	58.3	157.7	2 519
Beverages	23	51	68	73.7	117.4	4 589
Tobacco	138	389	433	53.1	91.1	2 779
Textiles	1 712	2 220	1 956	95.9	116.3	1 770
Apparel	30	69	125	103.5	161.7	1 743
Leather	36	40	52	137.4	156.4	2 870
Footwear	9	29	39	89.1	120.6	2 071
Wood and cork	63	82	81	114.9	129.6	1 102
Furniture	17	13	12	108.5	158.8	1 288
Paper	10	15	16	81.4	97.8	2 714
Printing	169	167	172	112.7	152.7	2 197
Industrial chemicals	122	212	258	73.8	152.4	8 484
Other chemicals	200	350	450	94.7	133.4	4 950
Petroleum refineries	13	25	26	78.5	137.7	26 853
Miscellaneous petroleum and coal products	9	26	40	167.3	130.2	4 422
Rubber	82	106	119	78.1	173.7	5 443
Plastics	41	50	68	120.6	175.5	2 917
Pottery	28	37	45	153.8	168.2	1 595
Glass	57	65	47	109.8	218.1	2 374
Other non-metallic minerals	200	302	432	102.4	144.3	2 614
Iron and steel	373	558	707	107.0	116.7	2 946
Non-ferrous metals	40	56	53	28.4	54.9	2 675
Metal products excluding machinery	200	223	216	110.7	139.5	2 480
Non-electrical machinery	325	428	470	129.3	196.4	3 879
Electrical machinery	237	346	412	119.4	200.9	5 253
Transport equipment	408	514	520	131.5	232.4	3 815
Professional and scientific goods	35	43	59	115.3	342.3	6 305
Other	51	36	36	143.8	240.3	3 936
TOTAL	5 469	8 109	8 180	95.0	153.6	3 112

Source: UNIDO consolidated Industrial Statistics.
[a] Estimated.

If the analysis is valid, the policy implication is clear. A policy of removing protection and administrative controls could reverse the adverse effects. Indeed, a comparative study has recommended the following:

> "... India's major R + D institutions particularly those under the Council of Scientific and Industrial Research (CSIR) need to be reoriented toward more commercial application of basic technology through active interactions with the private industrial sector. Indigenous technological capability can only be strengthened through competitive use of technology. Thus, drastic policy reforms to create more open, competitive environments are required to stimulate rapid technological upgrading" ([48], p. 42).

It has been reported that India has accumulated the world's third largest pool of qualified scientists, engineers, technicians and managers ([49], pp. 557). Furthermore, in spite of the basic policy stance toward technological "self-reliance", India's foreign technological collaboration has been accelerating (see table II.37). The recent success of the electronics and computer software industry bodes well for other modern industries to enjoy the benefits of greater international collaboration, thanks to the process of opening up the economy started in the mid-1980s.

The record of labour-productivity performance in the 1980s seems to support the optimism for the future (see table II.38). On average, the index of MVA per worker had declined to 95.0 in 1980 (1970=100); but the figure rose to 153.6 in 1990. Noteworthy is the leading role played by electrical and non-electrical machinery, transport equipment, professional equipment and other manufacturing, in raising the productivity index.

The industries concerned are obviously capital- and technology-intensive, inconsistent with the existing factor endowments. Debates abound, therefore, as to the appropriateness of allocating resources to them. But success or failure would seem to depend on whether "learning" is maximized and total factor productivity is raised at a rapid pace in those industries a dynamic gain which, if large enough, could more than compensate for the losses in static efficiency as was apparently the case in the industrialization of East Asia.

Deregulation (delicensing) could also promote and strengthen industrial growth if properly administered.

An elaborate econometric study ([50], p. 174) has reached the conclusion that "simulating a scenario in which the same commercial policy is combined with sectoral investments allowed to respond to the private rate of return obtained generates improvement on a different order of magnitude. By 1980, a 22 per cent gain in value added is recorded".

Whether the policy makers could continue to pursue a policy of liberalization and deregulation remains unclear. Although the global trend in that direction is encouraging, the domestic political environment could prove intractable. Policy makers face the challenge of having to deal with the "difficulty of taking collective action in large and heterogeneous coalitions, as Mancur Olson (1982) and others have emphasized . . ." ([51], p. 69).*

I. East and South-East Asia

The countries of East and South-East Asia exhibit a set of industrial fundamentals which forbode the continuation of high growth over the long-run, despite cyclical fluctuations. Virtually every country in the region (except the Philippines) has been experiencing industrial upgrading. They have introduced new products in their export composition, especially a variety of manufactured goods, raised labour productivity through investments in both physical and human capital on a continuous basis, institutionalized risk-taking to promote technical progress, and integrated trade and investment links among the countries in the region both horizontally and vertically (in particular, by sourcing inputs from abroad) at an accelerating pace. This dynamism in industrial progress, unless hindered by a catastrophe such as a total breakdown of the GATT system (a present worry) will probably impel growth throughout the 1990s, not only in the Pacific Rim but also in the world industrial economy. Unfortunately, however, the dynamism also carries the danger of causing industrial disputes with other regions (such as the EEC and the United States), and thereby a temptation to form a defensive trade bloc.

Economic growth in the region slowed in 1990, and is projected to decelerate further in 1991, reflecting the shortage of capacity and rising wages and labour shortages in certain skilled occupations. The average GDP growth rate for the region fell from 9.1 per cent in 1988 to 7 per cent in 1989, and 6.9 per cent in 1990, and is projected to fall further to 6 per cent in 1991. Singapore is predicted to be the worst hit, with its GDP growth rate falling from 8.6 per cent in 1990 to 6.7 per cent in 1991. Nevertheless, South-East Asia still maintained relatively high growth rates compared with other regions. The 1991 growth rate for OECD countries, for example, is expected to be only 2 per cent.

The Gulf crisis had a particularly harmful impact on the region in 1990, since it is highly dependent on oil imports. The North American recession is predicted to have a major negative effect on the economic growth of the region in 1991 since the United States remains the largest trading partner of many countries of South-East Asia. However, it should be noted that the main reason for the economic slow-down in 1990 was the relatively poor performance of the agricultural sector. The industrial sector registered growth rates that exceeded GDP in 1990. The only exception was the Philippines, with a GDP growth rate of 2.6 per cent in 1990.

Economic growth in 1990 was led by domestic demand, as seen by the rising ratio of domestic demand to gross domestic investment in recent years and the high rate of such investment in the region. With the exception of Taiwan Province and the Philippines, gross domestic investment grew faster than GDP in every country and area of the region. The main reason for the higher gross domestic investment in NICs was the high-technology, capital-intensive production methods in the industrial sector, while in the other South-East Asian countries and areas, it was the higher infusion of foreign direct investment that accounted for the rise in investment. The Republic of Korea is expected to attain the highest growth in the region in 1991, with its GDP forecast to grow by 8.7 per cent, up from 8.9 per cent in 1990. In the Philippines, the Republic of Korea and Taiwan Province, however, consumption rose faster than GDP. In 1991, for the third consecutive year, GDP growth in Malaysia and Thailand is expected to exceed that of the NICs (see figure II.10 for GDP and MVA growth in recent years and also for the pattern of structural change in industry).

1. Impact of the Gulf war

In the South-East Asian region, the country worst affected by the high oil prices and the loss of remittances, export markets and tourist reserves was the Philippines, with $1 billion lost in remittances alone and GDP expected to rise by only 3.5 per cent instead of the projected 6.5 per cent. The impact on East and South-East Asian countries and areas was diverse, ranging from net benefits to oil-exporting Indonesia and Malaysia, and losses incurred by oil importers such as the Republic of Korea (hardest hit with an estimated loss of $1.5 billion), Taiwan Province and Thailand. Moreover, with rising wage rates in the South-East Asian region, it seems unlikely that the NICs could gain substantially from reconstruction opportunities in Kuwait and Iraq.

2. Impact of the United States recession

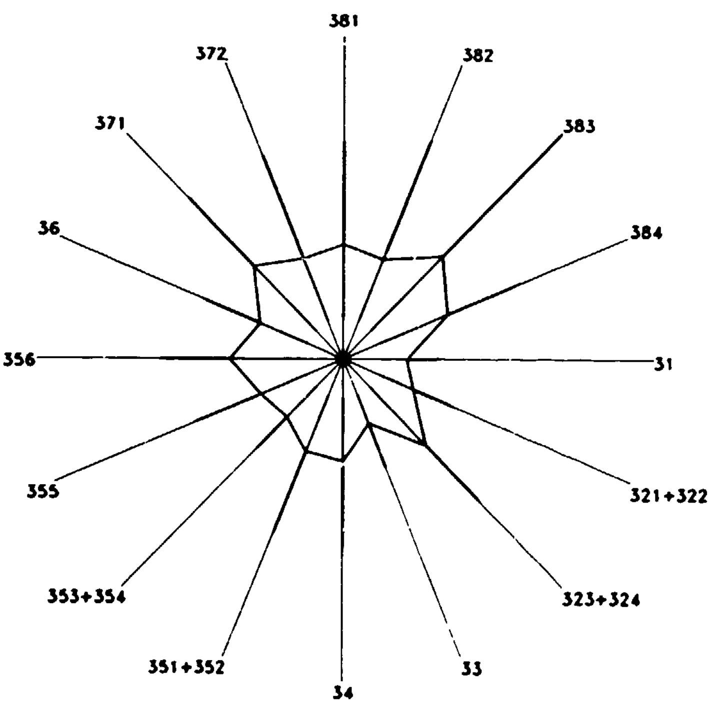
The recession in the industrialized countries, especially the United States, which is the region's main trading partner, will have an adverse effect on South-East Asian countries by depressing export earnings. United States GNP fell in two consecutive quarters—the last quarter of 1990 and the first quarter of 1991. However, the slow-down is expected to be short-lived. Moreover, the diversification of South-East Asian export markets, notably towards Japan, will somewhat ease the impact of the United States

*"The Indian public economy has thus become an elaborate network of patronage and subsidies. The heterogeneous proprietary classes fight and bargain for their share in the spoils of the system and often strike compromises in the form of 'log-rolling' in the usual fashion of pressure-group politics" ([51], pp. 65-66).

Figure II.10. Growth rates of GDP, MVA and manufacturing employment, 1985-1992, and industrial structural change, 1975-1992: East and South-East Asia

Industrial structural change

(Index of value added: 1975 = 100)



g = 8.18, θ = 21.76

Key:

Constant prices of 1980

g = Average annual growth rate, 1975–1992 (percentage)

θ = Index of structural change, 1975–1992

ISIC code	(industries):
31	(Food products)
321, 322	(Textiles)
323, 324	(Leather)
33	(Wood and furniture)
34	(Paper and printing)
351, 352	(Chemicals)
353, 354	(Petroleum and coal)
355	(Rubber products)
356	(Plastic products)
36	(Non-metal mineral products)
371	(Iron and steel)
372	(Non-ferrous metals)
381	(Metal products)
382	(Non-electrical machinery)
383	(Electrical machinery)
384	(Transport equipment)

1985–1992 forecast

1980–1985

1975–1980

Sources: UNIDO database; estimates and forecasts by UNIDO/PPD/IPP/GLO.

recession. The share of exports to the United States in the total exports of South-East Asian countries fell from 33 per cent in 1986 to 28 per cent in 1989, while the share of exports to Asia (with the bulk going to Japan) increased from 38 per cent to 44 per cent during the same period. For example, in Malaysia, which recorded one of the highest growth rates in the region in 1990, the Japanese presence is pervasive. Japan was its biggest source of foreign investment in 1989, at 2,682 million ringgit, and is its leading trading partner as well as its biggest provider of foreign aid (around $2.7 billion in total assistance in 1989). Japanese manufacturing investment is expected to create 40,000 jobs in Malaysia in 1990. Trade between Japan and Viet Nam, worth $394 million in 1990, was up 84 per cent from 1989. Japan is also Indonesia's main trading partner, accounting for 42.1 per cent of its total exports and 23 per cent of its total imports in 1989.

The shifting pattern of foreign investment in the South-East Asian region also reflects the decreased dependence on the United States economy. An increasing amount of foreign direct investment is coming from within the region itself, particularly from Japan and the NICs. By 1988, foreign direct investment in Asia had almost tripled to $12.7 billion from the 1983 level. However, external economic events will continue to play a significant, albeit diminishing, role in the economy of the region. For instance, Asia faces a shortage of international credit in 1991 because of the diversion of funds to Eastern Europe and the Gulf.

Consequently, the NICs have, on the one hand, shifted their labour-intensive industries to lower-cost countries in the region, such as Malaysia and the Philippines (and China), and, on the other hand, moved towards more capital and technology-intensive industries, particularly in the Republic of Korea and Taiwan Province. Labour-intensive manufacturing is continuing at a faster pace in the other South-East Asian countries, and a broad programme of economic liberalization has been announced all over the region, even in countries as diverse as Indonesia and Viet Nam.

3. *Comparison of the growth performance of Indonesia and the Philippines*

Indonesia

GDP growth in Indonesia was, in 1990, around 7 per cent, and is expected to slow to between 5.5 and 6 per cent in 1991. The oil and liquefied-natural-gas

Prospects of new frontiers: Viet Nam and Democratic People's Republic of Korea

Economic liberalization policies in isolationist nations such as Viet Nam and the Democratic People's Republic of Korea have opened up prospects of new frontiers for foreign investors in the region. Viet Nam has stepped up its economic liberalization programme with the announcement of steps towards market prices, a floating exchange rate, and revamping of business laws and regulations—after a sharp decline in development aid from its main donor, the USSR. Under a newly signed treaty with Moscow, Soviet aid flows to Viet Nam dropped from nearly $1,600 million in 1988 to only a little over $400 million in 1991. Faced with a mounting budget deficit (estimated at 20 per cent of GDP), an alarming rise in the inflation rate (predicted to reach 400 per cent by the end of 1991, according to official estimates), and deterioration of the manufacturing sector, the Government of Viet Nam is eager to welcome foreign investments.

Vietnamese industry has been the main victim of the cut in Soviet aid and trade. Heavy industry, which was already hard hit by the government reforms ending State subsidies and a sudden flow of foreign imports, is now reeling from the loss of cheap Soviet inputs and energy, while light industry (especially textile and handicrafts) has lost 60 per cent of its contracts worth $200 million as a result of the reduced trade with the USSR.

In order to achieve its goal of doubling per capita income to $400 a year by the year 2000, Viet Nam needs $35 billion worth of investments. The authorities expect $9 billion to $13 billion of that to come from foreign investors. In the past three years, a total of $1.5 billion in foreign investments have been approved, mostly in oil and gas projects, with 60 per cent of the investments coming from Europe, Canada and Australia. In order to enhance this relatively low level of foreign investment, the Vietnamese authorities should target regional investors. Hong Kong and Taiwan Province, the biggest individual investing areas, accounted for $174 million and $104 million, respectively, as of December 1990, and Taiwan Province received $200 million in approvals already in the first quarter of 1991. Moreover, United States firms are still barred from business with Viet Nam. Raising the overall level of foreign investment in Viet Nam, however, requires a relaxation of the United States embargo.

The Democratic People's Republic of Korea has also taken the first steps towards modernizing its economy and opening it up to world trade by its March 1991 announcement of increasing machinery and equipment imports from developed market economies, and its support for a proposal by Malaysia to establish an East Asian economic grouping. As with Viet Nam, one of the main reasons for economic liberalization is the changed position of the USSR, the main trading partner and aid donor. The USSR has demanded hard currency for its oil exports to the Democratic People's Republic of Korea. However, it will take more than announcements to steer the latter towards economic reform, and unless it seriously starts implementing the promised reforms, it will find foreign aid flows slow in coming (the country already owes about $800 million to banks in developed market economies after defaulting on loans arranged in the early 1970s).

industry expanded by 4 per cent, mainly owing to the 10 per cent increase in the production of liquefied natural gas. Indonesia, the largest supplier of liquefied natural gas, accounts for 40 per cent of world exports. Manufacturing growth remained at 10 per cent, and the investment flows boosted demand for the construction industry. The private investment rate remained high, helped by the economic deregulations, reform of the financial sector and a favourable exchange rate, while the high oil revenues boosted the public investment rate, particularly in infrastructure-building.

However, costs of growth have also materialized in the guise of higher inflation (9.5 per cent in 1990, up from 5.9 per cent in 1989). The tight monetary policy undertaken by the Government to remedy this situation, coupled with a weakened demand for imports in the main developed market economies (especially the United States), infrastructural bottlenecks, and the drop in international oil prices (to below $21 per barrel in 1991), has contributed to the economic slow-down. Non-oil exports (which account for 70 per cent of foreign exchange earnings) rose by only 6.7 per cent in 1990 to $15.3 billion, substantially below the 20.4 per cent growth rate recorded in 1989, while non-oil imports sharply rose by 29 per cent ($17.9 billion) in 1991, compared with 18.6 per cent growth in 1989. The trade surplus recorded in 1991 was mainly due to windfall oil revenues ($11.8 billion) from the Gulf war. However, the oil price shock also pushed Indonesia's external debt above $50 billion in 1990. Tight monetary policy and higher interest rates are predicted to raise the current account deficit substantially, reaching $3.5 billion to $4 billion in 1991 (up from $2.4 billion in 1990).

Manufacturing accounted for more than 18 per cent of Indonesia's GDP in fiscal year 1989/90, and is expected to grow to 24 per cent by the year 2000. Indonesian industry will also benefit from the rising inflow of foreign investments into the region. Of the $8.7 billion worth of foreign investment approved in 1990, Japan (Indonesia's largest trade partner) accounted for more than 25 per cent, Hong Kong 11.4 per cent, the Republic of Korea 8.3 per cent and Taiwan Province 7.1 per cent of the total. Indonesia is currently building up its pulp and paper industry: output is projected to rise from 1.5 million tonnes in 1991 to 3.5 million tonnes by the end of 1992. This industry was targeted for expansion because of Indonesia's fuel cost advances and low wage bills (representing 22 per cent of costs), which are about one third of those in Thailand and Malaysia, and one tenth of those in Taiwan Province. Manufactured goods already accounted for 27.9 per cent of goods exported in 1989.

However, one of the main obstacles to the future economic growth of Indonesia is inadequate investment in infrastructure. The State electricity monopoly, PLN, for example, is only able to provide electricity to 54 per cent of urban and 13 per cent of rural households. Even with increased public spending in infrastructure (owing to the windfall oil revenues), planned expansion in electricity will meet only 75 per cent of the projected new demand, while the phone service is grossly inadequate, with barely one line per 150 people.

The continued presence of trade-distorting rules in spite of successive trade policy reforms since the mid-1980s remain as yet another obstacle to long-term Indonesian growth prospects. According to GATT, the reforms have been too gradual and selective. Some State trading enterprises such as steel and shipbuilding remain sheltered from international competition, while tariff rates have escalated on consumer goods (tariffs on consumer goods are double those applied to capital goods).

Philippines

The GNP growth rate of the Philippines fell from 5.7 per cent in 1989 to 3.5 per cent in 1990*, and is forecast to drop to between 2.5 and 3 per cent in 1991. Total consumption rose in 1990 mainly as a result of increased personal consumption (which grew by 6.2 per cent in 1990, compared with 5.7 per cent in 1989), but is forecast to fall in 1991 to a mere 2.5 per cent annual growth rate. MVA grew by 1.5 per cent in 1990, and is expected to grow by 1.6 per cent in 1991 and 2.6 in 1992. Manufacturing productivity (index 1980=100) has been falling (from 130) since 1983, reaching a little over the 1980 base-year growth rate in 1990.

The slow-down in manufacturing growth rates is due to both domestic and international economic factors. Domestically, the disruptions of power supplies, higher wages and steep interest rates have had a negative effect on the manufacturing sector. Internationally, the weak world economy and the consequent reduced demand for exports led to a deterioration in the terms of trade of the Philippines, while a major earthquake and the high oil import bill due to the Gulf crisis further exacerbated the balance-of-payments deficit. The services sector also recorded a lower growth rate (3.3 per cent) in 1990 (down from 5.5 per cent in 1989), and is expected to fall further (to 2.6 per cent) in 1991.

The Government of the Philippines is currently in the process of implementing the structural reform policies prescribed by the IMF, after the IMF approval of a new standby facility and the $3.3 billion aid pledge of official donors under the IMF conditions. Aid flows to the Philippines are crucial not only to fill half the budget gap for 1991, but also to cover the predicted $2.1 billion external financing shortfall for 1991. Overall debt-service obligations have been steadily rising in recent years, from $2.65 billion in 1986 to $3.68 billion in 1990, while net resource outflows in 1990 accounted for $2.2 billion.

Cuts in fuel price subsidies and additional inflows of foreign aid have resulted in a reduced budget deficit, bringing down inflation and interest rates in 1991. This constitutes a positive sign that the economy is changing direction. Inflation was 1.6 per cent in February 1991, down from 2.8 per cent in January and 3.2 per cent in December 1990, and interest rates fell to 25 per cent in the March auction of treasury bills, after reaching 32 per cent in January. Industrial and economic growth could pick up in 1992 if the economic reforms continue, and development projects such as the CALABARZON (Cavite-Laguna-Batangas-Orezon) industrial estates and other infrastructural projects are implemented.

*Estimates of *The Economist Intelligence Unit*

4. *Long-run trend in productivity gains*

During the 1980s, despite the 1981-1982 recession, the volatility of exchange rates and interest rates in the world financial markets, the instability of oil prices, debt crises in Latin America, and so on, East and South-East Asia forged ahead in industrial growth, creating employment and raising labour productivity at the same time (see table II.39). The manufacturing sector is estimated to have employed over 12 million workers in 1990, compared with 9.3 million in 1980. The index of labour productivity (MVA per worker, 1970=100) jumped from 148.1 in 1980 to 240.0 in 1990 for the manufacturing sector as a whole.

Even more remarkable is the leading role played by the modern strategic industries. For instance, the electrical machinery industry increased employment from 975,000 in 1980 to 1,509,000 in 1990, and yet the labour productivity index almost doubled from 140.1 to 276.2. Similar improvements can be observed in iron and steel, non-electrical machinery, transport equipment and professional equipment. It should also be noted that no industry registered a negative growth in labour productivity either in the 1970s or in the 1980s.

The improvement in labour productivity could stem solely from an increase of the ratio of capital to labour, and not from technical progress. But available evidence suggests that it is not the case for this region. One way to gauge technical progress is to measure TFP, in spite of some conceptual problems ([52], pp. 1029-1064). Table II.40 shows the TFP contribution as compared with that of capital and labour for the Asian NICs. It is noteworthy that TFP contributed 20.4 per cent of MVA growth in Hong Kong (1960-1970), 18.03 per cent in the Republic of Korea and 39.8 per cent in Taiwan Province (1955-1970).

More recent studies of TFP growth in manufacturing are scarce, but what is available reveals the role of the modern strategic industries, and also suggests how comparative advantage is changing. Table II.41 and II.42 present TFP growth rates for the Republic of Korea (1966-1983) and Taiwan Province (1968-1982). Some broad similarities can be observed between the two economies. Output growth rates are higher in engineering-intensive (or capital goods) industries, compared with traditional industries such as food, beverages, tobacco, textiles and leather. Furthermore, a substantial part of output growth appears to be accounted for by the TFP contribution

Table II.39. East and South-East Asia: manufacturing employment, and labour productivity index, 1970, 1980 and 1990[a/]

Industry	Manufacturing employment			MVA per worker		
	1970	1980	1990	Index		Value[a/]
	(thousands)			1980	1990	1990
				(1970=100)		(1985 dollars)
Food	708	1 106	1 332	123.0	171.5	9 272
Beverages	93	118	141	120.2	199.4	27 540
Tobacco	201	220	282	178.4	253.1	17 366
Textiles	931	1 496	1 455	186.2	311.1	8 585
Apparel	337	930	1 179	134.2	183.8	5 980
Leather	26	77	115	189.4	353.5	10 053
Footwear	35	78	93	164.8	289.4	7 430
Wood and cork	230	390	469	128.6	161.1	6 147
Furniture	49	145	179	101.8	152.1	5 902
Paper	93	181	251	159.8	253.5	13 981
Printing	121	190	279	173.6	244.5	11 448
Industrial chemicals	78	156	193	141.1	309.4	33 905
Other chemicals	126	239	308	140.2	252.5	21 385
Petroleum refineries	12	18	27	178.7	212.9	249 699
Rubber	123	293	462	133.2	165.2	7 701
Plastics	214	405	599	160.5	251.9	8 911
Pottery	22	65	83	159.9	245.0	8 216
Glass	41	65	84	147.3	245.1	12 779
Non-metallic minerals	116	211	272	166.6	232.8	13 876
Iron and steel	76	187	235	202.6	364.5	26 910
Non-ferrous metals	21	64	66	174.2	289.7	17 189
Metal products	209	479	680	157.4	249.9	9 347
Non-electrical machinery	135	305	471	192.9	339.1	12 836
Electrical machinery	273	975	1 509	140.1	276.2	13 503
Transport equipment	152	439	578	132.3	257.1	17 484
Professional and scientific equipment	25	128	173	198.0	301.6	10 133
Other	191	313	517	207.0	256.9	9 108
TOTAL	4 664	9 302	12 064	148.1	243.0	12 223

Source: UNIDO consolidated Industrial Statistics.

[a/] Estimated.

Table II.40. Contribution of labour, capital and TFP to manufacturing growth in Japan and the Asian NICs during the 1960s
(Percentage, with percentage distribution in parentheses)

Country or area	Period	Explanation of sources of growth			
		Capital input	Labour input	Total factor productivity	Income growth rate
Hong Kong	1960-1966	6.64 (68.3)	1.47 (15.1)	1.61 (16.6)	9.72
	1966-1970	2.70 (25.3)	4.67 (43.7)	3.32 (31.1)	10.69
	1960-1970	5.20 (52.4)	2.70 (27.2)	2.03 (20.4)	9.93
Japan	1955-1960	4.60 (34.2)	3.09 (23.0)	5.75 (42.8)	13.44
	1960-1966	5.14 (64.9)	1.39 (17.6)	1.39 (17.6)	7.92
	1966-1970	5.06 (36.8)	1.72 (12.5)	6.97 (50.7)	13.75
	1955-1970	5.03 (43.9)	2.03 (17.7)	4.40 (38.4)	11.46
Republic of Korea	1960-1966	2.28 (18.3)	7.54 (60.6)	2.62 (21.1)	12.44
	1966-1970	4.80 (32.7)	5.12 (34.8)	4.77 (32.5)	14.69
	1960-1970	3.59 (26.0	7.14 (51.7)	3.08 (22.3)	13.81
Singapore	1960-1966	5.20 (31.9)	7.51 (46.1)	3.58 (22.0)	16.29
	1966-1970	6.68 (27.3)	13.76 (56.3)	4.01 (16.4)	24.45
	1960-1970	5.58 (30.6)	9.34 (51.2)	3.34 (18.3)	18.26
Taiwan Province	1955-1960	2.42 (21.0)	3.73 (32.3)	5.39 (46.7)	11.54
	1960-1966	4.25 (43.0)	1.84 (18.6)	3.80 (38.4)	9.89
	1966-1970	5.45 (38.7)	5.35 (38.0)	3.28 (23.3)	14.08
	1955-1970	4.16 (36.1)	2.78 (24.1)	4.58 (39.8)	11.52

Source: Edward K.Y. Chen "Factor inputs, total factor productivity, and economic growth: the Asian Case", *Developing Economies*, vol.15, No.1 (May 1977), p.135.

Table II.41. Republic of Korea: TFP and output growth rates in manufacturing industry, 1966-1983 annual average

Industry	Total factor productivity	Output
Food	1.87	15.66
Beverages	2.73	13.81
Tobacco	4.15	16.66
Yarn	2.24	18.43
Knitting products	2.34	19.95
Textiles	1.88	17.08
Clothing	1.07	11.98
Leather	1.99	17.80
Footwear	1.97	16.83
Wood and cork	1.05	10.07
Furniture	5.47	24.72
Paper	2.12	17.48
Printing	1.81	12.21
Industrial chemicals	-1.00	24.19
Other chemicals	4.92	26.44
Petroleum refining	-3.91	15.76
Petroleum products	0.69	7.74
Rubber	1.62	19.87
Plastics	0.49	23.87
Pottery	2.95	13.22
Glass	3.42	19.68
Non-metallic minerals	1.91	15.41
Iron and steel	1.41	25.86
Non-ferrous metals	1.58	22.42
Metal products	3.10	21.64
Motors and turbines	6.73	36.05
Industrial machinery	2.07	18.13
Office machinery	4.45	28.91
Electrical machinery	3.09	25.77
Telecommunications	4.11	46.51
Electrical appliances	2.81	29.90
Other electrical equipment	1.96	22.71
Shipbuilding	3.19	26.02
Railway equipment	1.54	10.50
Automobiles	2.55	24.21
Airplanes	2.01	20.97
Professional equipment	3.59	30.92
Other	2.82	22.57

Source: K.S. Kim and S.R. Park, *An Analysis of Productivity Changes in Korean Manufacturing* (Seoul, Korea Institute for Economics and Technology, 1988), p.129.

Note: TFP based on translog production function.

of the leading growth industries. These findings are consistent with an increasing proportion of engineering goods in the exports of the two economies.*

Rapid structural change in industrial output was promoted by market forces as well as by Government-initiated promotional measures. As the Asian NICs

*For a detailed analysis of structural and technological changes and trade in East and South-East Asia, see [53].

Table II.42. Taiwan Province: TFP and output growth rates in manufacturing industry, 1968-1982 annual average

Industry	Total factor productivity	Output
Food processing	-0.15	7.30
Beverages and tobacco	0.88	9.46
Textiles	3.46	18.54
Apparel	2.02	20.23
Leather and fur	4.14	27.40
Lumber and furniture	-0.76	8.19
Paper and paper products	-0.01	9.38
Chemicals	-0.67	12.96
Petroleum and coal	-0.63	11.83
Rubber	2.07	15.66
Clay, stone and glass	0.99	11.05
Basic metals	0.04	16.18
Fabricated metals	1.42	15.85
Machinery	3.63	15.81
Electronics and electrical machinery	2.12	19.44
Transport equipment	2.26	18.37

Source: Tain-Jy Chen and De-piao Tang, "Export performance and productivity growth: the case of Taiwan", *Economic Development and Cultural Change*, vol. 38, No.3 (April 1990), p.580.

Note: TFP based on translog production function.

succeeded in rapid industrial growth based on labour-intensive exports in the 1960s, domestic wages began to rise quickly, other developing countries competed with even lower wage rates, and protectionism intensified in developed countries. With a scarce endowment of natural resources, the Asian NICs had to diversify into skill- and capital-intensive sectors.

Government provided help to make it possible for enterprises to take greater risks in projects for industrial upgrading. In Taiwan Province, the "Statute for Encouragement of Productive Enterprises" was promulgated in 1960. With constant amendments since then, this law provided incentive measures as needed to promote technological capabilities in industry. As of 1983, they included the following ([54], p. 17):

(a) A five-year tax holiday or accelerated depreciation of fixed assets;

(b) A 10 or 15 per cent tax credit on total investment for purchases of imported machines or locally made ones, respectively;

(c) A maximum business tax of 22 per cent on annual taxable income, compared with a 25 per cent maximum tax in general;

(d) Duty-free import of machines and equipment for encouraged projects.

The government-sponsored Industrial Technology Research Institute (ITRI) provides subsidized research services in chemistry, mechanics, electronics, materials, energy and mining. "Due to the fact that the average size of the Taiwanese company generally is too small to make sufficient investments in R+D, the government, through ITRI, has come to play a most active and important role in adapting and diffusing imported technology" ([54], p. 31).

The Republic of Korea has likewise been pursuing a policy of upgrading the industrial base. Besides providing infrastructure of a general nature such as government-financed research institutes for science and technology and research and development activities, the Government has taken the initiative of establishing institutional mechanisms for conferring rewards for technological risk-taking by private enterprises. Some examples of such devices are listed below. It will require full-scale research to determine the relative importance of these institutional policy instruments. It suffices to point out here that various imperfections relating to technology and markets have apparently been removed by these instruments.

One effect of the industrial upgrading efforts has manifested itself in a rapidly growing number of new products in the export basket. In general, the new products have tended to be more skill- and technology-intensive, reflecting the technology learning process as an ongoing concern. The process of catching up has been providing a firm basis for Asian dynamism through intra-industry trade and investment. Table II.43 shows new products in which regional producers could gain export competitiveness within the next 3 to 10 years, as judged by the experience in Japanese markets.

In sum, industrial growth in the region is expected to slow down in the short-run, owing to a slump in North America, Australia and New Zealand. But the industrial fundamentals appear robust, providing a long-term foundation for sustained high growth, especially when compared with other regions of the world. The process of catching up in technological areas, improving factor productivity, and intraregional investment and trade provide evidence to support an optimistic view. However, industrial disputes with North America and Western Europe can be expected to increase, particularly if factor productivity growth lags behind the world average in those regions, a fundamental element of global imbalance.

Table II.43. Export competitiveness and catching-up in East Asian countries and areas

	Catching up in			Same level	More competitive in price at present	More competitive overall at present
	10 years	5 years	3 years			
Materials						
Steel (plate)	C		K,T			
Steel (sheet)		•••				
Carbon fibre	••					
Cement	C,M,Th				K,T	
Communication and information equipment						
Cptical fibre	••					
Digital PBX	•	K,HK,S Th				
Household telephones		C	M,Th	S	K,HK	T
Fixed-disk equipment	•				S,Th	
Personal computers	•				K,HK,S	
Printers	••					
Electronics						
Household videotape recorders					K.T.	
Colour television sets					K,T,HK	C,M,S Th
Liquid crystal television sets	•••					
Radio cassettes	M,Th	HK	K,T,S			
Headphone stereos			S,M		K,T	
Radios			S,M	K,T	HK,C	
Refrigerators		C,Th,M	T,HK	S	K	
Microwave ovens				T,S	K	
Electric fans		C	HK		K,T,S M,Th	
Calculators		C	K	T	HK	
Super large-scale integration	T	K	S,M			
Dynamic random access memory (less than 256 kilobits)	•				K	
Individual semi-conductors	C,M,Th	T,HK,S	K			
Machines						
Injection moulding machines	C,M,Th	HK,S	K,T			
Numerical control lathes	C,M.Th	S	K,T			
Industrial robots	C,M.Th		K,T,HK S			
Wide-use motors				T,K,S Th		
Agricultural tractors	•			K		
Forklifts	C	T	K			
Bearings	K,C,M				S.Th	
Cameras (luxury)		•••				
Watches (popular)			C	S,Th,M	K,T,HK	
Watches (luxury)	•	K,T,HK S				
Transport equipment						
Trucks (ordinary)	••					
Automobile parts	C,M,S HK	Th	K,T			
Motor bicycles	•				T	
Fashion, apparel and other						
women's outerwear	•	K,T,HK S,C,Th				
Sportswear	Th	S	T	HK	K	
Lingerie		•••				
Colour film	••					

Source: *Nihon Keizai Shimbun* (20 July 1988), quoted in Yung Chul Park "The little dragons and structural change in Pacific Asia", *The World Economy*, vol.12, No.1 (March 1989), p.144.

Notes: *Nihon Keizai Shimbun* (a Japanese newspaper) polled 50 Japanese producers on their evaluation of 50 manufactured goods from East Asian countries *vis-à-vis* Japanese competition.

C = China; HK = Hong Kong; K = Republic of Korea; M = Malaysia; S = Singapore; T = Taiwan Province; and Th = Thailand.

• Information incomplete.

•• Cannot catch up in five years.

••• Can catch up in five years (in most cases).

List of support schemes to replace imports with local production and to upgrade the industrial base in the Republic of Korea*

A. *Financial support schemes*

Manufacturing development fund
Industrial technology improvement fund
New enterprise creation support fund
Technology development fund
Venture capital fund
Special fund for small and medium enterprise
Equipment fund for export and import substitution in raw materials component parts
Lease fund
Procurement fund for domestically produced machines

B. *Tax benefit schemes*

Income tax exemption for foreign engineers
Exemption of local tax for real estate to construct research institutes by enterprises
Tax exemption for income from technology sales
Income tax exemption for technology-intensive enterprise initiators
Special accelerated depreciation allowance for projects using new technology
Tax credit plus accelerated depreciation for research and development equipment and vocational training equipment
Reserve funds for research and development accounted as losses
Tax credit for expenditures on research and development and training
Tariff reduction (65 to 70 per cent) on imports of research and development equipment
Tariff reduction (30 to 55 per cent) on imports of high-technology industrial equipment

C. *Technology support schemes*

Special research and development projects
Basic technology research and development projects
Technical guidance on
  Long-term training of researchers
  Inplant technical personnel development
  Simplified automation project
  Invited foreign experts
Free technological information dissemination
Free use of expensive test equipment
Test of precision equipment and repairs
Quality seal for domestically produced machines, parts and raw materials
Support measures for obtaining foreign quality seals

D. *Miscellaneous support schemes*

Comprehensive support package for promising small- and medium-scale suppliers of new products
System of identifying promising list of new exportable products (free marketing research) and priority products for import substitution
Exhibition of domestically produced machines
Government preference to procure domestically developed new products
Anti-dumping tariff system
Protection schemes for newly developed products with domestically developed technology
Monitoring system to observe impacts of new products
Fair trade and transaction law
Exemption of military services requirements for core researchers
Free consulting service for promotion of localization programme

*([55], p. 28)

J. China

The economic environment for resuming high industrial growth has improved in several respects. The economy achieved a trade surplus ($13.1 billion) in 1990 for the first time in many years, easing foreign exchange constraints. Foreign direct investment in the industrial sector is expected to step up thanks to liberal reforms to attract foreign direct investment (such as 100 per cent foreign ownership) and the improved international standing of China, as reflected in Japan's interest to resume investment there. In addition, commodity bottlenecks (shortages of steel, basic chemicals, cement, fertilizers, coal, crude oil, cotton, chemical fibres etc.) have been mitigated by investment designed to increase production capacity in these products. The prospects for trade in the Asia-Pacific area appears favourable, although the slowdown in United States growth will have an adverse effect.

On the industrial policy front, the "contract responsibility system" appears to be taking root, though not without problems. Export subsidies are being eliminated, relieving the Government from fiscal pressures, and at the same time exposing industries to greater competition; and technological development and innovations are being encouraged with a new set of incentive measures. These policy reforms are expected to help strengthen the industrial base in the long-run.

Formidable challenges remain, however, as to choosing an optimal mix of the market and planning, eliminating rent-seeking activities, reducing regional income disparities, and strengthening the macroeconomic policy apparatus, including banking and the fiscal system, so as to control the pace of inflation and growth.

In 1990, industrial output in China grew by 7.6 per cent and GNP by 5 per cent. This performance represents a modest recovery from 3.9 per cent GDP growth in 1989, when a drastic contractionary policy was adopted in order to arrest runaway growth and inflation. The prospect is for 5.5 per cent growth in industrial output (see table II.44 for other economic performance indicators).

The contractionary policy appears to have severely affected the "modern" branches of manufacturing, with negative growth registered in 1990 in machine tools (−34.1 per cent), refrigerators (−29.2 per cent), washing machines (−20.9 per cent), cameras (−22.6 per cent), bicycles (−14.6 per cent), ships (−13.4 per cent), motor vehicles (−12.8 per cent) etc. (see table II.45). Most of these industries use imported inputs in large quantity, and the reduction in foreign exchange availability seems to have been one of the main explanations for the negative growth.

In spite of a high price paid to control inflation at 2.1 per cent rate in 1990, its threat to re-emerge still exists. The total wage bill soared by 13 per cent, compared with a productivity increase of 0.8 per cent in 1990. Furthermore, annual government lending for the non-agricultural sector jumped by 46 per cent in 1990. Approximately one third of fiscal spending went to subsidies for the loss-making State-owned enterprises.

Nevertheless, a current account surplus of $13.1 billion achieved in 1990 provides policy makers with room for manoeuvre to manage further recovery in 1991 with low inflation. It is noteworthy that Chinese exports shot up by over 18 per cent in 1989, reaching $62 billion, and imports decreased by 9.8 per cent, to $53.4 billion. This marks the first surplus since 1983. It is also remarkable that the process of opening the economy to the world market has continued at a rapid pace. Exports as a proportion of GNP reached 22 per cent in 1989, compared with only 6 per cent in 1980. This process is expected to continue, providing widening markets for further exports and greater access to imported machines and technologies.

Foreign direct investments also add to the process of opening up the economy. In spite of the contractionary policy in force since 1989, such investment has flowed in steadily. In 1990 foreign direct investment registered $3.4 billion, compared with $3.3 billion in 1989 and $3.2 billion in 1988 (see table II.46 for the origin of foreign direct investment and table II.47 for the regional destination within China). This investment brought with it new technologies, capital equipment and managerial and marketing skills needed for invigorating industry.

Much of the foreign direct investment is attracted into new ventures such as petrochemicals (ethylene, chemical fibre and fertilizers etc.)* and telecommunications (optical fibre, switches, telephone equipment, microwave communication equipment, testing instruments etc.). In short, the backward-linkage industries are being developed, industries that are known to possess technological dynamism and at the same time will bring foreign exchange by import substitution as the industrialization progresses.

The new policy on foreign direct investment, promulgated on 22 October 1990, involves further concessions. For instance, new joint ventures can be 100-per-cent-owned by foreign investors. Furthermore, joint ventures with no time limit (or a minimum period of operation) can enjoy a two-year income tax holiday

Table II.44. Some key indicators of economic performance in China, 1988-1991
(Annual percentage growth rates)

Item	1988	1989	1990	1991 forecast
GNP	10.9	3.6	5.0	5.5
Industry	20.8	8.5	7.6	8.6
Agriculture	3.9	3.1	6.9	3.5
Investment	23.3	-8.0	7.6	12.0
Exports (f.o.b.)	20.5	10.7	18.1	4.5
Imports (c.i.f.)	27.7	7.0	-9.8	11.2
Money supply	20.3	18.0	27.8	20.8
Retail sales	27.8	8.9	1.9	10.1
Consumption	25.9	10.8	3.3	12.1
Inflation	18.5	17.8	2.1	6.2

Source: Economic Research Center, State Planning Commission of China.

*"The petrochemical industry is a new industry in China and, although China's annual ethylene production capacity has increased from 480,000 tonnes in 1980 to 2 million tonnes, China still has to import $4 billion worth of petrochemicals, especially processed chemicals ... China's Petrochemical Corporation (SINOPEC) noted that the 14 projects are located in Guangdong, Tilin, Trianjin, Beijing, Hebei, Henan, Zhejiang, Xinjiang, Jianzsu, Jiangsei, Human, Liasoning, Gangsu and Shanghai" ([56], p. 30).

Table II.45. Output of manufactured goods in China, 1989 and 1990

Product	Unit	1989	1990	1989-1990 (percentage change)
Consumer products				
Cloth	billion metres	18.9	18.0	-4.9
Woolen fabrics	million metres	280.0	280.0	0.0
Sugar	million tonnes	5.0	5.7	14.0
Crude salt	million crates	5.0	19.8	-29.9
Cigarettes	million crates	31.9	32.9	3.0
Bicycles	millions	36.8	31.4	-14.6
Television sets	millions	27.7	26.6	-3.8
Colour television sets	millions	9.4	10.2	8.8
Tape recorders	millions	23.5	29.7	26.4
Cameras	millions	2.5	1.9	-22.6
Washing machines, household	millions	8.3	6.5	-20.9
Refrigerators, household	millions	6.7	4.8	-29.2
Producer goods				
Cotton yarn	million tonnes	4.8	4.5	-5.6
Paper and paper board, machine-made	million tonnes	13.3	13.3	-0.2
Synthetic detergents	million tonnes	1.5	1.5	1.2
Aluminium wares	thousand tonnes	82.2	72.7	-11.6
Energy production (standard fuel)	billion tonnes	1.0	1.0	2.4
Crude coal	billion tonnes	1.1	1.1	2.5
Crude oil	million tonnes	134.6	138.0	2.5
Electricity	billion kilowatts	584.7	618.0	5.7
Hydroelectricity	billion kilowatts	118.3	126.0	6.5
Steel	million tonnes	61.6	66.0	7.2
Rolled steel	million tonnes	48.6	51.2	5.4
Cement	million tonnes	209.9	203.0	-3.3
Timber	million cubic metres	58.0	54.0	-6.9
Sulphuric acid	million tonnes	11.5	11.7	1.4
Soda ash	million tonnes	3.0	3.8	23.3
Chemical fertilizers	million tonnes	18.0	19.1	6.1
Chemical insecticides	thousand tonnes	207.9	229.3	10.3
Power-generating equipment capacity	million kilowatts	11.7	11.4	-2.7
Machine tools	thousands	178.8	117.8	-34.1
Motor vehicles	thousands	583.8	509.1	-12.8
Tractors	thousands	39.6	39.0	-1.5
Locomotives	numbers	680.2	655.0	-3.7
Steel ships, civilian use	million tonnes	1.4	1.2	13.4

Source: State Statistical Bureau communiqué, as quoted in *Business China*, 25 March 1991.

Table II.46. Foreign direct investment in China by country or area of origin, 1984-1989
(Million dollars)

Year	Hong Kong and Macao	United States	Japan	Taiwan Province	Total
1984	748	256	225	..	1 419
1985	956	357	315	..	1 956
1986	1 329	326	263	..	2 244
1987	1 598	263	220	100	2 314
1988	2 095	236	515	500	3 194
1989	2 037	284	356	400	3 300

Source: Ministry of Foreign Economic Relations and Trade, as quoted in *Far Eastern Economic Review*, 23 August 1990, p.42.

Table II.47. Foreign direct investment in China, 1979-1987

Province or region	Number of cases	Percentage of total	Value of investment (million dollars) Contract basis	Actual
Liaoning	212	1.99	779.2	145.0
Beijing	261	2.44	1 651.2	640.0
Tianjin	230	2.15	242.8	150.4
Hebei	103	0.96	98.4	19.5
Shandong	126	1.18	336.0	..
Jiangsu	194	1.82	219.9	88.9
Shanghai	291	2.73	1 842.6	366.4
Zhejian	153	1.43	158.7	62.2
Fujian	1 023	9.58	821.9	300.5
Guangdong	6 970	65.29	9 188.3	3 112.4
Guangxi	287	2.69	384.1	120.0
Subtotal	9 850	92.29	15 723.1	5 005.3
Heilongjiang	97	0.91	103.0	13.2
Jilin	45	0.42	95.1	..
Nei Mongol	15	0.14	48.8	12.6
Shanxi	19	0.18	5.7	2.8
Henan	78	0.73	224.8	16.4
Anhui	54	0.51	31.9	..
Hubei	78	0.73	55.9	36.1
Jiangxi	66	0.62	74.1	14.5
Hunan	99	0.93	67.5	9.7
Subtotal	551	5.16	706.8	105.3
Xinjiang	17	0.16	62.0	34.0
Gansu	19	0.18	23.6	4.1
Ningxia	2	0.02	2.0	..
Shaanxi	110	1.03	1 029.2	121.9
Quinghai	4	0.04	4.2	0.5
Sichuan	73	0.68	140.7	42.9
Guizhou	24	0.22	12.8	3.7
Yunnan	23	0.22	20.6	11.1
Xizang	2	0.02	1.2	1.1
Subtotal	274	2.57	1 296.3	219.3
TOTAL	10 675	100.02	17 726.2	5 330.2

Sources: Adapted from *Shanghai Industrial and Economic Journal*, 8 July 1988; *China Newsletter*, No.76 (1988), p.23; and Dali Yang, "Patterns of China's regional development strategy", *China Quarterly*, No.122 (June 1990), p.248.

and a three-year income tax reduction. However, some ventures still fall under time-limit policies, as in land development and real estate, and resource exploration and extraction. The new policy, coupled with Asian dynamism in trade and investment, in which China plays an important part, seems to augur well for active foreign direct investment inflows over the next few years, barring unexpected political instability.

The quietly evolving science-and-technology policy provides another instrument to strengthen the industrial base in the long-run. Currently, three technology programmes are in effect—the Spark Plan, the High-tech Plan and the Torch Plan.

The Spark Plan, designed to encourage innovation in rural areas, aims at setting up small demonstration enterprises to train for upgrading skills and to produce equipment for rural and township industries. As of 1988, over 9,000 projects had been launched producing 7.4 billion yuan renminbi worth of output, and had performed subcontracting operations for the export-oriented coastal enterprises.

The High-tech Plan, inaugurated in March 1986, represents China's response to the "new technological revolution" modelled on the EUREKA programme of the EEC. Priority areas include biotechnology, space, information, lasers, automation, energy and advanced materials. As of mid-1988, over 10,000 scientists and engineers have participated in the programme.

The Torch Plan aims at bridging the chasm between research and development on the one hand, and production, on the other.* With specially earmarked funds, the Plan would play a catalytic role in creating a "silicon valley fever" in China. The new approach is to introduce "technology markets" to stimulate the movement of technology through profit incentives. The first national technology fair was already held in Beijing in 1985, where 4,180 transactions worth 2.1 billion yuan renminbi were concluded. By 1987, 130,000 contracts valued at 3.35 billion yuan renminbi had been signed.

These technological initiatives in China have been underlined by a new realization that "technological progress should be combined with a policy of adjusting the industrial structure and the product mix" ([58], p. 2). This seems to be a critical factor determining the speed of upgrading the industrial structure and new comparative advantage that China might come to possess. However, it is a moot question whether the incentive structures embedded in the existing institutions (the market, science and technology organizations, the banks and the industrial enterprises) are coherent and conducive to innovation and industrial upgrading.

As an improved incentive element of the systemic reforms aimed at the modernization of Chinese industry on an efficiency-oriented basis, the "contract responsibility system" has been introduced. Under the new system, State-owned enterprises are entitled to keep realized profits after paying taxes and sharing with local Government a fixed sum of profits negotiated periodically. In return, the enterprises receive from local Government the intermediate inputs, energy and raw materials needed to produce output for the next period. The intermediate inputs and raw materials are negotiated and allocated by the Government usually below the market price. The local Government can also "recommend" bank loans for the enterprises. For this reason the new system has acquired new names, such as "bureaucrat capitalism", "negotiation exchange economy", and "bargaining regime".

The new system has resulted in the formation of a de facto coalition between the economic bureaucrats and the enterprise community, maximizing jointly their mutual benefits. "They jointly make decisions regarding enterprises' production and profit targets, and typically in cases of faltering performance, bureaucratics revise these targets downward and provide financial and other support to enterprises in trouble" ([59], p. 449). It seems to be clear that bargaining skilfully and cultivating non-market connections may

*"China now has over 9,100 research institutes, the majority (5,700+) of which are not directly connected with enterprises, by contrast 90 per cent of Japan's research and development units are directly linked to companies" ([57], p. 603)

prove more profitable than taking risks on innovation and technological upgrading under great uncertainty.* Stronger incentive measures may be necessary if technological risk-taking were to be encouraged in an effective manner.

Another related incentive problem concerns the arrangement for tax collection by local bureaucrats for the central Government. The bureaucrats' prerogative to negotiate with the enterprise on sharing profits tends to neglect the need of the central Government to collect revenues mainly because of the de facto coalition noted above. The interregional disparities in income and in tax collection (especially between the coastal provinces and the hinterland) exacerbate the issue of fairness and the problem of meeting the revenue needs of the central Government.**

K. Concluding remarks: institution-building—a key to efficiency creation?

This brief review of reform processes in each major region shows kaleidoscopic patterns and approaches to creating market institutions. This historical experimentation could serve as a laboratory for learning about the art of policy-making for efficiency creation. One unmistakable finding is that institution-building emerges as an important variable affecting long-run industrial performance because the arrangements of institutional components define the structure of incentives and information flows simultaneously, and these motivate risk-taking and the learning of new technologies.*** Thus, for example, the centrally planned economies seem to have failed to provide adequate information and incentives for innovative activities.

Developing countries face the task of rethinking and rebuilding their own structure of market institutions.**** Policy makers have a lesson to learn from observing how industrial countries benefit from each other's institution-building experiences. Comparative study of industrial organization and intra-firm behaviour in the United States and Japan has begun only recently (about 1985) in a serious manner. The research findings, however, are already beginning to make a substantial impact on policy formulation relating to technology and business actions, including the establishment of a growing number of joint ventures aimed at sharing newly developed institutional skills. There are many examples of the new approach. Notable features include the multifunctionality of workers, an essential ingredient of the *kanban* (just-in-time) system; a multidisciplinary team approach in development projects, particularly in high-technology industry where various disciplines, such as engineering, marketing, finance, supply and procurement, interact in an integrated manner; a de facto coalition of employee and stockholders organizations; the *keiretsu* system functioning on long-term trust rather than on contract specification and court-room litigation for enforcement; and a horizontal information flow system (Japan) versus a vertical system (United States).

This review and other available studies suggest that some institution-building regimes can be characterized as "market-augmenting" as contrasted to "market-repressing". The former distinguishes itself from the latter by encouraging expansion of supply (along with demand) capabilities of enterprises. Its aim is to increase industrial competitiveness in international markets, to encourage risk-taking for mastering new (imported) technologies, and to "repair" market imperfections such as fundamental uncertainties, prohibitive information costs facing individual enterprises (including information asymmetry or information monopoly), and technological as well as "psychological" externalities, as reflected in boom psychology and attempts to "keep up with the Joneses" not only in consumption but also in production. The market-repressing regime has negative attributes such as restricting competition, compartmentalizing existing markets, multiplying rent-seeking opportunities and forming politically strong groups of vested interests, thereby increasing transaction costs of enterprises.

But it must be recognized that a market mechanism does not come "naturally"; often painful institution-building efforts are required. Every institutional component of the market, be it a production system (for example, a firm organization), banking system, insurance and other implicit risk-sharing system, accounting system or contract system (labour laws, commercial laws, industrial licensing laws etc.), requires careful formulation and experimentation in order to improve on the efficiency of the component, and also on how to fit each component into the whole institutional edifice. The whole institution so organized will determine how effectively information and incentives would be "transmitted" to motivate economic actors to innovate, improve and produce, with high quality and low price, goods that people want.

This dynamic vista makes it possible to conceive of a market mechanism as an infant, growing or learning in an operational sense, as mature, or even as senile (in the sense of Mancur Olson's hypothesis—the market institution being sickened by rigidity, sclerosis and ossification) [68]. This view prompts caution regarding facile assumptions of a perfect market in theorizing as well as dispensing policy prescriptions.*

*A question still remains. What explains the difference in industrial growth performance between China and the countries of Eastern Europe and the USSR? One possible answer could be that the former (China) has had a thriving informal or second economy which has been operating continuously on a quasi-market mechanism outside the central planning framework since decades before the current reform movement started. For an insightful account, see [60], pp. 715-736.

**Some economists make a distinction between innovation and imitation. The latter carries supposedly less risk than the former. Nonetheless, even imitation (for example, importing foreign technology and adapting it to local conditions) bears great risk and uncertainty because of the possibility of miscalculation and the ignorance prevailing in developing countries about the market.

***Theoretical discussions have thrived in recent years regarding the role of institutions in economic development. See, for instance ([61]; [62]; [63], pp. 1361-1374; [64], pp. 903-918; [65]; and [66].

****But the direct transfer of an institutional component from other countries may not produce desired results. Among other reasons, "The performance of an individual institution depends on the structural arrangement of institutions. Under different arrangements performance will differ; this is probably one of the main reasons why an institution works in one society and not in another. . . ." ([67], p. 191).

*For instance, a general equilibrium model usually assumes a perfect market and excludes institutional content, a crucial long-run policy variable for the inducement of dynamic efficiency.

Market institutions need to be created or continuously modified to fit well a particular economic environment which often changes autonomously, and this requires much careful judgement.

Thus a detailed comparative diagnosis of building blocks in the existing institutional edifice could be immensely useful for improving technology absorption and efficiency creation. Particularly, least developed and heavily indebted countries should be encouraged and assisted to begin rebuilding their institutional structure.

Although these countries may be heavily constrained by the need to rehabilitate sick industries and to service their debt, it is imperative that their industrial sector be expanded, upgraded and made efficient, all the more so because the current technological revolution appears to be bypassing them, especially Tropical African countries, and this tendency has to be countered. Left neglected through inaction, many countries in the region would be rapidly marginalized, and communal stability could consequently be jeopardized. Although the least developed countries are generally placed at the lowest level of the technological ladder, they must learn to begin somehow to climb it quickly. History has proven that only science and technology judiciously applied can effectively fight the law of diminishing returns and the Malthusian population trap.

In this regard, it is encouraging to note that substantial differences exist in technology mastery and efficiency between firms within a country and between countries in Tropical Africa. This implies that there exists significant room to learn from each other's technology and skill level. Particularly notable is the relatively advanced stage of agro-industries in some countries, for example Zimbabwe. Indeed, agro-industries seem to promise to provide a powerful springboard in the industrializing process of the region.

III. Industrial energy consumption and industrial development

A. Overview

1. Energy problems in the North and the South

The Gulf war has once again brought the energy crisis to the forefront of global economic issues. The quadrupling of oil prices after the crisis of 1973 and the doubling after that of 1979 were reversed throughout the 1980s as oil prices steadily dropped to their pre-1973 levels in real terms. With the onset of the Gulf crisis in August 1991, prices skyrocketed from around $20 to nearly $40 per barrel, and then slumped again to around $20 per barrel in a matter of just several months. In fact, on one day, 17 January 1991, the price of oil tumbled from $32 to $21.45 per barrel. This extreme instability in world oil markets has reawakened policy makers, energy experts and even average citizens to the stark reality of the persistent energy crisis. In short, like environmental issues, the energy crisis has captured worldwide attention and become a major focus of current international economic and political debate.

Yet the term energy crisis means different things to different participants in the world economy and creates many paradoxical situations. In developed countries, the disruptive effects on the economy of a critical shortfall in the oil supply and the negative impacts of high energy costs on economic growth are major concerns. However, apart from the short-term economic difficulties caused by a sudden disruption of oil supplies, the fear that higher energy costs would dampen economic growth may have been overstated, since the overall share of energy costs in economic output in most developed countries, usually less than 5 per cent of GNP, has been too small to constitute a major brake on the engine of economic growth. In fact, a standard calculation shows that a doubling of energy costs would reduce the annual GNP growth rate of developed countries by less than one half of 1 per cent, for instance, from 3.5 per cent to 3.1 per cent over a 10-year period, assuming a "normal" economic growth rate of 3 to 4 per cent and energy costs amounting to 5 per cent of GNP. Energy conservation and substitution effects would further diminish the impact.

In this context, the most significant phenomenon that has occurred during the past 20 years in the global energy landscape has been the "delinking of industrial production from energy use", with a substantial increase in output accompanied by a decline in total energy consumption in developed countries. The delinking of energy and output in developed countries has been made possible by a structural change from the energy-intensive materials-processing industries to less energy-intensive, technologically sophisticated production in high-technology industries, by the emergence of a service economy, and by energy conservation and energy-efficiency measures.

The phenomenon of delinking is particularly pronounced in the industrial sector. Industrial final energy consumption in OECD countries declined at an annual rate of 0.65 per cent in 1973-1980 and 1.93 per cent in 1980-1985, while industrial output increased at a rate of 1.50 per cent in 1973-1980 and 2.24 per cent in 1980-1985 (see tables III.1 and III.2). In this regard, it should be noted that final energy consumption in the transport industry as well as other industries in OECD countries consistently registered positive growth rates during the same periods. By sharp contrast, there is a strong positive relationship between industrial output and energy consumption in developing countries. Industrial energy consumption in developing countries as a whole (excluding China) grew at an average annual rate of 6.32 per cent in 1973-1980 and 4.83 per cent in 1980-1985, while industrial output grew by 3.82 per cent and 0.03 per cent in the same periods (see tables III.1 and III.2).

The contrast between the North and the South is partly the result of impressive energy conservation measures coupled with energy-saving technologies introduced in developed countries since the two oil crises of the 1970s. There is abundant empirical evidence of huge potential for energy conservation and efficiency improvements, since virtually all manufacturing processes deviate considerably from the minimum energy requirements defined by the laws of thermodynamics. It was a change in the structure of industrial production, however, that may have been largely responsible for the decoupling of output and energy. It is well-known that the initial stage of transforming raw materials in the hierarchy of manufacturing processes is the most energy-intensive stage, after which energy-intensity progressively diminishes with the shift away from material conversion to fabrication and services. For instance, one study provides an illuminating example of comparative energy costs at different stages of production. Energy costs in the United States amount to $1.20 for every dollar spent on wages and capital in an aluminium smelter, 25 cents in the production of inorganic chemicals such as oxygen and chlorine, only 5 cents in the frozen foods industry, and 1.5 cents in the manufacture of computers ([1], p. 51). The shift away from heavy materials processing to high technology and sophisticated service industries in developed countries explains the apparent decoupling of indus-

Table III.1. Final energy consumption by sector in selected regions, 1973, 1980 and 1985
(Millions of tonnes of oil equivalent)

Region, country or economic grouping	1973	Percentage	1980	Percentage	1985	Percentage	Annual growth rates 1973-1980	1980-1985	1973-1985
Africa									
Industry a/	10.30	31.99	18.40	34.14	23.70	34.30	8.64	5.19	7.19
Transport b/	13.50	41.93	22.00	40.82	27.40	39.65	7.23	4.49	6.08
Other c/	8.40	26.09	13.50	25.05	18.00	26.05	7.01	5.92	6.56
Total	32.20	100.00	53.90	100.00	69.10	100.00	7.64	5.09	6.57
Africa share of world total		0.84		1.23		1.51	5.67	4.11	5.02
Asia (excluding China)									
Industry a/	78.40	52.27	116.20	53.57	142.70	44.93	5.78	4.19	5.12
Transport b/	41.60	27.73	54.50	25.13	67.90	21.38	3.93	4.49	4.17
Other c/	30.00	20.00	46.20	21.30	107.00	33.69	6.36	18.29	11.18
Total	150.00	100.00	216.90	100.00	317.60	100.00	5.41	7.93	6.45
Asia share of world total		3.90		4.96		6.93	3.48	6.92	4.90
Latin America									
Industry a/	51.80	35.55	84.10	38.38	96.70	39.91	7.17	2.83	5.34
Transport b/	61.90	42.48	87.30	39.84	90.10	37.19	5.03	0.63	3.18
Other	32.00	21.96	47.70	21.77	55.50	23.91	5.87	3.08	4.70
Total	145.70	100.00	219.10	100.00	242.30	100.00	6.00	2.03	4.33
Latin America share of world total		3.79		5.01		5.29	4.06	1.08	2.81
Western Asia									
Industry a/	15.80	44.13	21.30	28.90	40.70	33.80	4.36	13.83	8.20
Transport b/	12.70	35.47	33.60	45.59	48.50	40.28	14.91	7.62	11.81
Other c/	7.30	20.39	18.80	25.51	31.20	25.91	14.47	10.66	12.87
Total	35.80	100.00	73.70	100.00	120.40	100.00	10.87	10.31	10.64
Western Asia share of world total		0.93		1.69		2.63	8.84	9.28	9.02
Total developing countries (excluding China)									
Industry a/	156.30	42.97	240.00	42.58	303.80	40.54	6.32	4.83	5.69
Transport b/	129.70	35.66	197.40	35.02	233.90	31.21	6.18	3.45	5.04
Other c/	77.70	21.36	126.20	22.39	211.70	28.25	7.17	10.90	8.71
Total	363.70	100.00	563.60	100.00	749.40	100.00	6.46	5.86	6.21
Developing countries' share of world total		9.47		12.89		16.36	4.51	4.87	4.66
OECD									
Industry a/	1 044.00	40.85	997.20	38.33	904.70	35.35	-0.65	-1.93	-1.19
Transport b/	673.40	26.35	749.30	28.80	782.20	30.56	1.54	0.86	1.26
Other c/	838.10	32.80	855.00	32.87	872.70	34.10	0.29	0.41	0.34
Total	2 555.50	100.00	2 601.50	100.00	2 559.60	100.00	0.26	-0.32	0.01
OECD share of world total		66.52		59.51		55.86	-1.58	-1.26	-1.44
Eastern Europe d/ and USSR									
Industry a/	484.50	54.32	631.70	54.12	687.40	55.88	3.86	1.70	2.96
Transport b/	142.50	15.98	171.80	14.72	173.40	14.10	2.71	0.19	1.65
Other c/	265.00	29.71	363.70	31.16	369.40	30.03	4.63	0.31	2.81
Total	892.00	100.00	1 167.20	100.00	1 230.00	100.00	3.92	1.06	2.71
Eastern Europe and USSR share of world total		23.22		26.70		26.85	2.02	0.11	1.22

Region, country or economic grouping	1973	Percentage	1980	Percentage	1985	Percentage	Annual growth rates		
							1973-1980	1980-1985	1973-1985
Other developed countries[e]									
Industry[a]	17.80	57.98	24.40	62.09	25.70	60.33	4.61	1.04	3.11
Transport[b]	8.10	26.38	9.80	24.94	10.80	25.35	2.76	1.96	2.43
Other[c]	4.80	15.64	5.10	12.98	6.10	14.32	0.87	3.65	2.02
Total	30.70	100.00	39.90	100.00	42.60	100.00	3.59	1.63	2.77
Other developed countries' share of world total		0.80		0.90		0.93	1.70	0.68	1.27
Total developed countries									
Industry[a]	1 546.30	44.46	1 653.30	43.42	1 617.80	42.21	0.96	-0.43	0.38
Transport[b]	824.00	23.69	930.90	24.45	966.40	25.22	1.76	0.75	1.34
Other[c]	1 107.90	31.85	1 223.80	32.14	1 248.20	32.57	1.43	0.40	1.00
Total	3 478.20	100.00	3 808.00	100.00	3 832.40	100.00	1.30	0.13	0.81
Developed countries share of world total		90.53		87.11		83.64	-0.55	-0.81	-0.66
World									
Industry[a]	1 702.60	44.32	1 893.30	43.31	1 921.60	41.94	1.53	0.30	1.01
Transport[b]	953.70	24.82	1 128.30	25.81	1 200.20	26.20	2.43	1.24	1.93
Other[c]	1 185.60	30.86	1 350.00	30.88	1 459.90	31.86	1.87	1.58	1.75
Total	3 841.90	100.00	4 371.60	100.00	4 581.80	100.00	1.86	0.94	1.48
China									
Industry[a]			216.00	62.00	261.60	65.71		3.91	
Transport[b]			9.60	5.64	24.50	6.15		4.56	
Other[c]			111.80	32.18	112.00	28.13		0.04	
Total			347.40	100.00	398.10	100.00		2.76	

Sources: Organisation for Economic Co-operation and Development and International Energy Agency, *World Energy Statistics and Balances 1971-1987, 1985-1988 and Energy Balances of OECD Countries 1970/1985 and 1986/1987* (Paris, 1989, 1990).

a/ Industry includes manufacturing, construction, and mining and quarrying.

b/ Transport covers internal navigation and air, rail, road and non-specified transport.

c/ Other covers agriculture, commercial, public services, residential and non-specified consumption.

d/ Refers to formerly centrally planned economies.

e/ Cyprus, Gibraltar, Israel, Malta and South Africa.

trial growth and energy consumption in the long run. In this regard, it is worth recalling that when developed countries were going through the energy-intensive phase of industrialization with the building of basic infrastructure and heavy industries, their industrial energy consumption grew faster than their industrial output. Developing countries are now going through similar stages of energy-intensive industrialization, and this factor alone explains a positive link between energy and industrial output, as clearly shown in tables III.1 and III.2. It might be possible for developing countries to achieve a comparable level of industrialization with less energy consumption thanks to revolutionary technological breakthroughs in new materials sciences. For example, materials can now be produced using less energy, and new materials can replace a larger amount of old material. However, a critical precondition for such an achievement would be the transfer and diffusion of technology from the North to the South. Later in this chapter, a systematic study of the relationship between industrial output and industrial energy consumption will be presented, using a decomposition analysis.

Apart from its economic consequences, energy-intensive industrialization has serious environmental implications. Environmental problems such as acid rain, the greenhouse effect, thermal pollution and the general degradation of the quality of air, water and land are exacerbated by excessive energy use. Moreover, the environmental pressures of the trend toward energy-intensive industrialization in developing countries are likely to increase sharply, since the processes involved in, and the power generation required for, the manufacture of basic industrial materials contribute significantly to the degradation of the environment. Industrial energy efficiency takes on added importance because of its dual role of alleviating energy scarcity and at the same time mitigating the adverse effects of increasing energy use on the environment.

In this regard, slowing down the industrialization process in developing countries would not relieve the global pressure on the environment. On the contrary, this could bring about worse environmental damage. It has been widely accepted that abject poverty, overpopulation and intolerable living conditions in many regions of the South force people to resort to

Table III.2. Gross domestic product, industry value added and population by region, 1973, 1980 and 1985
(GDP and industry value added: billions of 1980 constant dollars; population: millions)

Region, country or economic grouping	1973	World share (percentage)	1980	World share (percentage)	1985	World share (percentage)	Annual growth rates		
							1973-1980	1980-1985	1973-1985
Africa									
GDP	181.48	2.06	268.42	2.40	299.13	2.34	5.75	2.19	4.25
Industry value added	84.90	2.30	106.21	2.35	112.83	2.22	3.25	1.22	2.40
Population	368.60	12.42	452.66	10.39	525.74	11.06	2.98	3.04	3.00
Per capita GDP	519.47	-	592.98	-	568.97	-	1.91	-0.82	0.76
Per capita MVA	48.48	-	52.77	-	57.36	-	1.22	1.68	1.41
Asia (excluding China)									
GDP	374.40	4.26	557.84	4.98	721.46	5.64	5.86	5.28	5.62
Industry value added	107.04	2.89	177.69	3.93	229.14	4.50	7.51	5.22	6.55
Population	1 089.20	36.71	1 272.30	29.21	1 423.80	29.94	2.24	2.28	2.26
Per capita GDP	343.75	-	438.45	-	506.72	-	3.54	2.94	3.29
Per capita MVA	57.70	-	86.01	-	104.88	-	5.87	4.05	5.11
Latin America									
GDP	515.97	5.87	747.09	6.67	792.10	6.19	5.43	1.18	3.64
Industry value added	196.05	5.30	267.31	5.91	269.96	5.30	4.53	0.20	2.70
Population	307.42	7.83	361.68	8.30	403.56	8.49	2.35	2.22	2.29
Per capita GDP	1 678.40	-	2 065.60	-	1 962.80	-	3.01	1.02	1.31
Per capita MVA	401.80	-	489.81	-	450.24	-	2.87	-1.67	0.95
Western Asia									
GDP	272.81	3.10	364.86	3.26	335.30	2.62	4.24	-1.68	1.73
Industry value added	207.26	5.60	222.46	4.92	162.97	3.20	1.02	-6.03	-1.98
Population	108.11	3.64	132.84	3.05	161.87	[illegible]	2.99	4.03	3.42
Per capita GDP	2 929.10	-	3 191.20	-	2 614.40	-	1.23	-3.91	-0.94
Per capita MVA	223.29	-	262.69	-	313.6[illegible]	-	2.35	3.61	2.87
Total developing countries (excluding China)									
GDP	1 344.65	15.29	1 928.21	17.30	2 148.00	16.78	5.36	2.08	3.98
Industry value added	595.24	16.09	773.67	17.10	774.90	15.22	3.82	0.03	2.22
Population (million)	1 873.33	63.14	2 219.48	50.96	2 514.97	52.89	2.45	2.53	2.48
Per capita GDP	741.91	-	899.26	-	886.34	-	2.79	-0.29	1.49
Per capita MVA	122.39	-	157.29	-	165.10	-	3.65	0.97	2.53
Total developing countries (including China)									
GDP	..	..	2 224.93	19.85	2 607.01	20.37	..	3.22	..
Industry value added	..	..	919.26	20.32	1 027.49	20.18	..	2.25	..
Population	..	..	3 197.98	73.42	3 555.37	74.77	..	2.14	..
Per capita GDP	..	..	899.26	..	886.34	..	..	-0.29	..
Per capita MVA	..	..	157.29	..	165.10	..	..	0.97	..
OECD									
GDP	6 665.78	75.78	7 901.23	70.51	8 923.49	69.73	2.46	2.46	2.46
Industry value added	2 643.13	71.47	2 934.34	64.84	3 277.51	64.38	1.50	2.24	1.81
Population	753.35	25.39	796.81	17.91	825.07	17.35	0.80	0.70	0.76
Per capita GDP	8 835.00	-	9 916.00	-	10 815.00	-	1.66	1.75	1.70
Per capita MVA	2 294.60	-	2 480.20	-	2 769.00	-	1.12	2.23	1.58
Eastern Europe and USSR									
GDP	785.80	8.60	1 802.00	9.64	1 266.69	9.90	4.65	3.24	4.06
Industry value added	459.98	11.95	671.36	14.56	786.01	15.44	5.55	3.20	4.57
Population	340.48	8.67	360.88	8.11	374.95	7.88	0.83	0.77	0.81
Per capita GDP	2 308.00	-	2 993.20	-	3 378.30	-	3.78	2.45	3.23
Per capita MVA	951.70	-	1 370.00	-	1 564.90	-	5.34	2.70	4.23

Region, country or economic grouping	1973	World share (percentage)	1980	World share (percentage)	1985	World share (percentage)	Annual growth rates		
							1973-1980	1980-1985	1973-1985
Total developed countries									
GDP	7 451.58	84.71	8 981.43	80.15	10 190.18	79.63	2.70	2.56	2.64
Industry value added	3 103.11	83.91	3 605.70	79.68	4 063.52	79.68	2.17	2.42	2.27
Population	1 093.83	36.86	1 157.69	26.58	1 200.02	25.23	0.81	0.72	0.78
Per capita GDP	6 907.10	-	7 880.80	-	8 628.00	-	1.90	1.83	1.87
Per capita MVA	1 899.70	-	2 163.80	-	2 424.00	-	1.88	2.30	2.05
World (excluding China)									
GDP	8 796.24	100.00	10 919.64	97.44	12 338.17	96.41	3.14	2.47	2.86
Industry value added	3 698.36	100.00	4 379.37	96.78	4 838.42	96.78	2.44	2.01	2.26
Population	2 967.16	100.00	3 377.17	77.54	3 714.99	78.12	1.87	1.93	1.89
Per capita GDP	2 326.20	-	2 270.48	-	2 241.30	-	-0.35	-0.26	-0.31
Per capita MVA	585.22	-	639.32	-	681.62	-	1.27	1.29	1.28
China									
GDP	..	..	286.72	2.56	459.01	3.59	..	9.87	
Industry value added	..	..	145.59	3.22	252.59	4.96	..	11.65	
Population	..	..	978.50	22.46	1 040.40	21.88	..	1.23	
Per capita GDP	..	..	293.02	..	441.20	..	..	8.53	
Per capita MVA									

Source: UNIDO database.
Note: GDP per capita and MVA per capita at 1980 constant dollars.

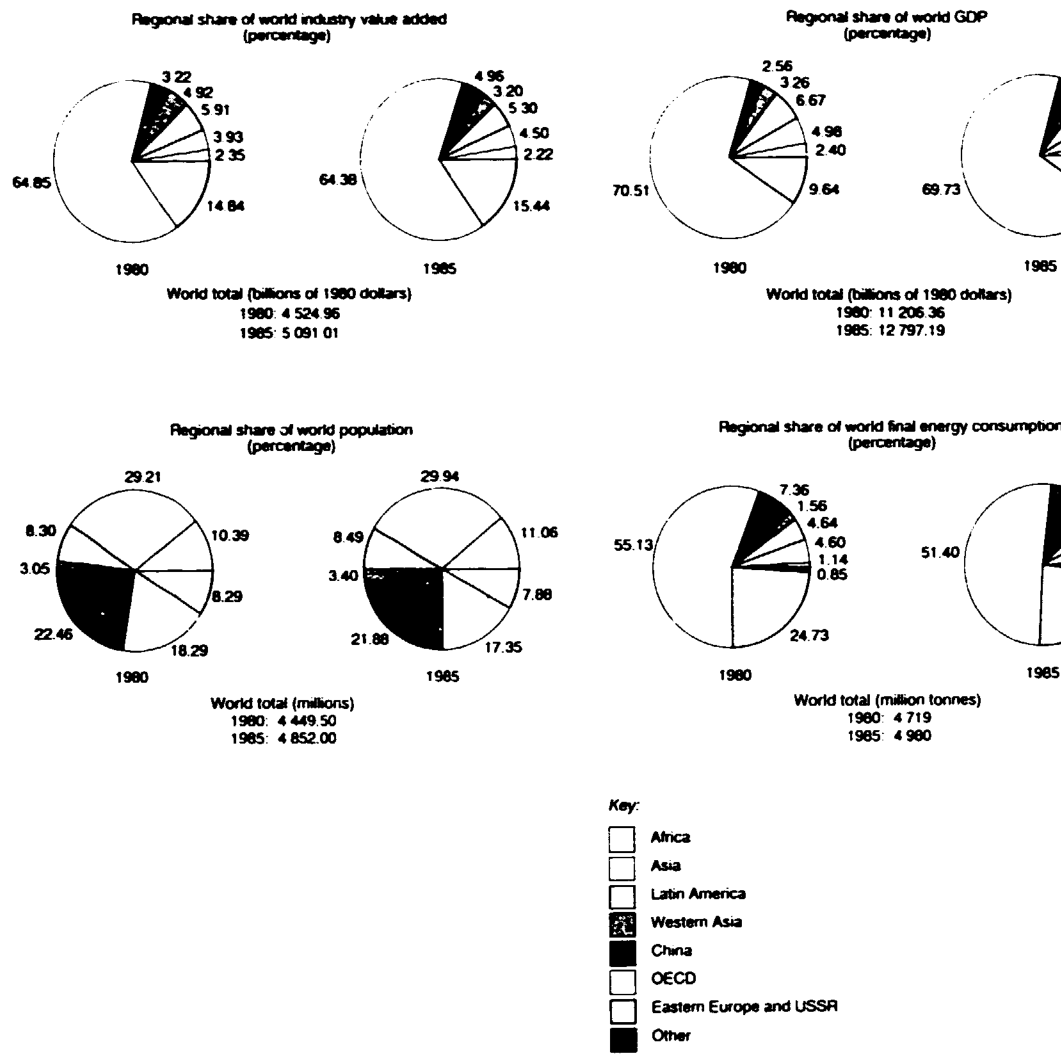
environmentally unsound farming, grazing and fishing, or to settlement on ecologically fragile marginal lands, giving rise to environmental disasters such as desertification, deforestation, flooding and depletion of top soils. Untreated human and other wastes dumped into the nearest body of flowing water remain one of the most serious environmental concerns, with four out of five common diseases in developing countries being caused either by contaminated water or unsanitary living conditions. One study estimates deforestation in developing countries accounting for 23 per cent of global carbon dioxide emissions with little sign of a reduction in the future ([2], p. 64). The result is a vicious circle of poverty leading to environmental degradation and destruction of the natural resource base, which in turn generates greater poverty.

2. *Importance of the South in global energy consumption*

A striking feature of the global energy consumption picture is the grossly asymmetrical and distorted nature of the energy crisis facing the North and the South. While overconsumption of energy places severe strains on developed countries, developing countries suffer from under-consumption. In 1985, for instance, developed countries as a whole, with roughly a quarter of the world population, accounted for 77 per cent of global final energy consumption, 80 per cent of world GDP and the same percentage of industrial output (see figure III.1). In contrast, three quarters of the world population in developing countries accounted for less than one quarter of final world energy consumption, producing about one fifth of world industrial output. This dramatic disparity is more clearly revealed when final energy consumption is measured in per capita terms and per unit of output. For instance, on a per capita basis OECD countries consumed nearly 10 times more energy in all its forms than developing countries in 1985, and almost seven times more industrial energy, while real GDP per capita was almost 15 times greater in OECD countries than in developing countries, and MVA per capita 10 times more (see table III.3). And yet, developing countries consumed energy very inefficiently in producing disproportionately smaller output, burning twice as much energy as developed countries in terms of energy consumption per unit of GDP and industrial output, as reflected in table III.3. Under-consumption, as revealed by these statistics, represents a crisis in the sense that it reflects extremely low standards of living and the relatively slow pace of industrialization in developing countries.

Although the share of developing countries in world final energy consumption remained modest at around 23 per cent in 1985, the rate of growth of their final energy consumption is substantially faster than that of developed countries. The average annual growth rate in developing countries (excluding China) was 6.21 per cent as compared with 0.81 per cent in developed countries during the period 1973-1985, with a growth rate differential of over 5 per cent between the two groups (table III.1). As a result, the share of developing countries in world energy consumption has also been expanding rapidly. In five years the share of developing countries (including China) increased by about 4 per cent, from 19 per cent in 1980 to 23 per cent in 1985. Should this growth rate continue, the share of developing countries in global energy demand may reach 50 per cent by 2010.

Figure III.1. World output, population and energy consumption by region, 1980 and 1985



Sources: UNIDO database and energy statistics and balance tables of the International Energy Agency

The major factors underlying the strong upsurge in energy consumption in developing countries include rapid population expansion and economic growth, an acceleration in the pace of urbanization, structural change toward more energy-intensive heavy industries, and replacement of traditional sources by commercial energy production.

A gross inequity in energy consumption exists today not only between the North and the South, but also within the South and within individual developing countries. In 1985, for instance, per capita final energy consumption and per capita industrial energy consumption in Africa amounted to about 30 per cent of the average consumption figures for developing countries. On the other hand, there is no energy crisis in oil-exporting developing countries. The most critical problem common to these countries, however, is that of an economy based on a single non-renewable resource and characterized by a failure to transform its physical and human assets into lasting sources of real wealth in the form of renewable flows of income, employment and non-oil exports. Great disparities are also likely to exist between the élites and the masses within individual developing countries in terms of the quantity and quality of energy consumption, given the vast differences in lifestyle and standards of living between the two groups, although empirical data to substantiate such disparities is scanty.

One important implication of the rapidly growing share of developing countries in world energy consumption is that the energy problems facing those countries can no longer be ignored. Developed countries have a shared interest in mitigating those problems, which are likely to have an increasingly adverse impact on the world as a whole, through their contribution to global energy scarcity and to the worldwide environmental degradation caused by increased energy use in developing countries. It is thus essential to ensure full participation by developing countries, together with the rest of the world com-

Table III.3. Final energy consumption and economic activity, 1985: OECD and developing countries [a]

Item	Unit	OECD	Developing countries	Ratio of OECD to developing countries
Per capita final energy consumption	t.o.e.	3.102	0.323	9.60
Per capita industrial energy consumption	t.o.e.	1.096	0.159	6.89
Real GDP per capita	1980 dollars	10 815	733	14.75
Real MVA per capita	1980 dollars	2 769	289	9.58
Final energy consumption per million dollars of real GDP	t.o.e.	287.8	440	0.65
Industrial energy consumption per million dollars of real industrial value added	t.o.e.	276	550	0.50

Source: Derived from tables III.1 and III.2.
Note: t.o.e. = tonnes of oil equivalent.
[a] Including China.

munity, in the process of mapping out an ecologically sound, long-term energy regime for the 1990s and beyond.

The aims of this study are to analyse relationships between output and energy consumption in the manufacturing sector in different countries; to identify key factors affecting manufacturing energy consumption and estimate the quantitative importance of each influencing factor; and to make a cross-country assessment of the results in order to determine the general pattern of changing manufacturing energy consumption in different phases of industrialization. It should be noted at the outset that this study does not cover such important supply-side problems as investment in and the production, generation, transmission, distribution and final supply of various forms of energy (including electricity, coal, gas, petroleum and biomass). Such issues will be the subject of further investigation in the future.

The organization of the study is as follows. The question of energy intensity and efficiency in the manufacturing sector in different countries is dealt with in section B. The relative importance of major determinants of change in the manufacturing energy consumption of selected developed and developing countries is quantitatively assessed and compared using a decomposition method in section C. The major conclusions and policy implications of the study are presented in the last section, together with a discussion of selected issues related to industrial energy conservation in developing countries and the environmental implications of industrial energy consumption.

B. Energy intensity and efficiency in the manufacturing sector

Industry is the most important end-user sector in total final energy consumption in most countries. The industry share of total final energy consumption in developing countries in 1985 ranged from 34 per cent in Africa to 40 per cent in Latin America and 45 per cent in Asia, while the share in OECD countries was 35 per cent and in Eastern Europe and the USSR around 55 per cent (see table III.1). Industry comprises manufacturing plus mining and construction. But mining and construction together accounted for less than 3 per cent of industrial energy consumption in OECD countries in 1985, the major exceptions being countries with economies based on mineral resources, such as Canada (10 per cent) and Australia (7 per cent). It is therefore reasonable to assume that manufacturing accounts for at least one third of total final energy consumption on the average.

Given the dominant share of manufacturing energy consumption, it is not difficult to see the enormous potential for energy savings through improved energy efficiency in the manufacturing sector, and the substantial economic and environmental benefits to be derived therefrom in both developing and developed countries. The widespread decoupling of output and energy in OECD countries in the past two decades has already been noted, while the opposite phenomenon of energy consumption increasing in step with output has been observed in developing countries during in the same period. Conservation and improvements in energy efficiency are therefore of crucial importance in developing countries.

The concepts need to be clarified and the terms defined in order to avoid ambiguities in the discussion of manufacturing energy consumption. Energy intensity is defined in this study as the consumption of energy per unit of output, and energy savings represent a reduction in this intensity. Although energy efficiency is related to process-specific optimal energy consumption in a narrow technical sense, the economic concept of energy efficiency is more broadly defined to include a minimal energy use per unit of output as a result of various energy-saving measures such as reductions in energy intensity, improved mixes of cheaper fuels, and rational management of energy use.

Despite a steep decline in real energy prices in recent years, especially after the collapse in oil prices in the second half of 1985, there remains an urgent need to improve energy efficiency and conservation in developing countries, especially oil-importing developing countries. To gain a competitive edge in world markets, developing countries need to economize on the use of raw materials and improve energy efficiency in manufacturing processes. More importantly, energy savings resulting from improved energy efficiency is an alternative form of energy supply, and it will probably be less costly, and more environmentally sound, to increase supplies from existing capacity rather than to create new capacity. For instance, according to a 1983 study on industrial energy conservation in India, an estimated investment of 36 billion rupees (Rs) would be required to realize an energy conservation potential of 35 per cent in the industrial sector, whereas an estimated total investment of Rs 58.25 billion would be required to generate capacity. The implementation of measures to improve energy efficiency would thus result in investment savings of Rs 22.25 billion. The results of the study are summarized in table III.4. The achievement of energy savings through improved efficiency and conservation measures is particularly important in view of the acute shortage of investment capital in developing countries. The expansion of power generation systems in developing countries is highly capital-intensive, requiring investment capital expenditure of approximately $55 billion per year (in 1982 constant dollars) ([3], p. 10). Energy efficiency is therefore an important means of curbing investment capital expenditure and saving scarce foreign exchange.

1. Recent trends in manufacturing energy intensity

Energy intensity is a measure of energy use per unit of output. Process-level microdata on energy use per physical unit of output (for example, per tonne of crude steel) would provide a true measure of energy efficiency, or, more accurately, of its inverse. But given an extremely wide range of products in a particular industry and a great variety of processes

Table III.4. Potential energy savings in the industrial sector in India, 1983

Form of energy	Unit	Current annual consumption	Savings possible	Investment required to create equivalent capacity (million rupees per unit)	Total investment (million rupees)
Coal	million tonnes	70	17.5	500	8 750
Oil	million tonnes	4	1.0	1 800	1 800
Electricity	billion kilowatt	60	5.3	9 000	47 700
Total investment required to create energy capacity		-	-	-	58 250
Investment required to implement energy conservation measures		-	-	-	36 000
Investment savings in industrial sector through implementation of conservation measures		-	-	-	22 250

Source: R.K. Pachauri, "Energy Efficiency and Conservation in India", *Industry and Environment* (United Nations Environment Programme, 1990), vol. 13, No. 2, p. 23, table 8.

used to produce each of them, it seems almost impossible and extremely costly to collect comprehensive industry data on a product-by-product basis, except for narrowly focused process-specific case-studies. Moreover, the problem of too many product types and of the many different processes used to produce them would make it much more difficult to analyse the patterns of energy use in industry than in other sectors such as transport, housing and commerce. As a result, aggregate energy data together with macroeconomic data at the industry group level are used to derive and compare industrial energy intensities across countries. But at the aggregate instead of the product level, the energy intensity of each industry is affected not only by efficiency improvements, but also by many other factors, such as changes in the product mix, fuel substitutions, production methods and process modifications in each industry group. Lastly, feedstocks such as naphtha and natural gas used as raw materials in the chemical industry should be excluded in calculating manufacturing energy intensity, since they are not consumed as energy sources. Unfortunately, most industrial energy data for developing countries do not include separate statistics for feedstocks, although such statistics are given for OECD countries, where feedstocks account for about 9 per cent of industrial energy use. Gross energy consumption (including feedstocks) is therefore used in this study to make the international comparisons consistent.

This study relies primarily on country energy balances and statistics compiled by the International Energy Agency for data on manufacturing energy consumption, and on the UNIDO database for statistics on manufacturing output and other macroeconomic data. National sources are used for data on Brazil, Indonesia and the Republic of Korea.

Figure III.2 reflects historical trends for total manufacturing energy intensity in selected countries, both developed and developing, from 1970 to 1988, with energy intensity being measured by the ratio of final manufacturing energy consumption to MVA. Manufacturing energy intensities differ vastly not only between countries in the North and the South, but also from country to country within the same region or economic grouping. This result is not surprising, because of wide variations between countries in industrial growth as well as long-term technological trends, including the adoption and diffusion of energy-efficient technologies, relative energy prices and the availability of supplies, all of which affect manufacturing energy intensity in varying degrees.

Despite substantial intercountry variations, a cross-country comparison reveals discernible regional patterns. Most obvious is the North-South difference in terms of the level and direction of change in manufacturing energy intensity. Not surprisingly, manufacturing energy intensity in most developing countries tends to be much higher than in OECD countries, exceeding 1 tonne of oil equivalent per $1,000 of MVA. Major exceptions are some Latin American countries and NICs such as the Republic of Korea and Taiwan Province. By contrast, energy intensities in all OECD countries were lower than 1 tonne of oil equivalent per $1,000 of MVA from 1970 to 1988. As expected, Eastern Europe and the USSR consumed more energy per unit of output than OECD countries, but somewhat less than many developing countries. More importantly, continued downward trends in energy intensity during the period considered are easily recognizable in all OECD countries except Portugal and Turkey, as well as in Eastern Europe and the USSR*. In contrast, manufacturing energy intensity seems to be rising in most developing countries.

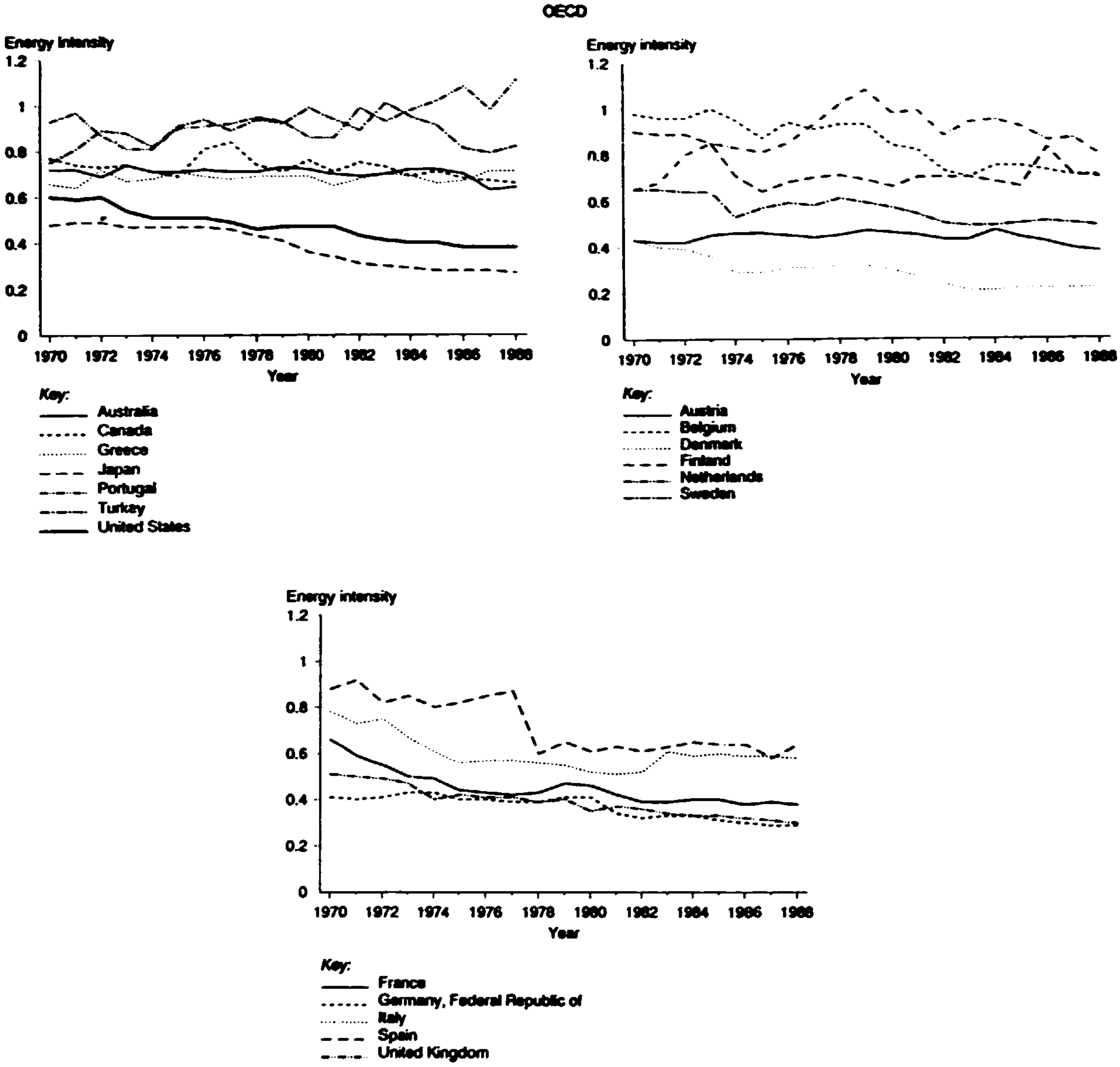
Even within the OECD group, total manufacturing energy intensity varies considerably from country to country. In general, more industrialized members of OECD, such as France, Germany, Federal Republic of, Japan, United Kingdom, and United States, showed a significant decline in manufacturing energy intensity from 1970 to 1988, although this decline tended to level off in some countries after 1982, when real energy prices began to fall. For instance, final manufacturing energy consumption in the United States declined by almost 19 per cent from 11,947 thousand billion to 9,698 thousand billion British thermal units between 1980 and 1985, while its manufacturing output increased by 8 per cent during the same period. These changes represent an overall decline in manufacturing energy intensity of 25 per cent between 1980 and 1985 ([4], p. 7). Similarly, combined manufacturing production in seven OECD countries (France, Germany, Federal Republic of, Japan, Norway, Sweden, United Kingdom and United States) increased by 2 per cent per year during the period 1973-1985, while combined energy consumption in those countries declined by 2.1 per cent per year, thus reducing total manufacturing energy consumption per unit of MVA by 39 per cent over the same period [5].

In contrast, some relatively less industrialized OECD countries (such as Greece, Portugal, Spain and Turkey), together with natural-resource-rich countries (such as Australia and Canada), not only consumed nearly twice as much energy per unit of output as the most energy-efficient countries such as the Federal Republic of Germany and Japan, but some of those countries, particularly Portugal, Spain and Turkey, showed a strong upward trend or a levelling-off in manufacturing energy intensity in the 1980s. In general, manufacturing energy intensity seems to be inversely related to the level of industrialization. At early and intermediate stages of industrialization, when the manufacturing sector is dominated by energy-intensive materials-processing industries (iron and steel, non-ferrous metals, non-metallic minerals, bulk chemicals, paper and pulp etc.), total manufacturing energy intensity tends to be high, because these energy-intensive industries account for the bulk of total manufacturing consumption, usually between 60 and 80 per cent, while producing less than a quarter of total MVA. At relatively advanced stages of industrialization, the dominant structure of manufacturing shifts from energy-intensive raw-materials processing to less energy-intensive and more skill-intensive metal fabrications, capital goods, new materials and other high-

*A recent study by the Economic Commission for Europe, within the framework of its Energy Efficiency 2000 Project, has projected that levels of energy intensity in Western Europe will be lowered to a range of 0.33 to 0.34 by the year 2010, and in Eastern Europe and the USSR to 0.60 to 0.71.

Figure III.2. Total manufacturing energy

(Tonnes of oil equivalent



Source: Organisation for Economic Co-operation and Development, *World Energy Statistics and Balances, 1971-1988* (Paris, 1989), and UNIDO database.

[a]1985 constant dollars.

technology products, resulting in a substantial reduction in overall manufacturing intensity. As a result, the relationship between manufacturing energy consumption and stages of industrialization may be generalized as an inverted U-shaped curve.

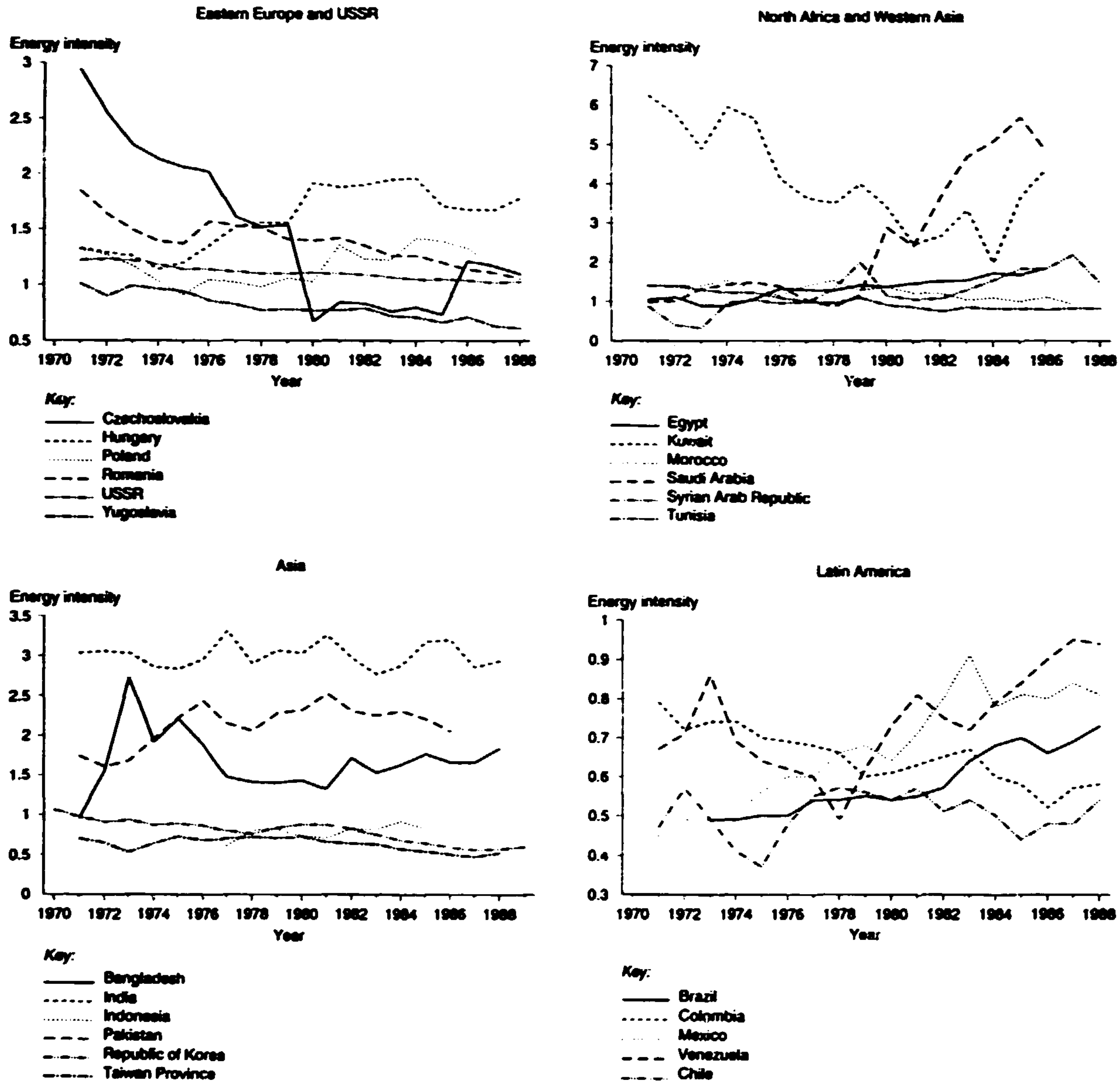
In addition, the technological capacity to improve energy efficiency and to curtail the use of other inputs grows during the process of structural change. Highly industrialized countries are thus in a better position to decouple output and energy than less industrialized countries. Such structural and technological factors may explain the energy-intensity differentials between OECD member countries.

Differences in manufacturing energy intensity are much more pronounced between OECD countries and most of the developing countries covered in this study. Not only are most developing countries going through the energy-intensive phase of industrialization, but they are also confronted with a whole host of technological, economic, and institutional barriers to the implementation of energy-efficiency measures in the manufacturing sector. All these factors may have contributed to high manufacturing intensities in developing countries, as reflected in figure III.2.

There are, however, wide variations in manufacturing energy intensity among developing countries. In

intensities in selected countries, 1970-1988

per $1,000ª of MVA)

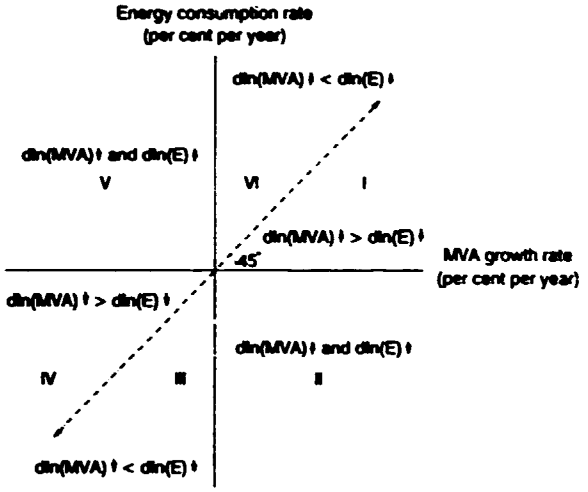


the Indian Subcontinent, for instance, Bangladesh, India and Pakistan show higher energy intensity than some other Asian countries and areas such as the Republic of Korea and Taiwan Province. Such a result is consistent with the relatively advanced stages of industrialization reached in the Republic of Korea and Taiwan Province and with the energy inefficiency of countries in the Indian Subcontinent. Extremely high energy intensity in oil-exporting countries in Western Asia, such as Kuwait and Saudi Arabia, is also consistent with the heavy concentration in petrochemicals and other energy-related industries in those countries. In Latin America, although manufacturing energy intensity remains low as compared with developing countries in other regions, there has been a strong upward trend in energy intensity, particularly in the 1980s.

2. *Relationships between manufacturing output and energy consumption*

One means of clarifying the relationship between manufacturing output and energy consumption is to compare the growth rates of both variables. Such a relationship may be represented by a simple graph

Figure III.3. Energy efficiency graph



Note: dlnE = ∆E/E, per cent change of energy consumption.
dlnMVA = ∆MVA/MVA, per cent change of MVA.

showing the energy consumption rate plotted on the vertical axis and the MVA growth rate on the horizontal axis, as in figure III.3. The graph is divided by a 45-degree diagonal line, the upper half representing inefficient energy consumption and the lower half efficient consumption. Each of the two regions is further subdivided into areas showing different combinations of energy consumption and MVA growth rates.

In the graph shown in figure III.3, the region of energy efficiency comprises the following areas:

Area	*Description*
I	Both MVA and energy consumption are growing, with a higher rate of MVA growth.
II	MVA is growing and energy consumption declining, an example of the delinking of output and energy.
III	Both MVA and energy consumption are declining, with a more rapid decline in energy consumption.

The region of energy inefficiency in figure III.3 consists of the following areas:

Area	*Description*
IV	Both MVA and energy consumption are falling, with a sharper fall in MVA.
V	MVA is declining and energy consumption increasing, an unusual case of "reversal of delinking".
VI	Both MVA and energy consumption are increasing, with a faster increase in energy consumption.

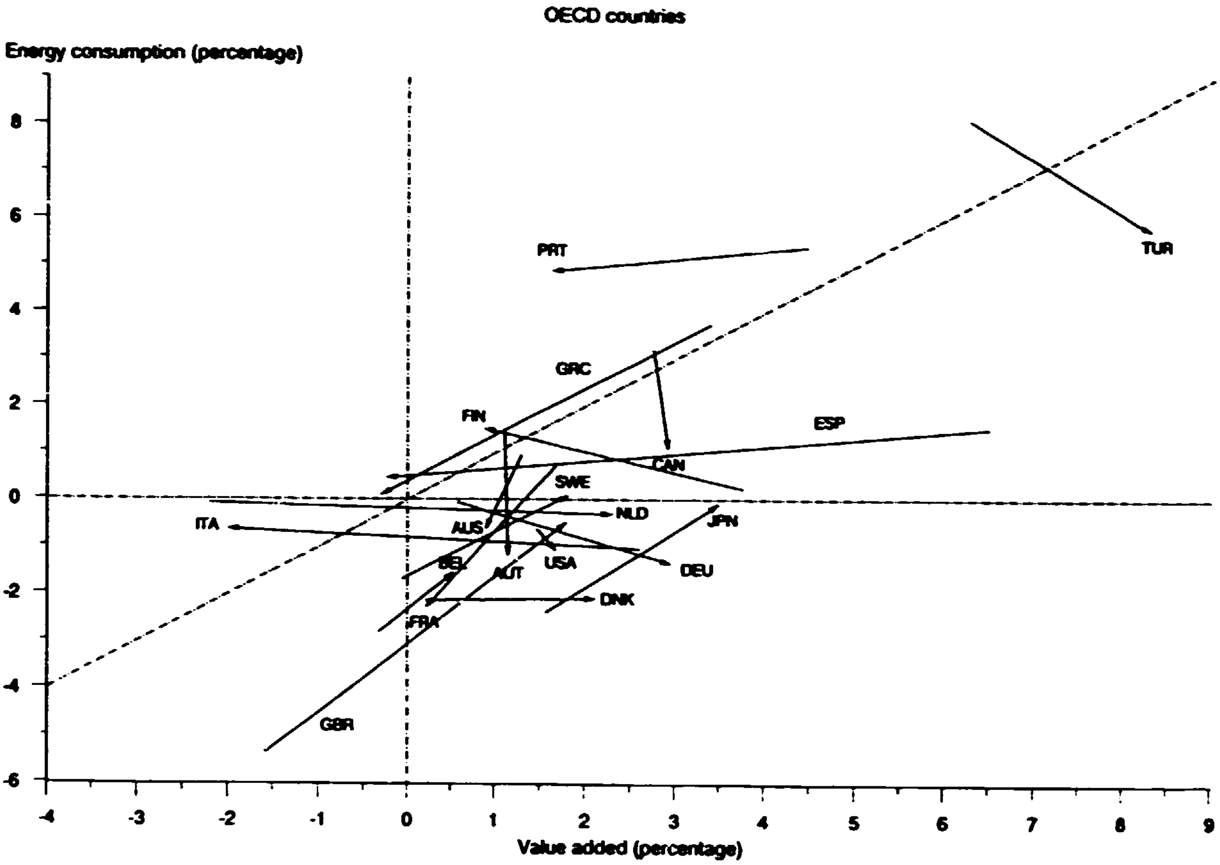
Diagrams of the relationship between output growth and energy consumption in different parts of the world during the periods 1973-1980 and 1980-1988 are presented in figure III.4. The two points for Japan in the first diagram can be interpreted as follows. The initial point at the base of the arrow describes the relationship prevailing in Japan between MVA and manufacturing energy consumption during the period 1973-1980. ...re specifically, MVA grew at an annual rate of 1.56 per cent, while manufacturing energy consumption declined by 2.39 per cent per year during that period. The decoupling of output and energy occurred in Japan during the 1970s. The second point at the arrow point characterizes the continued decoupling of output and energy in Japan during the period 1980-1988, when there was an annual MVA growth rate of 3.49 per cent and nearly zero growth in energy consumption (−0.08). The two points may reflect two different sets of macroeconomic conditions applied in Japan during the two periods. In the period of 1973-1980, the decline in energy consumption was considerable, possibly reflecting the significant energy price rises in the aftermath of the two oil crises. This decline in manufacturing energy consumption slowed down considerably during the 1980s, as real energy prices fell steadily after 1982, collapsing in the autumn of 1985. Meanwhile, manufacturing output in Japan grew almost three times faster in the 1980s than in the 1970s.

A cross-country comparison of MVA growth and manufacturing energy consumption as shown in figure III.4 reveals a striking difference in the energy-output relationship between developed and developing countries. The majority of OECD countries are densely concentrated in area II, and to a lesser extent in area I, with a few exceptions such as Greece and Portugal. In most cases, a positive MVA growth rate is associated with either a slower positive growth rate or a negative growth rate of manufacturing energy consumption. In other words, empirical evidence seems to support the hypothesis of a decoupling of output growth and energy consumption in most OECD countries in the 1970s and 1980s. At the same time, countries of Eastern Europe and the USSR remained positive, with MVA growth outpacing energy consumption in the two periods, but both growth rates slowed down considerably in the second period. A major exception is Poland, where both MVA and energy consumption registered a positive growth rate in the first period, but both showed a negative growth rate in the second.

By contrast, most developing countries are located in area VI, which implies the consumption of energy faster than output growth. There are several exceptional cases, such as Colombia, Republic of Korea and Taiwan Province, where MVA grew faster than energy consumption. But unlike OECD countries, no developing countries can be found in area II, where MVA grew with declining energy consumption, clearly showing a delinking of energy and output.

As reflected in figure III.4, the change between the periods 1973-1980 and 1980-1988 generally indicates movement in a north-east to south-west direction in most developing countries and in Eastern Europe and the USSR, but not in OECD countries. This implies that both MVA growth and energy consumption decelerated in developing countries and Eastern Europe during the 1980s as compared with the 1970s, perhaps reflecting their relatively sluggish industrial performance and consequent slower growth in energy requirements. The reasons for the slow-down in manufacturing production and investment in developing countries in the 1980s are not difficult to find. The 1980s were a period of uncertainty, instability and difficult adjustment for the world economy, buffeted by volatile exchange rates, worldwide recession at the beginning of the decade, a crippling debt burden, falling commodity prices, wild fluctuations in oil

Figure III.4. A cross-country comparison of annual growth rates of manufacturing energy consumption and MVA



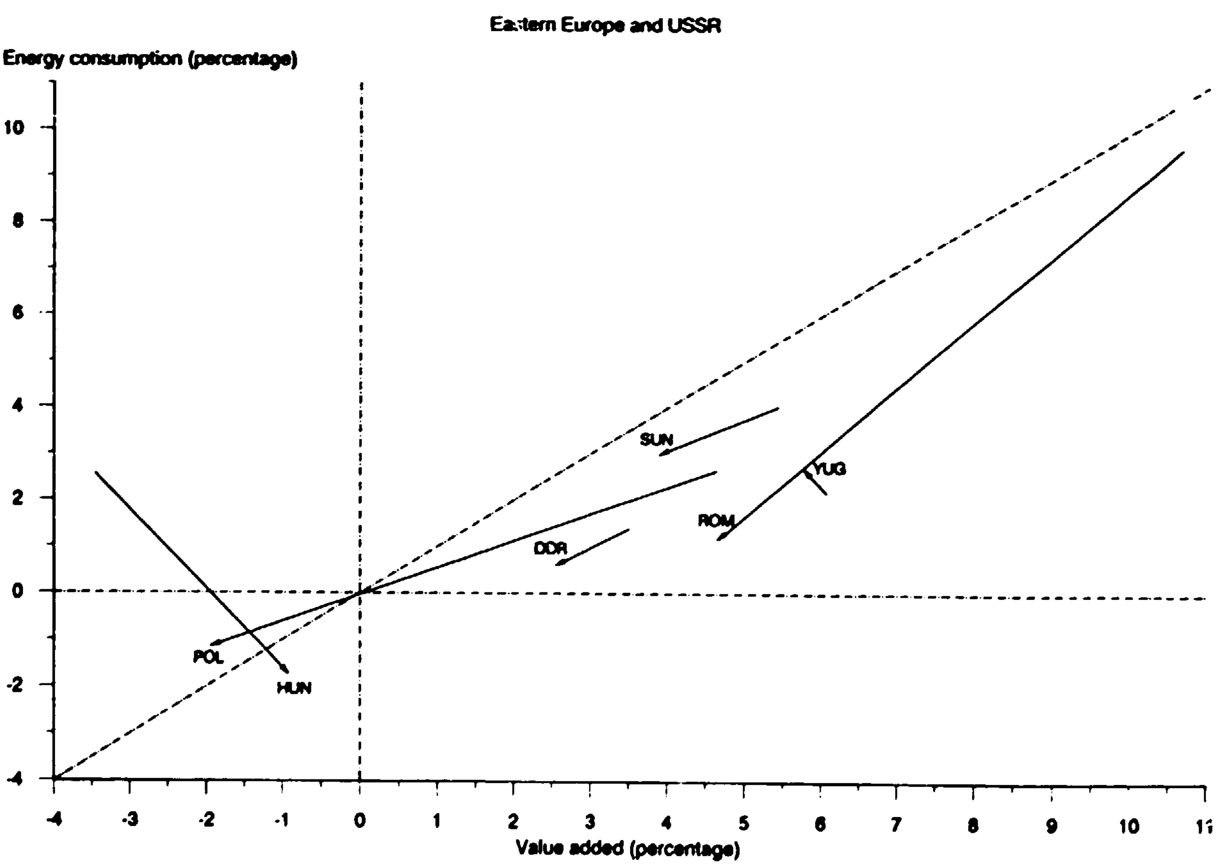
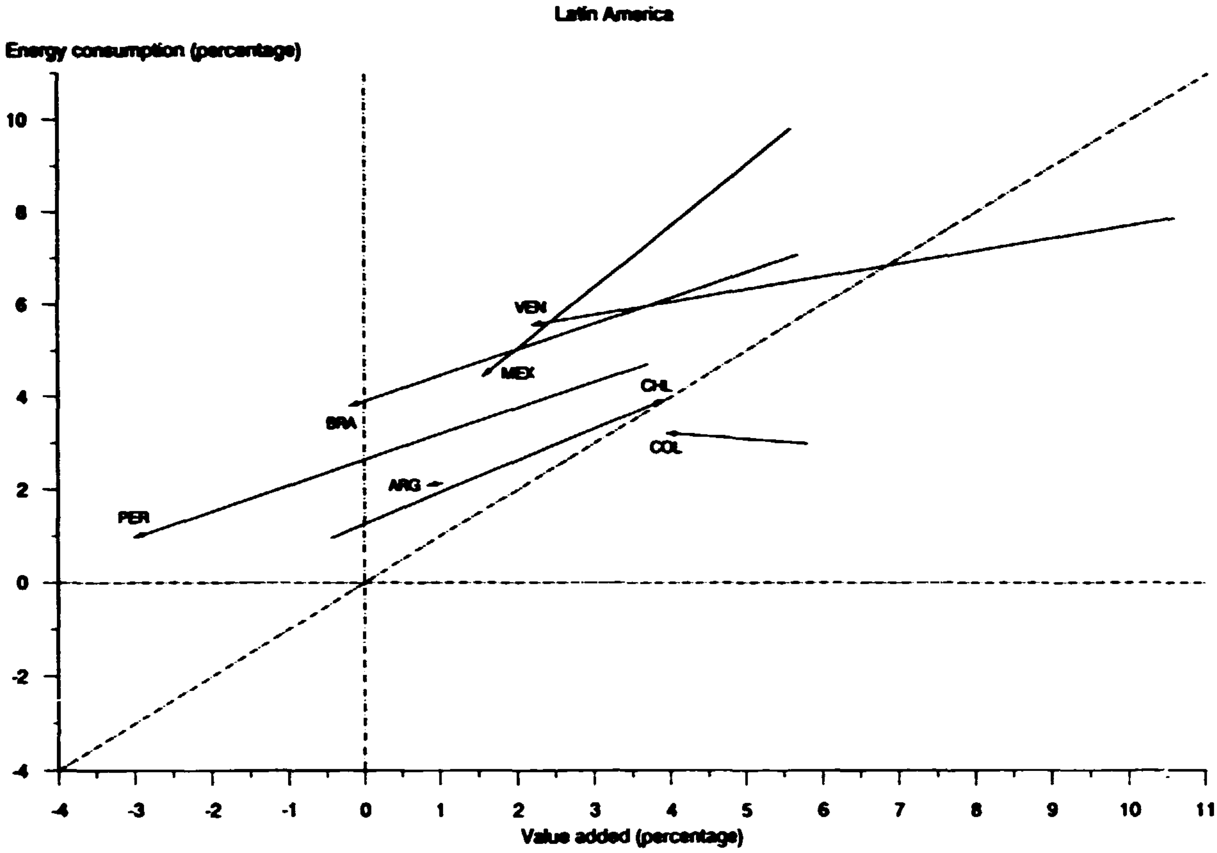
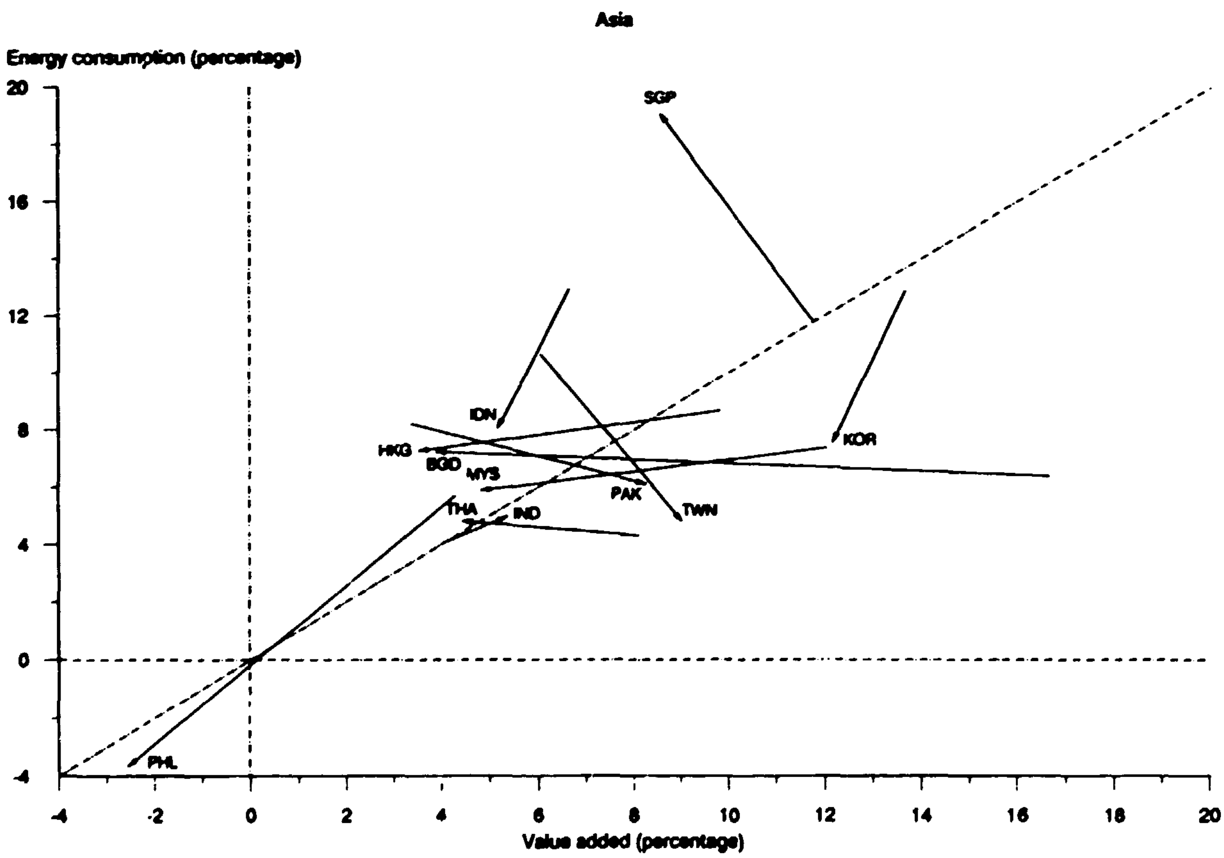
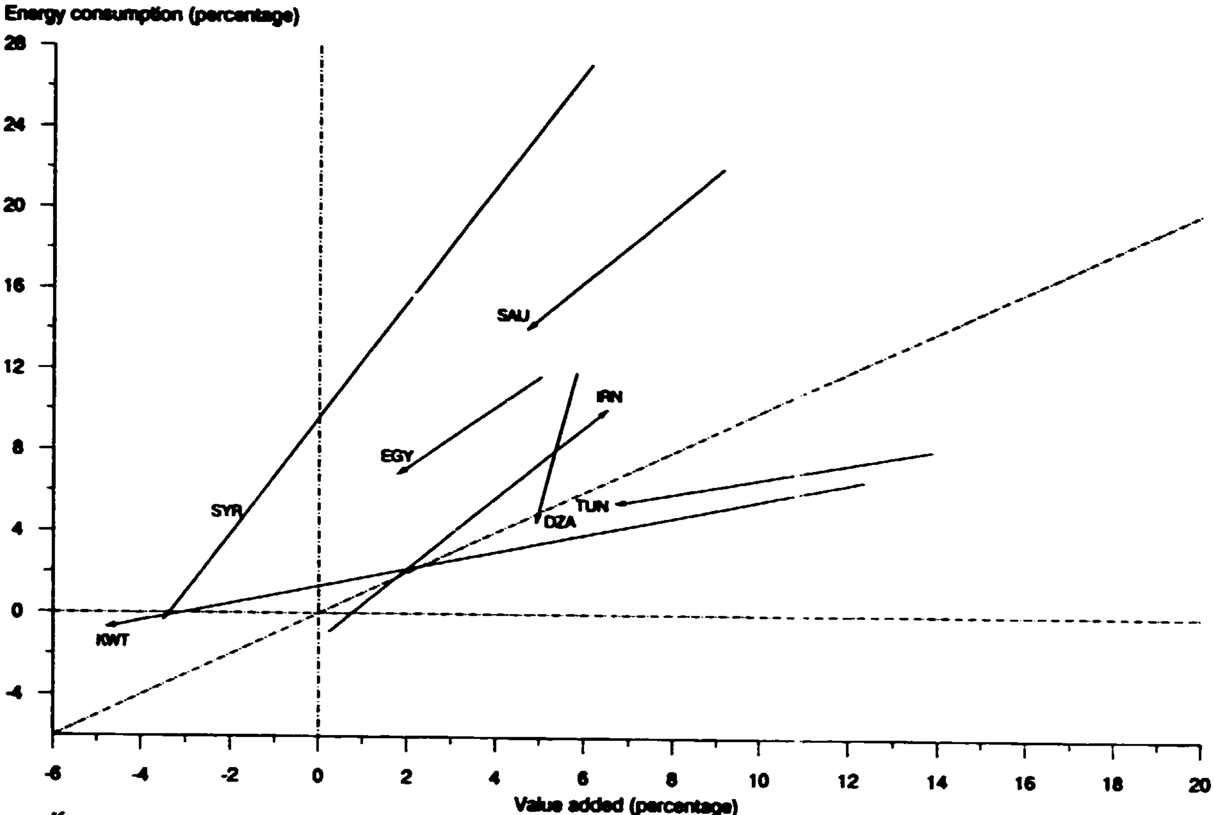


Figure III.4. *(continued)*





North Africa and Western Asia



Key:

ARG	Argentina	GRC	Greece	ROM	Romania
AUS	Australia	HKG	Hong Kong	SAU	Saudi Arabia
AUT	Austria	HUN	Hungary	SGP	Singapore
BEL	Belgium	IDN	Indonesia	SUN	USSR
BGD	Bangladesh	IND	India	SWE	Sweden
BRA	Brazil	IRN	Iran, Islamic Republic of	SYR	Syrian Arab Republic
CAN	Canada	ITA	Italy	THA	Thailand
CHL	Chile	JPN	Japan	TUN	Tunisia
COL	Colombia	KOR	Republic of Korea	TUR	Turkey
DDR	German Democratic Republic	KWT	Kuwait	TWN	Taiwan Province
DEU	Germany, Federal Republic of	MEX	Mexico	USA	United States
DNK	Denmark	MYS	Malaysia	VEN	Venezuela
DZA	Algeria	NLD	Netherlands	YUG	Yugoslavia
EGY	Egypt	PAK	Pakistan		
ESP	Spain	PHL	Philippines		
FIN	Finland	PER	Peru		
FRA	France	POL	Poland		
GBR	United Kingdom	PRT	Portugal		

Annual growth rate during the period:

1973-1980 ——————→ 1980-1988

Sources: International Energy Agency, *World Energy Statistics and Balances 1971-1987* (Paris, Organisation for Economic Co-operation and Development, 1989) and *World Energy Statistics and Balances 1985-1988* and *Energy Balances of OECD countries 1987-1988* (Paris, Organisation for Economic Co-operation and Development, 1990); UNIDO database; for Brazil, Ministerio das Minas e Energia, *Balanço Energético Nacional 1989* (Brasilia, 1990); for Indonesia, Economic and Social Commission for Asia and the Pacific, "Sectoral energy demand in Indonesia" (RAS/86/136); and for the Republic of Korea, annual statistical reports by the Bank of Korea for MVA, and estimates by the Korean Institute of Energy Economics for manufacturing energy consumption.

Notes: MVA is calculated in millions of 1987 dollars for Brazil, millions of 1983 dollars for Indonesia, and millions of 1985 dollars for other countries.

The periods covered vary for the following countries, as indicated:

Indonesia:	1977-1980
Malaysia:	1980-1985
Pakistan:	1980-1986
Republic of Korea:	1980-1989
Egypt:	1980-1986
Kuwait:	1980-1986
Saudi Arabia:	1980-1986

prices, sudden rises in nominal and real interest rates etc. All these external shocks as well as domestic economic mismanagement contributed to the disruption in the pattern of vigorous growth of MVA and investment in developing countries during the 1970s. Those countries suffered a sharp decline in MVA and real investment during the 1980s, particularly in Latin America and Africa*.

It may thus be concluded that although a pattern of decoupling of energy and output is clearly emerging in most developed countries, the link between energy and output growth appears to be still very strong in most developing countries, often with manufacturing energy consumption rising faster than output. Given the energy-intensive phase of structural change that most developing countries are about to move into or have already entered, coupled with their limited economic, technological, and institutional capacity to implement wide-ranging energy efficiency and conservation measures, it will be a long time, at least a few decades, before developing countries begin to enjoy increasing output using less energy. This means that developing countries will account for an ever-growing share of world energy consumption and play an increasingly significant role in the global energy scene.

*For further details, see *Industry and Development: Global Report 1987* (United Nations publication, Sales No.: E.87.II.B.2), chap.III.

3. *Variations in energy intensity among manufacturing industries*

Average values for manufacturing energy intensity conceal wide inter-industry variations in energy intensity. A small number of raw-materials-processing industries usually account for the major share of total manufacturing energy consumption, while producing a relatively small share of total manufacturing output. This energy-intensive group includes iron and steel (ISIC 371), non-ferrous metals (ISIC 372), non-metallic minerals (ISIC 36), chemicals (ISIC 352, 355, 356 and parts of ISIC 351 and 354), and pulp, paper and printing (ISIC 34). Ideally, printing should be separated from paper and pulp because of huge differences in energy intensity between the two activities. Unfortunately this was not done in the IEA energy statistics used as a basis of this study. These five raw-materials-processing industries account for between 60 and 80 per cent of total manufacturing energy consumption, while their MVA share ranges from 20 and 40 per cent. More detailed analysis of the energy-intensive industry group in various countries will be given later.

Vast inter-industry differences in energy intensity are shown very clearly in the results of the recent United States manufacturing energy consumption survey. Table III.5 summarizes the changes in energy

Table III.5. Changes in manufacturing energy intensity, 1980-1985, United States

United States SIC[a] code	Industry	Energy intensity 1980 (thousand B.t.u. per dollar[b] of shipment value)	Energy intensity 1985	Energy intensity change [c,d] (percentage)
20	Food and kindred products	3.5	2.7	22.9
21	Tobacco manufactures	[e]	[e]	[e]
22	Textile mill products	5.7	4.8	16.3
23	Apparel and other textile products	..	..	..
24	Lumber and wood products	[e]	[e]	[e]
25	Furniture and fixtures	1.9	1.6	17.4
26	Paper and allied products	16.0	13.9	13.0
27	Printing and publishing	1.1	0.9	15.2
28	Chemicals and allied products	15.1	12.4	17.6
29	Petroleum and coal products	5.4	4.4	19.8
30	Rubber and miscellaneous plastic products	4.3	3.1	27.8
31	Leather and leather products	[e]	[e]	[e]
32	Stone, clay and glass products	21.6	16.6	23.0
33	Primary metal industries	16.4	14.6	11.0
34	Fabricated metal products	2.8	2.3	16.4
35	Machinery, except electrical equipment	1.7	0.9	43.6
36	Electrical and electronic machinery	1.7	1.2	26.4
37	Transport equipment	1.5	1.1	25.0
38	Instruments and related products	1.7	1.2	29.3
39	Miscellaneous manufacturing industries	1.8	1.4	23.9
	All manufacturing	5.8	4.4	25.1

Source: Energy Information Administration, *Manufacturing Energy Consumption Survey: Consumption of Energy in 1980-1985* (Washington, D.C., Government Printing Office, 1990).

Note: B.t.u. = British thermal units.

[a] Standard Industrial Classification.

[b] 1980 constant dollars.

[c] A decrease in energy intensity from 1980 to 1985 indicates an improvement in energy efficiency, and thus a positive value for energy intensity change.

[d] The estimates of energy intensity change are calculated from unrounded energy intensity, and may differ from changes calculated from the rounded ratios in columns 1 and 2.

[e] Withheld because relative standard error is greater than or equal to 50 per cent.

intensity for the major manufacturing industry groups between 1980 and 1985.* The 1985 data on the consumption of purchased energy by the manufacturing sector are derived from a 1985 survey conducted by the United States Energy Information Administration, the first in a triennial series of national surveys of energy use by manufacturing establishments in the United States. The 1980 data on consumption of energy produced off-site are based on the 1980 annual survey of manufacturers conducted by the United States Bureau of the Census. Energy intensity in the raw-materials-processing industries (including stone, clay and glass products, primary metals, paper and allied products, chemicals, and to a lesser extent petroleum and coal products) is several times higher than in other industries. For instance, the stone, clay and glass products (or non-metallic minerals) industry consumes over 10 times more energy than the transport equipment, machinery or other fabricating industries. Also, the energy intensity in printing and publishing is less than one fourteenth of that of the paper and pulp industry, which is why data disaggregation is needed between those two industry groups.

More importantly, all these energy-intensive industries experienced a substantial decline in energy intensity between 1980 and 1985, by 23 per cent in non-metallic minerals, by nearly 18 per cent in chemicals, and by 17 per cent in paper and allied products, although their decline was less than the 25 per cent average for all manufacturing. The five energy-intensive industries collectively consumed 8,624 thousand billion British thermal units of purchased energy in 1980, or 72 per cent of total consumption by the manufacturing sector, and their consumption declined to 6,842 thousand billion British thermal units by 1985, approximately a 21 per cent decrease between 1980 and 1985. During the same period, the combined output of these industries decreased by 5 per cent. As a result, the combined energy intensity of these industries decreased by 17 per cent between 1980 and 1985 ([4], p. vii).

Figure III.5 shows changes in energy intensity by broad industry groups in selected countries over a period of time. Energy-intensive groups—iron and steel, non-ferrous metals, chemicals and non-metallic minerals—all exhibited considerably higher energy-intensity than the average manufacturing intensity. More importantly, the differences in energy intensity

*Energy intensity values given in table III.5 are not comparable to those presented elsewhere in this study, since energy intensity is defined not only in terms of British thermal units, but also per $1,000 dollars of the value of shipments instead of MVA.

Figure III.5. Energy intensities by industry in selected countries and areas

(Tonnes of oil equivalent per thousand dollars)

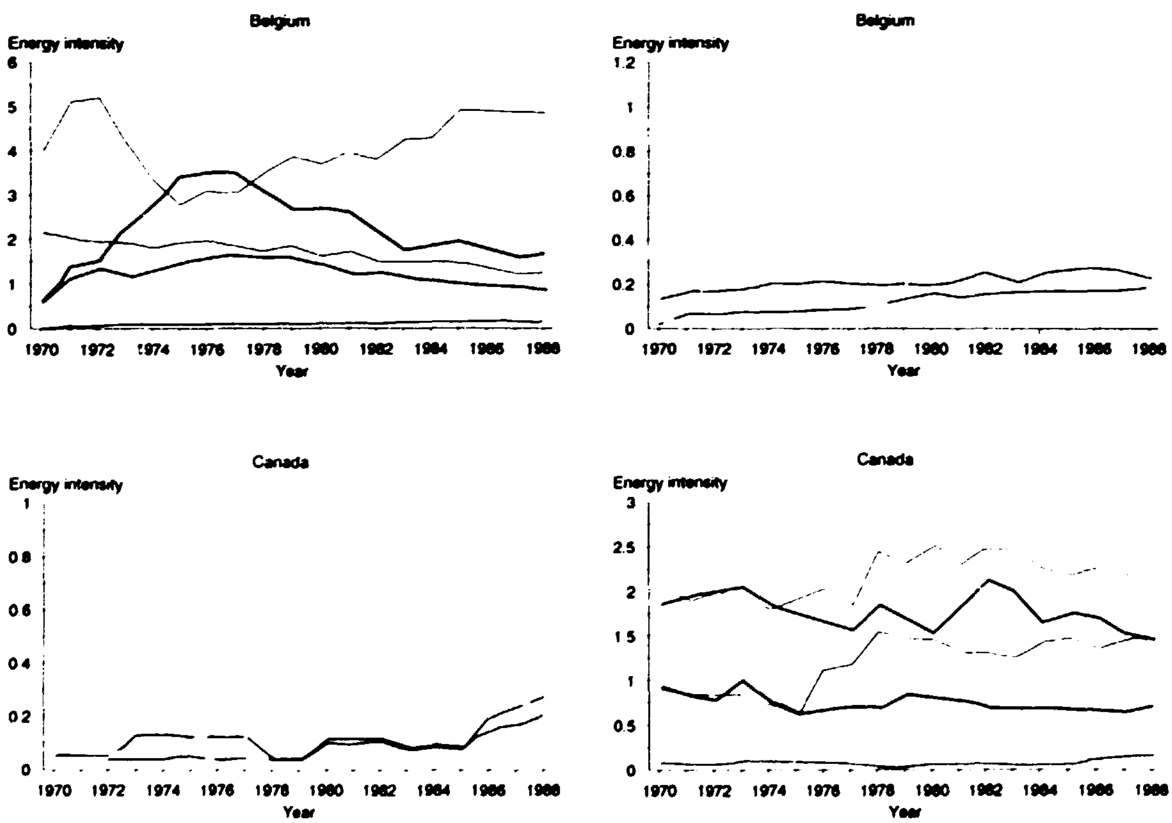
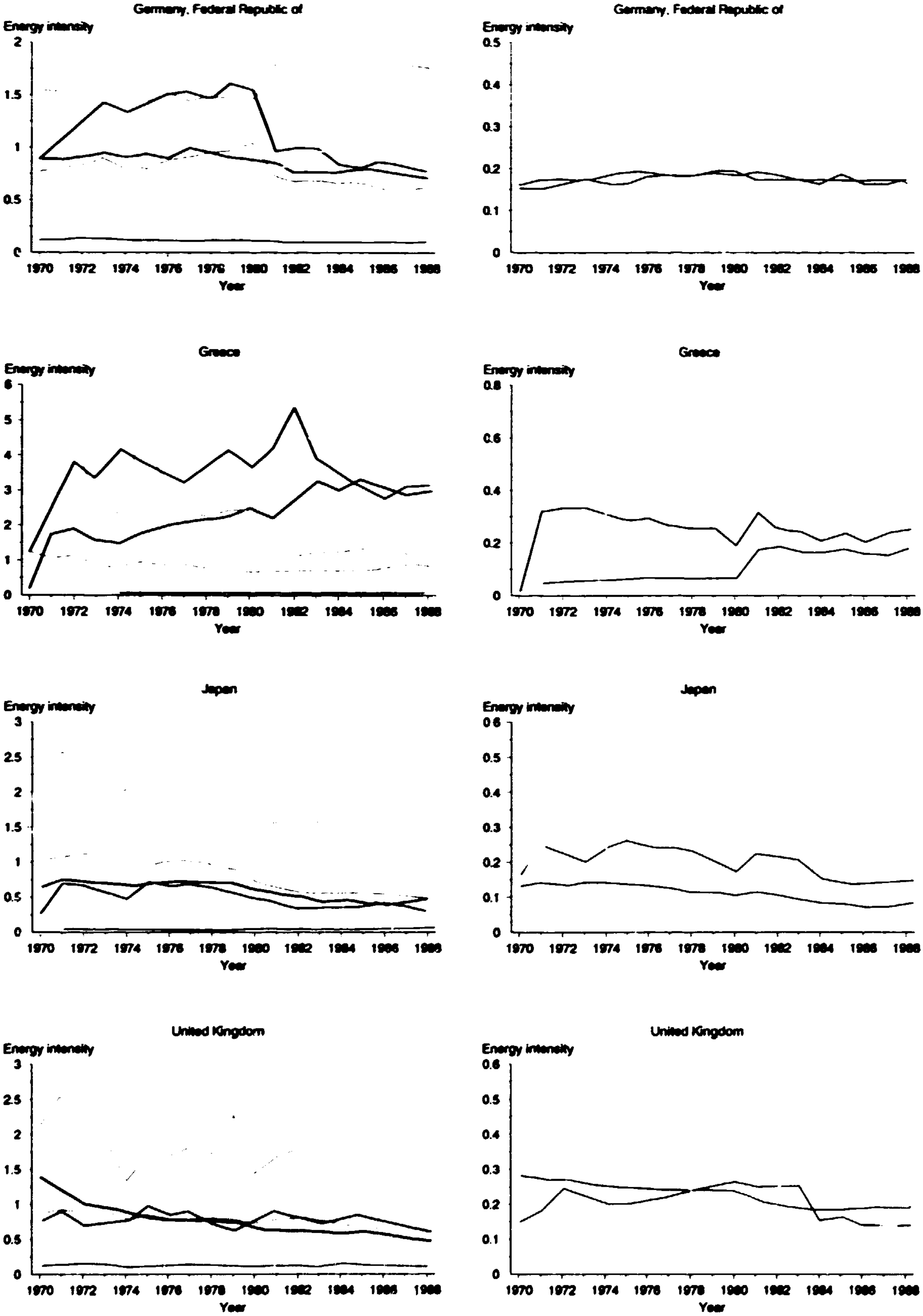
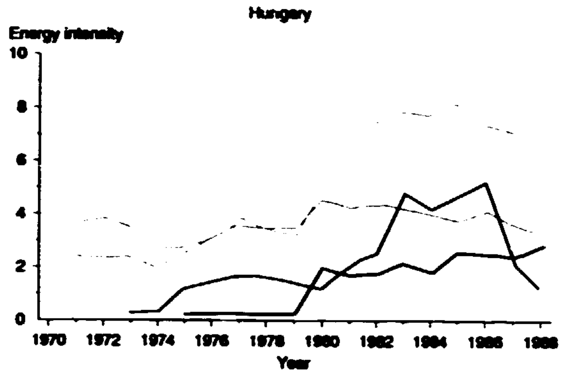
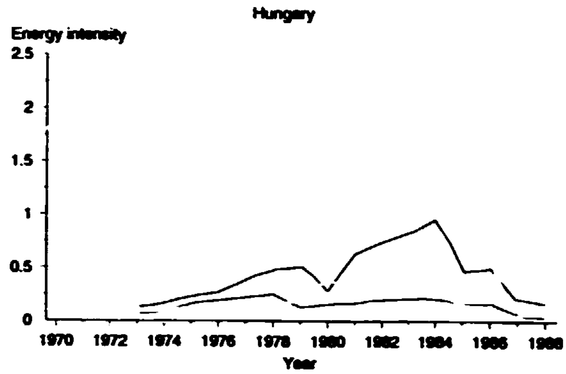


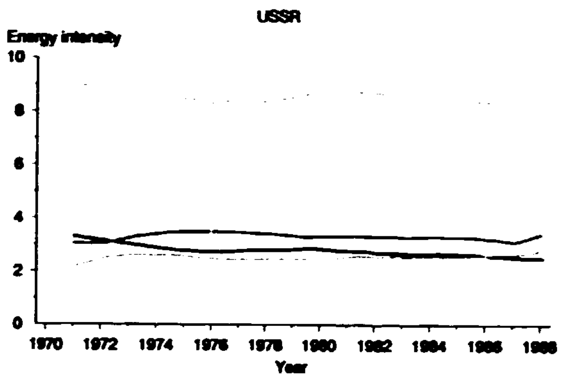
Figure III.5.

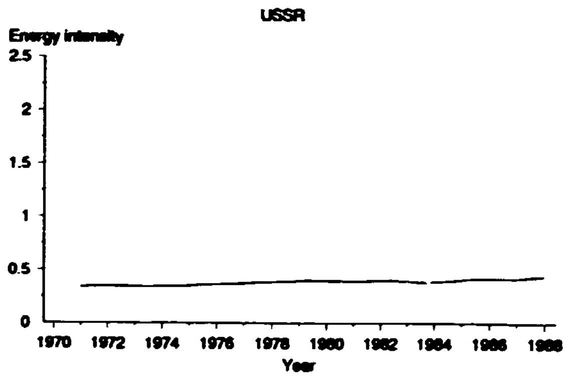

Germany, Federal Republic of
Energy intensity
Year
Germany, Federal Republic of
Energy intensity
Year
Greece
Energy intensity
Year
Greece
Energy intensity
Year
Japan
Energy intensity
Year
Japan
Energy intensity
Year
United Kingdom
Energy intensity
Year
United Kingdom
Energy intensity
Year

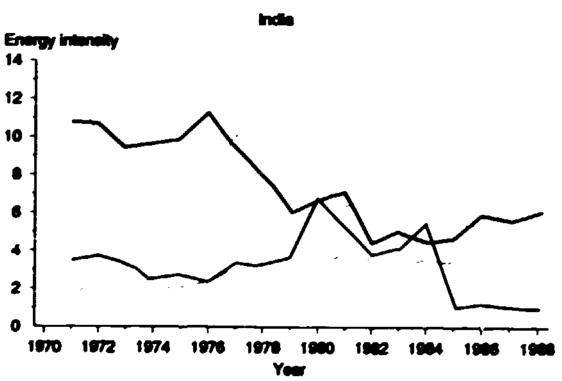
(continued)

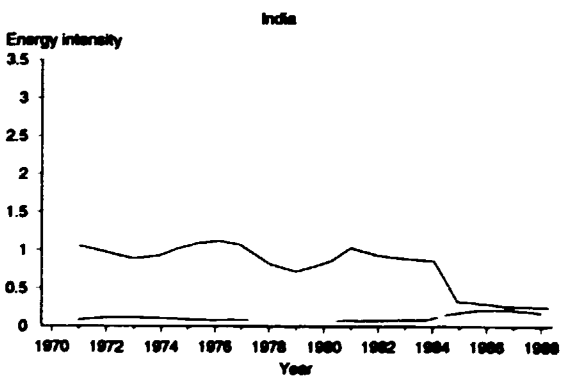

Hungary
Energy intensity
10
8
6
4
2
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988
Year

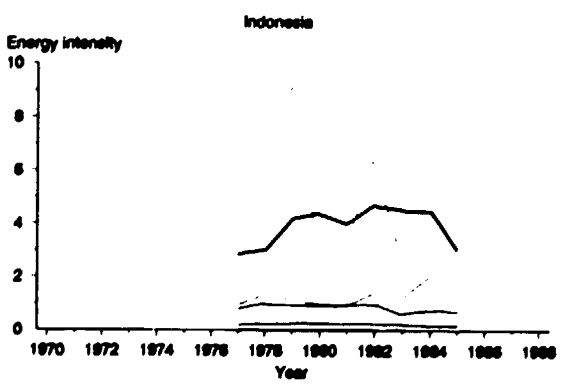

Hungary
Energy intensity
2.5
2
1.5
1
0.5
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988
Year


USSR
Energy intensity
10
8
6
4
2
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988
Year


USSR
Energy intensity
2.5
2
1.5
1
0.5
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988
Year


India
Energy intensity
14
12
10
8
6
4
2
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988
Year


India
Energy intensity
3.5
3
2.5
2
1.5
1
0.5
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988
Year


Indonesia
Energy intensity
10
8
6
4
2
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988
Year

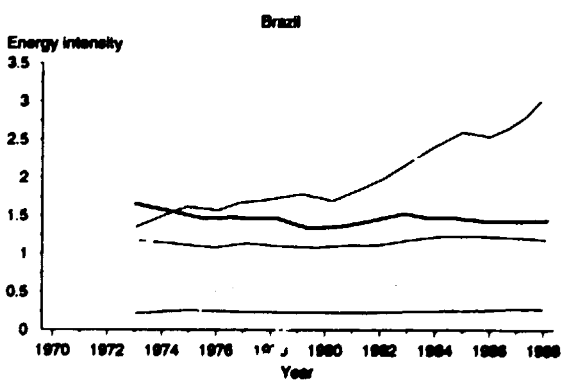
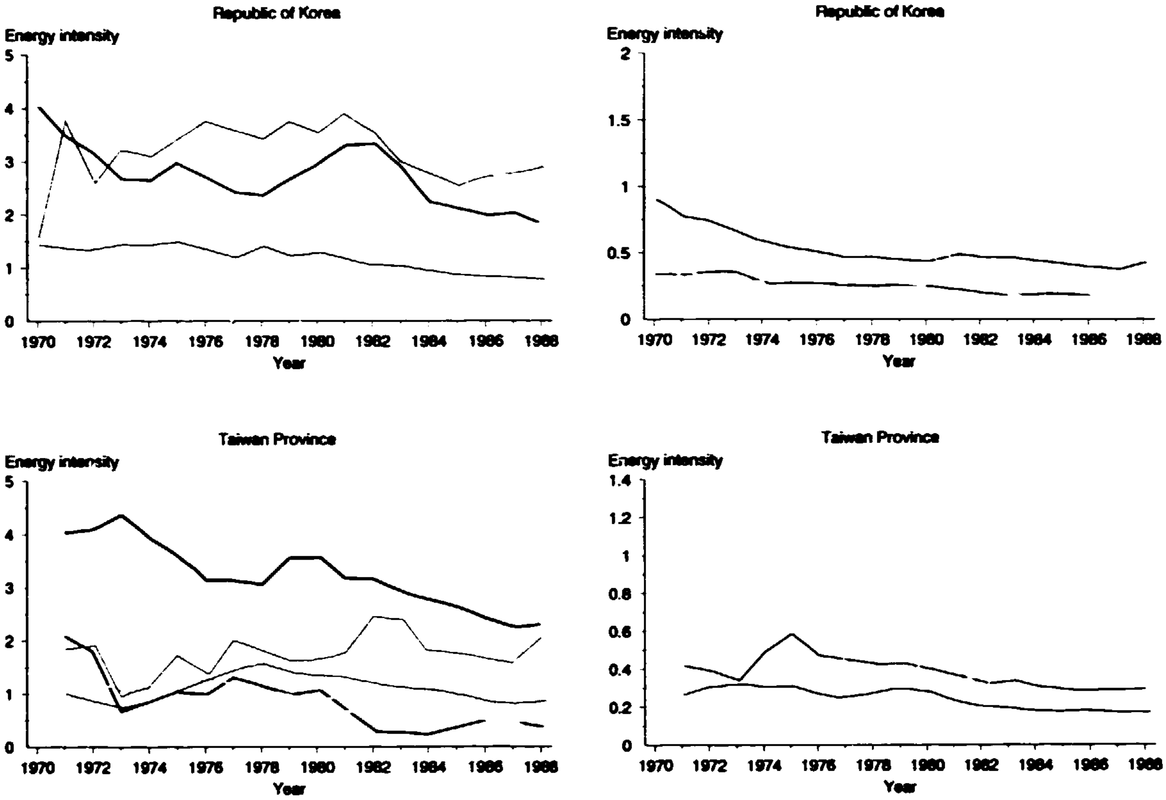

Brazil
Energy intensity
3.5
3
2.5
2
1.5
1
0.5
0
1970 1972 1974 1976 1980 1982 1984 1986 1988
Year

Figure III.5. *(continued)*



Key:

- Total
- Food and tobacco
- Textiles and leather
- Textiles
- Wood and wood products
- Paper, pulp and printing
- Chemicals
- Non-metallic minerals
- Ferrous and non-ferrous metals
- Iron and steel
- Non-ferrous metals
- Machinery
- Transport equipment
- Others

Source: International Energy Agency, *World Statistics and Balances 1971-1987*, and *World Energy Statistics and Balances 1985-1988* (Paris, Organisation for Economic Co-operation and Development, 1989 and 1990), and UNIDO database.

between the energy-intensive industries and other industries are substantial in all the countries considered, with the energy intensity of the former several times greater than that of the latter. Even among the energy-intensive industries, intercountry variations are equally pronounced. In Greece and India, in NICs such as the Republic of Korea and Taiwan Province, in countries of Eastern Europe such as Hungary, and in the USSR, individual industry energy intensities tend to be markedly higher than those in highly industrialized countries such as Canada, Germany, Federal Republic of, Japan and United Kingdom.

During the 1970s and 1980s a steady downward trend in energy intensities is clearly noticeable in many countries and areas, including Belgium and Germany, Federal Republic of, (except for iron and steel in both cases), Indonesia, Japan, Republic of Korea, Taiwan Province and United Kingdom. A gradual upward trend in energy intensity is discernible over the entire period in Brazil, and a sharp upturn in the late 1970s and early 1980s in Hungary. On the other hand, energy intensities remained relatively unchanged in such countries as Canada, Greece and USSR, except for notable variations in some industries.

A much more sharply focused picture emerges when the statistical averages for the five energy-intensive industry groups are compared with the average for other industries in different countries. Such results are depicted in figures III.6 and III.7. Most notable in figure III.6 are the disproportionately large shares of the energy-intensive groups in total manufacturing energy consumption, in sharp contrast to their disproportionately small shares of total MVA. In most of the countries shown in figure III.6, the share of the energy-intensive group in total manufacturing energy consumption ranges from 65 to 90 per cent. Some notable exceptions are Brazil, Canada, Hungary, India, Indonesia and Turkey. On the other hand, the energy-intensive industry group in these countries accounted for only 20 to 40 per cent of total MVA. These figures reflect the vast differences in energy intensity between the two groups.

The different patterns of change in energy intensity in different groups of countries are strikingly evident in figure III.7. In highly industrialized OECD countries, levels of energy intensity in the energy-intensive group fell sharply during the 1980s relative to those of the 1970s. For instance, the level of energy intensity in the energy-intensive group in Australia dropped by 3.51 per cent per year during the 1980s, compared with a decrease of 0.78 per cent per year during the 1970s. A similar situation prevailed in many other countries: in Austria, 0.62 per cent in the 1970s and −2.3 per cent in the 1980s; in Belgium, −1.87 per cent and −2.98 per cent; in Canada, 2.36 per cent and −1.45 per cent; in the Federal Republic of Germany, 0.21 per cent and −4.29 per cent; in Japan, 4.52 per cent and 3.9 per cent; in the Netherlands, 3.33 per cent and −3.29 per cent; in Sweden, 2.07 per cent and −2.72 per cent; and in the United Kingdom, −3.87 per cent and −2.89 per cent. In each case, the figures refer respectively to the periods 1973-1980 and 1980-1988. A major exception is Italy, where energy intensity in the same group declined by 3 per cent per year during the first period and increased by 1.55 per cent per year during the second (see table III.16 in appendix II to this chapter).

In less highly industrialized OECD countries, the pattern of change in the energy-intensive group is distinctively different from that in the OECD countries referred to above. For instance, the level of intensity in the energy-intensive group in Portugal continued to increase by 1.93 per cent per year in the 1970s and 2.75 per cent in the 1980s; in Turkey the increase was 2.01 per cent and 0.42 per cent respectively. In Spain, energy intensity dropped by 1.34 per cent per year during the first period, but increased by 0.2 per cent during the second.

In some countries of Eastern Europe, there was a continued sharp increase in energy intensity in the 1970s and 1980s, reflecting the relative energy inefficiency of their heavy industries. For instance, energy consumption per unit of output in the energy-intensive group in Hungary grew by 8.28 per cent per year in 1973-1980, but slowed down considerably to 2.10 per cent per year in 1980-1986. Similarly, the same group in Poland increased its energy intensity by 3.16 per cent per year in 1975-1980 and 1.66 per cent in 1980-1987. In the USSR, however, the energy intensity of this group declined moderately by 0.85 per cent and 0.66 per cent in both periods, but the energy intensity still remained relatively high at around 3.5 tonnes of oil equivalent per $1,000 of MVA during the same periods.

In the developing countries and areas considered, the levels of intensity in the energy-intensive group increased in varying degrees in the 1970s, but subsequently declined in the 1980s. This pattern is evident in Colombia, India, Indonesia, Republic of Korea and Taiwan Province. The decline in the 1980s was particularly steep in the Republic of Korea and Taiwan Province, 4.66 per cent and 6.55 per cent per year, respectively. The only exception was Brazil, where the energy intensity of the group continued to accelerate at a pace of 2.35 per cent per year in the 1970s and 4.55 per cent per year in the 1980s.

As noted earlier, energy intensity can be measured more meaningfully on a product-by-product basis, but the enormous range of products in a given industry makes it extremely difficult to compile industry-wide energy statistics for each product. Even if it is possible to assemble such statistics, an international comparison is still not a simple matter. It must be carried out with a great deal of caution owing to the vast differences in production technologies, factor costs and proportions, availability of raw materials, and trade in semi-finished materials between countries as well as between plants within a given country. The statistics are, however, useful in establishing general trends with regard to energy efficiency in a given industry. This problem may be illustrated by using statistics compiled by the International Iron and Steel Institute (IISI) on energy required for steelmaking. Table III.6 summarizes net energy requirements for steelmaking in 17 countries on the basis of questionnaire responses provided by IISI member countries.

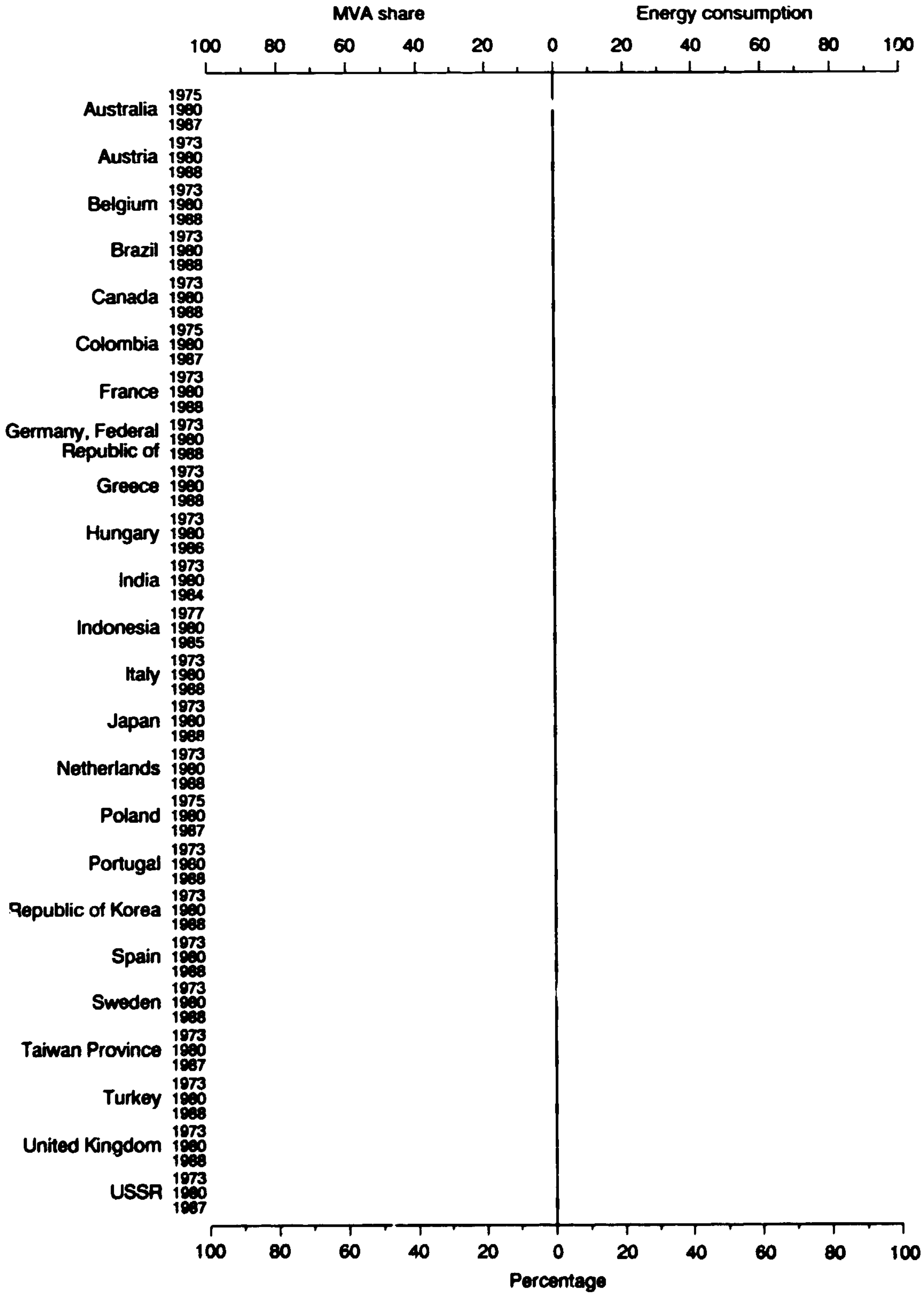
Particularly noteworthy in table III.6 is a steady decline in energy intensity in steelmaking in all countries during the period 1980-1988. A relatively low energy intensity in steelmaking is found in Italy, Japan, Netherlands and Spain, while more energy-intensive production is observed in South Africa, and to a far lesser extent in the other countries listed. But all of them, except Canada and South Africa, showed a pronounced decline in energy intensity between 1980 and 1988.

Marked intercountry differences in energy intensity are largely attributable to different production technologies used in different countries. For instance, the energy requirements of steelmaking by means of the scrap-based electric-arc furnace are considerably lower than those of the traditional method of first converting iron ore to pig-iron and then to crude steel in a basic oxygen furnace. Electric-arc-furnace process technology usually requires approximately 8.5 gigajoules of energy to produce 1 tonne of crude steel, compared with 19 gigajoules per tonne of crude steel in the basic-oxygen-furnace process. In Spain, therefore, where 60 per cent of steel output is produced by the electric-arc-furnace method, energy intensity in steelmaking is considerably lower than in Luxembourg, for instance, where all crude steel is produced by the basic-oxygen-furnace method ([6], p. 1).

High energy intensity in steelmaking does not necessarily imply inefficient or uneconomic production methods, since the factor combination and choice

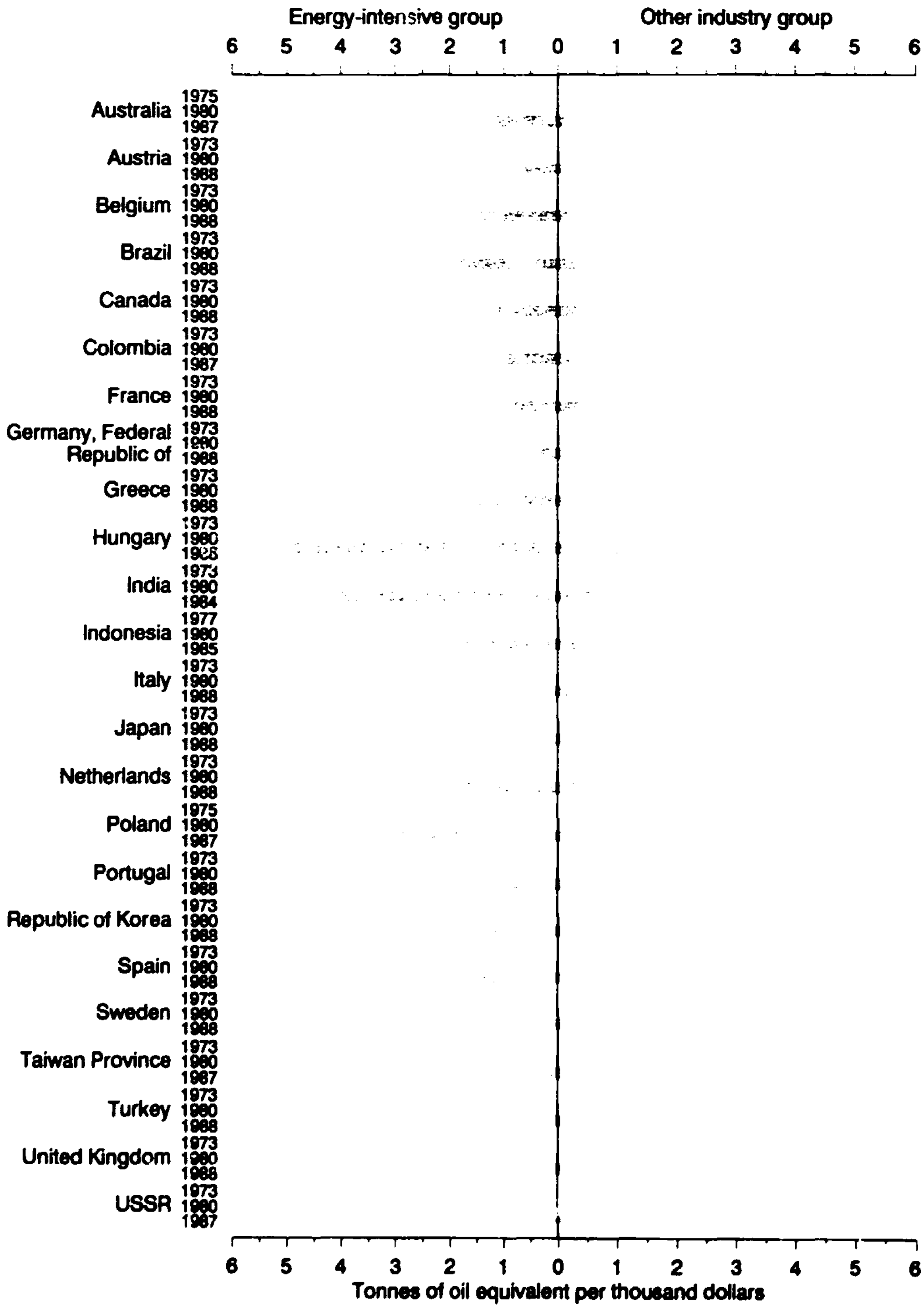
Figure III.6. Shares of energy-intensive industry groups in total manufacturing energy consumption and MVA in selected countries and areas

(Percentage)



Sources: International Energy Agency, *World Statistics and Balances 1971-1987*, and *World Energy Statistics and Balances 1985-1988*, *Energy Balances of OECD countries 1970-1985* and *Energy Balances of OECD countries 1986-1988* (Paris, Organisation for Economic Co-operation and Development, 1989 and 1990); and UNIDO database.

Figure III.7. Energy intensity of energy-intensive industry group and other industry group in selected countries and areas



Sources: International Energy Agency, *World Statistics and Balances 1971-1987*, and *World Energy Statistics and Balances 1985-1988*, *Energy Balances of OECD countries 1970-1985* and *Energy Balances of OECD countries 1986-1988* (Paris, Organisation for Economic Co-operation and Development, 1989 and 1990), and UNIDO database

Table III.6. Net energy requirement for steelmaking in selected countries, 1980-1988
(Gigajoules per tonne of crude steel)[a]

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Australia	25.0	22.0	24.4	22.5	20.9	22.4	22.9	..	..
Austria	22.8	21.7	21.1	20.0	20.0	20.8	20.9	20.1	19.5
Belgium	22.1	21.1	21.5	21.4	20.9	21.4	..	..	..
Brazil	..	..	..	..	..	20.6	20.5	21.2	20.8
Canada	22.9	22.9	23.7	23.0	22.0	22.1	23.2	24.4	23.7
Finland	20.5	21.6	21.4	21.4	20.6	20.7	20.2	20.6	19.6
France	24.3	23.4	23.9	22.7	22.6	22.4	21.1	20.6	20.7
Germany, Federal Republic of	22.2	21.9	21.8	20.7	20.9	21.4	21.6	20.2	19.9
Italy	19.0	19.7	18.7	18.6	18.0	17.7	18.4	17.8	18.8
Japan	19.5	19.1	18.7	18.1	18.0	17.7	17.6	17.5	17.6
Luxembourg	21.7	21.5	20.8	20.5	19.0	19.2	19.2	19.5	18.3
Netherlands	19.5	17.6	17.7	17.4	16.7	17.6	18.1	19.4	18.8
South Africa	31.4	31.6	32.1	31.8	29.8	29.0	28.5	29.0	29.0
Spain	18.8	18.7	17.5	17.2	16.8	15.5	16.4	16.0	15.8
Sweden	27.0	24.7	22.8	21.6	20.1	19.8	20.1	20.0	19.7
United Kingdom	23.3	22.7	22.1	21.2	20.8	21.2	20.8	20.3	19.8
United States	25.8	25.0	25.9	23.4	22.5	21.1	20.4	21.6	21.4

Source: International Iron and Steel Institute, *Statistics on Energy in the Steel Industry (1990 Update)* (Brussels, 1990), table 1.
[a] 1 gigajoule = 10^9 joules.

of production technology are often dictated by the local availability of raw materials, cheap energy sources and patterns of trade in semi-finished raw materials. With an abundant coal supply, South Africa uses largely coal-based direct-reduced iron (also known as sponge iron) instead of pig-iron. The dominant use of sponge iron tends to raise the energy intensity in steelmaking considerably more than the use of pig-iron, but not necessarily the cost of production. Both coke-fired blast-furnaces and charcoal-fired furnaces are extensively used in making pig-iron by steelmakers in Brazil, where charcoal is supplied by local cottage industries. Making charcoal-based pig-iron usually requires 80 per cent more energy per tonne of pig-iron than coke-based methods. Finally, energy intensity greatly depends on the stage at which production terminates. The production of ingots and semi-finished products clearly consumes far less energy than would be required if the process were carried to the stage of rolling and finishing the ingots and semi-finished products. Likewise, processing imported semi-finished products would require less energy per unit of output than producing steel from the initial phase of iron-ore reduction [6].

Most industrial energy efficiency and conservation measures taken in developed countries came in the aftermath of the oil price rises of 1973 and 1979. It seems reasonable to assume that energy intensity is sensitive to energy prices. This is particularly true in energy-intensive industries, but less likely in other manufacturing industries where energy costs account for a relatively small fraction of total production costs. On the other hand, as energy prices decrease, the decline in energy intensity is also expected to become slower or it may even reverse itself. During the period of the collapse in oil prices between 1985 and the invasion of Kuwait in August 1990*, there was much speculation on the impact of falling energy prices on manufacturing energy consumption and energy intensity. Evidence showing how manufacturing energy efficiency has changed since 1985 in various countries is very limited. It would be useful to ascertain whether the decoupling of energy and output that has occurred in industrialized countries since the first oil crisis of 1973 is not a temporary phenomenon, but a permanent shift that will continue to hold even in a period of falling energy prices.

Survey data on United States manufacturing energy consumption in 1985 and preliminary data for 1988 may shed light on recent trends in manufacturing energy consumption in highly industrialized countries. Manufacturing energy consumption for two-digit industry groups and selected four-digit energy-intensive industries in the United States in 1985 and 1988 is summarized in table III.7. Comparable MVA data for 1985 and 1988 are provided in the same table. In table III.5 United States data for 1980 and 1985 cover the consumption of only off-site energy purchased by various industries, whereas the data for 1985 and 1988 presented in table III.7 are for total energy inputs by manufacturing industries, including energy produced on-site. Bearing this discrepancy in mind, the relationships between energy and output during the periods 1980-1985 and 1985-1988 may now be assessed and compared. Total manufacturing energy consumption in the United States declined by around 20 per cent, while output increased by 8 per cent between 1980 and

*The price of crude oil and gas in the United States nosedived from $27 per barrel (current dollars) in 1985 to $14 in 1988. See Energy Information Administration, "Landed cost of imports", *Monthly Energy Review* (August 1989), p.91.

Table III.7. Total inputs of energy for heat, power, and electricity generation, and MVA in selected industries in the United States, 1985 and 1988

SIC[a] codes	Industry	Energy consumption 1985	Energy consumption 1988	MVA 1985	MVA 1988	Average annual growth rates (1985-1988) Energy consumption	Average annual growth rates (1985-1988) MVA
		(1,000 billion B.t.u.)		(billion 1982 dollars)		(percentage)	
20	Food and kindred products	946	1 005	64.8	67.8	2.04	1.52
21	Tobacco manufactures	19	24	6.2	4.7	8.10	-8.82
22	Textile mill products	248	260	15.6	16.8	1.59	2.50
23	Apparel and other textile products	30	43	20.1	23.2	12.75	4.90
24	Lumber and wood products	333	365	19.8	25.7	3.11	9.08
25	Furniture and fixtures	48	61	12.1	12.3	8.32	0.55
26	Paper and allied products	2 198	2 268	30.2	34.9	1.05	4.94
2621	Paper mills, except building paper	996	1 091	..	..	3.08	..
2631	Paperboard mills	758	804	..	..	1.98	..
27	Printing and publishing	76	91	42.5	45.5	6.19	2.30
28	Chemicals and allied products	2 407	2 694	59.1	74.2	3.83	7.88
2819	Industrial inorganic chemicals	295	240	..	..	-6.65	..
2821	Plastics materials and resins	277	298	..	..	2.47	..
2869	Industrial organic chemicals	797	1 036	..	..	9.14	..
2873	Nitrogenous fertilizers	213	181	..		-5.28	..
29	Petroleum and coal products	2 631	2 897	39.4	44.6	3.26	4.22
2911	Petroleum refining	2 570	2 833	..	..	3.30	..
30	Rubber and miscellaneous plastic products	212	232	26.6	29.8	3.05	3.86
31	Leather and leather products	13	12	3.2	2.9	-2.63	-3.23
32	Stone, clay and glass products	896	995	22.2	25.2	3.56	4.32
3241	Cement, hydraulic	328	338	..	..	1.01	..
33	Primary metal industries	2 391	2 282	32.7	37.9	-1.54	5.04
3312	Blast furnaces and steel mills	1 677	1 590	..	..	-1.76	..
3334	Primary aluminum	234	209	..	..	-3.70	..
34	Fabricated metal products	298	300	56.2	63.2	0.22	3.99
35	Machinery, except electrical	239	242	124.2	170.5	0.42	11.14
36	Electric and electronic equipment	209	189	74.3	88.1	-3.30	5.84
37	Transportation equipment	317	343	92.8	112.6	2.66	6.66
38	Instruments and related products	73	103	24.2	31.5	12.16	9.19
39	Miscellaneous manufacturing industries	13	35	13.0	16.1	4.13	7.39
	TOTAL	13 615	14 441	779.2	927.5	1.98	5.98

Sources: Department of Commerce, *Survey of Current Business* (Washington, D.C., January 1991), table 6; for 1985 energy figures, Energy Information Administration, *Manufacturing Energy Consumption Survey: Consumption of Energy, 1985* (Washington, D.C., 1988); and for 1988 figures, Energy Information Administration unpublished preliminary estimates of energy inputs by industry group and related industries.

Note: MVA growth rates are measured in 1982 constant dollars.

[a] United States Standard Industrial Classification.

1985. In contrast, total manufacturing energy consumption increased by approximately 6 per cent (an annual growth rate of 2 per cent) from 13,600 billion British thermal units to 14,400 billion British thermal units between 1985 and 1988, while output (in 1982 constant dollars) increased by approximately 20 per cent (an annual rate of 6 per cent) from $780 billion to almost $930 billion in the same period. In short, increased output was achieved with decreased energy consumption between 1980 and 1985, showing a clear decoupling of energy and output. Although apparently associated with an increase in energy consumption between 1985 and 1988, output grew three times faster, thus reducing the aggregate energy intensity of the manufacturing sector.

Similarly, the five energy-intensive industry groups increased their energy consumption by almost 6 per cent, from 10,532 thousand billion British thermal units to 11,136 thousand billion British thermal units, between 1985 and 1988, accounting for approximately 77 per cent of total manufacturing consumption in both years. This contrasts sharply with a 21 per cent decrease in the energy consumption of those industries between 1980 and 1985. In fact, all energy-intensive industries except primary metals showed a positive annual growth rate of energy consumption, 3.83 per cent for chemicals, 3.56 per cent for stone, clay and glass products, 3.26 per cent for petroleum and coal products, and 1.05 per cent for paper and allied products, while energy consumption in primary metals declined by 1.54 per cent per year during the period considered. But output grew much faster than energy consumption in the energy-intensive industries. In other industries, the opposite picture emerged, with energy consumption rising faster than output. For instance, energy consumption in apparel and other textile products increased by almost 13 per cent per year, compared with an annual MVA growth rate of 5 per cent; energy consumption grew by 8 per cent per year, while output of tobacco products declined by almost 9 per cent annually; energy consumption in professional instruments increased by 12.16 per cent per year, compared with an annual increase of 9.19 per cent in MVA; an increase of 8.32 per cent per year in energy consumption in furniture and fixtures was coupled with an annual MVA growth rate of less than 1 per cent; and energy consumption increased by 6.19 per cent in printing and publishing, as compared with annual MVA growth of 2.3 per cent. Other industries covered in table III.7 account for a very small fraction of total manufacturing energy consumption; exceptions are machinery, fabricated metals, rubber products and textile mill products, of which the rate of output growth was considerably faster than the rate of energy consumption. But these industries consume a far larger quantity of energy than tobacco, printing and publishing, textile apparel, furniture and professional instruments, although far less than the energy-intensive industries.

An analysis of United States data for the period since the collapse of oil prices in 1985 shows that the sensitivity of manufacturing energy consumption to a substantial drop in energy prices (that is, price elasticities) depends on the relative importance of energy costs as a percentage of total production costs in different industries. In energy-intensive industries, where energy costs are a significant part of production costs, energy consumption has been stimulated in response to lower energy prices, but energy has been used efficiently so as to improve energy intensity as part of cost-cutting measures. By contrast, some light industries (such as textile apparel, tobacco and furniture), where energy constitutes a small fraction of total costs, appear to have paid little attention to energy efficiency, and to have increased their energy consumption disproportionately greater than their output. Their high annual growth rates of energy consumption are also partly due to their small base figures*.

An analysis of recent United States data also shows that lower energy prices tend to stimulate industrial energy consumption, but do not necessarily promote inefficient energy use and increased industrial energy intensity. In fact, United States data points to a general improvement in energy intensity despite lower real energy prices, although the pace of improvement may have been somewhat slow. This phenomenon may be explained in part by the positive impact of low energy prices on economic growth, which in turn stimulates capital investment in various industries. New equipment and machinery are likely to embody technological improvements in the form of more efficient use of raw materials including energy. Moreover, extensive industrial restructuring in developed countries since the 1982 global recession has led some manufacturing industries, particularly the "smokestack" industries, permanently to phase out their old plants. As a result, old capacity is no longer available to reactivate in a period of strong economic growth.

Recent United States experience is likely to be repeated at least in other highly industrialized countries, where industrial energy consumption since 1985 would have been much higher in the absence of technological change. The question of how much energy is saved by the improvement of energy intensity through technological change will be covered in the decomposition analysis presented later in this chapter.

One important implication for developing countries can be derived from the preceding cross-country assessment of manufacturing energy consumption. A large number of developing countries, particularly those at early stages of industrialization, are about to initiate or have already begun a process of structural change involving a shift away from traditional labour-intensive light manufacturing to a more energy-and materials-intensive phase of industrialization based on the processing of industrial raw materials. A small number of industries processing industrial raw materials, in particular iron and steel, non-ferrous metals, non-metallic minerals, chemicals, and paper and pulp, have consistently accounted for the bulk of total manufacturing energy consumption, while producing a relatively small share of total manufacturing output. Changes in the relative energy intensities or output shares of these industries will have a disproportionate impact on aggregate manufacturing energy consumption. Energy consumption in these basic industries, particularly in highly industrialized OECD countries, markedly declined despite increasing output and energy prices during the 1970s and early 1980s. When energy prices started to fall in the mid-1980s, energy consumption rose, but at a far slower pace than output. In both cases, energy intensity in these industries continued to fall. This seems to suggest that the industrialization of developing countries could be achieved with the use of far less energy than developed countries needed at similar stages of industrialization. They key to energy-efficient industrialization in developing countries is the transfer and diffusion of energy-efficient manufacturing technologies from developed to developing countries.

Another important conclusion is that any industrial energy efficiency and conservation strategy for developing countries should target a small number of strategic energy-intensive industries, given their decisive impact on aggregate manufacturing energy use, instead of spreading scarce resources too thinly over the entire manufacturing sector.

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*For instance, one United Kingdom study estimated typical industrial energy costs as a percentage of total production costs in United Kingdom industries in 1976 as follows: iron and steel, 30 per cent; chemicals, 20 per cent; building materials, 20 per cent; textiles, 10 per cent, food, 5 per cent, engineering, 5 per cent; paper, 5 per cent; and other industries, 5 per cent. The above figures represent only direct costs, excluding indirect energy costs embodied in various inputs. Energy costs are a significant proportion of total costs in energy-intensive industries such as the first three mentioned above, while for the last four industries, which accounted for 80 per cent of total industrial production, the share of energy costs is small. For further details, see Walter Murgatroyd, "Industrial energy consumption and potential for conservation", in *World Energy Issues and Policies*, Robert Mabro, ed. (Oxford, Oxford University Press, 1980), pp. 113-126.

4. *The changing fuel mix in the manufacturing sector*

Energy or fuel substitution and mixes have an important effect on manufacturing energy intensity because of considerable differences in the amount of useful heat that can be generated from the combustion of different fuels. Fuel substitution or switching is largely the result of changing relative prices of various forms of energy. In response to the oil price rises of 1973 and 1979, the share of oil in total industrial energy consumption declined in varying degrees in all countries, both developing and developed, except Saudi Arabia, between 1975 and 1985 (see figure III.8). The shrinking share of oil was particularly pronounced in highly industrialized countries.

Coal is less energy-efficient and more polluting and labour-intensive, requiring larger storage space and transport infrastructure than other fuels such as oil, gas or electricity. But switching to coal often occurs because of its competitive price. The relative share of coal in total industrial energy consumption differs widely from country to country, depending on the size of coal deposits and the structure of industry. Countries endowed with rich coal deposits, such as Belgium, Colombia, Czechoslovakia, India, Poland and Turkey, use coal more extensively than other energy forms. In general, the share of coal in industrial energy consumption appears to be slowly declining, with some exceptions. It increased substantially between 1975 and 1985 in some developing countries and areas, including Brazil, Chile, Greece, Republic of Korea, Taiwan Province and Thailand, and moderately in some developed countries such as the Federal Republic of Germany and Japan. As these countries and areas are not noted for rich coal deposits, the increase in the share of coal may be structural, relating to an increase in the production of steel and cement, which relies heavily on coal. In contrast, industrial use of coal is insignificant or non-existent in most oil-rich countries, including Indonesia, Kuwait, Mexico, Saudi Arabia, Syrian Arab Republic and Venezuela.

The share of gas in total industrial energy consumption varied widely among countries covered in this study. Among those with a relatively large share of gas in 1985 were Bangladesh (75 per cent), Canada (36 per cent), Indonesia (52 per cent), Kuwait (76 per cent), Mexico (45 per cent), Netherlands (45 per cent), Pakistan (50 per cent), Romania (70 per cent), United States (37 per cent), USSR (36 per cent) and Venezuela (69 per cent). These countries are mostly oil-exporting countries producing a large quantity of natural gas as either a by-product of or an alternative to oil. Major exceptions are Egypt, Saudi Arabia and Syrian Arab Republic, where industry relies primarily on oil. Among countries or areas using a notably small share of gas for industrial energy are Brazil, Chile, Denmark, Finland, Greece, India, Japan, Morocco, Portugal, Spain, Sweden, Syrian Arab Republic, Taiwan Province, Thailand and Turkey.

Nowhere does electricity account for a dominant share of industrial energy consumption, but there is clear evidence of a trend toward greater industrial use of electricity. The share of electricity increased in varying degrees in almost all countries between 1975 and 1985, as reflected in figure III.8. Electricity is attractive for industrial consumption, because it is energy-efficient, clean and flexible, its supply is reliable, and its prices are stable*.

A steady upward trend in the industrial use of electricity appears to be partly related to strong growth in the capital goods industry, which relies heavily on electricity as a source of energy, particularly in OECD countries. Table III.8 shows electricity consumption in the three industries that accounted for about a half of total industrial electricity consumption during the period 1979-1988. The machinery and equipment industry increased its electricity consumption by 4.7 per cent per year, surpassing that of the iron and steel industry in 1987, the electricity consumption of which decreased by 2.1 per cent per year during the same period. The growth rate for the chemical industry was 0.6 per cent per year, smaller than the industry average of about 1 per cent. However, increased electricity use is not only confined to the machinery and equipment industry, but is also required by new process technologies in other industries. For instance, increased electricity intensity occurred in the paper and pulp industry with a shift toward mechanical pulping away from chemical pulping, and in the iron and steel industry with the increased use of electric-arc furnaces. In general, the emergence of new process technologies tends to increase the industrial use of electricity.

Table III.9 shows the growth rates of manufacturing energy consumption by major fuel types in selected countries and areas in different periods. The data provided in table III.9 shed light on some of the questions raised earlier. They tend to support the hypothesis that lower energy prices following a collapse in oil prices in late 1985 stimulated energy consumption or considerably slowed down the rate of decline in manufacturing energy consumption, at least in OECD countries. For instance, prices dropped by an average of almost 28 per cent between 1985 and 1988. During that period, in all OECD countries except Austria, the annual growth rates of manufacturing energy consumption either changed to positive from the negative rates of the period 1980-1985, or the rate of decline slowed markedly. The same hold true for Eastern Europe and the USSR. A sharp upsurge in manufacturing energy consumption during the period 1985-1988 is also clearly evident in the Latin American countries covered in table III.9, except for Mexico. In Asia, manufacturing energy consumption increased at double-digit growth rates in Bangladesh, Hong Kong, Republic of Korea and Taiwan Province, while growth rates declined in India and Pakistan during the same period. Growth rates also dropped sharply in North Africa and Western Asia, a decline likely to have been caused more by a substantial fall in industrial production than by a change in energy prices.

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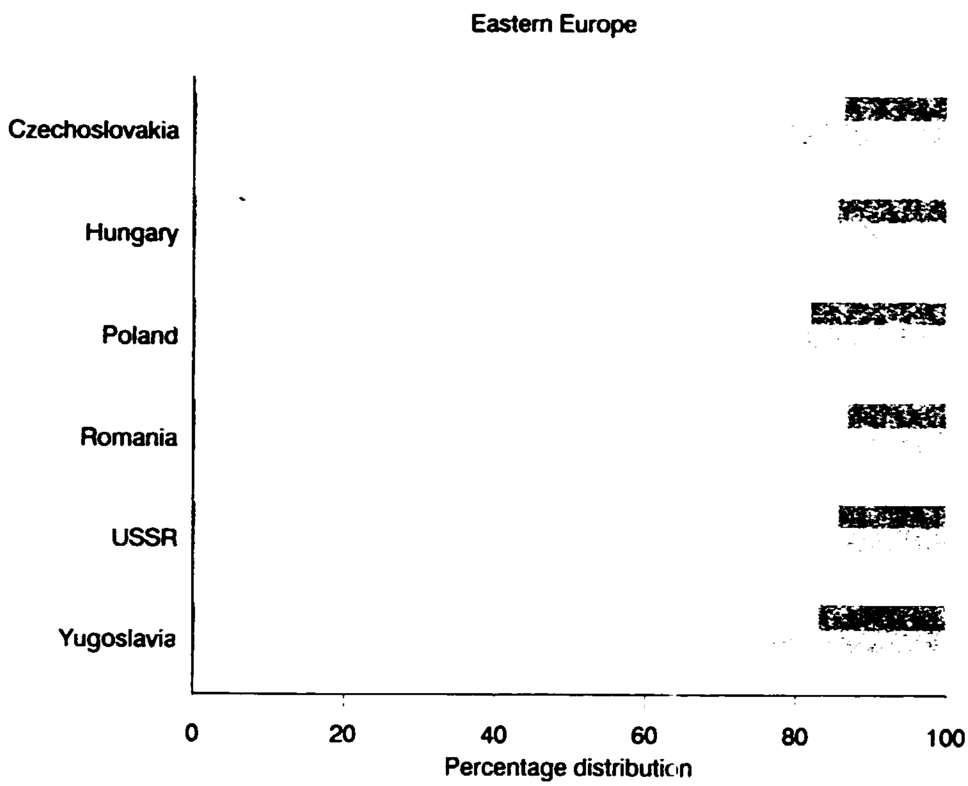
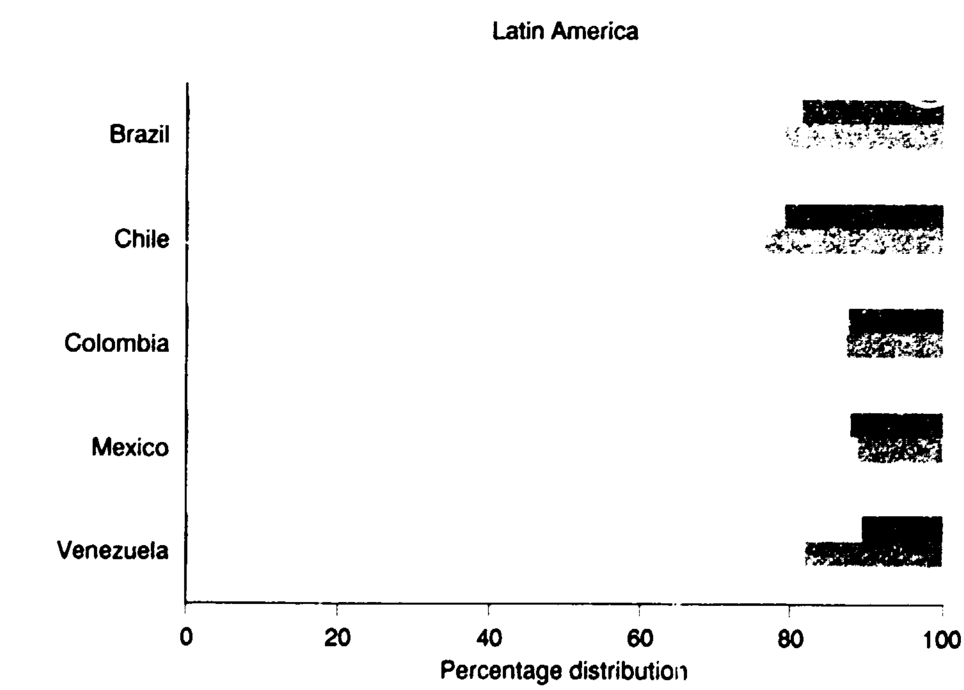
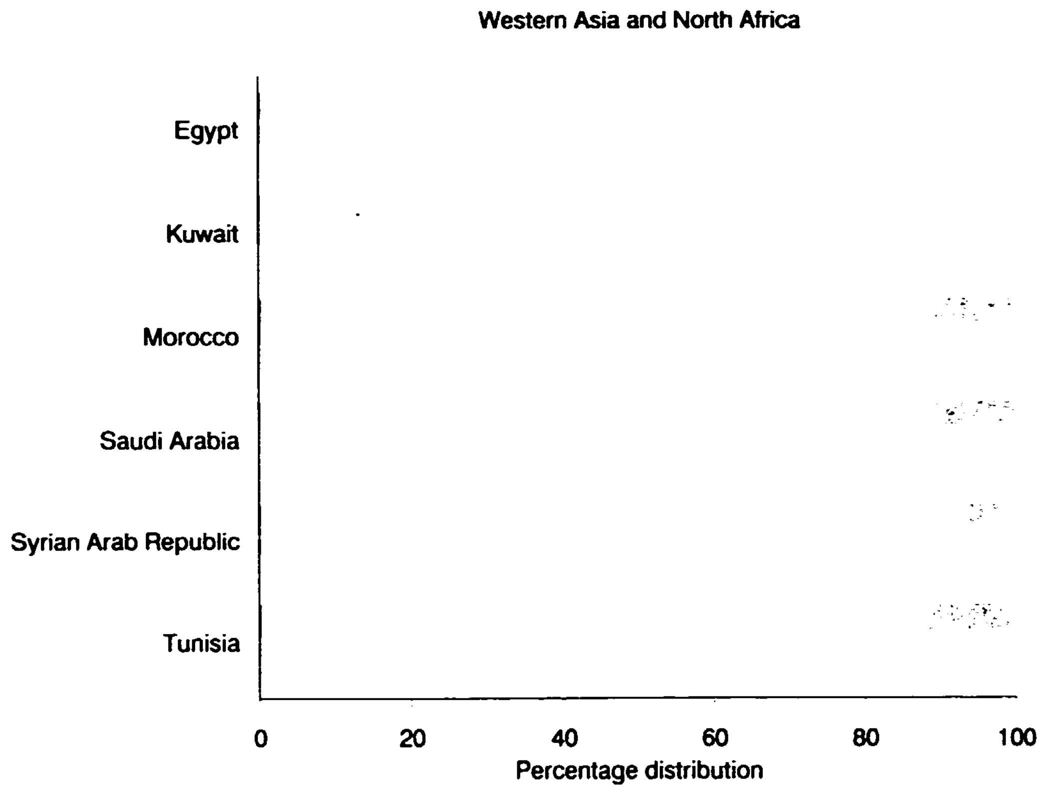
*Only the industrial end-use of electricity is discussed in this study. Electricity is generated from various primary sources, such as hydropower, nuclear power, gas, oil and coal. The share of each primary energy source used in generating electricity varies considerably from country to country. For OECD countries as a whole, the total amount of electricity generated in 1988 was 6,478,429 gigawatt-hours, of which about 40 per cent was accounted for by coal, 9 per cent by oil and gas each, 23 per cent by nuclear power, and 18 per cent by hydropower. For details, see International Energy Agency, *Energy Balances of OECD Countries 1987-1988* (Paris, Organisation for Economic Cooperation and Development, 1990).

Figure III.8. Shares of coal, oil, gas and electricity in total


Eastern Europe
Czechoslovakia
Hungary
Poland
Romania
USSR
Yugoslavia
0
20
40
60
80
100
Percentage distribution

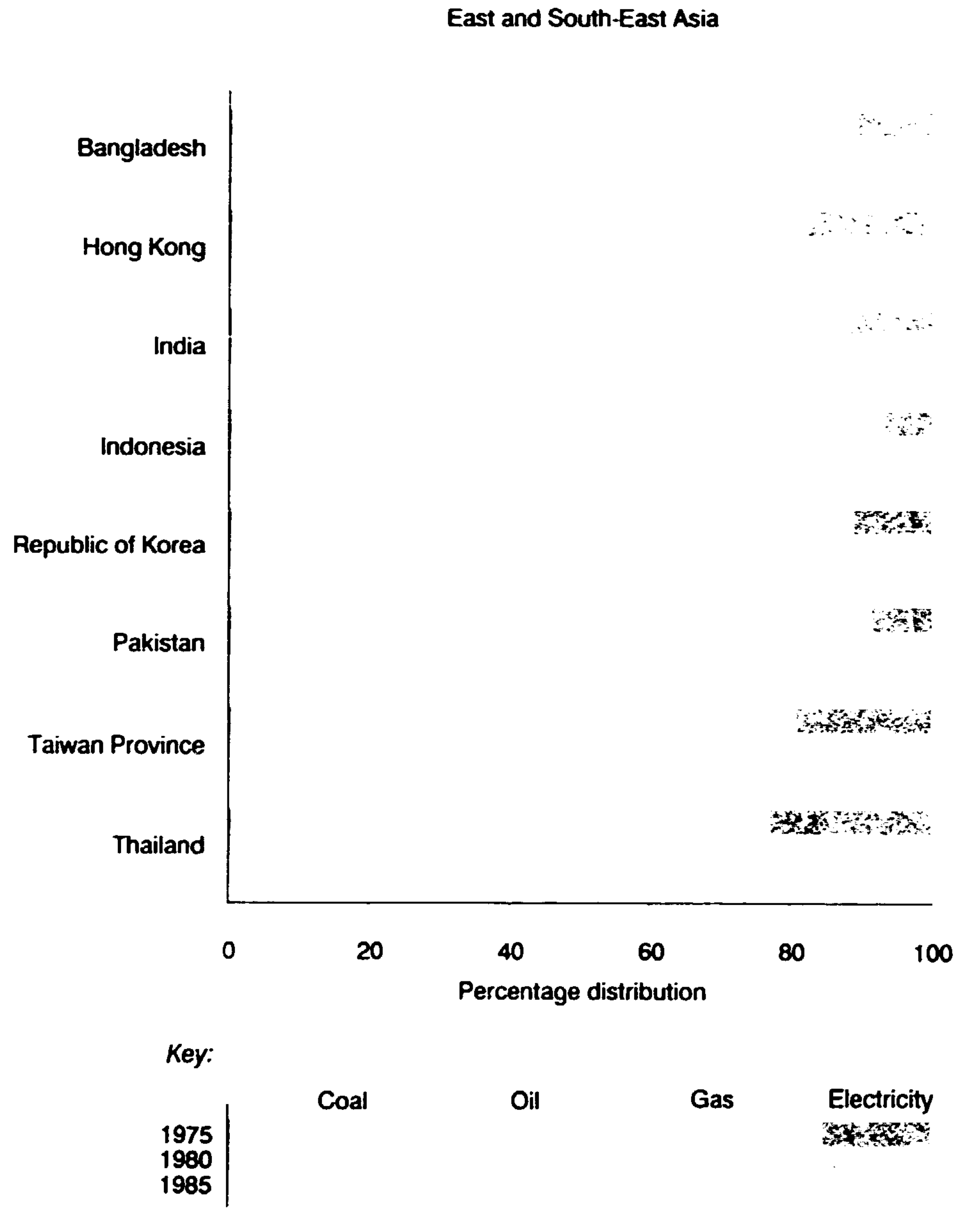

Latin America
Brazil
Chile
Colombia
Mexico
Venezuela
0
20
40
60
80
100
Percentage distribution



Source: International Energy Agency, Organisation for Economic Co-operation and Development, *World Energy Statistics and Balances 1971-1987* (Paris, 1988).

The growing importance of electricity as a major source of industrial energy, as reflected in the steady growth of industrial electricity consumption during the three periods 1973-1980, 1980-1985 and 1985-1988, marks the emergence of a new pattern of manufacturing energy consumption. Such a change has been most notable in all OECD countries except Italy (1980-1985) and the United Kingdom (1973-1980 and 1980-1985). The pattern of consistent growth in industrial electricity consumption in OECD countries is in sharp contrast to the relatively unstable pattern of change in the consumption of other industrial fuels during the same periods. With minor exceptions, the same general conditions appear to prevail in Eastern Europe and the USSR. Strong industrial demand for electricity was also notable in Asia and Latin America throughout the periods considered, and to a lesser extent in North Africa and Western Asia, except for Kuwait and Saudi Arabia, where trends were uneven.

(continued)



An interesting picture emerges when variations in the industrial consumption of gas are compared with those of oil in OECD countries. In Australia, Denmark, Spain and Sweden, and to a lesser extent the Federal Republic of Germany and Japan, a large increase in the rate of industrial gas consumption was associated with a substantial decline or a small increase in the rate of industrial oil consumption. For instance, industrial gas consumption in Denmark increased by almost 45 per cent per year during the periods 1980-1985 and 1985-1988, while industrial oil consumption dropped by approximately 7 and 9 per cent per year, respectively (see table III.9). This suggests that a substantial part of the reduced oil consumption in the manufacturing sector was replaced by gas. The statistical evidence is consistent with one of the conclusions derived from the survey of United States manufacturing energy consumption, namely that natural gas is the main fuel used to replace oil.

Table III.8. Industrial electricity use in OECD countries, 1979, 1982 and 1987

Industry	1979	1982	1987	Average annual growth rates 1979-1987
	(million tonnes of oil equivalent)			(per cent)
Iron and steel	24.7	20.2	20.9	-2.1
Chemicals	34.5	31.6	36.1	0.6
Machinery, equipment	18.1	19.2	26.1	4.7
Total industry	171.6	158.5	186.6	1.1

Sources: International Energy Agency, *Energy Balances of OECD countries 1970-1985 and Energy Balances of OECD countries 1987-1988* (Paris, Organisation for Economic Co-operation and Development, 1987 and 1990).

Table III.9. Growth rates of total manufacturing energy consumption by fuel types in selected periods and countries and areas
(Percentage)

Year	Total	Annual average growth rates			
		Coal	Oil	Gas	Electricity
OECD countries					
Australia					
1973-1980	2.17	-0.89	-0.30	14.60	5.00
1980-1985	-1.03	-2.53	-9.31	6.26	5.68
1985-1988	-0.97	-8.58	-6.21	3.92	6.60
Austria					
1973-1980	1.12	1.96	-2.95	5.92	2.31
1980-1985	-0.31	2.75	-5.05	0.24	1.43
1985-1988	-4.22	-7.21	-12.17	-0.98	3.44
Belgium					
1973-1980	-3.12	-3.14	-7.90	1.30	0.86
1980-1985	-2.76	-3.44	-0.76	-6.25	1.23
1985-1988	1.10	-1.76	2.01	1.67	4.09
Canada					
1973-1980	1.81	-0.55	-0.62	4.54	3.28
1980-1985	0.07	-1.08	-4.82	1.40	4.31
1985-1988	3.61	-0.24	3.46	5.22	3.15
Denmark					
1973-1980	-2.07	10.41	-4.46	..	3.24
1980-1985	-3.23	-5.89	-6.76	45.41	5.71
1985-1988	-0.39	2.11	-9.42	44.22	3.42
Finland					
1973-1980	-0.80	-2.66	-3.88	..	3.41
1980-1985	0.40	6.20	-3.56	1.39	3.52
1985-1988	1.90	15.92	-11.12	17.50	4.51
France					
1973-1980	0.29	-3.43	-0.62	7.54	1.83
1980-1985	-3.63	-0.13	-9.39	2.32	0.34
1985-1988	-0.74	-2.22	-2.13	-1.23	3.99
Germany, Federal Republic of					
1973-1980	-0.09	0.43	-2.85	4.21	1.46
1980-1985	-1.81	0.42	-5.76	-0.70	0.94
1985-1988	-0.57	-4.31	-0.38	0.75	2.46

Year	Total	Annual average growth rates			
		Coal	Oil	Gas	Electricity
Greece					
1973-1980	3.77	-1.74	4.48	..	5.23
1980-1985	-1.74	21.34	-10.70	..	1.09
1985-1988	2.89	-1.68	5.93	18.56	2.06
Italy					
1973-1980	-0.97	1.27	-4.54	3.63	2.88
1980-1985	-2.58	5.63	-6.15	-2.57	-0.25
1985-1988	2.92	-7.52	0.59	10.36	3.97
Japan					
1973-1980	-2.31	-0.30	-4.89	4.02	1.70
1980-1985	-1.25	0.27	-3.94	4.47	1.53
1985-1988	2.15	1.77	1.73	3.26	3.14
Netherlands					
1973-1980	-0.08	-2.65	-0.91	0.46	3.07
1980-1985	-0.52	7.57	-4.77	1.23	0.33
1985-1988	0.05	0.07	0.32	-0.25	0.30
Portugal					
1973-1980	5.45	1.84	5.43	..	7.07
1980-1985	3.11	12.47	2.03	..	2.67
1985-1988	7.59	15.31	7.03	..	4.71
Spain					
1973-1980	1.49	-6.89	3.10	6.09	5.17
1980-1985	-1.61	6.99	-6.27	14.31	1.14
1985-1988	3.46	-2.12	3.13	26.85	1.80
Sweden					
1973-1980	-2.21	..	-4.04	..	0.41
1980-1985	-2.81	2.03	-9.73	47.58	3.42
1985-1988	1.85	-1.24	-0.82	37.00	4.02
Turkey					
1973-1980	8.09	7.51	8.10	..	9.53
1980-1985	3.62	3.80	1.85	..	8.45
1985-1988	11.06	17.69	5.59	78.28	9.00
United Kingdom					
1973-1980	-5.31	-11.38	-8.63	4.21	-0.63
1980-1985	-1.68	4.36	-6.07	-0.59	0.54
1985-1988	1.63	3.54	3.88	-3.27	3.90
United States					
1973-1980	-0.86	-3.80	1.42	-2.50	2.08
1980-1985	-3.40	-1.10	-6.79	-3.03	0.15
1985-1988	1.22	0.32	1.04	1.13	2.45
Eastern Europe and USSR					
Czechoslovakia					
1973-1980	-4.10	-8.72	75.80	5.08	2.97
1980-1985	-2.75	-0.79	-52.84	-6.18	-0.13
1985-1988	17.56	24.15	..	7.42	4.72
Hungary					
1973-1980	3.40	-10.72	9.44	5.91	3.58
1980-1985	-4.98	-6.40	-5.44	-7.02	1.34
1985-1988	-0.95	-6.43	-0.05	-2.73	2.92
Poland					
1973-1980	2.25	1.14	4.18	1.72	4.64
1980-1985	-3.17	-4.11	-5.14	-1.56	-1.18
1985-1988	0.68	-0.65	0.80	3.25	0.82

Table III.9. (continued)

Year	Total	Annual average growth rates			
		Coal	Oil	Gas	Electricity
Eastern Europe and USSR (continued)					
Romania					
1973-1980	11.13	6.18	4.48	13.20	7.66
1980-1985	0.96	1.48	7.69	0.01	4.46
1985-1988	2.29	1.11	10.27	2.12	1.55
USSR					
1973-1980	3.97	2.22	5.01	5.26	3.98
1980-1985	1.85	-0.09	-0.99	5.12	2.77
1985-1988	3.23	0.26	1.64	6.47	2.83
Yugoslavia					
1973-1980	2.20	-8.98	3.75	11.17	8.01
1980-1985	1.43	5.14	-7.27	6.95	6.34
1985-1988	2.66	-8.21	5.49	11.87	-2.09
Asia					
Bangladesh					
1973-1980	6.41	0.47	6.21	8.98	1.74
1980-1985	3.77	-16.95	-16.05	11.21	16.53
1985-1988	12.81	34.79	-39.32	17.06	4.59
Hong Kong					
1973-1980	8.65	-9.17	8.95	10.75	8.20
1980-1985	4.82	-2.91	4.95	4.65	4.47
1985-1988	11.40	-17.17	11.90	17.21	9.75
India					
1973-1980	4.11	3.99	3.24	13.07	5.27
1980-1985	6.11	4.90	5.10	27.77	8.90
1985-1988	2.71	-2.90	8.15	31.25	10.29
Indonesia					
1973-1980	19.36	20.61	15.85	44.43	12.68
1980-1985	1.27	10.94	-10.12	17.09	11.86
1985-1988	1.50	35.78	0.78	5.49	..
Pakistan					
1973-1980	8.48	7.18	11.69	9.08	5.96
1980-1985	8.31	11.24	34.05	2.12	21.[illegible]
1985-1988	-0.54	-4.80	15.52	0.21	-9.35
Republic of Korea					
1973-1980	10.66	23.74	7.68	..	14.77
1980-1985	2.52	11.55	-2.22	..	7.19
1985-1988	11.50	11.35	10.54	93.96	14.05
Taiwan Province					
1973-1980	10.73	1.83	18.34	3.20	10.97
1980-1985	1.53	11.54	-0.89	-16.31	2.97
1985-1988	9.92	14.84	7.82	-4.57	9.82
Latin America					
Brazil					
1973-1980	10.22	15.20	7.98	34.40	12.82
1980-1985	0.04	11.50	-8.55	13.78	7.02
1985-1988	5.94	5.30	6.27	10.80	5.13
Chile					
1973-1980	1.28	-0.36	0.54	6.17	4.36
1980-1985	0.06	4.69	-3.45	-2.42	3.14
1985-1988	9.35	5.67	6.99	71.40	6.45

Year	Total	Annual average growth rates			
		Coal	Oil	Gas	Electricity
Colombia					
1973-1980	3.75	5.50	-3.29	16.39	5.61
1980-1985	2.97	3.33	0.48	4.66	4.05
1985-1988	5.50	2.24	10.44	2.56	10.95
Mexico					
1973-1980	9.84	2.30	8.15	13.12	7.60
1980-1985	7.32	3.69	12.77	4.37	6.35
1985-1988	-0.53	-10.97	2.13	-3.20	5.45
Venezuela					
1973-1980	7.88	-7.23	2.32	8.14	18.26
1980-1985	4.69	-2.39	2.97	5.16	4.79
1985-1988	6.50	1.91	19.91	3.49	8.52
North Africa and Western Asia					
Egypt					
1973-1980	11.76	10.41	8.72	177.71	13.22
1980-1985	9.16	6.55	6.85	13.44	15.25
1985-1988	-0.37	0.11	-0.91	0.33	0.40
Kuwait					
1973-1980	6.71	..	..	6.00	12.34
1980-1985	-4.30	..	35.19	-8.25	-2.71
Morocco					
1973-1980	6.52	-12.05	7.67	-0.74	9.31
1980-1985	-2.36	15.73	-5.03	6.84	5.15
1985-1988	-25.51	-18.45	-22.00	-3.96	..
Saudi Arabia					
1973-1980	21.99	..	26.87	1.60	-4.58
1980-1985	19.84	..	16.86	45.69	37.61
1985-1986	-0.99	..	-1.47	1.37	-1.35
Syrian Arab Republic					
1973-1980	27.39	..	30.20	..	11.52
1980-1985	7.63	-19.73	6.55	..	17.98
1985-1988	-11.60	..	-14.00	..	2.36
Tunisia					
1973-1980	10.54	-2.10	10.46	40.60	13.68
1980-1985	3.91	1.42	3.32	10.17	2.99
1985-1988	3.34	-9.37	-0.96	25.85	7.20

Source: International Energy Agency, *World Energy Statistics and Balances 1971-1987* and *World Energy Statistics and Balances 1985-1988*, (Paris, Organisation for Economic Co-operation and Development, 1989 and 1990).

The pattern of substituting gas for oil appears to be less clear in the other countries covered in this study. In some countries (such as Brazil, Chile, Republic of Korea, Turkey, United States and USSR), industrial consumption of all four energy forms increased during the period 1985-1988, but gas consumption grew most rapidly. In other countries (for example, Bangladesh and Finland), a sharp cutback in industrial oil consumption was compensated for by a substantial increase in the use of both gas and coal during the period 1985-1988. On the other hand, in another group of countries (notably, France, Hungary and Morocco), the industrial use of all four energy forms simultaneously declined in the most recent periods.

Falling oil prices since 1985 has stimulated industrial oil consumption in most of the countries covered. One of two things has happened since 1985 in these countries. There has been either a levelling off or reversal to a positive growth rate from the steep decline in industrial oil consumption that characterized the periods prior to 1985. Some important exceptions are to be found in North Africa and Western Asia, in OECD countries (Austria and Denmark), and in various other developing countries (Bangladesh, Indonesia and Mexico), where industrial oil consumption declined sharply during the period 1985-1988 as compared with the preceding period 1980-1985. However, an increase in industrial oil consumption does not necessarily lead to an increase in industrial oil intensity, that is, oil consumption per unit of output, as long as industrial output grows faster than industrial oil consumption. A recent report of the International Energy Agency substantiates this point. Despite a general increase in industrial oil consumption owing to higher industrial production levels coupled with lower oil prices in OECD countries, oil intensity was reduced by 2.2 per cent per year between 1985 and 1987 [7]. Part of the continuing decline in oil energy intensity in OECD countries despite an increase in industrial oil consumption in recent years can be attributed to efficiency improvements through new investment in energy-efficient technologies.

Fuel substitution prompted by changing relative energy prices significantly affects the energy intensity and costs of manufacturing output. Substitution capabilities in the manufacturing process are essential not only for lowering production costs by switching to less expensive fuels, but also for such purposes as mitigating the impact of disruptions in the supply of particular types of energy and promoting ecologically sustainable industrial production through the use of cleaner fuels.

The practice of substituting one fuel for another is common in the manufacturing industries. For instance, some combustors are designed to use two or more fuels simultaneously in varying proportions to yield the desired heat output. Others can burn one fuel at a time, but can be converted to the use of another fuel within a short time. There are also multiple combustors capable of using different fuels for the same purpose. Such a wide range of combustors requiring different fuel mixes makes it easier to carry out fuel substitution in response to changing relative fuel prices and other circumstances.

Energy substitution depends on the time horizon considered. In the long run, all types of energy substitution are possible. It is within a short time span that the question of substitutability becomes critical. Substitution capabilities in the short run are affected by a host of factors, such as equipment characteristics, the nature of supply contracts, the reliability of the flow of supplies, environmental regulations, and the availability of and accessibility to distribution systems for a particular alternative energy.

Empirical data on the fuel substitution capabilities of manufacturing industries are scarce. However, a survey of manufacturing energy consumption conducted by the United States Energy Information Administration provides information on the fuel-switching capabilities of United States manufacturing industries in 1985. The main findings of this survey, the first in a triennial series, are summarized and analysed below. Although it may not be possible to replicate United States experience in other countries, the data provide valuable information on the nature, possibilities and limitations of fuel substitution in various manufacturing industries in a relatively advanced stage of industrialization.

In the survey of United States manufacturing energy, fuel-switching capabilities are measured relative to 1985 consumption for five energy types, namely purchased electricity, natural gas, distillate fuel oil, residual fuel oil, and coal and coke. The survey results for the entire manufacturing sector are summarized in table III.10. The statistics refer to substitution potential, in particular how much of the 1985 consumption of a particular fuel type could have been substituted for by one or more alternative fuels, and how much each alternative fuel could have contributed to this substitution. The data do not cover the actual fuel substitution that took place in 1985 [8]. They reflect, however, the short-term capability to switch to alternative fuels in response to an emergency situation, changing relative fuel prices or other factors, where the short term is construed to be within a period of 30 days.

One of the striking results reflected in table III.10 is the wide variation in substitution possibilities among different fuels. Residual fuel oil and natural gas allow the widest scope for substitution, about 42 per cent of their actual consumption, followed by coal and coke (30 per cent), and distillate fuels (20 per cent). Purchased electricity offers the least scope for substitution, amounting to less than 2 per cent of its actual total consumption in 1985. This very limited range of fuel substitutability for electricity may partly explain the steady growth in manufacturing electricity consumption discussed earlier.

The oil price rises of 1973 and 1979 focused attention on the importance of saving oil. In 1985 the manufacturing sector in the United States consumed approximately 112 million barrels of residual and distillate oils to produce heat and power and to generate electricity. Of this total, petroleum fuel consumption, approximately 40 million barrels or 37 per cent, could have been saved by substituting other fuels for oil, while maintaining production in United States manufacturing industries at 1985 levels. This would have amounted to a foreign exchange saving of around $800 million at a price of $20 per barrel.

Moreover, about four fifths of the 40 million barrels of petroleum fuel could have been replaced solely by natural gas. In fact, natural gas is the most important alternative fuel capable of substituting for other energy forms. The proportions of total switchable fuels that natural gas could have replaced were 73 per cent for residual fuel oil, 67 per cent for distillate fuel, 68 per cent for coal and coke, and 70 per cent for electricity. The next most important alternative fuels are petroleum oils, ranging between 20 and 45 per cent in their capability to replace other switchable fuels. By contrast, electricity and coal and coke are least suited for replacing other fuels, their replacement capability being estimated at below 6 per cent.

Tables III.11 and III.12 cover energy substitution possibilities for purchased electricity and residual fuel oil at disaggregated industry levels. The top five industrial users of electricity in 1985 were primary metals, chemicals, paper and pulp, foods, and petroleum products, which together accounted for over 60 per cent of total manufacturing consumption of electricity. It is noteworthy that the margin for substituting alternative fuels for electricity is very small for almost all industries listed in table III.11. In the case of residual fuel oil, the group of top five consumers consists of the same industries, namely petroleum products, paper and pulp, chemicals, primary metals and foods, which together accounted for about three quarters of total manufacturing consump-

Table III.10. Inter-energy substitution possibilities in the United States manufacturing sector, 1985

Type of energy	Original energy			Alternative types of energy[a]						
	Total[b] consumed	Switchable	Not switchable	Purchased electricity	Natural fuel oil	Distillate fuel oil	Residual coke	Coal and coke	Liquefied petroleum gas	Other[c]
1. Purchased electricity (millions of kilowatt-hours)	643 362	10 631 (1.65)	550 886 (85.63)	-	7 437 (69.96)	2 937 (27.63)	4 149 (39.03)	626 (5.89)	1 654 (15.56)	1 358 (12.59)
2. Natural gas (billions of cubic feet)	4 512	1 895 (42.00)	2 238 (49.60)	42 (2.22)	-	810 (42.74)	830 (43.80)	38 (2.00)	493 (26.00)	45 (2.37)
3. Distillate fuel oil (thousand barrels)	31 684	6 236 (19.68)	18 844 (59.47)	344 (5.52)	4 165 (66.79)	-	1 300 (20.85)	178 (2.85)	d/	59 (0.95)
4. Residual fuel oil (thousand barrels)	80 252	34 156 (42.56)	38 467 (47.93)	1 035 (3.03)	24 937 (73.00)	10 592 (31.01)	-	1 365 (4.00)	5 009 (14.67)	1 563 (4.58)
5. Coal and coke (thousand short tons)[e]	83 003	24 907 (30.00)	52 076 (62.74)	568 (2.28)	16 835 (67.59)	5 762 (23.13)	8 894 (35.71)	-	542 (2.18)	439 (1.76)

Source: Energy Information Administration, *Manufacturing Energy Consumption Survey: Fuel Switching, 1985* (Washington, D.C., Government Printing Office, 1988).

Notes: Numbers in parentheses in the original energy columns represent percentage shares of switchable and non-switchable energy, and those under alternative types of energy represent various alternative energies as a percentage of total switchable energy.

Totals may not equal sum of components because of rounding.

a/ Alternative types of energy consist of those that could have been substituted for the energy in question during 1985, expressed in the physical unit of the original energy.

b/ Estimates of total consumption include those quantitites that were ascertained switchable or not switchable, plus an additional quantity for which the switching status was not ascertained.

c/ "Other" includes all other types of energy that respondents indicated could have been consumed in place of the original energy.

d/ Withheld because relative standard error is greater than or equal to 50 per cent.

e/ 1 short ton = 0.907 tonne.

Table III.11. Substitution possibilities for purchased electricity in the United States manufacturing sector, 1985
(Million kilowatt-hours)

SIC a/ code	Industry	Purchased electricity			Alternative types of energy b/					
		Total purchased c/	Switchable	Not switchable	Purchased electricity	Natural gas	Distillate fuel oil	Coal and coke	LPG	Other d/
20	Food and kindred products	45 053	1 004	37 545	616	404	179	92	f/	f/
21	Tobacco manufactures	1 389	g/	1 301	f/	g/	-	-	-	-
22	Textile mill products	25 416	20	22 106	g/	f/	f/	g/	-	f/
23	Apparel and other textile products	4 026	f/	2 868	-	f/	-	-	-	-
24	Lumber and wood products	14 039	213	10 835	f/	f/	g/	-	f/	95
25	Furniture and fixtures	4 243	f/	3 297	f/	-	-	-	-	f/
26	Paper and allied products	53 302	1 824	44 196	1 291	710	983	255	f/	148
2621	Paper mills, except building paper	28 813	1 211	23 309	914	g/	575	115	-	148
2631	Paperboard mills	10 390	414	9 115	317	117	297	89	-	-
27	Printing and publishing	11 182	175	8 383	70	46	f/	-	f/	-
28	Chemicals and allied products	124 698	1 242	114 094	817	347	492	g/	67	g/
2819	Industrial inorganic chemicals	33 438	210	31 675	107	38	63	102	-	g/
2821	Plastics materials and resins	11 805	40	10 803	g/	8	14	-	-	-
2869	Industrial organic chemicals	19 927	146	19 046	94	3	g/	-	g/	g/
2873	Nitrogenous fertilizers	3 714	45	3 213	g/	g/	-	-	-	-
29	Petroleum and coal products	35 516	2 647	30 451	2 047	784	705	34	1 276	754
2911	Petroleum refining	33 912	2 625	29 231	2 032	762	690	g/	1 261	754

30	Rubber and miscellaneous plastics products	25 757	133	20 233	f/	25	f/	-	f/	f/
31	Leather and leather products	1 053	8	827	e/	-	-	f/	-	-
32	Stone, clay and glass products	30 700	165	25 563	f/	40	-	-	5	f/
3241	Cement, hydraulic	9 926	1	8 143	1	-	-	-	-	-
33	Primary metal industries	136 081	1 938	125 854	1 854	116	1 438	1	f/	e/
3312	Blast-furnaces and steel mills	37 711	1 783	34 280	1 738	e/	1 438	-	-	e/
3334	Primary aluminium	58 846	e/	58 548	e/	e/	-	-	-	-
34	Fabricated metal products	26 694	248	20 983	82	61	4	e/	f/	f/
35	Machinery, except electrical	28 942	332	21 507	39	47	105	-	f/	f/
36	Electric and electronic equipment	30 683	283	23 285	126	170	f/	1	f/	-
37	Transportation equipment	33 669	308	28 524	209	117	e/	e/	e/	-
38	Instruments and related products	7 732	65	6 439	f/	f/	58	e/	-	-
39	Miscellaneous manufacturing industries	3 188	f/	2 594	f/	f/	-	f/	-	-
	TOTAL	643 362	10 631	550 886	7 437	2 937	4 149	626	1 654	1 358

Source: Energy Information Administration, *Manufacturing Energy Consumption Survey: Fuel switching, 1985* (Washington, D.C., Government Printing Office, 1988), table 3.

a/ United States Standard Industrial Classification.

b/ Alternative types of energy consist of those that could have been substituted for purchased electricity during 1985. The quantities are expressed in millions of kilowatt-hours, and therefore represent the quantity of purchased electricity that could have been replaced by the given alternate type of energy.

c/ The estimates of total purchased electricity represent the quantities that were available for use on site during 1985. Estimates include those quantities that were ascertained switchable or not switchable, plus an additional quantity for which the switching status was not ascertained.

d/ "Other" includes all other types of energy that respondents indicated could have been consumed in place of purchased electricity.

e/ Witheld to avoid disclosing individual company data. Data are included in higher-level totals.

f/ Withheld because relative standard error is greater than or equal to 50 per cent. Data are included in higher-level totals.

g/ Estimate less than 0.5 rounded to zero.

Table III.12. Substitution possibilities for residual fuel oil in the United States manufacturing sector
(Thousand barrels)

SIC[a/] code	Industry	Residual fuel oil			Alternative types of energy [b/]					
		Total consumed[c/]	Switchable	Not switchable	Purchased electricity	Natural gas	Distillate fuel oil	Coal and coke	LPG	Other[d/]
20	Food and kindred products	6 290	2 883	2 694	g/	2 485	850	66	95	-
21	Tobacco manufactures	308	107	176	-	107	-	-	f/	f/
22	Textile mill products	2 858	1 125	1 176	f/	903	275	86	f/	f/
23	Apparel and other textile products	165	36	f/	-	f/	29	-	-	-
24	Lumber and wood products	g/	138	132	-	79	107	-	-	-
25	Furniture and fixtures	145	38	73	-	14	24	-	-	-
26	Paper and allied products	g/	7 000	15 684	219	4 377	2 565	423	150	366
2621	Paper mills, except building paper	12 567	3 694	7 710	g/	1 967	1 945	92	g/	298
2623	Paperboard mills	6 697	1 944	4 435	23	1 508	463	8	f/	-
27	Printing and publishing	g/	f/	48	-	f/	f/	-	f/	-
28	Chemicals and allied products	11 477	4 634	5 413	74	3 258	1 581	191	g/	64
2819	Industrial inorganic chemicals	1 220	523	543	36	306	166	129	-	-
2821	Plastics materials and and resins	1 059	323	472	-	279	90	-	g/	g/
2869	Industrial organic chemicals	g/	854	554	-	770	214	g/	-	g/
2873	Nitrogenous fertilizers	g/	g/	-	-	g/	g/	-	-	-
29	Petroleum and coal products	17 079	10 473	5 299	383	8 352	2 423	g/	4 438	945
2911	Petroleum refining	15 731	10 017	4 789	383	8 330	1 990	g/	4 438	945

30	Rubber and miscellaneous plastics products	1 729	905	556	-	543	488	e/	f/	-
31	Leather and leather products	378	33	220	-	31	e/	-	-	-
32	Stone, clay and glass products	1 491	1 199	86	-	704	707	104	e/	-
3241	Cement, hydraulic	e/	148	e/	-	103	44	e/	-	-
33	Primary metal industries	6 405	2 974	3 382	e/	2 380	374	e/	e/	e/
3312	Blast-furnaces and steel mills	5 458	2 776	2 682	e/	2 292	e/	e/	e/	e/
3334	Primary aluminum	e/	e/	-	-	e/	e/	-	-	-
34	Fabricated metal products	801	351	398	e/	270	96	e/	13	-
35	Machinery, except electrical	1 152	557	388	f/	334	365	e/	f/	-
36	Electric and electronic equipment	984	389	407	f/	256	159	e/	e/	-
37	Transportation equipment	2 630	771	1 530	89	543	223	e/	e/	e/
38	Instruments and related products	e/	422	633	-	212	251	-	-	-
39	Miscellaneous manufacturing industries	312	106	150	f/	68	62	-	-	-
	TOTAL	80 252	34 156	38 467	1 035	24 937	10 592	1 365	5 009	1 563

Source: Energy Information Administration, *Manufacturing Energy Consumption Survey: Fuel switching, 1985*, (Washington, D.C., Government Printing Office, 1988), table 6.

a United States Standard Industrial Classification.

b/ Alternative types of energy consist of those that could have been substituted for residual fuel oil during 1985. The quantities are expressed in thousands of barrels, and therefore represent the quantity of residual fuel oil that could have been replaced by the given alternate type of energy.

c/ Estimates of total consumption include those quantities that were ascertained switchable or not switchable, plus an additional quantity for which the switching status was not ascertained.

d/ "Other" includes all other types of energy that respondents indicated could have been consumed in place of residual fuel oil.

e Withheld to avoid disclosing data for individual companies. Data are included in higher level totals.

f Withheld because relative standard error is greater than or equal to 50 per cent. Data are included in higher level totals.

tion of residual fuel oil in 1985. A substantial portion of the consumed residual fuel oil could have been replaced, however, by alternative fuels, in particular natural gas and distillate fuel oils.

As noted earlier, any fuel substitution would be possible in the long run. But the length of time required for fuel switching is considered crucial in the short run, particularly in an emergency, when even 30 days could be a long time period. The 1985 survey of United States manufacturing energy consumption produced a surprising result in this respect: approximately one half of switchable fuels could have been replaced by alternative fuels within one day, and 75 to 84 per cent of them within one week. The short-run substitutability of fuels depends on the type of fuels involved. Natural gas and fuel oils usually require longer switching periods, while electricity and coal and coke need less time [8].

C. Decomposition analysis of change in manufacturing energy consumption in selected countries

Industry is a major consumer of energy, and its pattern of consumption has a great bearing on the energy balance and overall performance of an economy. It is becoming increasingly clear that the quantitative analysis of various factors affecting industrial energy consumption is essential not only for a better understanding of past industrial energy consumption, but also for forecasting industrial energy demand, and in particular for estimating energy requirements for alternative industrialization strategies in developing countries.

A decomposition method will be used to partition a change in manufacturing energy consumption into the following three main components: output growth; a change in energy intensity; and structural change (or a change in the composition of industry output), where disaggregate industrial data are available*. The impacts on manufacturing energy consumption of other important variables such as relative energy prices, conservation and energy-saving investment are subsumed under change in the energy intensity of industry (that is, energy consumption per unit of industrial output).

The decomposition quantifies the portion of a change in total consumption of manufacturing energy attributable to each different component, and is represented in figure III.9 in the form of charts with five bars for 26 selected countries and covering two periods, the 1970s and the 1980s. The first bar in figure III.9 represents the actual change in the consumption of total manufacturing energy in the respective periods, while the remaining four bars show the partition of this total change among the three components and an interaction term.

The first component affecting the consumption of manufacturing energy is output. Manufacturing energy consumption is directly affected by change in the level of manufacturing output, other things being equal. The growth of and shifts in consumption of manufactured goods by various sources of final demand, such as households, industry, Governments and foreign sources, determine the level of manufacturing output. The rise in manufacturing output is expected to increase the consumption of manufacturing energy, *ceteris paribus*. Ultimately, factors such as changing consumer tastes, demographic shifts, income growth, and expansion of international trade contribute to a change in the level and composition of manufacturing output.

The second component affecting variations in the consumption of manufacturing energy is a change in the energy intensity of different industries. Such a change at the individual industry level is caused by a multitude of factors, including industrial energy conservation, investment in energy-efficient equipment and machinery, optimal fuel mixes, the substitution of less energy-intensive materials for more energy-intensive inputs (for example, plastics versus steel), and managerial and operational improvements that affect energy input per unit of output as well as profits.

The third determining factor in manufacturing energy consumption identified in this study is structural change, narrowly defined as a change in the composition of industry output. Of particular interest is a shift in the distribution of energy-intensive industries and other industries. Structural change, as defined in this study, originates in a changing mix of consumer spending, other sources of final demand such as exports, and the use of non-energy inputs in the production process. Changes in inter-industry purchases or imports of non-energy inputs as a result of modifications in production technology are likely to affect energy requirements at the firm level because of energy embodied in such non-energy inputs.

Lastly, the analytical structure of the decomposition method used in this study gives rise to various interaction terms*. Interaction is the joint effect of the simultaneous movement of two or more variables, without such an effect being unambiguously attributable to any specific variable. Mathematically, interaction terms arise in the decomposition analysis when data are measured over a discrete time space instead of a continuous one. The three variables identified in this study generate the following four interaction terms: between output and energy efficiency; between output and structural change; between energy efficiency and structural change; and between all three variables. Only the net effect of all four interaction terms is represented in the bar charts. It is important not to confuse the interaction terms with a residual in regression analysis, which is an unexplained remainder. The interaction terms measure a real, quantifiable effect that is often conceptually difficult to analyse and not easy to explain. A case in point is the interaction between energy intensity and output growth. In the upswing phase of the business cycle, industrial output picks up fast, leading to increased industrial energy consumption. On the other hand, capital expenditure on plant and equipment is also likely to rise, which may in turn help to reduce industrial

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*For a mathematical derivation of the decomposition formulas and further details, see appendix I to this chapter and Se-Hark Park, "Decomposition of industrial energy consumption: an alternative method" (mimeograph).

*For a more complete and formal mathematical treatment of the analytical structure used in this study, see appendix I to this chapter.

energy intensity, since new equipment and machinery tend to be more energy-efficient and economical in the use of other inputs. The net effect of these opposite movements, which depend on the relative strength of each variable, is not clear. The same can be said of the interaction between structural change and energy intensity. When the economy shifts from smokestack industries toward the less energy-intensive production of technologically sophisticated goods such as electronic equipment, such structural change not only affects the composition of manufacturing output, but also reduces overall manufacturing energy intensity.

It would be impracticable to attempt a detailed country-by-country interpretation of the decomposition results obtained for the 28 countries covered in this analysis. This would require a separate, in-depth country study of the evolution of the manufacturing sector and its energy consumption for each country over nearly two decades. The case of one country is instead selected to illustrate the information that lies behind the decomposition results given in each graph, and how such information could help to explain the results of the decomposition analysis. The data for the Republic of Korea will be used for such an illustrative example, after which a cross-country comparative assessment of the decomposition results will be undertaken.

First of all, it is worth noting from tables III.13 and III.14 that total real MVA in the Republic of Korea increased 2.7 times to $44,925 million from $16,581 million between 1980 and 1988, while manufacturing energy consumption rose 1.7 times from 14.6 million tonnes of oil equivalent to 25.6 million tonnes of oil equivalent during the same period. As a result, manufacturing energy intensity dropped from 0.8816 to 0.5690 tonnes of oil equivalent per $1,000 of MVA between 1980 and 1988, a decline of approximately 35 per cent.

The average figure disguises, however, the relative strength of different factors affecting overall industrial energy consumption. The combined energy consumption of four energy-intensive industries (paper, chemicals, non-ferrous metals and iron and steel) accounted for approximately 67 per cent of total industrial energy consumption in 1973, and this share steadily increased to 80 per cent in 1980, followed by a slight decline to 76 per cent in 1988, while these four industries produced only 30 to 35 per cent of total MVA during the period considered (table III.13). On the other hand, the MVA share of the machinery industry increased from 13 per cent in 1973 to 37 per cent in 1988, while its share of energy consumption rose modestly from 3.5 to 6.3 per cent during the same period. At the same time, energy intensity across

Figure III.9. Decomposition of change in manufacturing energy consumption in selected periods and countries and areas

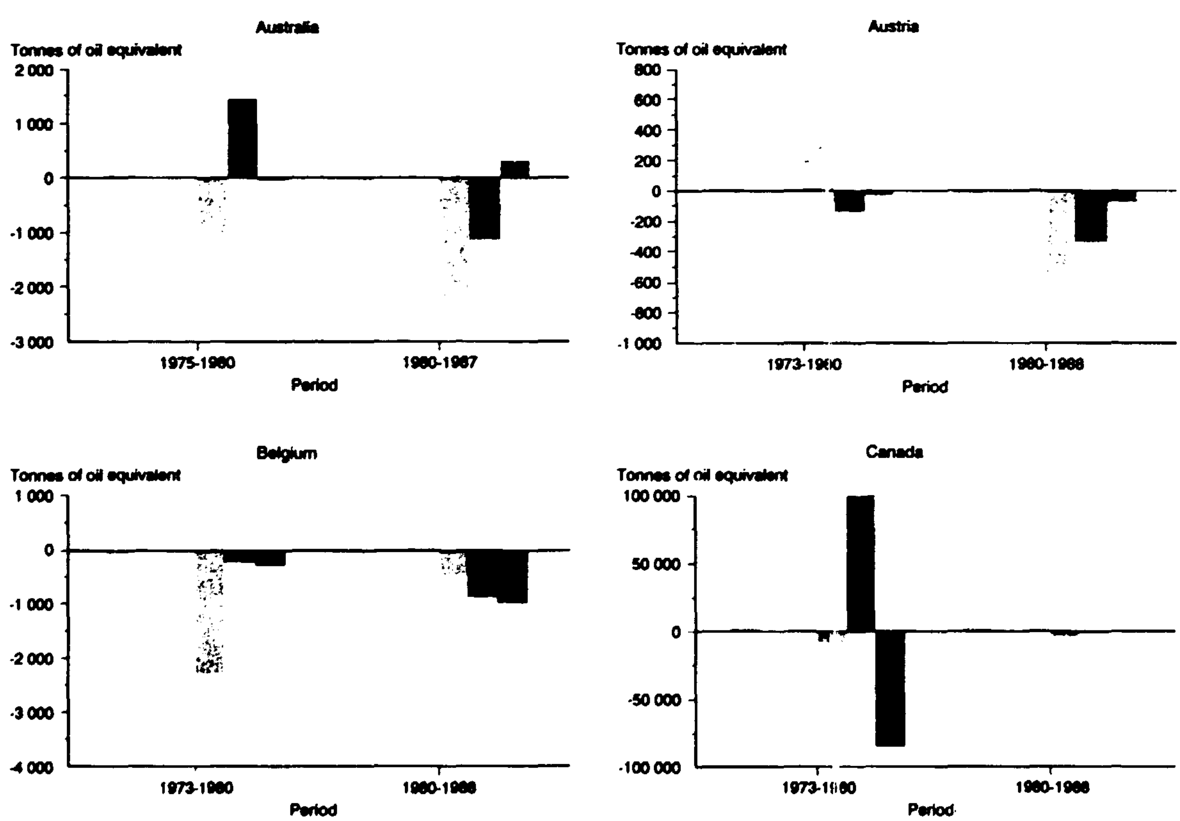
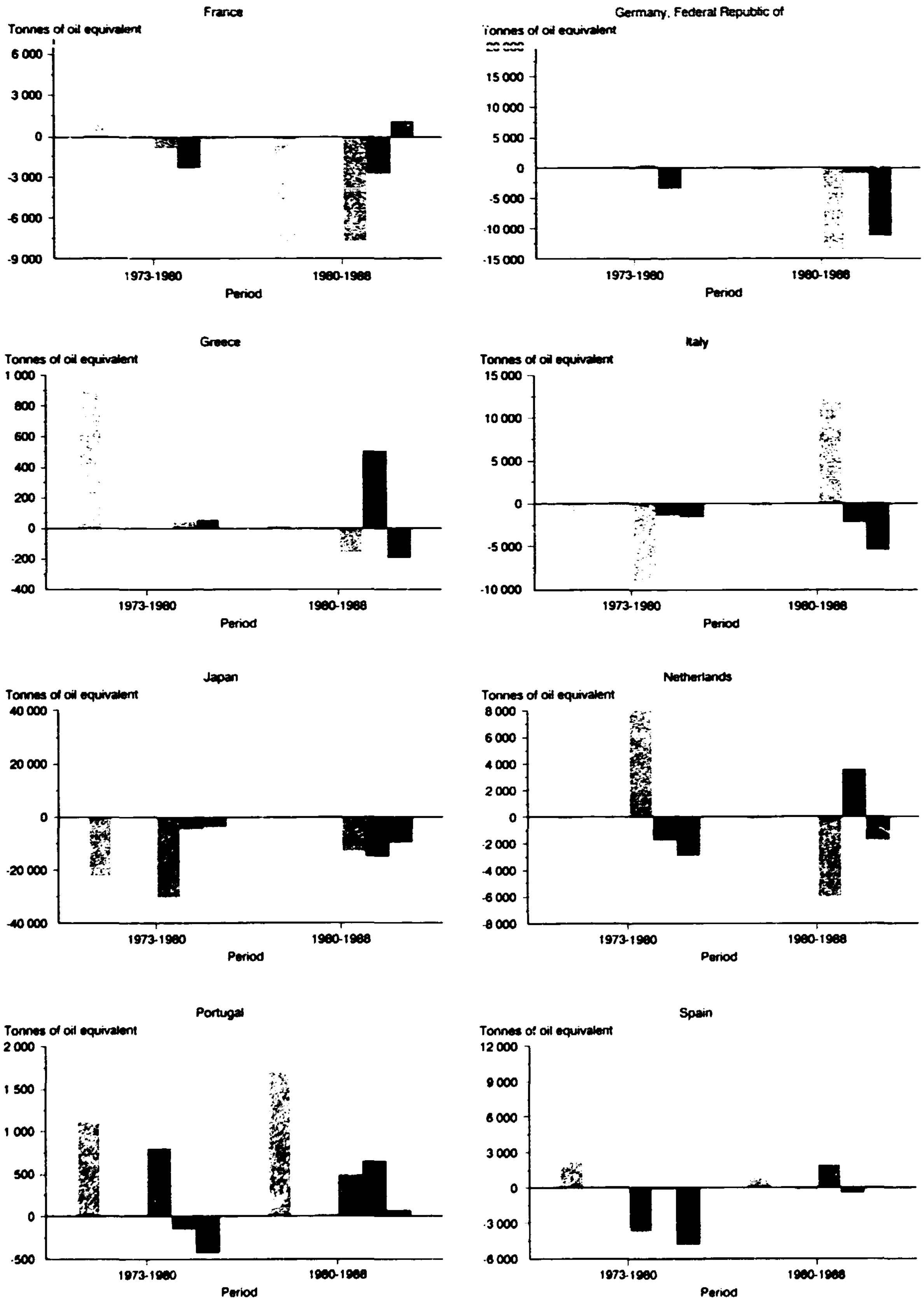
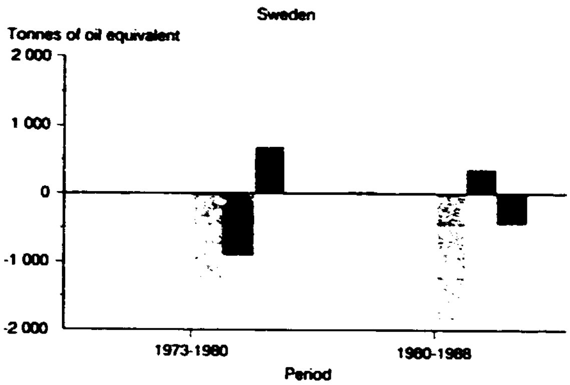


Figure III.9.

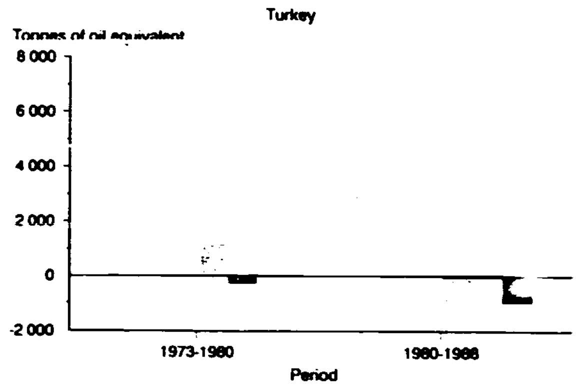


France
Tonnes of oil equivalent
6 000
3 000
0
-3 000
-6 000
-9 000
1973-1980
1980-1988
Period
Germany, Federal Republic of
Tonnes of oil equivalent
15 000
10 000
5 000
0
-5 000
-10 000
-15 000
1973-1980
1980-1988
Period
Greece
Tonnes of oil equivalent
1 000
800
600
400
200
0
-200
-400
1973-1980
1980-1988
Period
Italy
Tonnes of oil equivalent
15 000
10 000
5 000
0
-5 000
-10 000
1973-1980
1980-1988
Period
Japan
Tonnes of oil equivalent
40 000
20 000
0
-20 000
-40 000
1973-1980
1980-1988
Period
Netherlands
Tonnes of oil equivalent
8 000
6 000
4 000
2 000
0
-2 000
-4 000
-6 000
-8 000
1973-1980
1980-1988
Period
Portugal
Tonnes of oil equivalent
2 000
1 500
1 000
500
0
-500
1973-1980
1980-1988
Period
Spain
Tonnes of oil equivalent
12 000
9 000
6 000
3 000
0
-3 000
-6 000
1973-1980
1980-1988
Period

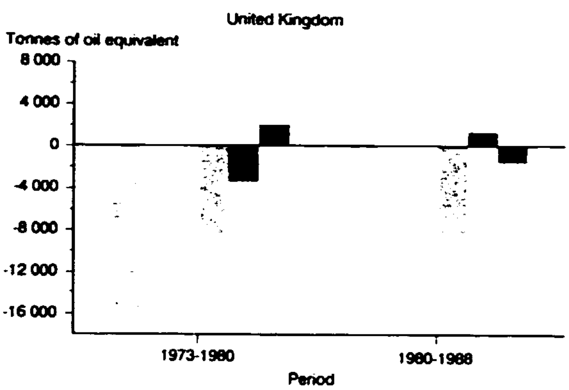
(continued)



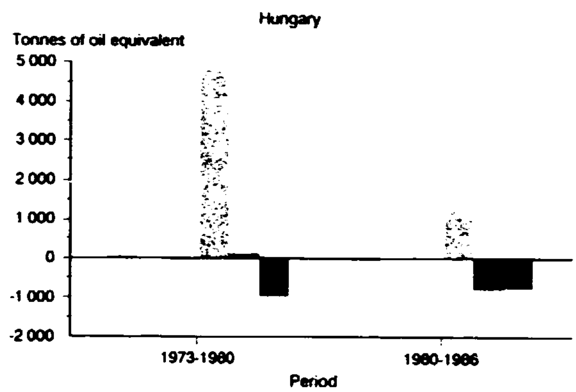
Sweden
Tonnes of oil equivalent
2 000
1 000
0
-1 000
-2 000
1973-1980
1980-1988
Period



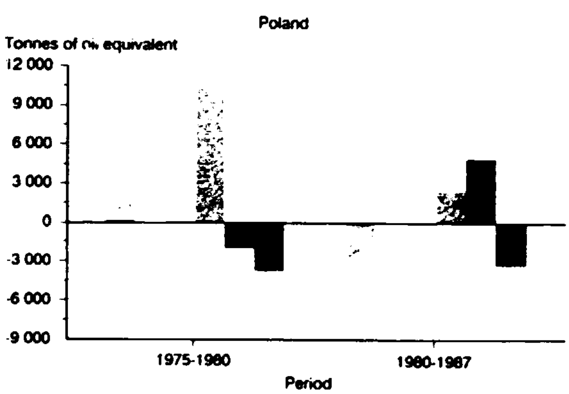
Turkey
8 000
6 000
4 000
2 000
0
-2 000
1973-1980
1980-1988
Period



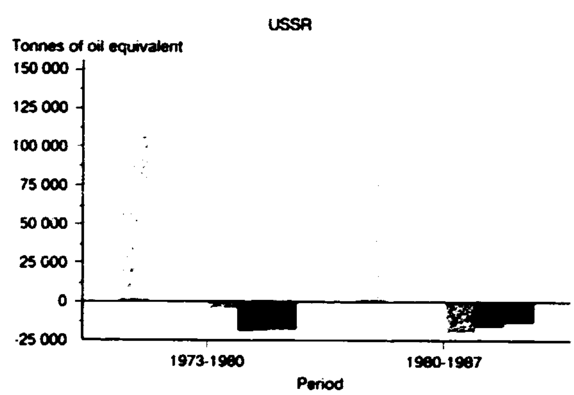
United Kingdom
Tonnes of oil equivalent
8 000
4 000
0
-4 000
-8 000
-12 000
-16 000
1973-1980
1980-1988
Period



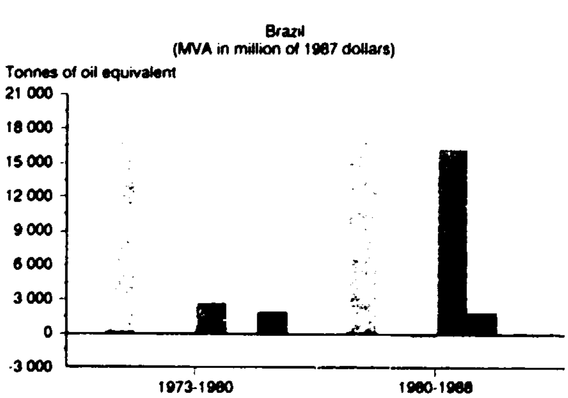
Hungary
Tonnes of oil equivalent
5 000
4 000
3 000
2 000
1 000
0
-1 000
-2 000
1973-1980
1980-1986
Period



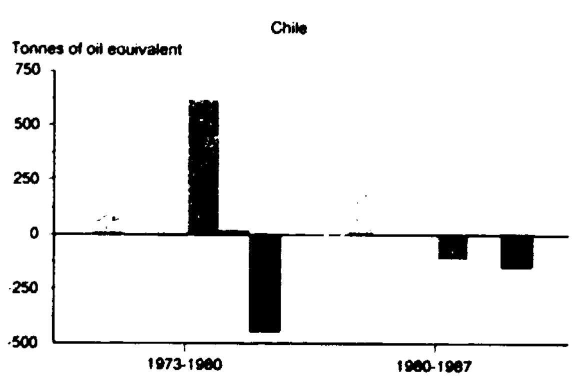
Poland
12 000
9 000
6 000
3 000
0
-3 000
-6 000
-9 000
1975-1980
1980-1987
Period



USSR
Tonnes of oil equivalent
150 000
125 000
100 000
75 000
50 000
25 000
0
-25 000
1973-1980
1980-1987
Period

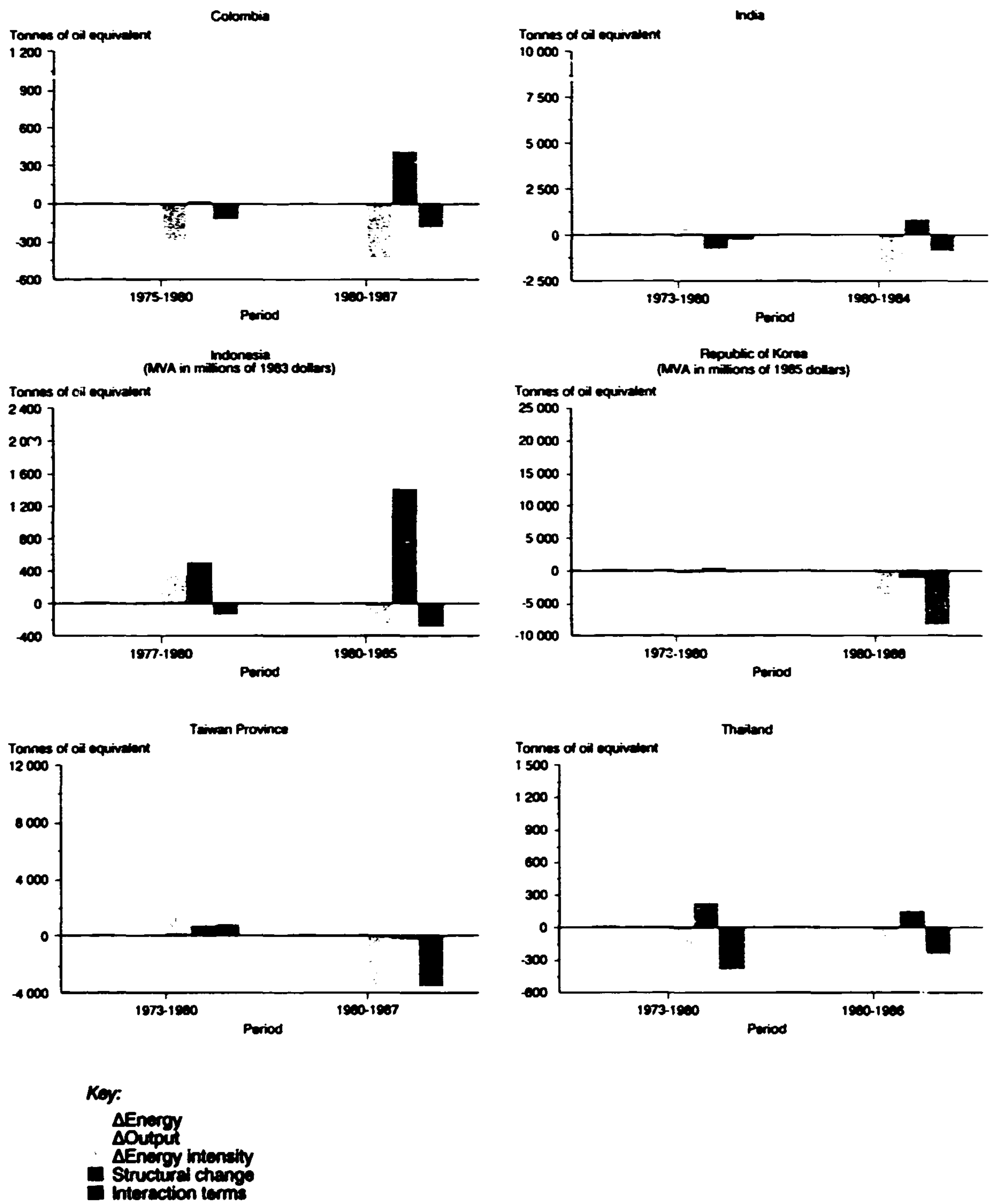


Brazil
(MVA in million of 1987 dollars)
Tonnes of oil equivalent
21 000
18 000
15 000
12 000
9 000
6 000
3 000
0
-3 000
1973-1980
1980-1988
Period



Chile
750
500
250
0
-250
-500
1973-1980
1980-1987
Period

Figure III.9. *(continued)*



Source: International Energy Agency, *World Statistics and Balances 1971-1987*, and *World Energy Statistics and Balances 1985-1988* (Paris, Organisation for Economic Co-operation and Development, 1989 and 1990). International Energy Agency *Energy Balances of OECD Countries 1987-1988* (Paris, Organisation for Economic Co-operation and Development, 1990); Ministerio das Minas e Energia, *Balanço Energético Nacional 1989* (Brasilia, 1990); for data on Indonesia, Economic and Social Commission for Asia and the Pacific, "Sectoral energy demand in Indonesia" (RAS/86/136), and annual statistical reports of the Bank of Korea for MVA data on the Republic of Korea, and the Korean Institute of Energy Economics for manufacturing energy consumption, and UNIDO database.

Note: MVA in millions of 1985 dollars.

Table III.13. Manufacturing energy consumption and MVA in the Republic of Korea in selected years

Industry	1973	1980	1988	1973	1980	1988
	A. Energy consumption (thousand tonnes of oil equivalent)			B. MVA (millions of 1985 dollars)		
Iron and steel	766 (12.2)	4 017 (27.5)	8 084 (31.6)	239 (3.5)	1 138 (6.9)	2 808 (6.3)
Chemicals	2 139 (34.2)	4 723 (32.3)	6 801 (26.6)	1 470 (21.8)	3 679 (22.2)	8 740 (19.5)
Non-ferrous metals	992 (15.8)	2 354 (16.1)	3 610 (14.1)	371 (5.5)	806 (4.9)	1 997 (4.4)
Machinery	218 (3.5)	587 (4.0)	1 619 (6.3)	866 (12.8)	3 264 (19.7)	16 448 (36.6)
Food and tobacco	653 (10.4)	886 (6.1)	1 164 (4.6)	1 848 (27.4)	3 562 (21.5)	6 408 (14.3)
Paper and pulp	304 (4.9)	494 (3.4)	952 (3.7)	267 (4.0)	605 (3.6)	1 770 (3.9)
Woods	205 (3.3)	153 (1.0)	82 (0.3)	133 (2.0)	216 (1.3)	481 (1.1)
Textiles and leather	938 (15.0)	1 326 (9.1)	2 192 (8.6)	1 422 (21.0)	3 013 (18.2)	5 264 (11.7)
Others	44 (0.7)	78 (0.5)	1 062 (4.2)	141 (2.1)	298 (1.8)	1 009 (2.2)
TOTAL	6 259(100.0)	14 618(100.0)	25 564(100.0)	6 756(100.0)	16 581(100.0)	44 925(100.0)
	C. Energy intensity (tonnes of oil equivalent per $1,000)			D. MVA share (percentage)		
Iron and steel	3.2059	3.5297	2.8790	3.54	6.86	6.25
Chemicals	1.4551	1.2838	0.7781	21.76	22.19	19.45
Non-ferrous metals	2.6733	2.9203	1.8075	5.49	4.86	4.45
Machinery	0.2518	0.1799	0.0984	12.82	19.69	36.61
Food and tobacco	0.3534	0.2487	0.1816	27.35	21.48	14.26
Paper and pulp	1.1393	0.8165	0.5377	3.95	3.65	3.94
Woods	1.5429	0.7102	0.1694	1.97	1.30	1.07
Textiles and leather	0.6594	0.4401	0.4164	21.05	18.17	11.72
Others	0.3121	0.2604	1.0526	2.09	1.80	2.25
TOTAL	0.9265	0.8816	0.5690	100.00	100.00	100.00

Sources: Annual statistical reports of the Bank of Korea, for MVA data, and Korean Institute of Energy Economics for manufacturing energy consumption.

Note: Figures in parentheses indicate percentage of total.

Table III.14. Decomposition of change in energy consumption in the Republic of Korea in selected periods[a]

Item	Decomposition of change 1973-1980 (thousand tonnes of oil equivalent)	Decomposition of change 1980-1988 (thousand tonnes of oil equivalent)	Percentage share 1973-1980	Percentage share 1980-1988
Output	9 102.5	24 987.9	108.9	228.3
Energy intensity	-854.6	-4 123.7	-10.2	-37.7
Structural change	398.3	-1 374.1	4.8	-12.6
Output and energy intensity	-1 242.8	-7 049.2	14.9	-64.4
Output and structural change	579.3	-2 349.0	6.9	-21.5
Energy intensity and structural change	153.1	315.4	1.8	2.9
All three variables	222.7	539.1	2.7	4.9
TOTAL	8 358.5	10 946.3	100.0	100.0
Sum of interaction terms	- 287.74	-8 543.72	-3.4	-78.1

[a] Based on data presented in table III.13.

industries sharply declined between 1970 and 1988. Rapid output growth, a sharp decline in energy intensity, and remarkable structural change at individual industry levels all contributed to the change in manufacturing energy consumption during the period 1970-1988, and the decomposition analysis in table III.14 reveals the relative importance of these three factors. The dominant factor is shown to be output. For instance, the near trebling of real manufacturing output between 1980 and 1988 alone would have more than doubled total manufacturing energy consumption, had the energy intensity and composition of output in individual industries remained the same as those prevailing in 1980. Output was likewise the strongest factor during the period 1973-1980. Such a result is not surprising, given the remarkable industrial growth that took place during the periods considered.

The energy intensity for all individual industries has declined considerably, and the decomposition analysis strongly reflects such a decline. Total industrial energy consumption would have been decreased by approximately 38 per cent between 1980 and 1988 as a result of the decline in energy intensity alone, had the composition and level of industrial output been frozen at 1980 levels.

By contrast, despite remarkable structural change during the period 1973-1988, the overall structural effect turned out to be relatively weak, with a 5 per cent increase in energy consumption from 1973 to 1980, and a decline of approximately 13 per cent from 1980 to 1988. The structural effect might be better explained by examining its interaction with energy intensity. On the one hand, the energy-intensive industries (paper, chemicals, non-ferrous metals and iron and steel) together maintained about the same share of rapidly growing total output, while the share of less energy-intensive light industries (food, textiles and wood) declined during the periods concerned, thus exerting upward pressure on total manufacturing energy consumption. On the other hand, because of its low energy intensity, the rapidly growing machinery industry, with its MVA share rising from 13 per cent in 1973 to 37 per cent in 1988, at an average annual growth rate of over 20 per cent, tended to pull down overall manufacturing energy intensity. The energy effects of the simultaneous expansion of both energy-intensive basic industries and the low-energy-intensive machine industry may therefore have cancelled each other out, resulting in a smaller net increase of 2.7 per cent and 4.9 per cent in total manufacturing energy consumption during the two periods considered.

The decomposition results vary widely from country to country, reflecting the different historical strategies of industrialization, structural transformation and energy use that each country has adopted in the last two decades. Nevertheless, some common patterns of change for different groups of countries could be discerned from the seemingly heterogeneous country pictures.

In the developing countries covered in this study, output growth is clearly shown to be the most powerful factor affecting manufacturing energy consumption (see figure III.9). The output effect is several times greater than other effects in most cases, with minor exceptions, including those of Brazil (1980-1988) and Chile (1973-1980). The dominance of the output effect is consistent with the rapid growth of MVA during the 1970s and 1980s in the developing countries considered, with annual growth rates ranging from 4 to 14 per cent except in Brazil, which suffered industrial stagnation during the 1980s (see table III.15).

Improvements in energy intensity, however, appear to have offset part of an increase in energy consumption induced by output growth in most of the developing countries, at least during the 1980s. One exception is Brazil, where the rise in energy intensity continued to accelerate throughout the periods concerned, adding further energy requirements to those induced by output growth. On the other hand, most of the developing countries and areas covered seem to be moving towards a more energy-intensive phase of structural change, which would increase manufacturing energy consumption. Two exceptions are the Republic of Korea and Taiwan Province, where the structural effect changed from positive to negative between the two periods. The increase in energy consumption due to structural change could be partly explained by comparing the relative MVA growth rates of the energy-intensive industry group and the other industry group as presented in table III.15. In most cases, MVA in the energy-intensive group grew faster than that in the other industry group. The case of the Republic of Korea is particularly interesting. In 1973-1980, output in the energy-intensive group increased slightly faster than that in the other industry group (15 per cent versus 13 per cent), and the structural effect was positive, accounting for approximately 5 per cent of the change in total manufacturing consumption during this period. However, during the period 1980-1988, MVA in the other industry group grew faster than that in the energy-intensive group (12 per cent versus 14 per cent), mainly owing to the rapid growth of the machinery industry, and the structural effect was negative, offsetting some of the increase in total manufacturing energy consumption induced by the growth factor.

The following conclusions can be drawn from the decomposition results for the developing countries. In most of those countries, manufacturing energy consumption is likely to continue to soar in the 1990s The main driving force for an upsurge in manufacturing energy consumption is the anticipated rapid growth in manufacturing output, coupled with structural change oriented toward the more energy-intensive phase of industrialization. Notable improvements in manufacturing energy intensity, particularly in the 1980s, may somewhat mitigate the effects of rapidly rising energy requirements, but may not be sufficient to curb their increase. A few NICs, such as the Republic of Korea and Taiwan Province, could be regarded as exceptions to the rule. But they are entering a more mature phase of industrialization, with an increasing share of skill- and technology-intensive output, and are thus beginning to resemble developed countries in many respects.

The decomposition results in OECD countries varied widely from country to country and over time. Unlike in developing countries, the clear dominance of the output growth effect is not evident. In many OECD countries, the positive effect of output growth on manufacturing energy consumption is substantial, but the effect of declining energy intensity counter-

Table III.15. Average annual growth rates of MVA and energy intensity by industry groups in selected periods and countries and areas

Country or area	Period	MVA share (percentage)			Energy intensity (tonnes of oil equivalent per $1,000 of MVA)		
		Energy-intensive industry group	Other industry group	Total	Energy-intensive industry group	Other industry group	Total
OECD							
Australia	1975-1980	2.07	0.21	0.88	-0.78	0.61	0.29
	1980-1987	1.49	0.73	1.02	-3.51	0.28	-2.38
Austria	1973-1980	1.19	1.06	1.10	0.62	-1.05	0.38
	1980-1988	1.05	1.19	1.15	-2.30	-1.98	-2.32
Belgium	1973-1980	-0.42	-0.28	-0.33	-1.87	-4.95	-2.48
	1980-1988	1.12	0.20	0.53	-2.98	-0.04	-2.07
Canada	1973-1980	3.66	2.23	2.75	2.36	-2.73	0.43
	1980-1988	3.21	2.73	2.92	-1.45	-2.74	-1.80
France	1973-1980	1.35	1.82	1.67	-1.68	1.14	-0.95
	1980-1988	1.03	-0.17	0.21	-1.68	-5.78	-2.48
Germany, Federal Republic of	1973-1980	-0.24	0.95	0.57	0.21	-1.12	-0.64
	1980-1988	3.46	2.73	2.95	-4.29	-5.27	-4.18
Greece							
	1973-1980	2.84	3.65	3.40	0.77	0.37	0.34
	1980-1988	-0.19	-0.36	-0.31	0.40	1.95	0.40
Italy	1973-1980	1.73	3.13	2.59	-3.00	-3.05	-3.52
	1980-1988	-2.26	-1.85	-2.00	1.55	1.69	1.42
Japan	1973-1980	1.68	1.50	1.56	-4.52	-2.00	-3.89
	1980-1988	2.82	3.86	3.49	-3.90	-0.87	-3.45
Portugal	1973-1980	3.87	4.82	4.51	1.93	-0.43	0.83
	1980-1988	3.49	0.61	1.60	2.75	0.52	3.21
Spain	1973-1980	3.65	8.28	6.51	-1.34	-8.68	-4.61
	1980-1988	0.27	-0.53	-0.25	0.18	1.01	0.71
Sweden	1973-1980	0.09	-0.14	-0.06	2.07	-9.68	-1.62
	1980-1988	2.75	1.28	1.81	-2.72	-0.75	-1.70
Turkey	1973-1980	9.06	4.89	6.27	2.01	1.04	1.72
	1980-1988	8.96	7.93	8.31	0.42	-5.59	-2.39
United Kingdom	1973-1980	-1.55	-1.61	-1.59	-3.87	-1.21	-2.91
	1980-1988	3.18	1.04	1.80	-2.89	-2.61	-2.22
Eastern Europe							
Hungary	1973-1980	-2.65	-3.69	-3.46	8.28	5.12	6.91
	1980-1986	-3.36	1.16	0.18	2.10	-1.03	-0.79
Poland	1975-1980	-0.46	1.05	0.68	3.16	3.48	2.48
	1980-1987	-2.88	-3.29	-3.19	1.66	1.47	1.83
USSR	1973-1980	4.21	5.82	5.43	-0.85	-0.19	-1.35
	1980-1987	3.04	4.04	3.81	-0.66	-1.56	-1.38
Yugoslavia	1982-1987	3.19	5.90	5.12	-1.52	-6.95	-4.39

Table III.15. (continued)

Country or area	Period	MVA share			Energy intensity		
		Energy-intensive industry group	Other industry group	Total	Energy-intensive industry group	Other industry group	Total
		(percentage)			(tonnes of oil equivalent per $1,000 of MVA)		
Developing							
Brazil[a]	1973-1980	7.65	6.57	6.87	2.35	-0.78	1.38
	1980-1988	0.45	-0.45	-0.21	4.55	1.93	3.99
Chile	1973-1980	3.05	-3.04	-0.45	-1.31	3.11	1.39
	1980-1987	5.30	1.23	3.32	-5.18	2.27	-1.73
Colombia	1975-1980	5.18	6.02	5.75	0.46	-8.29	-2.44
	1980-1987	6.92	2.64	4.09	-4.21	3.05	-0.75
India	1973-1980	4.03	4.18	4.12	1.66	-2.27	-0.01
	1980-1984	6.95	5.78	6.24	-1.82	-1.12	-1.31
Indonesia[b]	1977-1980	7.73	6.33	6.63	6.67	4.02	5.90
	1980-1985	13.78	2.14	5.15	-0.95	-1.38	2.73
Republic of Korea[c]	1973-1980	14.96	12.97	13.68	0.55	-6.45	-0.70
	1980-1988	11.90	14.04	13.27	-4.66	-4.26	-5.30
Taiwan Province	1973-1980	6.86	5.65	6.04	5.26	0.00	4.30
	1980-1987	10.46	9.71	9.97	-6.55	-5.12	-5.90
Thailand	1973-1980	10.69	6.64	8.09	-6.80	-1.18	-3.51
	1980-1986	3.73	4.02	3.91	-3.51	-0.16	-1.68

Sources: International Energy Agency, *World Energy Statistics and Balances 1971-1987* (Paris, Organisation for Economic Co-operation and Development, 1989) and *Energy Balances of OECD Countries, 1987-1988* (Paris, Organisation for Economic Co-operation and Development, 1990); UNIDO database; for Brazil, Ministerio das Minas e Energia, *Balanço Energético Nacional 1989* (Brasilia, 1990); for Indonesia, Economic and Social Commission for Asia and the Pacific, "Sectoral energy demand in Indonesia" (RAS/86/136); for MVA data on the Republic of Korea, annual statistical reports of the Bank of Korea, and the Korean Institute of Energy Economics for manufacturing energy consumption.

Notes: Energy intensive industry group: iron and steel (ISIC 371); chemicals (ISIC 352, 355, 356 and parts of ISIC 351 and 354); non-ferrous metals (ISIC 372); non-metallic minerals (ISIC 36); and pulp, paper and printing (ISIC 34).

Other industry group: food, beverages and tobacco (ISIC 31); wood and wood products (ISIC 33); machinery other than transport equipment (ISIC 38, excluding ISIC 384); transport equipment (384); textiles and leather (ISIC 32); and other unspecified industries.

MVA in millions of 1985 dollars.

a/ MVA in millions of 1987 dollars.

b/ MVA in millions of 1983 dollars.

c/ MVA in millions of 1985 dollars.

acted a major part or more than the entire amount of the growth-induced increase in energy consumption, particularly in the 1980s. This is true of a number of countries with different industrial structures, such as Australia, Austria, Belgium, France, Greece, Sweden and United Kingdom. It is also noteworthy that the output effect dominated the other two effects, particularly in the second period, in a number of countries such as Canada, Germany, Federal Republic of, Japan and Turkey. There are other cases, namely Austria (1973-1980), Germany, Federal Republic of, (1973-1980), and Portugal, where both the growth effect and the energy-intensity effect reinforced each other in increasing energy consumption.

Similarly, the structural effect differed widely from country to country and does not permit easy generalization. In most cases, its impact tends to be somewhat smaller than the energy-intensity effect, and points to movement from an energy-intensive to a less-energy-intensive structure between the two periods considered. Exceptions are Greece, Portugal, Sweden and United Kingdom.

The widely varying country results suggest that no single element can be uniformly singled out as a dominant factor affecting manufacturing energy consumption in OECD countries. It seems, however, that energy intensity and structural change exert a more pronounced impact on manufacturing energy consumption in developed countries than in developing countries. Structural change has opposing effects in the two groups of countries. It is generally an augmenting factor in manufacturing energy consumption in developing countries, and a dampening factor in developed countries.

A sample of four countries in Eastern Europe and the USSR may be too small to generalize the patterns of change in manufacturing energy consumption in this region. Nevertheless, their results may shed some light on the nature of the relationship between industrial output and energy consumption in centrally planned economies. An increase in energy intensity was a dominant factor affecting variations in manufacturing energy consumption in Hungary in both periods and in Poland in the 1970s. On the other hand, the output effect dominated over the other two factors in the USSR and Yugoslavia. The dominance of the output effect in the USSR and Yugoslavia reflects relatively rapid annual MVA growth rates of between 3 and 5 per cent in those countries during the periods covered, while MVA growth rates in Hungary and Poland were negative. The effect of structural change was mixed and generally not significant in the countries concerned, with the exception, in certain periods, of Hungary (1980-1986) and Poland (1980-1987). In short, the energy-intensitive structure of the manufacturing sector and fluctuations in output appear to a large extent to explain the variations in manufacturing energy consumption in Eastern Europe and the USSR.

D. Conclusions and policy implications

All the empirical evidence presented in this study point clearly to the emergence of two divergent energy patterns along the global dividing line between North and South over the last two decades. A fundamental change described as the delinking of energy and growth has swept across developed countries since the first oil crisis of 1973, while the traditional positive link between energy consumption and industrial growth has been maintained and strengthened in developing countries during the period in question. The same holds true for the broader relationship between GNP and total energy consumption of the economy as a whole, although this study has focused solely on the manufacturing sector.

Various factors have contributed to the emergence of the phenomenon of delinking of energy and output in developed countries. As shown in this study, markedly improved energy efficiency through a substantial reduction in manufacturing energy conservation and rationalization policies has been a significant factor. Another important factor responsible for the delinking of output and energy was an extensive restructuring of the manufacturing sector in developed countries in the early 1980s. Such restructuring has resulted in a clear shift toward the rapid expansion of less energy-intensive high-technology industries along with the growth of services industries at the expense of energy-intensive smokestack industries. Despite considerable cross-country variations, decomposition analysis generally tends to confirm both improved energy efficiency and structural change as important factors contributing to the decoupling of energy and industrial output in developed countries.

In this regard, however, most industrial energy efficiency and conservation measures in developed countries have been taken in response to sharp oil price rises in 1973 and 1979. In recent years, between the collapse of oil prices in 1985 and the outbreak of the Gulf war in 1991, there has been much speculation on the impact of falling energy prices on manufacturing consumption and energy intensity. Evidence showing the relationship between energy and output in the face of falling energy prices has remained limited. However, a recent survey of United States manufacturing energy consumption has shown that whereas increased output was realized with decreased energy consumption between 1980 and 1985, thus demonstrating a clear decoupling of energy and output, rapid output growth was apparently associated with a modest increase in energy consumption between 1985 and 1988. In fact, manufacturing output grew three times faster than manufacturing energy consumption during the period 1985-1988, thus continuing to reduce overall manufacturing energy intensity. Recent United States experience may have underscored the importance of technology-induced energy efficiency in manufacturing energy consumption. One of the reasons for the continued decline in manufacturing energy intensity despite falling energy prices has been that low energy prices might be conducive to economic growth, which in turn would stimulate capital investment in various industries. New equipment and machinery would probably embody technological improvements in the form of more efficient use of raw materials including energy. Moreover, the extensive industrial restructuring that has taken place in developed countries since the 1982 global recession has led some manufacturing industries, particularly smokestack industries, to phase out their old plants permanently. As a result, in some cases there no longer exists old capacity to reactivate in a period of expansion. Recent United States experience in this respect is likely to be replicated in most developed countries.

In developing countries, there has been some evidence that energy efficiency for certain activities has improved, with a reduction in energy intensity. But this efficiency improvement has not been sufficient to dampen soaring manufacturing consumption fuelled by two development forces at play, namely rapid growth and structural change. The findings of this study have identified rapid growth in manufacturing output as the dominant factor affecting manufacturing energy consumption in developing countries. The stimulating effect of industrial growth on energy consumption has been reinforced by structural transformation in the manufacturing sector toward more energy-intensive production and processing of industrial raw materials. Energy-intensive industrialization is a concomitant phase of the development process, entailing urbanization, electrification and the building of other basic infrastructure, all of which serve to raise energy intensity in all sectors of the economy.

Given the two basic forces of industrial growth and structural change, income elasticity of energy consumption in developing countries is expected to be high, and price elasticity low. In other words, energy consumption in developing countries is likely to increase disproportionately greater than output growth, and to remain relatively insensitive to changes in energy prices. As a result, manufacturing energy consumption will probably continue to increase, with prospects for delinking growth and energy in developing countries remaining remote for some time to come.

Delinking of growth and energy on the demand side seems to be a slow process. However, there is wide scope for counteracting rising energy consumption through industrial energy conservation and overall energy efficiency improvements in developing countries. The literature on industrial energy conservation in developing counties is abundant, and most country studies indicate large potential for energy savings through conservation and efficiency improvements*. Furthermore, many projects have payback periods of less than one year with very small investment requirements or no investment costs at all. Simple housekeeping improvements could yield energy savings of 35 million to 65 million tonnes of oil equivalent per year, and more costly measures such as retrofitting and process changes could save an additional 60 million to 110 million tonnes of oil equivalent per year in developing countries ([3], pp. 17-18). In this regard, it is important to draw policy implications from one of the main findings of this study, namely that most energy is consumed by a small number of industrial materials-processing industries, notably iron and steel, non-ferrous metals, non-metallic minerals, chemicals, and paper and pulp. Resources should therefore be concentrated on industrial conservation efforts and efficiency improvement measures in this small group of energy-intensive industries, and not spread thinly over the entire manufacturing sector.

In designing an energy conservation strategy, it is important to recognize that the goals of industrial energy conservation go beyond conserving scarce resources to encompassing a broader range of activities such as the following: improving the technical efficiency of energy conversion and use; finding optimal fuel mixes, including substitution of cheaper fuels for more expensive ones; and mitigating or even reversing the negative impact of energy production and consumption on the environment.

There are virtually unlimited opportunities for industrial energy conservation in developing countries, but examples of successful projects in developing countries are usually found in the following general areas: installing variable-speed devices and ensuring the appropriate motor capacity to control the speed of rotating process equipment such as pumps, fans, refiners and agitators; enhancing heat recovery from and recycling of both liquids and gases; establishing computer-aided control systems to regulate temperature, flow speed and timing of energy consumption; and cogeneration to produce both heat and power.

Despite success in the implementation of some industrial energy conservation projects, only a fraction of the huge potential for industrial energy conservation has been tapped in developing countries. Most of the energy conservation projects undertaken have short payback periods of less than one year and very small investment requirements [9]. The reasons for the very low rate of implementation of technically proven, cost-effective projects are numerous, involving technical, economic, financial and institutional factors, as well as policy barriers that affect the willingness and ability of enterprises to invest in energy conservation. For instance, the size, competitive structure and export-orientation of the industry in question have some bearing on the scope for project implementation. Generally, large export-oriented companies with high energy costs are likely to make major investments in energy conservation to improve their competitiveness in the world market. Rational energy pricing is also considered one of the most effective policy tools for encouraging energy conservation. Equally important are financial and fiscal instruments such as tax incentives and duty exemption, which effectively reduce the capital cost of a project. There are many other important issues related to the implementation of industrial energy conservation projects and requiring more careful and systematic analysis. These will be the subject of separate studies in the future.

Various measures to improve industrial energy efficiency and enhance industrial energy conservation could alleviate the soaring industrial energy demand of developing countries in the short and medium terms. But significant contributions to the delinking of energy and output may come through accelerated investment in machinery and equipment embodying efficient technology that reduces not only industrial energy consumption but also the use of other industrial raw materials with high energy contents. The importance of technological factors in improving industrial energy efficiency in developed countries has been amply demonstrated in this study. A high rate of investment speeds up technological change, since adding new capital to the existing stock or replacing the old stock increases the proportion of output produced with energy-efficient technologies. As a result, industrial development in developing countries could be accelerated with much smaller energy requirements than developed countries experienced at similar stages of industrialization. A conscious policy of promoting the adoption and diffusion of the best available technologies in developing countries would be essential for achieving the goal of delinking energy and output in the long run.

Another contentious area of industrial energy consumption concerns environmental implications. It must be noted at the outset that the causality of the relationship between energy and environment runs both ways, posing a trade-off problem. For instance, policies and regulations designed to reduce pollution and preserve a clean environment may run counter to energy policies and programmes aimed at securing energy supplies at the lowest possible cost. The

*For instance, see "Seminar on Energy Conservation in Developing Countries" (TCD/SEM.90/3; INT/89/R31), final report of the Seminar organized by the United Nations Department of Technical Cooperation for Development in cooperation with the Government of Sweden, held at Stockholm from 3 to 9 September 1989, and a series of joint World Bank and United Nations Development Programme country reports under their Bilateral Aid Energy Sector Management Assistance Programme.

production and consumption of various forms of energy will have certain adverse effects on the environment. The difficulty of a trade-off between energy security and protection of the environment thus arises because energy scarcity could lead to inflation, the disruption of production, a shortage of foreign exchange, an increasing debt burden and other problems, while a deterioration of the environment could adversely affect the quality of life and pose dangers to health and life-support systems.

Environmental problems such as acid rain, the greenhouse effect, thermal pollution and the general degradation of the quality of air, water and land are caused not only by the direct energy consumption of various manufacturing industries but also by the activities of the energy-supplying industries. The indirect environmental effects of increased industrial energy consumption requiring increased production in the energy industry are more serious than the direct effects of industrial energy consumption*. In this regard, the environmental implications of the entire fuel cycle in the energy sector must be considered, including production, refining and processing, transformation and conversion, transport and distribution to end-users, and disposal.

Of particular interest for the rational use of industrial energy is the potential conflict between environmental considerations and industrial energy needs that may arise from fuel substitutions in the manufacturing process. Fuel substitution or switching is largely caused by changing relative prices of various forms of energy. It has been shown in this study that the share of oil in total final manufacturing consumption has declined considerably in most countries, both developed and developing, in response to the oil price rises of 1973 and 1979. In many countries, a sharp cutback in industrial oil consumption was compensated for by a substantial increase in the use of both gas and coal, while industrial electricity consumption has risen steadily over the last two decades.

Different industrial fuel substitutions could give rise to different environmental impacts. Among the environmental problems of substitution, that posed by the increasing dependence on coal worldwide as an alternative source of energy for industrialization is of particular concern. Given the large known reserves worldwide, totalling over 600 billion tonnes of hard coal and brown coal, the increasing utilization of coal may represent a viable alternative source of energy in view of diminishing oil reserves. This is not only true of developing countries with abundant coal deposits such as China and India, but also of many developed countries, including the United States, where the energy content of coal reserves are estimated to exceed that of oil in Western Asia.

The increased utilization of coal has serious environmental implications. Both human works and natural ecosystems are threatened by the acid depositions from pollution caused by coal combustion, which generates solid residues and gaseous and liquid effluents of well-known environmental significance, in particular, sulphur and nitrogen dioxides, carbon monoxides, and the hydrocarbons in flue gases. The nature of the problem is illustrated by the following example. At the process level, ammonia production is the core of the nitrogen fertilizer industry, since all synthetic nitrogen fertilizers are derived from ammonia, which is manufactured from natural gas. A limited supply of natural gas may force ammonia producers worldwide to switch to coal as the basic raw material in the future. However, coal-based ammonia production produces a far larger waste stream than gas-based production.

Despite the serious environmental implications of coal combustion, there seems to be no alternative for developing countries but to depend increasingly on coal as an alternative source of energy for rapid industrialization.* A key to sustainable industrialization of developing countries with increasing reliance on coal lies in clean coal technologies. In general, clean coal technologies could help to mitigate the negative environmental impact of coal utilization through improved operating efficiency and reduced costs of emission controls. In developed countries, billions of dollars have been spent over the last two decades on research and development work in clean coal technologies encompassing all the stages of the coal cycle, including mining, preparation, transportation, transformation (for example, liquefaction and gasification), combustion and post-combustion clean-up. A wide range of clean technologies relating to different phases of the coal cycle have passed the stage of demonstration and are ready for commercial application. In the United States during the past decade, significant advances were made in the following areas of clean coal technologies: longwall mining; coal blending; flue-gas desulphurization; combined-cycle gas turbines; coal-burning steam-electric generating units; and atmospheric and fluidized bed combustion**. Despite the progress in clean coal technologies during the past decade in developed countries, the market penetration of such technologies has been very limited in those countries, particularly when compared with the technological impact of advances in such areas as telecommunications, electronics and chemicals. There are numerous technical, socio-economic and institutional barriers to the diffusion of clean coal technologies, such as large capital investment requirements, commercial risks, uncertain environmental regulations affecting the profitability and viability of investments, and long construction lead times of three to seven years in many projects. But one of the major stumbling-blocks to widespread commercial adoption of clean coal technologies in developed countries, and of clean energy technologies in general, has proved to be the structure of energy markets, as reflected in the availability and relative

*The major impacts on the environment (including air, water, land and wildlife) are described in *Industry and Development: Global Report 1990/91* (United Nations publication, Sales No.: E.90.III.E.12), chap III.

*Many developing countries depend on coal as a major source of commercial energy. For instance, in 1988 coal accounted for approximately 75 per cent of the commercial energy needs of China, 53 per cent of those of India, and 35 per cent of those of the Republic of Korea. In China, nearly 1 billion tonnes of coal were consumed in 1988, of which industry accounted for 73 per cent and power generation 25 per cent. See International Energy Agency, *Coal Information 1989* (Paris, Organisation for Economic Co-operation and Development, 1990), and Asian Development Bank, *Energy Indicators 1989* (Manila, 1990).

**For an illuminating article on the development of and prospects for clean coal technologies in the United States economy, see A. Rose, W. Labys and T. Torries, "Clean coal technologies and future prospects for coal", *Annual Review of Energy 1991*.

cost of natural gas, oil and coal. It has been shown in this study that natural gas is by far the most convenient source of energy, the most easily substituted for other forms of energy, and, above all, the cleanest environmentally. When available, it remains the fuel of choice, so long as price differentials between gas and coal do not justify additional capital costs and the operating inconveniences of switching to coal. In particular, in industries such as glass manufacturing, which requires major changes in converting to coal from gas, the price differential is not yet sufficient to warrant such a switch, because of the heavy capital investment requirements and additional operating expenses associated with the industrial use of coal.

The problems of transfer and diffusion of clean coal technologies in developing countries are far more daunting, given the weak technological absorptive capacity and the inadequate development of human resources and of the technical and physical infrastructure in developing countries. Basically, to remain competitive in the world market, industries in developing countries may be forced to take advantage of a more readily available or less costly fuel such as coal, despite its environmental implications, unless clean coal technologies from developed countries are provided to them on a massive scale. Developed and developing countries alike have a common interest in strengthening international cooperation in the design and implementation of imaginative and effective mechanisms for the transfer and diffusion of clean energy technology from North to South.

The findings of this study suggest that given the huge potential for saving energy in developing countries, it is often more cost-effective and environmentally sound to spend money on energy conservation and efficiency improvement rather than on new sources of energy supply. Despite considerable efforts to conserve energy and promote efficiency throughout the world in recent years, the allocation of financial resources to energy projects in developing countries has continued to be supply-biased. Opportunities to promote energy conservation and improve industrial energy efficiency through demand management, and to reduce energy costs through optimal fuel substitution measures have thus been neglected. Moreover, international lending agencies usually lend several times more money to expand the supply of electricity than to conserve already existing supplies. An in-depth policy review and a reordering of priorities are therefore urgently needed.

Appendix I

METHODOLOGY FOR DECOMPOSITION ANALYSIS

In recent years a variety of decomposition techniques have been used to analyse the relationship between energy use and variables such as structural change, energy intensity and industrial growth. The techniques range from a relatively simple method such as the indices method (the Divisa and the Lapeyres methods) to a more comprehensive technique using input-output tables*. Although the input-output technique is an elegant and conceptually sound approach to decomposition analysis, it is more suited to a country case-study than to a cross-country study because of the extreme difficulty of preparing comparable input-output tables over time for a large number of countries. On the other hand, the indices method does not lend itself to easy interpretation, since the results are expressed in indices and percentage change per year, and it is cumbersome to calculate the absolute change of each component from indices. As a result, a conceptually more straightforward and logically consistent method for decomposing industrial energy consumption by major sources of change has been developed at UNIDO, primarily on the basis of the total differential concept in mathematics. A numerical illustration of the method is given at the end of this appendix using simple hypothetical figures.

A. Decomposition method

The variables are defined as follows:

E_t = Total industrial energy consumption (individual fuels or total combined energy consumption) in physical units in the period t

P_t = Total industrial output in constant prices (usually MVA)

E_{it} = energy consumption in industry branch "i" in the period t

P_{it} = output in industry branch "i" in constant prices

Then

$$E_t = \sum_{i=1}^{m} E_{it}$$

$$P_t = \sum_{i=1}^{m} P_{it}$$

Let the energy intensity of industry "i" (that is, the ratio of energy consumption to output in industry "i" be denoted

$$e_{it} = E_{it}/P_{it}$$

*For a description of the Divisa decomposition techniques, see G. A. Boyd, D. A. Hansen and T. Sterner, "Decomposition of changes in energy intensities", *Energy Economics*, vol. 10, No. 4 (1988), pp. 309-312, and Li Jing-Wen, R. M. Shrestha and W. K. Foell, "Structural change and energy use", *Energy Economics*, vol. 12, No. 2 (1990), pp. 109-115. For the Lapeyres method, see R. B. Howarth and others, "Manufacturing oil and energy use in eight OECD countries: decomposition of the impacts of changes in output, industry structure, and energy intensity" (Berkeley, California, Lawrence Berkeley Laboratory), paper presented at the Bergen Energy Conference held at Bergen, Norway, from 23 to 24 August 1990. For the use of an input-output table for a decomposition analysis, see J. M. Roop and D. B. Belzer, *Changes in the Structure of the United States Economy: an Input-Output Analysis* (Richland, Washington, Pacific Northwest Laboratory, 1987); Department of Energy, *Energy's Role in International Trade: Structural Changes and Competitiveness* (Washington, D.C., Government Printing Office, 1989); and Office of Technology Assessment, *Energy Use and the United States Economy* (Washington, D.C., Government Printing Office, 1990). For an alternative input-output method for decomposing energy consumption in the macroeconomic context, see Se-Hark Park, "An input-output framework for analysing energy consumption, *Energy Economics*, vol. 4, No. 2 (1982), pp. 105-110.

A change in the total industry energy consumption between a base period ($t = 0$) and a later period ($t = n$) can then be algebraically stated as:

$$\Delta E = E_n - E_0 \sum_{i=1}^{m} P_{in}e_{in} - \sum_{i=1}^{m} P_{i0}e_{i0} \qquad (1)$$

The right-hand side of equation (1) can alternatively be written as:

$$\Delta E = P_n \sum_i a_{in}e_{in} - P_0 \sum a_{i0}e_{i0} \qquad (2)$$

where

$$a_{it} = P_{it}/P_t$$

It can be readily seen that equation (2) is a function of three variables, total output level (P_t), energy intensity of individual industries (e_{it}), and the structural parameter, or the share of individual industries in total output (a_{it}). Applying the total differential formula, equation (2) can be decomposed as follows:

$$\begin{aligned} \Delta E &= P_n \sum_i a_{in}e_{in} - P_0 \sum_i a_{i0}e_{i0} \qquad (3)\\ &= (P_n - P_0) \sum a_{i0}e_{i0} \\ &+ P_0 \sum_i (e_{in} - e_{i0})\, a_{i0} \\ &+ P_0 \sum_i (a_{in} - a_{i0})\, e_{i0} \\ &+ \text{interaction terms} \end{aligned}$$

where interaction terms (R) can be further broken down into four combinatorial product terms of the three variables as follows:

$$\begin{aligned} R &= (P_n - P_0) \sum_i (e_{in} - e_{i0})\, a_{i0} \\ &+ (P_n - P_0) \sum_i (a_{in} - a_{i0})\, e_{i0} \\ &+ P_0 \sum_i (e_{in} - e_{i0})(a_{in} - a_{i0}) \\ &+ (P_n - P_0) \sum_i (e_{in} - e_{i0})(a_{in} - a_{i0}) \end{aligned}$$

where the first term is the joint effect of changes in output and energy intensity; the second term, the joint effect of output and structural change; the third term, the joint effect of energy intensity and structural change; and the last term, the joint effect of all three variables.

Rewriting equation (3) in total differential form will give:

$$\begin{aligned} \Delta E &= \Delta P \sum_i a_{i0}e_{i0} + P_0 \sum_i \Delta e_i a_{i0} + P_0 \sum_i \Delta a_i e_{i0} \qquad (4)\\ &+ \Delta P \sum_i \Delta a_i e_{i0} + \Delta P \sum_i \Delta e_i a_{i0} \\ &+ P_0 \sum_i \Delta e_i \Delta a_i + \Delta P \sum_i \Delta e_i \Delta a_i \end{aligned}$$

where

$$\Delta E = E_n - E_0$$

$$\Delta P = P_n - P_0$$

$$\Delta a_i = a_{in} - a_{i0}$$

$$\Delta e_i = e_{in} - e_{i0}$$

By setting in equation (4)

$$\Delta P = \Delta e_i = 0$$

the following is obtained

$$\Delta E = P_0 \sum_i \Delta a_i e_{i0}$$

which corresponds to the net effect of structural change under *ceteris paribus* conditions. The separate effects of output (ΔP) and energy intensity (Δe_i) can be obtained in the same way, by setting $\Delta e_i = \Delta a_i = 0$ and $\Delta P = \Delta a_i = 0$ respectively.

Finally, some of the limitations associated with the application of the method presented above (which are also common to any type of decomposition analysis) must be considered. First, the estimate is devoid of any causal relationships by the nature of the identity relation. The technique is useful in disaggregating the past energy consumption change into its different components, but it fails to offer any explanations as to why a given component, for example, structural effect, is the dominant factor in explaining the actual change in energy consumption in a given country. Nevertheless, the technique helps to identify the areas in which explanations can be sought. Secondly, the technique is not stochastic in form, and hence is not valid for econometric projections: the procedure can be used only to analyse the *ex post* performance. Thirdly, the conclusions drawn from a decomposition analysis are valid only for the particular time period chosen, the level of industry disaggregation and the particular energy mixes used. An alternative set of these parameters may produce different results and conclusions.

B. Numerical illustrations

The following simple numerical data for two industries and two periods are used to verify the mathematical consistency of the equation (3).

Year		*Base (0)*	*End (n)*
Energy consumption	$i = 1$	34	80
	$i = 2$	66	120
	Total	100	200
Production	$i = 1$	20	50
	$i = 2$	30	30
	Total	50	80
Energy intensity	$i = 1$	1.7	1.6
	$i = 2$	2.2	4.0
	Total	2.0	2.5

The following can be readily calculated:

$$\begin{aligned} E_n - E_0 &= 200 - 100 = 100 \\ &= (P_n - P_0) \sum_i a_{i0}e_{i0} = 60 \\ &+ P_0 \sum_i (e_{in} - e_{i0})\, a_{i0} = 52 \\ &+ P_0 \sum_i (a_{in} - a_{i0})\, e_{i0} = -5.625 \\ &+ (P_n - P_0) \sum_i (a_{in} - e_{i0})\, a_{i0} = 31.2 \\ &+ (P_n - P_0) \sum_i (a_{in} - a_{i0})\, e_{i0} = -3.375 \\ &+ P_0 \sum_i (e_{in} - e_{i0})(a_{in} - a_{i0}) = -21.375 \\ &+ (P_n - P_0) \sum_i (e_{in} - e_{i0})(a_{in} - a_{i0}) = -12.82 \end{aligned}$$

It can be verified that the sum of component changes is equal to a change in total energy consumption between the two periods, that is, 100.

STATISTICAL TABLES

Table III.16. Shares of energy-intensive industry groups in total manufacturing energy consumption and MVA in selected years and countries and areas, with average annual growth rates[a/]

Country or area	Energy consumption: Energy-intensive industry group (percentage)	Energy consumption: Other industry group (percentage)	MVA share: Energy-intensive industry group (percentage)	MVA share: Other industry group (percentage)	Energy intensity (tonnes of oil equivalent per $1.000 of MVA): Energy-in'ensive industry group (percentage)	Energy intensity (tonnes of oil equivalent per $1.000 of MVA): Other industry group (percentage)
Australia						
1975	79.01	20.98	35.26	64.73	1.59	0.23
1980	79.37	20.62	37.39	62.60	1.53	0.24
1987	75.61	24.38	38.63	61.36	1.19	0.24
Average annual growth rate						
1975-1980	1.27	0.82	2.07	0.21	-0.78	0.61
1980-1987	-2.07	1.01	1.49	0.73	-3.51	0.28
Austria						
1973	81.09	18.90	32.44	67.55	1.12	0.13
1980	82.94	17.05	32.64	67.35	1.17	0.12
1988	82.40	17.59	32.38	67.61	0.97	0.10
Average annual growth rate						
1973-1980	1.82	0.00	1.19	1.06	0.62	-1.05
1980-1988	-1.28	-0.81	1.05	1.19	-2.30	-1.98
Belgium						
1973	80.95	19.04	35.46	65.53	2.28	0.30
1980	84.01	15.98	35.23	64.76	2.00	0.21
1988	81.66	18.33	36.91	63.08	1.57	0.21
Average annual growth rate						
1973-1980	-2.29	-5.21	-0.42	-0.28	-1.87	-4.95
1980-1988	-1.90	0.15	1.12	0.2	-2.98	-0.04
Brazil						
1973	55.17	44.82	24.99	75.00	1.08	0.29
1980	62.14	37.85	26.33	73.66	1.27	0.28
1988	68.37	31.62	27.75	72.24	1.81	0.32
Average annual growth rate						
1973-1980	10.18	5.74	7.65	6.57	2.35	-0.78
1980-1988	5.02	1.47	0.45	-0.45	4.55	1.93
Canada						
1973	51.41	48.58	35.45	64.54	1.08	0.56
1980	62.51	37.48	37.71	62.28	1.27	0.46
1988	65.79	34.20	38.59	61.04	1.13	0.37
Average annual growth rate						
1973-1980	6.11	-0.56	3.66	2.23	2.36	-2.73
1980-1988	1.71	-0.09	3.21	2.73	-1.45	-2.74
Colombia						
1975	67.01	32.98	31.97	68.02	1.36	0.32
1980	75.48	24.51	31.12	68.87	1.40	0.20
1987	71.08	28.91	37.55	62.44	1.03	0.25
Average annual growth rate						
1975-1980	5.67	-2.77	5.18	6.02	0.46	[illegible]
1980-1987	2.42	5.77	6.92	2.64	-4.21	[illegible]

Country or area	Energy consumption: Energy-intensive industry group (percentage)	Energy consumption: Other industry group (percentage)	MVA share: Energy-intensive industry group (percentage)	MVA share: Other industry group (percentage)	Energy intensity (tonnes of oil equivalent per $1,000 of MVA): Energy-intensive industry group (percentage)	Energy intensity (tonnes of oil equivalent per $1,000 of MVA): Other industry group (percentage)
France						
1973	70.31	29.68	31.29	68.70	1.11	0.50
1980	65.29	34.70	30.59	69.40	0.99	0.46
1988	74.43	25.56	32.66	67.33	0.86	0.38
Average annual growth rate						
1973-1980	-0.35	2.98	1.35	1.82	-1.68	1.14
1980-1988	-0.67	-5.94	1.03	-0.17	-1.68	-5.74
Germany, Federal Republic of						
1973	76.94	23.05	32.31	67.68	1.01	0.14
1980	77.13	22.86	30.52	69.47	1.03	0.13
1988	79.50	20.49	31.73	68.26	0.72	0.09
Average annual growth rate						
1973-1980	-0.04	-0.19	-0.24	0.95	0.21	-1.12
1980-1988	-0.98	-2.69	3.46	2.73	-4.29	-5.27
Greece						
1973	70.92	29.07	31.17	68.82	1.53	0.28
1980	70.37	29.62	30.01	69.98	1.62	0.29
1988	66.66	33.33	30.31	69.68	1.57	0.34
Average annual growth rate						
1973-1980	3.63	4.03	2.84	3.65	0.77	0.37
1980-1988	-0.58	1.58	-0.19	-0.36	-0.40	1.95
Hungary						
1973	44.46	55.53	22.33	77.66	2.51	0.90
1980	51.50	48.49	23.66	76.33	4.38	1.28
1986	49.30	50.69	19.07	80.92	4.96	1.20
Average annual growth rate						
1973-1980	5.41	1.24	-3.69	-3.46	8.28	5.12
1980-1986	-1.34	0.12	1.16	0.18	2.10	-1.03
India						
1973	55.28	44.71	38.69	61.30	4.35	2.22
1980	61.73	38.26	38.45	61.45	4.88	1.89
1984	62.09	37.90	39.50	60.49	4.53	1.81
Average annual growth rate						
1973-1980	5.76	1.82	4.03	4.18	1.66	-2.27
1980-1984	5.00	4.60	6.95	5.78	-1.82	-1.12
Indonesia						
1977	52.65	47.34	21.17	78.82	1.52	0.37
1980	55.50	44.49	21.83	78.16	1.84	0.41
1985	68.61	31.38	32.39	67.60	1.76	0.39
Average annual growth rate						
1977-1980	14.92	10.61	7.73	6.33	6.67	4.02
1980-1985	12.70	0.73	13.78	2.14	-0.95	-1.38
Italy						
1973	77.98	22.01	39.22	60.77	1.33	0.24
1980	76.36	23.63	36.97	63.02	1.07	0.20
1988	75.55	24.44	36.20	63.79	1.22	0.22
Average annual growth rate						
1973-1980	-1.32	-0.01	1.73	3.13	-3.00	-3.05
1980-1988	-0.75	-0.20	-2.26	-1.85	1.55	1.69

Table III.16. (continued)

Country or area	Energy consumption (percentage)		MVA share (percentage)		Energy intensity (tonnes of oil equivalent per $1,000 of MVA) (percentage)	
	Energy-intensive industry group	Other industry group	Energy-intensive industry group	Other industry group	Energy-intensive industry group	Other industry group
Japan						
1973	79.00	20.99	36.19	63.80	1.03	0.16
1980	76.00	23.96	36.48	63.51	0.75	0.13
1988	69.54	30.45	34.63	65.36	0.54	0.13
Average annual growth rate						
1973-1980	-2.92	-0.53	1.68	1.50	-4.52	-2.00
1980-1988	-1.19	2.96	2.82	3.86	-3.90	-0.87
Netherlands						
1973	82.06	17.93	36.10	63.89	1.93	0.85
1980	83.83	16.16	34.02	65.97	2.42	0.98
1988	87.82	12.17	37.91	62.08	1.85	0.80
Average annual growth rate						
1973-1980	0.21	-1.57	-3.02	-1.75	3.33	0.18
1980-1988	0.29	-3.76	3.70	1.53	-3.29	-5.21
Poland						
1975	74.47	25.52	24.68	75.31	2.75	0.31
1980	72.71	27.28	23.31	76.68	3.21	0.37
1987	73.56	26.43	23.85	76.14	3.61	0.41
Average annual growth rate						
1975-1980	2.69	4.57	-0.46	1.05	3.16	3.48
1980-1987	-1.26	-1.87	-2.88	-3.29	1.66	1.47
Portugal						
1973	66.00	33.99	33.67	66.32	1.60	0.42
1980	68.21	31.78	32.37	67.72	1.82	0.40
1988	76.21	23.78	37.37	62.62	2.26	0.40
Average annual growth rate						
1973-1980	5.87	4.37	3.87	4.82	1.93	-0.43
1980-1988	6.33	1.14	3.49	0.61	2.75	0.52
Republic of Korea						
1973	67.12	32.87	34.73	65.26	1.79	0.47
1980	79.27	20.72	37.56	62.43	1.86	0.29
1988	76.06	23.93	34.09	65.90	1.27	0.21
Average annual growth rate						
1973-1980	15.60	5.68	14.96	12.97	0.55	-6.45
1980-1988	6.69	9.18	11.90	14.04	-4.66	-4.26
Spain						
1973	76.19	23.80	41.38	58.61	1.56	0.35
1980	80.18	19.81	34.20	65.79	1.42	0.18
1988	80.15	19.84	35.66	64.33	1.44	0.20
Average annual growth rate						
1973-1980	2.26	-1.12	3.65	8.28	-1.34	-8.68
1980-1988	0.45	0.48	0.27	-0.53	0.18	1.01

Country or area	Energy consumption		MVA share		Energy intensity (tonnes of oil equivalent per $1,000 of MVA)	
	Energy-intensive industry group (percentage)	Other industry group (percentage)	Energy-intensive industry group (percentage)	Other industry group (percentage)	Energy-intensive industry group (percentage)	Other industry group (percentage)
Sweden						
1973	59.56	40.43	35.52	65.47	1.10	0.39
1980	77.89	22.10	34.89	65.10	1.26	0.19
1988	77.10	22.89	37.54	62.45	1.01	0.18
Average annual growth rate						
1973-1980	2.16	-9.81	0.09	-0.14	2.07	-9.68
1980-1988	-0.05	0.52	2.75	1.28	-2.72	-0.75
Taiwan Province						
1973	68.67	31.32	31.78	68.21	1.16	0.25
1980	77.27	22.72	33.53	66.46	1.66	0.25
1987	76.22	23.77	34.61	65.38	1.03	0.17
Average annual growth rate						
1973-1980	12.48	5.65	6.86	5.65	5.26	0.00
1980-1987	3.23	4.09	10.46	9.71	-6.55	-5.12
Turkey						
1973	36.56	63.43	30.50	69.49	1.06	0.80
1980	44.73	55.26	36.57	63.42	1.21	0.87
1988	58.87	41.12	38.35	61.64	1.26	0.55
Average annual growth rate						
1973-1980	11.25	5.98	9.06	4.89	2.01	1.04
1980-1988	9.42	1.89	8.96	7.93	0.42	-5.59
United Kingdom						
1973	66.13	33.86	33.65	66.34	0.86	0.22
1980	61.83	38.16	33.74	66.25	0.65	0.20
1988	65.17	34.82	37.57	62.42	0.51	0.17
Average annual growth rate						
1973-1980	-5.37	-2.80	-1.55	-1.61	-3.87	-1.21
1980-1988	0.20	-1.59	3.18	[illegible]	-2.89	-2.61
USSR						
1973	71.95	28.04	25.38	74.61	3.88	0.51
1980	68.75	31.24	23.39	76.60	3.66	0.51
1987	68.66	31.33	22.20	77.79	3.49	0.45
Average annual growth rate						
1973-1980	3.32	5.62	4.21	5.82	-0.85	-0.19
1980-1987	2.36	2.42	3.04	4.04	-0.66	-1.56

Sources: International Energy Agency, *World Energy Statistics and Balances 1971-1987*, and *World Energy Statistics and Balances 1985-1988* (Paris, Organisation for Economic Co-operation and Development, 1989 and 1990).

Notes: Energy-intensive industry group: iron and steel (ISIC 371); chemicals (ISIC 352, 355, 356 and parts of ISIC 351 and 354); non-ferrous metals (ISIC 372); non-metallic minerals (ISIC 36), and pulp, paper and printing (ISIC 34).

Other industry groups: foods, beverage and tobacco (ISIC 31), wood and wood products (ISIC 33); machinery except transport equipment (ISIC 38, excluding ISIC 384); transport equipment (ISIC 384); textiles and leather (ISIC 32); and other unspecified industries.

a/ Average annual growth rates over two periods are given for each country or area. The average annual growth rate refers to an annual growth rate of actual energy consumption (not shares) and MVA, an average rate of change per year in energy intensity by the energy-intensive industry group and other industry group.

Table III.17. Cross-country comparison of annual growth rates of manufacturing energy consumption and MVA in selected years and countries and areas
(Percentage)

Country or area	Annual growth rate of manufacturing energy consumption		Annual growth rates of MVA	
	1973-1980	1980-1988	1973-1980	1980-1988
OECD				
Australia	0.82	-0.57	1.13	0.79
Austria	1.30	-1.07	0.96	1.02
Belgium	-2.46	-1.38	-0.29	0.47
Canada	2.79	0.95	2.41	2.59
Denmark	-1.87	-1.87	0.19	1.87
Finland	0.20	1.34	3.29	0.78
France	0.62	-2.03	1.46	0.18
Germany, Federal Republic of	-0.06	-1.20	0.50	2.62
Greece	3.27	0.08	2.97	-0.28
Italy	0.90	-0.55	2.26	-1.78
Japan	-2.09	-0.07	1.37	3.09
Netherlands	-0.08	-0.26	-0.05	1.61
Portugal	4.69	4.32	3.90	1.45
Spain	1.32	0.40	5.67	-0.22
Sweden	-1.47	0.07	-0.05	1.61
Turkey	7.04	5.07	5.46	7.36
United Kingdom	-4.69	-0.41	-1.39	1.60
United States	-0.55	-0.97	1.29	1.49
Asia				
Bangladesh	5.57	6.38	14.44	3.44
Hong Kong	7.53	6.41	8.54	3.11
India	3.58	4.38	3.60	4.75
Indonesia[a/]	9.54	6.64	4.93[b/]	4.27
Malaysia	6.39	5.20	10.45	4.26[c/]
Pakistan	7.13	5.19	2.93	7.04[d/]
Philippines	4.92	-2.75	3.73	-2.30
Republic of Korea	11.18	6.74	11.88	10.88
Singapore	10.23	16.80	10.23	7.56
Taiwan Province	9.23	4.22	5.27	7.98
Thailand	3.74	4.25	7.04	3.92
Eastern Europe and USSR				
German Democratic Republic	1.21	0.52	3.06	2.26
Hungary	2.23	-1.57	-0.74	1.94
Poland	2.23	-1.04	4.04	-1.74
Romania	8.40	1.02	9.27	4.11
USSR	3.52	2.65	3.45	1.57
Yugoslavia	2.41	0.10	5.29	5.11
Latin America				
Argentina	1.86	1.83	0.89	0.73
Brazil[e/]	6.16	3.35	4.95	-0.18
Chile	3.50	1.23	-0.40	3.48
Colombia	2.62	2.85	3.49	4.66
Mexico	8.53	3.93	4.86	1.37
Peru	4.10	0.83	3.22	-2.64
Venezuela	6.86	4.90	9.20	1.94

Country or area	Annual growth rate of manufacturing energy consumption		Annual growth rates of MVA	
	1973-1980	1980-1988	1973-1980	1980-1988
North Africa and Western Asia				
Algeria	10.35	3.92	5.08	4.35
Egypt	10.18	5.83	4.38	1.51[d/]
Iran (Islamic Republic of)	-0.80	8.94	0.20	5.78
Kuwait	5.79	-0.67	10.70	-4.16[d/]
Saudi Arabia	19.04	11.90	7.94	4.01[d/]
Syrian Arab Republic	24.43	-0.38	5.34	-3.13
Tunisia	7.06	4.81	12.02	5.91

Sources: International Energy Agency, *World Energy Statistics and Balances 1971-1987*, and *World Energy Statistic and Balances 1985-1988* (Paris, Organisation for Economic Co-operation and Development, 1989 and 1990); for Brazil, Ministerio das Minas e Energia, *Balanço Energético Nacional 1989* (Brasilia, 1990); for Indonesia, Economic and Social Commission for Asia and the Pacific, "Sectoral energy demand in Indcnesia", (RAS/86/136); and annual statistical reports of the Bank of Korea for MVA in the Republic of Korea and the Korean Institute of Energy Economics for estimates of manufacturing energy consumption.

Note: MVA is measured in millions of 1985 dollars.

a/ MVA in millions of 1983 dollars.

b/ 1977-1980

c/ 1980-1985

d/ 1980-1986

e/ MVA in millions of 1987 dollars.

IV. Financial innovations for industrial development

The formal justification for this chapter is to respond to a request by the governing bodies of UNIDO to consider proposals for the adoption of specific measures and mechanisms with respect to new forms of resource flows to industry in indebted developing countries*. The new forms identified involve market-oriented resource mobilization and allocation or market-oriented debt conversion and allocation. These innovative financing measures and mechanisms are of importance in providing investment to the industrial sector in some developing countries.

A further justification for the focus on financing innovations is provided by the fact that during the 1980s resources available for industrial investment became very scarce in severely indebted developing countries**, new external bank loans dried up, and direct foreign investment remained stagnant throughout most of the decade. Yet, the supply of internationally mobile capital increased significantly during this period. How can developing countries, including severely indebted countries, attract an increased proportion of this internationally mobile capital? To succeed in that effort, many wide-ranging changes will have to be adopted and effectively implemented by these countries, and the adoption of particular financing measures and mechanisms are only a very small part of the required changes.

Such justifications help to explain the emphasis placed on debt-equity swaps; venture capital companies and funds; country funds focused on developing-country stock markets; industrial leasing; and build-operate-transfer (BOT) arrangements. These mechanisms have been selected because available data indicate that more than about half of the investment mobilized via these particular innovations in developing countries has gone to the industrial sector, or to investment in infrastructure of major importance to industry in these countries. By using the mechanism of debt-equity swap programmes, at least $4.4 billion of debt was swapped with the proceeds flowing to investment in industry in the five most indebted countries of Latin America in the period 1985-1989. Foreign portfolio investment in developing countries has increased rapidly since 1985, with more than $7.5 billion flowing to industry, mostly via country funds, in the period to 1989. The venture capital pool in developing countries, mostly invested in industry, grew to about $4 billion in 1989. Similar rapid growth is shown with industrial equipment leasing, which amounted to at least $7 billion in 1989. Scattered information for BOT indicates that projects that have been implemented or that are under serious consideration or under construction in industry-linked infrastructure would in the second half of 1980s amount to more than $10 billion. In contrast, in 1989 direct foreign investment flows to developing countries amounted to about $22 billion and new external commercial bank lending to $3 billion, or less than 10 per cent of such lending in 1980 ([1], p. 16).

Apart from the growing quantity of resources mobilized by these innovative mechanisms, their quality has been significantly different. Thus venture capital arrangements, whether through venture capital companies or venture capital funds, have been important in the financing of small- and medium-scale enterprises, especially where these enterprises produce non-traditional products. This is also the case with industrial leasing, which provides an effective means of financing small-scale enterprises which are of major importance in providing much-needed employment and in deepening the industrial fabric in many developing countries. Investment resulting from debt-equity swaps is often oriented to the export of non-traditional products in particular manufactures. BOT arrangements involve the private sector in the provision of infrastructure services, with the objective that the quantity, quality and price of such services provide better value than government-supplied services. Country funds provide the means through which the "star performers" within the economy of a developing country are identified and acclaimed. In fact, it should be emphasized that all of these innovations, and in particular country funds, provide a high-profile image of a country's economic policies, whereby the success of such policies becomes highly visible to the international financial community. Investors' decisions regarding country creditworthiness and the attractiveness of a location for direct foreign investment are based to a considerable extent on an analysis of growth rates, debt-servicing ratios and other internal economic factors. Just as important, however, are investor perceptions of the dynamism of the economy of a country, with these perceptions being governed to a considerable extent by a country's willingness to adapt and to succeed in implementing such high-profile financial innovations as country funds, BOT and venture capital companies. Thus these positive investor perceptions can be regarded as a valuable "externality" to successful innovations.

*See General Conference resolution GC.3/Res.6 of 24 November 1989, on external debt and industrial development, paras 2(b) and 6.

**For a discussion of external economic shocks and their impact on industrial investment and output, see *Industry and Development: Global Report 1987* (United Nations publication, Sales No. E.87.II.B.2), chap. III.

These innovations tend to mobilize both foreign and domestic financial resources, through the involvement of foreign and domestic private investors. In practice, foreign finance has often triggered the formation of venture capital and industrial leasing, which mobilize mostly domestic financial resources. In contrast, country funds are focused directly on foreign portfolio investors who provide foreign financial resources to industry via developing-country "emerging" stock markets. BOT arrangements provide injections of external loan finance, with debt service funded through the anticipated cash flow of primarily industry-linked infrastructure, with strictly limited recourse to developing-country host Governments. Debt-equity swaps have been of particular interest to highly indebted countries, since the debt reduction brought by this innovation has been coupled often either with foreign investment in the export sector, or with the provision of "new money" in accelerated direct investment plans. These mechanisms have formed an integral part in a determined effort at financial resource mobilization within the general objectives of broadening and deepening national financial systems, strengthening the development of domestic capital markets, and increasing the involvement of the private sector in industrial development in some developing countries.

The important feature of all these mechanisms and measures is that they are market-linked, although none can operate without the involvement of Governments. In some cases, this involvement will be direct and very considerable, as in the case of BOT arrangements that require complex legal commitments by Governments or in the case of debt-equity swaps where one party to the transaction is the central bank of a debtor country. For country funds, venture capital and industrial leasing, the involvement of Governments is more often indirect, that is, in the provision of a particular financial environment and in codified norms, regulations and laws. Nevertheless, all these financial arrangements depend on market signals, and to a greater or lesser degree on the involvement of the private sector and decentralized decision-making. The intent of the analysis here is pragmatic: how to increase the efficiency of resource mobilization and allocation and how to expand the quantum of domestic and foreign financial resources mobilized. Thus venture capital funds and companies usually have a strong private sector component, with clear incentives for managers of venture capital funds to aim at efficient and profitable operation. Debt-equity conversion provides an important incentive to direct foreign investment and releases domestic resource proceeds for new investment often with a new money component, controlled by the private sector, in the context of countries with difficult economic conditions. Industrial leasing is a simple non-bureaucratic mechanism providing resources rapidly to small industry entrepreneurs, often the most dynamic industrial group in developing countries. All of these mechanisms tend to reduce contributions from government budgets, especially so for BOT arrangements, focused as these are on infrastructure and its efficient operation.

It is possible to take the view that none of the mechanisms examined is really new. Strictly this is correct, and perhaps it is more a matter of rediscovery and readaptation of old mechanisms. More precisely, these mechanisms are innovative in terms of their formal application in developing countries, and take some time gaining acceptance. However, this acceptance has grown at impressive rates in recent years. Perhaps the most persuasive reason for examining the workings of these mechanisms and the necessary framework for their support is the fact that promotion of most of these new mechanisms has been vigorous in Hong Kong, Malaysia, Republic of Korea, Singapore, Taiwan Province and Thailand. The effective promotion of these financing mechanisms is but a small part of the policy package in these developing countries and areas, but the very success of their industrial sectors is a persuasive argument that these mechanisms deserve serious consideration, possible modification and adaptation in other developing countries. To paraphrase the famous Chinese leader, the colour of the cat does not matter; what matters is that it catches mice.

In the discussion that follows attention will focus on some of the key economic and institutional constraints that must be overcome if the adoption of any particular mechanism or innovation is considered desirable. However, since many developing countries have a long way to go before some of these financing mechanisms can be considered as realistic avenues for resource mobilization and allocation, some attention will also be given to possible modifications of these mechanisms so that they may become feasible options in more countries. Given the waning attractions of investment through State-run industrial enterprises, the financial mechanisms and modifications to these mechanisms proposed here represent an attempt to facilitate private sector involvement in industrial development in countries where the domestic private sector is weak, and where the foreign private sector requires incentives. New means have to be found to harness the capabilities of the private sector, where necessary in partnership with local governments and bilateral and multilateral finance agencies. As national entrepreneurs become more experienced and self-confident, it becomes possible for Governments to withdraw from the day-to-day operations of industry; to keep in place a policy framework including a stable macroeconomic framework, which will foster the industrial development process; and to depend to an increasing extent on market mechanisms to facilitate industrial efficiency and economic growth.

A. Debt-equity swaps

Debt-equity swaps (DES) have emerged as one way of increasing the volume of direct foreign investment to industry in highly indebted countries and at the same time of reducing the level of their external debt outstanding. While the volume of DES has increased over the last five years and the list of countries that have introduced or are considering formal DES programmes is becoming longer, the design and implementation of these programmes is still controversial. This section will review patterns of DES as a mechanism for industrial sector financing in developing countries. In this context, the following questions will be addressed:

(a) What is the volume of funds arising from DES that have catered for the emerging needs of industry?

(b) Who are the participants in industrial DES and what are the benefits and costs for each of them?

(c) For what type of investment in industry have foreign investors used DES?

1. DES as one debt conversion instrument

The process of selling off commercial bank claims on developing countries at discount is the main feature of all debt restructuring schemes that are based on market solutions to the debt problem. A whole set of instruments has been developed for trading debt below face value. Debt conversions comprise instruments that transform loans into other forms of liabilities (for example, DES or debt securitization), and transactions that are aimed at retiring debt at discount by paying cash to creditors directly (debt buy-backs) or indirectly through export of goods or services (debt-export swap). The volume of debt conversions has grown significantly since 1985. From an annual average of less than $4 billion in the period 1985-1987 to almost $20 billion in the record year 1988, the volume fell to $13 billion in 1989, mainly as a result of a significant fall in the volume of DES ([2], p. 23). Although the number of debtor countries participating in these transactions has been constantly increasing, Argentina, Brazil, Chile and Mexico have accounted for 85 per cent of total debt conversions in this period.

Of the various debt conversion instruments, DES have been one of the most widely applied and most publicized market-based schemes for debt reduction. To be precise, DES are transactions conducted in the framework of official programmes that involve a purchase of eligible foreign exchange debt instruments in the secondary market by a foreign investor who then exchanges this instrument domestically in order to acquire an equity investment in a domestic company. Foreign equity investment, direct or portfolio, may take the form of a share purchase in an existing company or may be used for investment in a new company. When a transaction involves a resident of a developing country instead of a foreign resident, this transaction is a "debt-peso swap" as a segment of DES. In case of "debt-peso swaps", residents buy their own country's debt in the secondary market using their foreign currency funds abroad or foreign currency acquired in the parallel market at home.*

Debt-equity conversion (including DES and "straightforward debt equity conversions", but excluding "informal debt-equity conversions") accounted for 46 per cent of the total volume of debt conversions in the period 1985-1987, while in the following two years its share was reduced to about one third. The loss of the market share of debt-equity conversion was caused by the 1989 suspension of several official DES programmes. Critics blamed these programmes for fuelling inflation and for unfairly subsidizing foreign investors, but there was also a growing prominence of other debt conversion schemes. Recently much media attention has been given to ecological, educational and other debt-for-development swaps, although the amounts involved here are small. However, these initiatives have a significance beyond the sums involved. In 15 debt-for-nature swaps arranged between August 1987 and August 1990, an equivalent of $59.8 million in local currency was generated for nature conservation and other environmental purposes in countries such as Costa Rica, Madagascar, Philippines, Poland and Zambia ([3], p. 13). Although debt-for-nature swaps have been in the past relatively small, their economic justification is that they provide external benefits through a better environment. Their particular relevance is that similar external benefits would be provided by using DES for the funding of small-scale and cottage industries which are employment-generating and poverty-alleviating.

2. Pros and cons of DES

DES is a mechanism that usually involves three main parties: the corporate investor (foreign or national), the lending bank and the debtor country. In addition, the complexity of DES often requires one or more intermediaries to link these three parties by providing highly specialized expertise and in-depth knowledge of markets. Each party in a transaction tries to maximize its benefits. Each has its own objectives, and these objectives are not identical, but can on the contrary be non-convergent, and sometimes even conflicting. For each DES transaction the advantages for each party must outweigh the disadvantages.

For corporate investors who are the main source of demand for DES, the main incentive is to obtain local currency at a discount. This provides an incentive for investment which otherwise may be held back, or which may provide a higher return for perceived higher risks, or both. In this context, DES expedite stalled investment or may promote new projects fitting with global competitive corporate strategies. DES are used in corporate restructuring of enterprises with financial problems. Certain investors, banks in particular, use DES also as a mechanism for entering or strengthening their position in certain markets without increasing their overall loan portfolios. The most important disadvantage is probably tougher rules on dividend remittances and capital repatriation as compared with using "new" money.

DES provide a flexible way for banks to reduce their exposure by selling loans to third parties or by converting loans into equity investment. DES are therefore a good portfolio management tool. However, on the negative side, the sale of a loan at a discount involves an upfront loss. This is also the main reason for the very different reaction of banks, particularly United States banks, on transactions offered by secondary market alternatives. Before 1987, the secondary market was mainly supplied by European and Japanese banks as well as by some of the United States regional banks. These banks had relatively small amounts invested in doubtful debts which they wished to reduce or eliminate. In that period, United States

*This definition of DES includes only one subgroup of all debt equity conversions. The other two subgroups which are not of direct interest to this analysis but have been of importance in some debtor countries are the following: first, "formal straightforward debt-equity conversions", which comprise conversions of intracompany loans into equity at no discount; and secondly, "informal debt-equity conversions" as operations with public and private unmatured debt transacted at secondary market prices and carried out outside official DES programmes.

money centre banks with greater exposure in highly indebted countries and stronger interests in maintaining a long-term financial role in these countries were engaged in a good deal of brokerage, but not in the sale of their own debt instruments. With the increase of loan loss reserves (in 1987), and with the changes in regulation K (in 1987 and 1988), which allow United States banks to assume, through DES, full or partial ownership in any foreign company, the strategy of the major United States banks changed significantly. They have become much more active on the secondary market not only as traders, but also as equity investors in non-financial firms in some debtor countries.

However, it is the debtor countries that are the driving force with DES programmes. Their strong interest is based, in whole or in part, on their desire to reduce debt and debt servicing; to attract direct foreign investment; and to repatriate flight capital. From a central bank perspective, each DES reduces the country's external debt and replaces its fixed debt-servicing obligation with equity liabilities, which tends to match investment success with domestic economic cycles. Direct foreign investment is encouraged because debtor Governments redeem swapped debt in domestic currency at more than market price, thus reducing the cost of investment. Investors are encouraged to be more willing to take risks and consider investing in highly indebted countries with usually uncertain investment climates. Many debtor countries have adopted more liberal foreign investment policies, which DES have complemented, particularly where DES have stimulated investment in export-oriented industries. It is also an instrument well suited to the privatization process which often accompanies liberal policies. During the period 1974-1985, capital flight from developing countries amounted to some $250 billion according to IMF estimates ([4], p. 37). The return of this flight capital has been an important objective of debt-peso swaps. In principle, new assets created by debt-peso swaps would require future servicing only in local currency.

It must be emphasized that DES can also involve costs. Foreign investors exchange external debt with the Government, which in return provides domestic resource assets that it owns. These exchanges can be financed by raising taxes, accommodating them within existing budgets, issuing domestic debt or printing money. Or the exchange can be financed by the sale of State property. Chile is the only country to have succeeded in providing local currency for DES through domestic government bond issues without a significant increase of inflation and domestic interest rates. This was possible because the country's capital market was relatively well developed and the volume of swaps relatively small in relation to its monetary base. More frequently, swaps have been financed through money creation, with attempts at monetary regulation being unsuccessful, thus leading to inflation and the suspension of DES programmes. Argentina and Mexico reintroduced their DES programmes in 1990, but ensured that conversions were closely associated with the privatization of State-owned companies. Privatization does not involve local currency creation, and therefore does not create inflationary pressures.

By replacing external debt obligations which require immediate hard currency payments on debt service with equity liabilities due only after several years, DES have a positive short-term balance-of-payments impact since most DES programmes stipulate grace periods on capital and dividend remittances. The country's debt-servicing capacity is improved in the short-run, thus contributing towards restoring its creditworthiness. In the longer term, however, benefits stemming from lower debt service payments may be counterbalanced by higher dividend remittances, capital repatriation and any additional factor payments to foreigners connected with domestic asset ownership. There is another mechanism through which DES influences the balance-of-payments of a country. Unlike direct foreign investment, there is not necessarily any foreign exchange inflow from DES. Moreover, "round-tripping" may occur, that is, an investor obtains local currency at a discount from the Government, purchases equity, sells this equity and buys foreign exchange on the parallel markets, thus depressing the domestic exchange rate. Thereby additional pressure for local currency devaluation is created.

To the extent that DES divert capital inflows that would otherwise have taken place, such swaps are less than fully "additional", and these transactions have a negative impact on the balance of payments, that is, there is an opportunity cost of a DES replacing a traditional direct foreign investment. A survey by the International Finance Corporation (IFC) has found that 33 per cent of the transactions of corporate non-bank investors were clearly additional, while another 10 per cent were "partly additional" ([5], p. 5), where investment would have occurred later or for a smaller amount. In contrast to less than full additionality of non-bank investors, the same survey shows that every single DES transaction performed by banks was fully additional and would not have happened without a swap programme. One mechanism used by banks for converting debt into indirect equity is the closed-end country fund which provides banks with a certain level of comfort by diversifying risk. The other DES investment alternative for banks is to enter into a direct swap of debt for equity either to acquire minority shares in existing companies or to cofinance the establishment of a new company, normally jointly with transnational corporations. However, non-bank DES investment additionality, although less than full, is higher for export-oriented than for domestic-oriented investments, since the incentive effect is higher on projects competing in export markets where higher costs cannot be transferred to captive domestic customers ([5], p. 8).

3. *Main patterns of DES programmes*

Chile first introduced a formal DES programme in 1985, followed later by at least 10 other countries, mostly from Latin America, but including the Philippines and Yugoslavia. The programmes differ as to the type of debt eligible for transactions, the participants qualifying for conversions, the exchange rates or redemption prices at which the swaps take place, the quotas and ceilings on the amount of debt that can be swapped, the conversion procedure, investment priorities, the new money requirement, the restrictions that are placed on profit remittances and capital repatriation, as well as the continuity of the programme, as summarized in table IV.1. In an attempt to channel investments into priority sectors or geographic areas or into priority uses, most DES schemes have provided incentives through superior treatment with respect to capital repatriation and profit remittances, local currency discounts on converted debt, new money requirements etc. With the exception of Brazil, where investment priorities were defined exclusively on a geographic basis, all other countries have considered investments in the industrial sector to be preferential. In the Philippines and Venezuela, industrial sector projects were categorized as high priority, while the other countries gave preferential treatment to all export-oriented projects. Industrial sector projects carried out through DES have been mostly export-oriented, so that in effect they have also been accorded priority status.

4. *Importance of industrial sector DES in selected countries*

Some highlights of DES, with regard to the industrial sector, are presented below for Argentina, Brazil, Chile, Mexico and the Philippines. These countries have accounted for about 90 per cent of DES carried out in developing countries to date.

(a) Argentina

DES programmes were implemented between the beginning of 1988 and May 1989 using the auction mechanism, and subsequently on a highly selective case-by-case basis for export-oriented investments and more recently for privatization. Five public auctions were held in 1988, with bids showing increasing discounts from 37 per cent at the first to 72 per cent at the fifth bidding. Some $695.1 million in investment resulted, with $310.3 million financed by DES and the remainder by other sources, such as direct foreign investment and loans ([6], pp. 38-39). New money amounted to 55 per cent of investment, well over initial government and subsequent guidelines of 50 per cent and 30 per cent, respectively. By using DES, Argentina retired about 2 per cent of its external debt in 1988. Of greater importance, debt-equity conversions accounted for almost one third of the total volume of direct foreign investment inflows in that year. The Argentine programme did not specify priority regions or sectors, so that investment choice reflected particularly dynamic sectors of its economy. Table IV.2 indicates that 70 per cent of 1988 DES investment went to industrial projects, with agro-industry and the automotive industry obtaining almost 50 per cent of investments. This concentration has raised questions about the "additionality" of the DES programme. "Additionality" has been especially questionable for investments in some food processing projects where the country has comparative advantage, and where the quality of natural resources determines where the project will be located. It can be assumed that less than full additionality of DES diminished positive features of the programme, especially the high and constantly growing government share in the secondary market price discount.

Although large and small local companies participated in the country's DES programme, the main players were transnational corporations. Those participating included: Swift Argentina (affiliate of Campbell Soup Co.; value of $70.9 million; meat production); Coca-Cola S.A. (affiliate of Coca-Cola; value of $22.8 million; beverages production); and Renault Argentina S.A. (affiliate of Renault; value of $22.7 million; automotive industry) ([6], pp. 38-39). Some 46 of the winning projects involved an average investment of $1.5 million, as a result of an auction quota for small- and medium-sized investors. Although eligible, banks did not participate at that time, since it required investment in new facilities and prohibited investment for financial restructuring and privatization. The programme was suspended in April 1989, owing to extreme volatility in the foreign exchange market and increased inflation, coincident with the reforms and liberalization policies of President Carlos Menem. However, over the past two years, the country has undergone a dramatic change, with cuts in price increases, fiscal adjustment with the widespread removal of state controls, and a gradual opening-up of the economy. There has been a significant improvement of the investment climate, and progress in cutting down inflation and the fiscal deficit, as well as in privatization.

By the end of 1990, seven major firms and services had been already delivered to the private sector, including ENTEL, the telephone company, Aerolíneas Argentinas, the national airline, and a major railway link covering over 5,000 kilometres. Argentina plans to sell off some 150 State companies in 1991. The list includes SEGBA, the power supply company, OSN, the water company, Gas del Estado, a gas distributor and ELMA, a shipping line. The Government plans to privatize the entire energy sector and key transport links while concessions to operate oilfields, coal mines, highways and some other infrastructure projects are also envisaged [7]. Although a driving force behind the privatization process has been the need to reduce the public sector deficit and to increase the efficiency of government-owned enterprises, one of its objectives has been also to reduce the country's outstanding debt and debt-service obligations by using DES. The authorities allowed two big privatizations involving DES in 1990, ENTEL and Aerolíneas Argentinas, through which the country has reduced its foreign debt by $7 billion. An even higher target has been set for 1991. There is another advantage which has pushed this combination of DES and privatization. DES used as a tool in the privatization process does not cause inflation.

The other important innovation in Argentina is a growing participation of its largest bank creditors in DES transactions. Banks have become involved not only in DES linked to privatization, but also in other promising large-scale industrial projects. Attracted by the low prices of Argentine debt, significantly liberalized capital flows and certain legislative provisions in home countries, United States banks have shown great interest in equity investments. Such interest has been strongly concentrated on export-oriented projects, the most notable examples being two large swaps in the pulp and paper industry. While Citibank has swapped $300 million in sovereign debt

Table IV.1. Main patterns of DES programmes in nine developing countries

Country	Introduction/suspension of programme	Status of programme at the end of 1990	Price of external debt on seconday market, April 1990 (percentage of face value)	Government's share in discount[a] (percentage)	Incentive to investor[b] (percentage)
Argentina	Approved in June 1987; became operational in January 1988; suspended in April 1989 because of inflationary impact of DES	Conversions done on case-by-case basis, in 1990 especially for privatization	12-13	77 (1988)	40 (1988)
Brazil	Passed in February 1988; because of anti-inflation package, programme suspended in January 1989	Suspended	25-26	62 (1988 free area) 25 (1988 incentive area)	29 (1988 free area) 45 (1988 incentive area)
Chile[c]	Introduced in May 1985	Operational	66-67	36 (1988)	32 (1988)
Costa Rica	Approved in early 1986; suspended in December 1986; new programme adopted in April 1990	Operational	33-35 [d] 45-47 [e]	60 (1986 for export-oriented projects only)	33 (1986 for export-oriented projects only)
Jamaica	Started in July 1987	Operational	38-40	10 (1988)	47 (1988)
Mexico	Introduced in April 1986; suspended in November 1987 because of inflationary impact of DES; the programme was reintroduced in April 1990	The $3.5 billion of external debt earmarked for 1990-1993 DES programme was already traded during the 2 auctions in 1990	41-42	34 (Jan. 1987) 68 (Nov. 1987)	34 (Jan. 1987) 22 (Nov. 1987)
Philippines	Introduced in August 1986; stopped in the first half of 1988 because of inflationary impact	Revised programme approved by Philippine debt council; expected to be launched in the first half of 1991	50-51	..	..
Uruguay	Introduced in December 1987; amended in January 1989	Operational	45-47	29-45 (1988)	28-34 (1988)
Venezuela	Introduced in April 1987; significantly amended in April 1989	Operational	43-44	0 (1988)	48 (1988)

Country	How redemption price is established	Eligible participants	Conversion exchange rate	Restriction on profit remittance	Restriction on capital
Argentina	Central bank auctions under programme; case-by-case basis since then	Foreign and national companies and banks	Free rate	Banned for 4 years	Banned for 10 years
Brazil	Auctions	Foreign companies, banks and non-residents	Official rate	Not specified	Banned for 12 years
Chile[c]	Case-by-case	Foreign companies banks and non-residents	Official rate	Banned for 4 years, with no more than 25 per cent of the first 4 years profits' remitted beginning in the fifth year	Banned for 10 years
Costa Rica	Case-by-case	Foreign and national companies and banks	Official rate	As soon as profits realized	Period not less than period of original debt
Jamaica	Case-by-case	Foreign companies, banks and non-residents	Official rate	Banned for 3 years	Banned for 3 years for priority projects; banned for 7 years for other projects
Mexico	Case-by-case in the programme from April 1986 to November 1987; auction in the programme introduced in April 1990	Foreign and national companies and banks	Free rate	As soon as profits realized	Banned for 12 years
Philippines	Case-by-case	Foreign and national companies and banks	Official rate	As soon as profits realized in priority sectors; banned for 4 years in other sectors	Banned for 3 years in priority sectors; banned for 5 years in other sectors
Uruguay	Case-by-case	Foreign and national companies and banks	Official rate	As soon as profits realized	Period not less than period of original debt
Venezuela	Originally case-by-case, but after programme amendments in April 1989, through auctions	Foreign and national companies and banks (before April 1989 amendments, only foreign investors)	Official rate (before April 1989), free rate (after April 1989)	10 per cent per annum of the dollar amount of the registered capital for the first three years	Banned for 5 years; thereafter not more than 12.5 per cent per annum of the initial investment

Sources: Various sources, including publications of authorities of individual countries, *Business International*, Dresdner Bank, IMF and United Nations Centre on Transnational Corporations.

[a] Difference between face value and redemption price (price at which the debtor country redeems the debt to the investor), expressed as a percentage of the discount.

[b] Difference between redemption price and secondary market price, expressed as a percentage of redemption price.

[c] Under Chapter XIX of the Compendium of Foreign Exchange Rules.

[d] Principal bonds.

[e] Interest bonds.

Table IV.2. Approved investment projects utilizing debt equity conversions in Argentina, by industry 1988 a/

Rank	Industry	Million dollars	Percentage
1	Agriculture, agro-industry (meat-packing)	219.2 (76.7)	31.5 (11.0)
2	Tourism	168.9	24.3
3	Automotive and related products	121.3	17.5
4	Chemicals, pharmaceuticals	78.9	11.4
5	Construction materials	34.7	5.0
6	Textiles, shoes	25.0	3.6
7	Fishing	18.9	2.7
8	Glass and related products	10.2	1.5
9	Others	17.7	2.5
	TOTAL	695.1	100.0

Source: *Debt Equity Conversions: A Guide for Decision-makers* (United Nations publication, Sales No. E.90.II.A.22), p.88.

a/ Includes proportion corresponding to national investors.

paper for debt held by the leading Argentinian paper giant Celulosa Argentina S.A., and intends to invest an additional $300 million in completing the company's paper pulp plant at Puerto Piray, Manufacturers Hanover swapped $200 million for acquiring 29 per cent of assets in another paper company, Massuh S.A. ([8], pp. 1 and 3).

In summary, DES have been an important element of the Argentine economic policy aimed at generating direct foreign investment in a period when the country has been eliminated from international capital markets, and when foreign investors have shown little interest in increasing their commitments to Argentina. Through debt-equity conversions which constituted one third of the total net direct foreign investment inflow into the country in 1988 and 1989, the industrial sector raised a volume of around $500 million. Although the 1988 DES programme had a special provision for small- and medium-sized transactions, which had been used also for investment in the industrial sector, the dominant proportion of DES in this sector has consisted of large-scale investments carried out by transnational corporations, and later on, in 1989, also by transnational banks in three export-oriented manufacturing sectors—food processing and the automotive industry in 1988, and pulp and paper production in 1989.

(b) Brazil

Prior to the introduction of the Brazilian DES programme in February 1988, formal debt-equity conversions were restricted primarily to parent companies converting loans to their subsidiaries in Brazil into equity at 100 per cent face value ("straightforward debt-equity conversions"), that is, increasing the registered direct foreign investment in subsidiaries. As an investment incentive following the onset of the debt crisis, a 10 per cent tax credit was offered on debt-equity conversions in 1982-1984, but these transactions were criticized as lacking additionality, and this incentive was phased out. However, some $2.5 billion entered Brazil between 1982 and 1987 through straightforward debt equity conversions ([4], p. 75).

As the discount on Brazilian debt grew, and as stipulated in a rescheduling agreement with commercial banks, Brazil introduced a new DES programme in February 1988, where in contrast to the earlier programme debt reduction became an equally important objective. The programme has provided two methods for converting debt, negotiations and a monthly auction system. A total of 370 projects were approved at 10 auctions from March through December 1988 (at the beginning of 1989 the auctions were suspended because of questionable additionality, inflation pressure and growth of the parallel market dollar rates), and the total amount converted amounted to $1,472.2 million. The total volume of debt-equity conversions in 1988 amounted to $6.2 billion, a figure that includes $2.6 billion of informal debt-equity conversions ([9], p. 89). These informal conversons include transactions negotiated directly between investor and borrower, without participation of the central bank, and without the right to repatriate capital and dividends.

Most DES in Brazil have been undertaken by foreign corporate investors in existing firms, to expand and technologically upgrade subsidiary operations. Initially transnational banks were involved in DES mainly as intermediaries providing financial services in the conversion of debt paper held by third parties, but later on they became more active in swapping loans from their own portfolio with the objective of investing in financial sector activities, especially in investment banking. The industrial sector accounted for 57 per cent of the total funds converted through the Brazilian auction mechanism in 1988, with four export-oriented subsectors, namely electronics, paper cellulose, machinery and capital goods, and chemicals and petrochemicals, accounting for more than a half of industrial sector swaps ([6], p. 54). Projects range from very small to investments of $50 million, with an average swap amounting to less than $4 million. This may indicate that DES have been used more for capitalization purposes than for investment in new production capacities. Fragmented data on additionality suggests that a number of projects, such as Dow Corning (glass) and Coats-Viyella (fibres), may be classified as "partly additional" investments. In both cases companies had already decided to invest. However, in the case of Dow Corning, the programme influenced the timing of the investment, while in that of Coats-Viyella, the programme influenced the investment location within Brazil ([6], pp. 54-56).

(c) Chile

The debt reduction programme of the Government of Chile was launched in 1985. The programme has been in many respects unique, has operated continuously without significant changes, and has been used extensively. From June 1985 to August 1989, the total volume of transactions under the programme amounted to $7,960 million. The country's total medium- and long-term debt was, however, reduced by a smaller amount owing to increased liabilities to official creditors, especially to multilateral finance institutions, which rose from $2.1 billion in 1985 to $4.6 billion in 1989 ([10], p. 62).

The debt reduction programme of Chile is composed of three main elements; provisions under chapters XVIII and XIX of the Compendium of Foreign Exchange Rules and provisions under Decree Law No.600(DL600). In contrast to chapter XVIII, which is aimed at returning flight capital and reducing external debt without remittance provisions, provisions under chapter XIX regulate those DES transactions which have all the main features of any other foreign investment. Their total volume amounted to $2,625 million between 1985 and 1989. Non-resident foreigners and Chileans can use these provisions either for new equity investments or for the purchase of existing assets. Initially all transactions were treated the same, but later preference was given to long-term projects involving job creation and exports.

As shown in table IV.3, forestry and pulp and paper have been by far the most important sector of Chilean DES under chapter XIX, followed by investments in financial services, manufacturing, agriculture and mining. The two largest DES projects approved so far in Chile have been the pulp projects Celulosa del Pacifico S.A. (Celpac) and Forestal e Industrial Santa Fe. Celpac is a Chilean corporation formed as a joint venture of Chile's largest paper company, Compañía Manufacturera de Papeles y Cartones, and Simpson Paper Co. of the United States. In the financial package of the $587 million project needed for the construction of a new pulp mill in Mininco, a five-bank syndicate participated with a $225 million DES, and Simpson Paper Co. converted another $60 million ([11], p. 107). The Forestal e Industrial Santa Fe project has involved again a strategic alliance of two transnational corporations and one bank. They joined forces for the acquisition of a half-completed paper-pulp mill and two forestry plantations. The total investment is in the range of $425 million, of which some $285 were financed with DES. In the consortium, Scott Paper and Shell contributed management expertise and part of the money required, while Citibank (United States) is taking the role of a "silent" partner interested in gradually reducing its Chilean exposure ([6], p. 67). These two forestry, pulp and paper projects plus some other big projects in this industry, in particular the $165 million investment of Carter Colt Harvey and a $135 million investment of Fletcher Challenge, both from New Zealand, are expected to contribute towards doubling the country's forestry products production by 1993. In 1988 Chile's exports of these products amounted to $730 million—10.4 per cent of total exports.

Besides investing in new projects, provisions under chapter XIX have been extensively used also for recapitalization of existing companies and for privatization of public enterprises. Some of the foreign companies that have used DES for strengthening the financial structure of their Chilean affiliates include Mitsubishi (Japan) and Unisys, Pepsi Cola, Abbot, Johnson and Johnson and Burroughs (all from the United States). An example of a foreign company participating in the privatization is the acquisition by Alan Bond (Australia) of shares in the privatized telephone company CTC. Foreign commercial banks have been active in converting debt into equity for their own account. Between June 1985 and June 1989, some $1 billion or 38 per cent of the total swapped under chapter XIX was done by banks, either for the shares in their Chilean subsidiaries, or for shares of local banks and other financial institutions. Banks have been active in using swaps for the acquisition of productive sector assets. Indeed, a specific mechanism of bank participation in the chapter XIX scheme is provided by multi-bank debt conversion funds.

The programme of Chile may be near its end, since only about $2.5 billion in commercial debt is available on the secondary market, and discounts on this market have fallen to less than 25 per cent ([12], p. 17; [13], p. 15). Moreover, Chile has been able, in 1991, to return to borrowing on a voluntary basis from international banks, albeit at wide margins. In assessing the DES programme of Chile in the past few years, there is no doubt that it has been very successful in reducing the country's external debt. The implementation of the programme has, however, been accompanied by two criticisms related to the structure of DES investments. Use of DES for privatization purposes, and especially sales to foreign companies, has created some public frictions with the argument that the price paid has seemed excessively favourable to the new investors. The other criticism is related to a high share of DES investments in forestry and other natural-resource-based industries. Their proponents have argued that DESs in these industries are an unjustified concession to foreign investors, and that equity conversions have crowded out fresh-money direct foreign investment. The argument about less than full additionality might be valid for some of the non-bank investors, but these projects have also attracted significant resources of banks that would not have gone to equity investments without DES provision. To address these two criticisms and to make the most effective use of the country's shrinking commercial debt, the Government adopted in 1991 new DES guidelines which give priority to entirely new investments and expansions of non-natural-resource-based projects.

Table IV.3. Chile: Sectoral breakdown of investments[a/]
(As of 30 September 1988)

Sector or industry	Amount (million dollars)	Percentage share of total
Forestry, pulp and paper	520.9	32.0
Financial services	202.3	12.4
Miscellaneous [b/]	189.3	11.6
Manufacturing	163.7	10.0
Agriculture	136.9	8.4
Mining	113.7	7.0
Fishing	96.5	5.9
Other services	75.6	4.6
Commerce and transport	65.7	4.0
Electricity, gas, water	43.4	2.7
Communications	22.2	1.4
TOTAL	1 630.2	100.0

Source: Francisco Garces, *Alternative Foreign Investment Mechanism in Chile: Recent Developments* (unpublished paper).

a/ Under chapter XIX of the Compendium of Foreign Exchange Rules.

b/ Including capital increases made by recipient enterprises activity of which is to carry out investment in numerous economic sectors.

(d) Mexico

The official DES programme of Mexico was formally launched in April 1986 and suspended after one and a half years of full operation, in November 1987, because of its adverse monetary and fiscal effects. During this period, an estimated $3.1 billion was authorized, while a large number of projects was left in the pipeline. Some of these were approved in 1988 and 1989, bringing the total volume of public debt converted between April 1986 and June 1989 to $3,938.2 million ([14], p. 76).

As a result of its 1989 debt reduction agreement by which, *inter alia*, creditor banks championed swaps, Mexico announced the resumption of a modified programme that limited DES to the purchase of up to 50 per cent of privatized companies and to the financing of approved infrastructure, in an effort to limit inflationary effects. Another modification was a strict limitation on DES volume to $3.5 billion from January 1990 to June 1993. Although scheduled for a three-and-a-half-year period, the programme had exhausted its limit in six months. Mexico accelerated its programme because the net inflow of direct foreign investment was lower in 1990 than anticipated, and because officials took advantage of attractive discounts, wanted to conclude the programme so that investors would not delay their investment plans waiting for DES, and expected that the price of Mexican debt on the external secondary market would increase during the following year, as confidence in its economy improved. The 1990 auctions led to an increase of public sector internal debt of $1.6 billion, but officials estimate that every dollar of converted debt will catalyze another dollar of investment, supporting at least $7 billion of investment through 1993 ([15], pp. 341 and 347).

The earlier 1986 Mexican DES programme was heavily investment-oriented. DES investment had received the same treatment as other forms of foreign investment, except with respect to capital repatriation and remittance of dividends. According to a relatively restrictive foreign investment law, in 1986 all new investments, including expansion of existing operations, required majority Mexican ownership. The chief exception was the *maquiladora* sector*, where 100 per cent foreign capital was allowed. The programme was initially open only to foreigners, but this restriction was circumvented by some domestic firms arranging deals through United States, Panamanian or Cayman Islands firms. Later on, Mexican firms also were authorized for DES transactions. The authorized purposes of the 1986 DES programme included the purchase of enterprises being privatized; repayment or prepayment of peso debt owed to Mexican banks; prepayment of obligations enrolled in the Foreign Exchange Risk Coverage Fund; payment to local suppliers for locally provided goods and services; and acquisition of capital stock positions in new or existing firms. However, the programme specifically banned payments for goods and services of non-national origin; payments for imports of inputs or capital goods; intercompany loan repayment; and provision of working capital.

*Special sites situated close to the United States border, offering firms special trading benefits into the United States market, as well as a large pool of rather low cost labour

There was a clear ranking of investment in terms of priority in the Mexican DES programme. Priorities were given to investments in privatization and new investments or expansions focused on exports, imports replacement, advanced technology, employee training, research and development. For investments in the highest-priority areas, debt redemption was at full face value, falling to a discount of 25 per cent of face value in the lowest category.

While the volume of Mexican DES in the period April 1986-June 1989 was only 6.5 per cent of the country's commercial bank debt in 1988, more than one third of the total volume of net direct foreign investment inflow in 1986-1988 was associated with debt-equity conversions. During 1987 this figure was close to 50 per cent, indicating that the scheme was much more successful as a direct foreign investment incentive than a debt reduction mechanism ([16], appendix table). Some 50 per cent of DES made between April 1986 and June 1989 flowed to the industrial sector, especially the automotive sector in which $630 million was invested ([14], p. 76). DES in the automotive sector can be classified as partly additional investments, since expansion plans were mostly in place in advance of the availability of the swap programme. Among the most frequently cited DES investors in this branch are the following: Volkswagen ($141 million); Chrysler ($100 million); Nissan ($60 million); Ford ($50 million); Daimler Benz ($25 million); and Renault ($15 million). Another important focus for DES in Mexico was the *maquiladora*, accounting for 11 per cent of the total DES concluded. Beside the automobile and *maquiladora* industry, which differ significantly in their investment patterns, government priorities have focused on metalworking and selected segments of electronics, agro-industry and pharmaceuticals.

(e) Philippines

The initial Philippines DES programme of August 1986 had two prime objectives, to stimulate investment inflow and to attract investment to designated districts, although reduction of the external debt burden and the repatriation of flight capital were also regarded as important. Most categories of public and private debt were eligible, and foreigners and nationals were eligible to participate. Preferred investment areas included export-oriented manufacturing and agriculture, health care, construction of low- and middle-income housing, and education; banking and privatization were added in February 1988. Some 397 transactions valued at $1,458 million were approved up to September 1989, but only $742 million were implemented because of the 1988 restriction on the conversion of government debt arising from high monetary growth and inflation* ([17], p. 32). Almost a half of the total volume of all transactions was funded by residents of the country, including 7 out of the 20 largest (see table IV.4), while foreign investors have included groups from the United States, which participated with 16.9 per cent in the total volume; China and Hong Kong, with 13.7 per cent; and Japan, with 8.9 per cent. Round-tripping and increased inflation have been strong arguments against DES in the Philippines.

*The programme was re-established at the end of 1990 with preferred areas to include the sale of State-owned firms and banks.

Table IV.4. Philippines: top 20 debt-equity conversions, end of 1989

Company or bank	Country or area of origin	Approved (million dollars)
Gokongwei group	Philippines	120.0
Bank of the Philippine Islands	Philippines	109.4
Benpres et.al.	Philippines	76.3
Henry Sy's Shoemart	Philippines	70.0
USI Far East	Taiwan Province	45.0
Team Holdings	Virgin Islands (U.K.)	35.0
Bank of Nova Scotia	Canada	30.0
Solid Cement	Philippines	29.2
First Bank of Boston	United States	26.0
Aboitiz companies	Philippines	25.4
Castle & Cooke	United States	23.6
Bank of Tokyo and Prudential Bank	Japan, United States	22.7
Benguet Corp. firms	Philippines	20.3
Joyoung	Hong Kong	19.0
Texas Instruments	United States	17.9
Pathfinder Holdings	Hong Kong	16.7
Intel	United States	15.0
BMC Marine	Hong Kong	13.3
Pecanola et. al.	Hong Kong	12.7
First Pacific Capital	Hong Kong	12.0

Source: *Far Eastern Economic Review*, 28 June 1990, p.79.

The DES programme has had a significant impact on foreign investment flows to the Philippines. From $140 million in 1986, net direct foreign investment in the country increased to over $600 million in 1988 when the programme was at its peak. In 1987 and 1988, over three quarters of these investments were transacted through DES ([17], p. 26). Although the question as to the number of investments made through DES which would have occurred anyway remains unanswered, it seems that the programme has been an important incentive in attracting equity investments. According to available information, the programme has in many cases stimulated investments, increased the size of already planned investment, or advanced their timing. The Philippine DES programme has also been successful in terms of policy priorities, with 87 per cent of all transactions being made under preferential schemes. Export-oriented projects and projects under the privatization programme have been predominant, and available information indicates that the industrial sector has received finance of over one half of this total. A significant volume of industrial DES has been done by semiconductors companies such as Intel Corporation, Advanced Micro Devices and Fairchild Semiconductors. Other branches have included food processing, pharmaceuticals, lumber and wood products, and particularly textile and garment production; two large projects financed partly through DES were a $138.9 million float-glass project and a $157 million polyester plant. Nevertheless, the programme has been used by industrial investors primarily to increase the capital of existing companies and for acquisition of shares. Deals of this kind are, for example, the $25 million purchase by Gokongwei of a sugar mill and a textile factory, or $45 million investment by USI Far East in a petrochemical plant ([18], p. 79).

5. *Further considerations of DES*

In Latin America, which has dominated debt-equity conversions, some 40 per cent of the total direct foreign investment flow to 10 countries was financed through this mechanism in the period 1985-1989, although less than 4 per cent of the external debt of the region was retired by using this mechanism in the same period. Thus DES programmes, which were the most important segment of all debt-equity conversions, have worked primarily as an incentive to direct foreign investment rather than as a mechanism for reducing external debt. The significant exception is Chile, which succeeded both in considerably increasing its direct foreign investment as well as in reducing its commercial bank debt to a major extent. The success of Chile in implementing its DES programmes was due in large part to its effective internal debt management. Despite the risk of some bias owing to imperfect data (only those DES for which the sectoral structure is available are taken into account), it should be noted that in the five surveyed countries, a total of $8.1 billion was converted in the period 1985-1989, as shown in table IV.5. As the table indicates, $4.4 billion or 54 per cent was the share of conversions earmarked for industry, which received funding from between 50 and 70 per cent of conversion proceeds in individual countries.

It should be emphasized that direct foreign investment encompasses externalities such as technology and skill transfer, and that such private investment in industry usually increased efficiency and competitiveness in domestic markets. Moreover, there was a strong export orientation in industrial DES, implying not only favourable balance-of-payments effects, but the production of relatively non-traditional industrial products of a quality to succeed in export markets.

Table IV.5. DES and the industrial sector in selected countries, 1985-1989

Item	Argentina 1988 a/	Brazil 1988 a/	Chile b/ 1985-September 1988 a/	Mexico 1986-June 1989 a/	Philippines 1986-June 1989 a/
Eligibility status of DES in industrial sector					
Eligible	x	x	x	x	x
Non-eligible					
Priority status of DES in industrial sector					
Explicit priority given to industrial sector projects				x	
Priority given to export-oriented projects	x		x		x
No priority		x			
Eligible DES investors and their actual activity in industrial sector projects					
Foreign companies	Eligible; very active	Eligible; very active	Eligible; very active	Eligible; very active	Eligible; very active
Foreign banks	Eligible; not active	Eligible; active	Eligible; very active	Eligible; not active	Eligible; active
Residents	Eligible; very active	Not eligible	Not eligible	Eligible; not active	Eligible; very active
Eligibility of DES uses and their actual application					
Financial restructuring and acquisition of shares	Not eligible	Not eligible c/	Eligible; very active	Eligible; active	Eligible; active
Investment in new capacities and/or new companies	Eligible; very active	Eligible; very active	Eligible; very active	Eligible; very active	Eligible; very active
Total value of debt converted (million dollars) (A) d/	310	1 472	1 630	3 938	728
Total value of debt converted for industrial sector projects (million dollars) (B) d/	220 e/	845 f/ g/	994 h/	1 969	364 i/
(B) : (A) (percentage)	70 j/	57 f/ g/	61	50	50 k/

Source: Various sources, including *Business International*, IMF, United Nations Centre on Transnational Corporations, as well as UNIDO country surveys and estimates.

a/ Indicates the period for which data on the sectoral structure of DES are available.
b/ Relates only to transactions under chapter XIX of the Compendium of Foreign Exchange Rules.
c/ Equity participation in debt conversion investment funds was allowed.
d/ Approximate figures. Includes implemented DES in Chile, Mexico and the Philippines as well as approved DES in Argentina and Brazil.
e/ Estimate computed from an approximately 70 per cent share of industrial swaps in total DES.
f/ Relates only to transactions carried out through auctions.
g/ Includes manufacturing and mining
h/ Includes manufacturing, natural resource sectors (mining, forestry, fishing) and a half classified as miscellaneous.
i/ Estimate computed from an approximately 50 per cent share of industrial swaps in total DES.
j/ Estimate based on the structure of total approved investment projects utilizing DES.
k/ Estimate.

It should also be noted that while there was an initial resistance to the linking of DES programmes in some of the surveyed countries to the privatization of State enterprises, such resistance has been eroded as countries have better understood the macroeconomics of swap transactions and the benefits to be gained through efficiency increases and subsidy cuts to State enterprises. A further externality of the DES programme, evident in Chile and increasingly so in other countries such as Mexico and Argentina, is the positive impact of the programme on overall investor perceptions. Lastly, changes in the ruling discount rate for DES transactions as these programmes succeeded have sent positive signals to the international financial community on Wall Street and in the City of London and Tokyo.

There is a considerable potential elsewhere in Latin America, as well as in other indebted developing countries, to use the successful elements of the programmes surveyed, modified where necessary, as an incentive for direct foreign investment, including investment financed through the return of flight capital.

There is an increasing awareness of the need to reduce the debt overhang, since this serves as a major disincentive to private investors in heavily indebted countries. Current rescheduling exercises have been inadequate in solving the problem of the overhang. However, in the context of market-based mechanisms for the alleviation of the debt problem, the initiative of United States President George Bush of June 1990 offers very considerable incentives for both domestic and foreign direct investment. The "Enterprise for the Americas" initiative calls for a comprehensive free trade agreement, a new investment programme to support and promote market reform, and legislation that will reduce that part of the debt overhang arising from past official United States lending to Latin America and the Caribbean. Elements of the initiative envisage the creation of funding directed towards the removal of impediments to private investment, and arrangements for the sale of past bilateral export and trade credits, with the funds from these sales to be used in DES or for environmental projects. Currently, DES programmes are propelled by the sale of external commercial bank debt, rather than of official bilateral debt. The United States initiative has the potential of making available considerable quantities of local resources since United States government loans to Latin America and the Caribbean amount to $12 billion. Moreover, if other members of OECD were to propose similar reductions, the positive impacts on the economies of indebted developing countries and on industrial investment in these countries would be even greater. The debt to official creditors of developing countries with recent debt servicing difficulties amounts to about $360 billion, comprising multilateral debt, bilateral official development assistance and export credits.

Since one of the important components of the United States initiative is the promotion of private investment, a suggestion is made here on a modification to the DES mechanism that would facilitate private investment in the small-scale and cottage industry sector in indebted developing countries. The suggestion is that debtor developing countries seek to repurchase at a discount their official debt from creditor Governments. The proceeds of these repurchases could be channelled through the domestic commercial banking system for investment in high-priority development activities, such as rural enterprises, and more generally in small-scale and micro-industrial enterprises. It would be important that a share of the discount be passed on to borrowers, to provide an incentive or subsidy to the type of private investment envisaged. The incentive to private foreign investment and especially export-oriented industrial investment in typical DES programmes has been justified above; the justification for a subsidy element or incentive in lending to small industrial and cottage enterprises is that it would promote entrepreneurial activity at the grass roots, and in providing considerable employment benefits it would alleviate poverty. It should be emphasized that, as noted in the discussion above of the pros and cons of DES, intermediaries who provide highly specialized expertise are required to facilitate DES transactions. It would be essential in implementing the suggestion above that arrangements be made to supply funds in a simple manner so as to limit overhead expertise costs.

B. Country funds in emerging stock markets

Problems of external indebtedness and government budget deficits and the need to integrate more effectively in the global economy have combined to emphasize the importance of organized domestic capital markets in many developing countries. Organized markets for corporate equity shares have a very considerable potential as an instrument well suited to corporate funding, privatization, large-scale debt-equity conversions and venture capital activities, and as a vital factor in promoting rapid economic growth. Although in Germany and some other developed countries such growth was based primarily on bank-supplied credit, equity markets have been much more important in mobilizing and allocating resources in the United Kingdom and the United States. In developing countries, equity markets have the potential to assist through the encouragement of savings, by directing savings into productive investment, including industrial investment, and through encouraging entrepreneurs in improving investment efficiency. Through equity markets managers can be made more accountable for the efficiency and performance of their firms.

Foreign portfolio investment flows into developing-country equity markets, of which country funds form an important part, amounted to more than $2.5 billion in 1989. This figure should be seen in the context of net direct foreign investment flows of about $22 billion, and new external commercial bank lending of $3 billion, in 1989 ([19]; and [21], p. 16). The potential of foreign portfolio investment can be found in considering that although the current sum of such investment in developing-country stock markets amounts to about $18 billion ([20], p.3; and [21], pp. 6-7), this sum has been rising sharply over the past five years. Major institutional investors, and in particular pension funds, controlled over $7,500 billion of assets in 1989 ([20], p. 12) part of the portfolio, albeit a small part, is reinvested each year. In addition, the fact that the pension funds have an additional $600 billion of "new money" (arising out of normal growth) to invest each year, gives an indication of the significant potential of this source of investment finance. Attracting annually only 1 per cent of this increase, or $6 billion, would be a valuable prize for developing country stock markets.

The other major reason for the importance of foreign portfolio investment and, in particular, country funds is that they can promote a country's investment profile in the international financial market-place. Thus it provides a highly visible signal to the investment community. This signal contributes to such crucial perceptions as that of the investment climate of a country. On the financial pages of the world's major newspapers daily indices are presented of the stock markets in such cities as Bangkok, Bombay, Jakarta, Hong Kong, Kuala Lumpur, Manila, Mexico, São Paulo, Seoul, Singapore and Taipei. It should also be noted that foreign investors have been willing to face various risks inherent in developing-country stock markets, including the risks of portfolio investment in highly-indebted countries such as Brazil, Mexico and the Philippines, and in low-income developing countries such as India.

This section of the chapter places country funds in the context of emerging stock markets, and briefly reviews the success of these funds. Country funds comprise about one half of foreign portfolio investment in emerging markets.

1. *Equity markets in developing countries*

Developing country capital markets have grown substantially in recent years. UNIDO estimates of this growth in the period 1980 to 1989 are as follows:

(a) Market capitalization of developing country markets increased from $149 billion to $700 billion, and their share in the total world stock market capitalization has risen from 5.4 to 6 per cent;

(b) The number of listed domestic companies in developing-country markets increased from 5,316 to 10,651, and their share in the total number of listed companies in the world from 25 to 36 per cent;

(c) The average daily value traded in developing-country markets increased about twentyfold, and their share in the total value traded in stock markets of the world increased from about 6 to about 16 per cent. Some 32 developing countries and areas have equity stock markets, although several of these are either embryonic or stagnant. Two of these markets, those of Hong Kong and Singapore, are regarded as developed, with a capitalization of $77 billion and $36 billion respectively (at the end of 1989), and these two markets are as open to foreign investment as the markets of New York, London and Tokyo. Two markets in East Asia (those of Taiwan Province and the Republic of Korea), with a capital valuation of $384 billion (at the end of 1989), or 55 per cent of the total for developing-country markets, dominate the remainder of developing-country stock markets. Brazil, India, Malaysia, and Mexico account for a further market capitalization of $140 billion. It is estimated that about 790 listed firms out of a total of more than 10,000 are of interest to the foreign portfolio investor. This interest is based on the liquidity of the stock of particular firms, the reliability of underlying company information, its timeliness, and whether insiders, rather than the public, have first use of this information ([20], p.24). Of these listed firms, about one half of them are estimated to be engaged primarily in industrial activities.

Domestic equity markets have to be developed in order to re-establish a better balance of debt and equity in developing countries. A broad range of constraints on equity market development in most of these countries has been reflected in a relatively limited supply of equities in the primary markets (where companies raise finance by selling new issues of shares), and through weak investor demand for equities in the secondary markets (where already issued shares are traded). Among the factors limiting the supply of equities in the primary markets are the following:

(a) Difficulties in setting the price of assets;

(b) The high cost of issuing equity in an economic environment in which strong enterprises may have access to often subsidized loan finance;

(c) The high share of family-owned companies;

(d) The reluctance to disclose information to the public;

(e) The preference of State-owned enterprises for relying on public funds;

(f) Lack of fiscal and other incentives, as in some countries where the tax treatment of a quoted company is harsher than that of a privately held company;

(g) Restrictions on foreign portfolio investment;

(h) Outdated company laws. For example, domestic individual investors are constrained by: lack of confidence stemming from the absence of sufficient information; lack of transparency with regard to accounting and auditing standards; and discriminatory taxes. Institutional investors in developing countries are constrained by: risk aversion to possible capital loss; lack of confidence stemming from absence of sufficient information; government policies inducing investment in alternative public instruments; lack of development of financial sector infrastructure and institutions; and lack of understanding with regard to equity market operation. Institutional weaknesses in both the accounting and the credit analysis capacity is an additional cause of the problems of insufficient supply and demand of equities*.

The markets** included in the IFC composite index of emerging markets have a total capitalization of $596 billion, or 85 per cent of all developing country markets. The IFC index is based on 651 stocks selected on the basis of liquidity, market capitalization and sector classification, the combined market value of which amounts to 54 per cent of the total capitalization of emerging markets. As shown in table IV.6, manufacturing is the most important economic sector in the IFC index, with 381 manufacturing firms capitalized at $145 billion, or with a weight of 44 per

*For more detailed discussion of the factors limiting supply and demand of equities in developing countries, see Paul Popiel, *Development of Money and Capital Markets* (World Bank-EDI, Washington, D.C. 1988), and *Capital Market Development in Asia-Pacific Region* (Manila, Asian Development Bank, 1986).

**In Argentina, Brazil, Chile, Colombia, Greece, India, Jordan, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Portugal, Republic of Korea, Taiwan Province, Thailand, Turkey, Venezuela and Zimbabwe

Table IV.6. Distribution of principal industries, end of 1989 (IFC composition Index)

Sector or industry	Number of stocks	Market capitalization (million dollars)	Weight (percentage)
Agriculture, forestry, fishing	18	3 463.7	1.05
Mining	37	12 023.1	3.64
Construction	21	10 467.0	3.17
Manufacturing	381	145 878.1	44.15
Transport, communications, utilities	23	10 558.8	3.[illegible]
Wholesale, retail trade	22	7 059.0	2.14
Finance, insurance, real estate	106	128 545.3	38.91
Services	11	2 880.7	0.87
Other, diversified holding companies	32	9 525.1	2.88
TOTAL	651	330 400.8	100.00

Source: *Emerging Stock Markets Factbook 1990*, (Washington, D.C., International Finance Corporation, 1990), p.35.

cent in the IFC index. It should be noted that the IFC classification of emerging markets includes Greece and Portugal; Hong Kong and Singapore are classified as having mature markets. The removal of Greece and Portugal from the classification and the inclusion of Hong Kong and Singapore would have the effect of decreasing the weight of the manufacturing sector in the IFC index to below 44 per cent. UNIDO estimates the market capitalization of all manufacturing firms in developing countries stock markets to have been at about $300 billion in 1989.

The IFC has focused on establishing private-sector financial institutions and securities-markets-based entities in assisting in the institutionalization of capital markets in a number of developing countries, in attracting foreign investors for investment in the equity markets of these countries, and in setting up country funds into which foreign money can be channelled to these markets. Foreign-portfolio investor interest in developing-country markets stems from a recognition of economic growth potential and low market capitalization. These markets are likely to grow in the long-run much faster than the developed markets; the perception of foreign investors is that these are attractive markets, despite economic problems and possible political instability in some of the countries. Price earnings ratios, although rising, are still low, especially in Latin America, and developing-country markets have been good performers, by and large outperforming well-established markets in the short as well as the longer run. In recent years more detailed and reliable information has become available, and foreign investor access to these markets is easier.

There are some domestic constraints on increased foreign portfolio investments in developing-country markets by investors from capital-exporting countries, but the main constraints are to be found in most developing countries themselves, and stem from market difficulties, such as volatility and illiquidity of still tiny emerging markets, low trading volume as a result of close family control over shareholdings, and an uncertain and sometimes over-speculative trading atmosphere. In addition, government regulations limit or make foreign equity participation difficult, because of fears of attracting inflows of "hot money", whereby foreign investors quickly buy and sell stocks leading to very high price volatility, as well as fears that foreign portfolio investors might end up controlling domestic corporations. For these reasons, the degree of openness to foreign investors varies considerably among emerging stock markets, although a general trend towards gradual liberalization is under way. At the end of 1989, Argentina, Hong Kong, Indonesia, Jordan, Malaysia, Singapore and Turkey were the only developing countries or areas with markets where foreign portfolio investors had free entry to listed stocks and free repatriation of capital and dividend income, while Chile, Costa Rica, Jamaica, Kenya, Mexico, Sri Lanka, Trinidad and Tobago, Thailand, and Venezuela allowed relatively free entry but with repatriation subject to various restrictions. The Philippines and Zimbabwe can be classified as relatively closed markets, allowing foreigners to invest in certain classes of specially designed stocks. Brazil, India, Republic of Korea*, and Taiwan Province permit foreign investment only through special country funds, while some other countries (Bangladesh, Colombia, Nigeria, Peru) are closed to foreigners ([21], p. 162).

2. *Country funds in developing-country markets*

Although there are several forms of foreign portfolio investment in developing countries, the most efficient and widely used form is that of country funds. Such funds are collective investment instruments or mutual funds (unit trusts in United Kingdom terminology), the main function of which is portfolio investment. Country funds, as well as other mutual funds, are

*The Government has decided to allow foreigners to make direct investments in the Seoul Stock Exchange from 1 January 1992.

found principally in two forms, closed-end funds, and open-end funds. Country funds generally focus on the stock market of a particular developing country or group of developing countries (multicountry funds).

Closed-end funds raise initial sums of money from investors through an issue of a fixed number of shares in a major market, and invest these sums in the securities of a particular emerging market or set of markets. Normally, the portfolio is thereafter actively managed in the emerging market, while the shares are simultaneously traded in one of the major world securities markets. Generally, shares are not redeemable at the option of the shareholders. The closed-end arrangement enables an individual investor to withdraw from a particular developing country without requiring that country to supply foreign exchange, since this holding is bought by another foreign investor. The country therefore needs to provide foreign exchange only for dividend remittances. Many country funds are closed-end, although in some countries open-end funds also exist. The main advantage of closed-end funds is the fact that they prevent "hot money" effects, that is, rapid fluctuation of share prices caused by the flow of money into and out of relatively small stock markets, while the disadvantage is that they require considerable scale to achieve the critical mass of capital that will provide liquidity on the secondary market of major stock exchanges. When listed in one of these exchanges, country funds become eligible for purchase by many foreign institutional investors whose policies and rules restrict them to investment on major stock exchanges. Public listing on a major stock market also facilitates investment by individual investors, who would otherwise find it very difficult to invest in developing-country markets.

The IFC has been the leading promoter of country funds for developing countries. Its promotional role and its role in the structuring of these funds have been even more valuable than its financial commitment which has been normally modest. Between June 1984 and October 1989, the IFC assisted in the formation of some 20 country or multicountry funds, and in 1988 the IFC was joined by the Asian Development Bank in these activities. Most valuable of all, however, has been the success of the IFC in promoting the country fund concept to the international financial community. Between 1984 and 1990, the number of closed-end country funds specializing in developing-country markets increased steadily from two to 120 (as of 30 September 1990), as shown in table IV.7. Moreover, as table IV.7 indicates, annual investment flows into

Table IV.7. Growth of closed-end country funds

Year	Number of new funds established	Resources mobilized (million dollars)
Pre-1984	2	325
1985	4	200
1986	5	727
1987	12	964
1988	18	1 541
1989	38	2 482
1990 (to end September)	41	2 639

Source: Calculated from *Lipper Emerging Markets Funds Service*, (New Jersey, Lipper Reports, Inc., 1990).

these markets from new country funds have risen sharply, with the inflow in the nine months to 30 September 1990 amounting to $2.6 billion. In addition, some 190 open-end mutual funds had been set up by 1990. These 310 country, multicountry, open-end and closed-end funds all have a very strong though not exclusive focus on these developing-country equity markets.

Institutional investors such as pension fund managers have great information needs in managing the huge volume of funds under their control. These information needs are met through a number of specialized publications such as *Lipper Emerging Markets Fund Service*, which provides a comprehensive information service, in particular to major institutional investors. For example, in the case of a country fund such as Brazil Fund Inc., it indicates the names of the managing and advising firms, investment objectives, underwriters, where quoted and listed, when launched, total net assets, structure, management and other fees, and tax information on the fund. Data are also given on price movements in recent years, the number of shares issued, market capitalization, dividend history etc., in addition to a summary portfolio analysis that provides data on the individual stocks in the country fund portfolio. The institutional investment manager uses this information to consider investment in a particular country fund, but the manager also receives important signals on investment confidence in that country, and on the strength of various industrial branches and firms. Such signals are important for the success of a particular country fund, and may also govern the interest of very active investment managers in other types of investment in that country. The identification of firms by name in the overall portfolio holdings represents a vote of confidence in these firms by usually influential investment managers and advisers who in effect provide a signal to the wider investment and trading community, including potential foreign joint-venture partners, as well as major industrial corporations in developed countries.

3. *Industrial investments in selected country funds**

The India Fund, the India Magnum Fund and the India Growth Fund were launched in 1986, 1989 and 1988, respectively. Total net assets of these funds stood at about $920 million on 28 September 1990. Under Indian law, foreign investment in domestic equities must be through special trust arrangements, and the Unit Trust of India, an Indian financial institution based in Bombay, has played a key role in setting up and managing these special trust arrangements. More than 95 per cent of the money attracted by these country funds have been invested in equity shareholdings in the industrial sector, with textiles attracting $192 million, the automotive industry $120 million, dyes and chemicals $67 million, basic metals $118 million, engineering $52 million and pharmaceuticals $30 million. The India Fund is listed on the London Stock Exchange, with daily quotations in the *Financial Times*. The India Magnum Fund is traded in Amsterdam and quoted in the *Financial Times*. The India Growth Fund

*Calculations based on data contained in [19].

is traded on the New York Stock Exchange and quoted daily in the *New York Times*, the *International Herald Tribune* and the *Wall Street Journal*. Among the Indian industrial firms the shares of which figure prominently in the portfolios of these country funds are Century Textiles, TELCO (automotive industry), Hindalco (basic metals), Gujarat Cement, ICICI (industrial bank), Indian Aluminium, Tata Iron and Steel, Bajaj Automotive, and Bhadrachalam Paper Boards.

The Indonesia Equity Fund and the Indonesia Capital Fund were set up in 1990 and 1989, respectively, and their total net assets stood at $68 million in September 1990. Industry has accounted for the bulk of their equity shareholding; significant sectors to attract attention have been building materials with a $6 million holding and textiles with $4.3 million. Among the important equity stakes of these country funds have been United Tractors, UIC (textiles), Petrosea (diversified industries), Indocement Tunggal Parakasa (cement) and Great Rivers Garment. Indonesia Equity is traded in London and Singapore and quoted in the *Financial Times*, while Indonesia Capital is traded in Amsterdam and quoted in the *Financial Times* and *International Herald Tribune*.

The Mexico Fund was established as long ago as 1981, while the Brazil Fund was established in 1987, both with the technical and financial assistance of IFC. In September 1990, total net assets of these funds amounted to $377 million, invested predominantly in the industrial sector. Branches of industry that appeared particularly attractive to fund managers included chemicals and petrochemicals with equity holdings valued at $38 million, paper and paper products at $34 million, and the textile industry at $19 million. In addition, development finance companies in Mexico attracted $55 million. Among the individual industrial firms to attract attention were Suzano de Papel e Celulosa, Aracruz Celulosa, and Kimberley Clark, all in pulp and paper, Cervecería Brahma (brewing), Metal Leve S.A. (automotive parts), Bimbo (consumer durables) and Grupo Condumex (electronics).

The stock market of the Republic of Korea is one of the developing-country markets most attractive to foreign portfolio investors. At least eight country funds of the Republic of Korea have been established in a growth process which accelerated in 1984 with the start of the Korea Fund. In the following six years, the Korea 1990 Trust, Korea Emerging Companies Trust, Korea Equity Trust, Korea Growth Trust, Korea Liberalization Fund, Korea Pacific Trust and Korea-Europe Fund were added. Given the interest of foreign portfolio investors in the economy of the Republic of Korea, individual funds are traded in Amsterdam, Hong Kong, London and New York. When the Korea Fund was established in 1984, only 336 firms were listed on the Seoul Stock Exchange, with a market capitalization of about $6 billion. By 1989, however, the number of firms listed had risen to 626, with a market capitalization of $140 billion. The growth in the number of firms listed and their market capitalization on the exchange reflected not only the growth of the economy, but also the success of government measures in persuading private owners to raise public equity on the market, and their success in fostering the growth of an over-the-counter market with less expensive and simpler regulatory procedures. The weight of the different sectors of manufacturing among the firms listed in Seoul can be estimated only very roughly, because the major firms on the exchange are diversified not merely across a wide range of manufacturing industries, but across many economic activities such as banking and financial services and media services. However, with this provision, upwards of 80 per cent of the portfolios of individual funds appears to be in the equity of primarily manufacturing firms. The total net assets of the eight country funds amounted to about $660 million in September 1990, of which more than $520 million were in manufacturing. In the largest fund, the Korea Fund, more than $190 million of its net assets of $240 million was in the equity of primarily manufacturing firms. Among the firms the names of which recur in the portfolios of these funds of the Republic of Korea are Samsung, Lucky, Hyundai, Daelim Industrial, Keum Kang, Cheil Food and Chemical, Ssangyong and Gold Star.

4. *Conclusions*

Very considerable sums of investment capital flow through the international financial markets. The bulk of these sums are destined for direct foreign investment or foreign portfolio investment in developed countries. Developing countries have attempted, with growing success, to attract a part of this internationally mobile capital for portfolio equity investment in their industrial enterprises. UNIDO estimates that between 1985 and 1989 at least $7.5 billion of foreign portfolio investment has been attracted to the manufacturing sector in developing countries. Several stock markets in the Asian region, including those of Bangkok, Hong Kong, Seoul, Singapore and Taipei have attracted a major share of foreign portfolio investment became of high rates of economic growth.

Apart from the markets of Hong Kong and Singapore, which are mature, country and multicountry funds have served as the basic financial mechanism in facilitating foreign portfolio investment in other developing-country markets, including the markets in indebted countries such as Argentina, Brazil, India and Mexico. In many of these country funds, including some of the largest such as the three Indian funds ($920 million) and the Korea Fund ($240 million), upwards of 80 per cent of assets have been in the shares of manufacturing companies. These funds have also served the purpose of identifying some of the star performers in developing-country manufacturing, and in introducing these firms to the international investment community, including the fund managers of financial institutions such as life insurance companies. As a result, some manufacturing firms such as Samsung from the Republic of Korea, and PT Indorayon and Indocement from Indonesia, as well as manufacturers from Thailand and Taiwan Province, have been able to issue convertible bonds or warrant bonds in 1990 and 1991 directly on major stock exchanges. So too has the Mexican company Telmex, the formerly State-owned telecommunications company, which raised $2 billion from international investors; in one of the largest ever international offerings of equity, some 800 million shares were issued by Telmex in New York.

C. Venture capital financing

Informal venture capital financing has deep historical roots, but it is only since the late 1940s that modern venture capital, that is, venture capital invested by specialist bodies, was invented in the United States. In fact, modern venture capital represents a formalization and institutionalization of high-risk-taking activity. Such venture capital financing in developing countries is only about 15 years old, but it has achieved a significant expansion in some countries, especially in developing Asia. What is at the core of this investment technique—in both developed and developing countries—is not the quantity of funds mobilized, but rather the quality of these funds, and the quality of the resulting investment. Typically, venture capital investment is targeted towards new enterprises, often involving new technology and indeed high technology, or towards corporate restructuring involving ownership and management changes in which existing assets, particularly industrial assets, are managed with a much increased efficiency. Furthermore, in line with the remarks made in the introduction to this chapter, the venture capitalist can play one of the purest private-enterprise and private-sector roles: the identification of potentially profitable business ventures, particularly industrial ventures. Critically, the venture capitalist selects winners and rejects losers, in an institutional setting where either personally owned funds are at stake, or in an incentive context where salaries, fees or other rewards are closely linked to efficiency and success in the market-place. Venture capital activities are high risk, but the rewards and penalties for success and failure are correspondingly high. The tests of success and failure depend on the market-place.

1. *Essential elements of venture capital financing*

Venture capital financing is medium- to long-term equity investment especially suitable for financing high-risk new business start-ups or expansions. The concept is based upon the identification of entrepreneurs with potentially marketable ideas and the contribution of a venture capitalist prepared to provide risk capital and expertise in certain management functions needed for the success of such joint ventures. It is the combination of the entrepreneur's business idea and the venture capitalist's advisory services in finance, strategic planning or management recruitment that provides the value added to a new company. In contrast to a commercial banker or other traditional financier who provides a loan for a specific project and is mainly concerned that the project generates sufficient cash flow to service the loan, a venture capitalist adds value to his investment through assisting entrepreneurs in the above-mentioned areas. In addition, traditional financiers require loan collateral to limit their risks. In contrast, venture capitalists' investments involve substantially higher risks since their clients normally lack tangible collateral; their investments are based on the growth and profit potential of the new companies in which they invest. Since a venture capitalist provides not only money to his investee, but also supplies management assistance, he actually becomes a partner in business ventures, including industrial ventures.

A significant change in venture capital investments in recent years, both in the United States and Europe, is a growing preference to invest in less risky management buy-outs and management buy-ins, particularly in those countries which have been most active in restructuring their industrial enterprises. Venture capital investment in management buy-outs of existing industrial firms offers reasonable returns over a time scale shorter than the five to seven years required for starting up new industrial enterprises. For example, in the United Kingdom, the share of buy-outs and buy-ins has increased from less than one third to almost two thirds of total investments between 1984 and 1988, with corresponding declines in start-up, other early-stage investments and expansion investments. This change in the structure of investment has been accompanied by a significant increase in the average size of investments, from £392,000 in 1984 to £1.6 million in 1988 ([22], p. 79). The situation in the United Kingdom was instructive. During the 1980s, the Government undertook a number of radical measures designed to create a more dynamic economy. These measures accelerated the privatization of State industries, contracted out municipal and provincial services, reformed trade unions, attacked restrictive trade and work practices, and abolished wage, price and foreign exchange controls. One significant result of the resulting so-called enterprise culture was the growth of management buy-outs and management buy-ins and the availability of funding for these activities. A significant broadening of the target of venture capital occurred in a recognition not only that financial success could be found through identifying the brilliant high-technology inventor, but also that the professionally trained manager employed in a large industrial company had a better chance of succeeding as an owner manager.

2. *Venture capital in developing countries*

(a) *Evolution and main players*

During the past 15 years, and especially during the 1980s, venture capital appeared in developing countries, influenced by the success of the industry in the United States and Europe. Over that period two factors were recognized to be of predominant importance for small business: the lack of financial resources and management skills, and the concurrence of the venture capital with the economic policy changes in developing countries during the 1980s, and the changed emphasis on entrepreneurship, privatization, and risk-taking. Moreover, there has been an increased recognition over the past 15 years, and particularly in the last 5 to 10 years, of the role of international competition, mobility of factors of production, and flows of technology and finance. Governments and business leaders in many developing countries have come to value flexibility of the industrial structure in a highly uncertain international environment as a matter of necessity. To achieve greater flexibility and efficiency of their economies, these Governments have shifted their development strategy from the public sector as the principal agent of development to the private sector, and to market signals as major agents and partners in development; part of this process has been an appreciation of the role of venture capital. In this context where banks dominate financial intermediation and where owner's equity hardly exists, venture capital financing has been seen as an innovation that can contribute toward mobilization of risk capital, domestic and foreign, for investment in innovative industrial projects undertaken by entrepreneurs with a sound business plan, but limited financial resources. Management services contributed by the venture capitalist are seen to be valuable, as is the potential contribution to technological progress and high-quality job creation.

The venture capital industry in a significant number of developing countries has been initiated in close cooperation with foreign capital, especially with IFC, and more recently the Asian Development Bank and the Inter-American Development Bank, as part of their efforts to assist the private sector. IFC begun funding its venture capital operations in 1978, with the objective that its initial venture capital activity in a country would serve as a model that would be independently copied by other investors. Between 1978 and mid-1990, IFC has assisted in the foundation and development of 11 venture capital companies, in countries such as Argentina, Brazil, Côte d'Ivoire, India, Kenya, Malaysia, Philippines and Republic of Korea. Its funding contribution has been relatively limited, from zero up to 20 per cent equity shareholding, so that although IFC has helped to create and develop all these venture capital companies, its financial participation as a shareholder has been rather low. IFC participation has, however, attracted other foreign investors, which have in some cases taken up over 50 per cent of total funding. The Asian Development Bank has become increasingly involved in venture capital activities, with eight investments in this field since 1987, although its first venture capital investment of $960,000 took place in December 1983, when it helped set up the Korean Development Investment Corporation. It has assisted in India, Pakistan, Philippines and Republic of Korea and in two regional funds. With $20.29 million invested in these companies*, the Asian Development Bank has helped newly established funds attract around $100 million from other sources, both domestic and foreign. Most recently, the Inter-American Investment Corporation was formed by the Inter-American Development Bank, to promote *inter alia* venture capital financing in Latin America and the Caribbean. Besides the multilateral financial institutions, a number of bilateral development finance agencies, including the Commonwealth Development Corporation of the United Kingdom, the German Finance Company for Investment in Developing Countries as well as transnational corporations, banks, institutional investors and the largest venture capital funds from the North, have been active in venture capital creation and funding in developing countries. Despite the importance of foreign funding for venture capital activities in developing countries, these activities still largely depend on domestic resources. Venture capital financing can be seen as a mechanism for both foreign and domestic resource mobilization. This is particularly important for those developing countries whose macroeconomic performance does not stimulate direct foreign investment.

*Data provided by the Asian Development Bank.

As a part of their policy to encourage the development of small- and medium-scale enterprises, Governments in a number of developing countries have started to provide financial resource to entrepreneurs with some elements of the venture capital concept. Governments have usually created specialized companies or funds with the main purpose of promoting entrepreneurial activity, or exporting, or fostering regional development, or creating new jobs. Profit has always been a lower-priority objective, and resources provided to investees have seldom taken the form of equity investment but often the form of loans, sometimes on concessional terms. Besides direct government funds, which have been of major importance for the development of the venture capital industry in some developing countries and areas, such as the Republic of Korea and Taiwan Province, and to a lesser extent, Singapore, the other mechanism used for providing risk capital from public domestic resources has been the setting-up of subsidiaries by development banks. In Brazil, for example, the State-owned National Development Bank established the subsidiary BNDESPAR in 1982 with the objective of providing equity finance, including venture capital financing, for Brazilian enterprises ([23], p. 126). In Indonesia, one of the non-bank financial institutions, Bahana Pembinaan Usaha Indonesia (Bahana), has been permitted to conduct venture capital transactions. Bahana, which is 100 per cent government-controlled, was established in 1973 as a holding company assisting small enterprises in the framework of national development efforts. Later on, in 1985, the company was transformed to give it the structure and attributes of a venture capital company (its debt-equity ratio shifted heavily in favour of equity). Since then, the investee profile of the company has changed significantly, with an increased emphasis on investment in manufacturing at the expense of agro-business. However, the company is still fighting with the lack of financial resources and high project costs. In 1990, Bahana initiated negotiations with foreign partners to create a venture capital joint venture with paid-up capital of at least 15 billion rupiahs ([24], p. 72). India provides another example of a risk capital scheme created already in the 1960s by the public sector. However, the country's first venture capital company in the private sector, Credit Capital Venture Fund, was established only recently with the participation of the Bank of India, India's second largest commercial bank. Banks are also the main sponsors of all 17 companies in the Philippines, which provide equity financing, very often in combination with some other instruments, such as loans, leases and working capital finance.

In spite of a growing importance of venture capital financing in developing countries during the 1980s, the volume of the industry, measured by the venture capital pool and number of venture capital firms, is still very limited, both in absolute terms and in relation to the level of its development in the United States and the United Kingdom. The industry exists today in about 15 developing countries, while most developed countries have introduced this form of financial and management assistance to small entrepreneurs. Table IV.8 indicates that in 1985, developing countries have participated with around 1 per cent in the global venture capital pool, and with less than 4 per cent in the

Table IV.8. Estimated 1985 data on national venture capital industries [a]

Country	First year	Number of venture capital companies	Committed capital: Million dollars [b]	Committed capital: As percentage of GDP
United Kingdom	1945 [c]	100 [d]	2 400	0.054
United States	1946	500 [d]	19 600	0.049
Canada	1962	50 [d]	1 300	0.042
France	1972	15 [d]	770	0.016
Japan [f]	1972 [c]	80	1 000	0.007
Sweden	1973	200 [e] [d]	400	0.040
Republic of Korea	1974 [c]	4	11	0.001
Germany, Federal Republic of	1975 [c]	35	500	0.008
Spain	1978	10	50	0.003
Brazil	1979	3	200	0.009
Philippines	1980	17 [e]	5	0.001
Netherlands	1981	30	1 000	0.080
Kenya	1983	1	1	0.001
Australia [f]	1984	11	80	0.005
Malaysia	1984	1	5	0.001
Singapore	1984	1	6	0.002
Argentina [f]	1986	1	10	0.001
India [f]	1986	4	35	0.001

Source: Peter Wall, "Venture capital activities in selected countries: another look," mimeograph (Washington, D.C., IFC, 1986).

[a] Venture capital here is used in a broad sense, including some institutions providing term finance for small businesses in addition to equity.

[b] At end-1985 exchange rates.

[c] Initially formed as government-sponsored small-business lending mechanisms, with equity finance usually coming later.

[d] An even larger number of additional institutions could be considered "venture capital firms", given only a slight shift in definition.

[e] Legally incorporated, of which only a much smaller number are active.

[f] Figures shown are for mid-year 1986.

global number of venture capital firms. An important indicator of the significance of the venture capital industry in a national economy is also the volume of venture capital as a percentage of GDP. These figures were in general much higher for developed than for developing countries in 1985, and the situation has not changed significantly since then. According to more recent data, the venture capital pool of developed countries and areas exceeded $50 billion in 1988-1989 (United States, $27.4 billion in 1988; Europe, $19.6 billion in 1988; and Japan and Australia, $6.2 billion in 1989). For developing countries reliable data exist only for Asia ([25], p. 1; and [26], p. 38). From a small and negligible pool of venture capital funds at the beginning of the 1980s, the industry increased to an estimated volume of $3 billion to $3.3 billion in 1989. Figures for some of the Asian developing countries and areas are as follows: Hong Kong ($1 billion), Republic of Korea ($900 million), Singapore ($350 million), Taiwan Province ($250 million), Thailand ($50 million). Country data for the venture capital industry in Africa and Latin America are not available, but on the basis of numerous interviews it is estimated that these two regions have been relatively passive in developing this form of equity financing. Consequently, the venture capital pool of Asian developing countries participates with a dominant share in the total venture capital pool of all developing countries of the order of $4 billion in 1989, that is, around 7 per cent of the total funds of the venture capital industry in the world. The increasing share of developing countries in the global venture capital pool since 1985 is exclusively the result of the fast-growing venture capital industry in the above-mentioned Asian developing countries.

(b) Problems

Many obstacles have prevented the growth of venture capital activities in developing countries despite the need for equity finance to balance risk and return, and despite government efforts to promote the private sector through an encouraging policy framework. The major obstacle in most developing economies excluding Hong Kong, Republic of Korea, Singapore and Taiwan Province, has been weak macroeconomic performance. But an adequate macroeconomic performance, though necessary, is by itself not sufficient to foster the growth of venture capital, and hence to obtain the quality improvements to industry that venture capital can bring. The point has been made already that the success of venture capital activities depends significantly on the availability of an adequate divestment mechanism, and this poses a second important obstacle. Venture capital companies have at their disposal a relatively small pool of resources in developing countries. Unless these funds can be revolved, funding for investment in new opportunities soon dry up. There has to be a market where locked-in capital can be released for new investment. Securities markets in most developing countries are either non-existent or underdeveloped. The alternative is to sell to a more powerful corporate buyer, but this poses the problem that such buyers are few in number, and also there are valuation problems since the market is small. Most important, perhaps, is the fact that without an adequate divestment mechanism, government- and IFC-supported model venture capital companies will not be copied by the private sector.

For the above-mentioned obstacles to be overcome, the initial step is usually for the government to initiate special programmes of financial support, such as the provision of loan finance, full or partial guarantee schemes, and direct equity investment, in order to nurture fledgling venture capital operations. Subsequently, the government role is also crucial in providing tax incentives and a viable legal and regulatory environment for venture capital activities. The strong dependence of these investments on the fiscal climate has been confirmed in numerous developed countries and in a number of Asian developing countries. Governments have succeeded in promoting the growth of venture capital activities through fiscal measures, such as tax deductions for capital subscribed for venture capital purposes (Australia, Canada, France, United Kingdom), tax reliefs on dividend payments by venture capital-supported enterprises (Brazil, Netherlands, Republic of Korea), reduction of capital gains taxes (United States), reduction of corporate taxes and an allowance for capital losses from one investment to be set off against capital gains on other investment (United Kingdom) ([27], p. 15). However, in many developing countries, tax systems still discriminate against equity financing, for example through the double taxation of dividends or through no indexation of capital gains. It cannot be too highly emphasized that where a country is serious about the promotion of venture capital financing, it is necessary to design special legislation in the area of tax policy and to develop a legal and regulatory framework that specifically aims at promoting venture capital transactions, as in the case of the Republic of Korea and Taiwan Province. Fiscal incentives must be provided to facilitate the high-risk operations of venture capital firms, and investment policy measures aimed at attracting foreign investment must be introduced. Non-financial government support for the entrance of newcomers in the business may be channelled either through the provision of financial advisory services, such as accounting, or through the provision of technical, marketing, legal and other business advisory services. The Asian Development Bank has identified a number of other obstacles, including a tendency of venture capital investors to equate venture capital with high-technology, ignoring low-technology and "appropriate" technology areas (agribusiness, aquaculture, horticulture, and services in Asia), the conservative and inward-looking business culture and practice prevailing in some business communities, a preference for short-term investment, and a preference for collateral-based financing by domestic banks ([28], pp. 31-39). These obstacles have been identified in the Asian region, although this region has had far more experience and success with regard to venture capital than Latin America or Africa. Moreover, Latin America and Africa have also faced the additional major obstacle of poor macroeconomic management and performance.

3. *Brief survey of venture capital industry in selected East and South-East Asian countries and areas**

(a) Republic of Korea

Republic of Korea venture capital is deeply rooted in government-sponsored research and government programmes to support small business activities. Venture capital activities were initiated in 1974 with the establishment of the Korea Advanced Technology Corporation to commercialize research and development results of public research institutes. At the beginning of the 1980s, venture capital activities accelerated with the incorporation of three technology development finance corporations, the Korea Technology Development Corporation, the Korea Development Investment Corporation and the Korean Technology Financing Corporation. These institutions, founded on the initiative and strong support of the Government, focused on the domestic small- and medium-scale enterprises sector, with the intention of increasing the technological capability of industry of the Republic of Korea. Further measures were taken to support venture capital in 1986, when the legal framework for the venture capital industry was strengthened by the enactment of laws to provide favourable financing and tax treatment for small business and encourage formation of new venture capital companies. In April 1987, an over-the-counter equity market was introduced, facilitating trading in company shares. Such promotion measures had by the end of 1989 led to the growth of approximately 33 venture capital firms and a venture capital pool of $900 million ([29], p. 40).

The venture capital industry of the Republic of Korea, working in cooperation with Japanese and United States high-technology firms, has invested heavily in manufacturing and especially in high-technology. By the end of 1987, the Korea Development Investment Corporation had invested 10,454 million won, with its largest exposure in electronics (32.6 per cent of the total), followed by metal fabrication and machinery (18.5 per cent), and chemicals and plastics (14.3 per cent). The manufacturing sector has a priority status also in the investment strategy of the Korea Technology Development Corporation. It had provided funding, by the end of 1987, of $408 million to 1,083 projects, in the form of venture equity capital as well as leasing, factoring or other financial arrangements. In the four years to the end of June 1987, the Korea Development Investment Corporation had received 933 new business proposals, of which less than 5 per cent had actually been accepted. The record of the Corporation at that time included one portfolio investment listed on the Korea Stock Exchange, 25 operating as planned, four having recovered with Corporation assistance after experiencing serious troubles, two near but recovering failures, four sold at a moderate profit, and three with severe problems to be written off.

*The survey relies heavily on information and data from *Venture Capital Financing in the Asia-Pacific Region* (Manila, Asian Development Bank, 1988) and from Wendy Todd Buchanan, "Venture capital funds a special survey", *Singapore Business Review*, January 1989

(b) Singapore

Venture capital activities started in Singapore at the beginning of the 1980s, but before 1983, there were only two active players in this field, the Development Bank of Singapore and the National Iron and Steel Mills. The latter launched a corporate venture capital investment programme in 1981 through a wholly owned subsidiary which invested primarily in United States-based high-technology enterprises. In 1983, the South-East Asian Venture Investment (SEAVI) programme was initiated, leading to the swift creation of three related venture capital funds. Two of these, South East Asia Venture Investment Company (SEAVIC) and Venture Investment (Singapore), Ltd. (VIS), were based in Singapore, while the third, Malaysian Ventures Berhad (MVB), was based in Malaysia. The Singapore venture capital industry benefited greatly in 1986, when tax and legislative concessions for venture capitalists were provided, especially for their investment in high-technology sectors. Furthermore, the Economic Development Board established the Venture Capital Fund aimed at venture capital investment in those foreign firms that offer unique technologies and hold potential for future development in Singapore. This orientation clearly indicates another important pattern of the country's venture capital industry, that is an outward-looking investment strategy. In the context of this strategy, Singapore has made a further step in the development of its venture capital industry. One of its venture capital companies, Transtech Ventures, launched in 1989, jointly with Techno-Ventures of Hong Kong, a new venture capital firm, Transpar Venture Management, which would have a regional rather than country orientation.

As a result of the 1986 economic policy incentives and the formation of the secondary stock market in January 1987, Singapore had, by the end of 1989, 10 venture capital funds with an investment pool of over $350 million, and these figures have increased further in the last two years. Capitalization of all funds with one exception has been at the level of between $10 million and $56 million. Beside funds financed by solely public or private capital, there are also venture capital firms funded from both sources, although investment objectives differ between public and private investors.

Available data on the sectoral structure of investments of venture capital companies clearly indicate a focus on high-technology investments. As shown in table IV.9 out of 16 Singapore companies with venture capital fund participation, 12 are classified as high-technology, 2 as middle-technology, and 1 as low-technology investments. As far as structure by branches is concerned, the allocation of $53.25 million invested by VIS (part of SEAVI) and Transtech shows the highest share for communications at 32 per cent, followed by computer hardware and software at 20 per cent, electronics at 12 per cent and the semiconductor industry at 9 per cent.

Table IV.9. Singapore companies with venture capital fund participation

Company	Fund	Remarks
Amtek Engineering Ltd.[a]	VIS I/Transtech	Mid-tech/profitable
CSA Research Pte Ltd.	Transtech	Hi-tech/transfer of technology
Electro-Magnetic (S) Ltd.[b]	VIS I/Transtech	Hi-tech/profitable
Esco Group	Transtech	Hi-tech/revenue
Kompac Technology Pte. Ltd.	Transtech	Hi-tech/start-up
Medi-Rad Associates Pte. Ltd.	VIS I	Hi-tech/profitable
North Atlantic Industries (S)	VIS I	Hi-tech/transfer of technology
PBIX Consultancy Pte. Ltd.	VIS I/Transtech	Hi-tech/revenue
Proteq Technologies Pte. Ltd.	Transtech	Hi-tech/start-up
Research Pacific	VIS I	Hi-tech/start-up
Sun Industrial Coatings Pte. Ltd.	Pica	Mid-tech/profitable
Tai Wah Holdings Pte. Ltd.	Pica	Low-tech/profitable
Teledata (S) Pte. Ltd.	VIS I	Hi-tech/profitable
Transnational Express Courier Service Pte. Ltd.	VIS I	Service/profitable
Unitrode Electronics (S) Pte. Ltd.	VIS I	Hi-tech/transfer of technology
Venture Manufacturing Singapore Pte. Ltd.	VIS I	Hi-tech/start-up

Source: Wendy Todd Buchanan, "Venture capital: a special survey", *Singapore Business Review*, January 1989, p.18.

Notes: Details of companies in which Venture Capital Fund (Economic Development Bank) has participated are not available. This list does not include corporate venture capital transactions.

Hi-tech = high technology

Low-tech = low technology

Mid-tech = middle technology

[a] Listed on Sesdaq in 1987.

[b] Listed on the Stock Exchange Main Board in April 1988.

The Singapore venture capital industry is characterized by a low failure rate, as a consequence of its preference for financing later stages of industrial enterprise development. On average, only 26.4 per cent of funds managed by SEAVI, Transtech and Elders Pica has been invested in company start-ups. Against this background Elders Pica has also preferred larger equity participation in fewer investee companies, and seeks an investment time frame of three to five years. At the end of 1987, the investment portfolio of Elders Pica consisted of four investments in place and one commitment. Three of the investments relate to the manufacturing sector, in Australia, Malaysia and Taiwan Province, while the remaining two equity participations have been made in distribution companies in Hong Kong and Singapore. Strong outward orientation has also been followed by Transtech and SEAVI. They have invested a significant proportion of their portfolio outside Asia, especially in the United States, mainly for transfer-of-technology purposes. The representative businesses of SEAVI and Transtech in foreign companies include investments in voice and data multiplexors for private lines, fault-tolerant computers for on-line transaction processing, electronic first-class mail distribution services, terminals for point-of-sale credit card authorization and data capture, computer disk drives, lithotripters for the treatment of organ stones, and point-to-multipoint communications.

(c) Taiwan Province

"Regulations Governing the Administration of Venture Capital Investment Enterprises", enacted in 1983, offered various tax incentives for investors, including a favourable income tax rate, "pass through" of capital gains, a tax holiday and foreign tax credit for overseas investment, investment tax credit, tax deferment on stock dividends, retention of excess retained earnings, and 80 per cent exclusion of return on investment. The Government, which has played a strong role in initiating the industry, has seen venture capital investment as an instrument for the purchase of foreign technology, for fostering the growth of the domestic high-technology sector, and for restructuring the industry of the country. The Regulations give priority status to energy technology, production automation, biotechnology, new materials technology, food technology, laser/optical fibre technology, prevention of hepatitis and information technology.

The key role of the Government in the establishment of the venture capital industry in Taiwan Province illustrates the fact that prior to 1986 there were three institutions providing venture capital, the Bank of Communications, the Development Fund of the Executive Yuan and the China Development Corporation, and all of them have been in close association with the Government. In 1985, the Bank and the Development Fund initiated a $28 million fund for co-investing with private investors, domestic and foreign, in new venture capital firms, and the first investment of this fund in Taiwan Province was equity participation ($10 million) in the HanTech Venture Capital Company, the two investment priorities of which were to invest in United States-based technology companies and in Taiwan Province. Two years later, another five venture capital companies had been established, with a mix of public and private investors and with investment strategies ranging from balanced portfolios to export of venture capital to small high-technology United States firms that may wish to begin commercial production in Taiwan Province. These investments represent one way to purchase new technology, with considerable domestic externalities.

(d) Hong Kong

The first venture capital company in Hong Kong, Inter-Asia Management, was established already in 1973 with an initial investment of $0.5 million. More recently, the Hong Kong Venture Investment Trust was established in 1986 and the Hong Kong Venture Capital Association in 1987. It is estimated that about $1 billion was held by Hong Kong venture capital firms at the end of 1989 ([29], p. 41) at which time that area held the largest venture capital pool among developing countries and areas. The main factors behind this expansion seem to be strong economic growth, a highly developed financial infrastructure with an established stock market, and the regulatory freedom required to stimulate entrepreneurs to take risks associated with venture capital investments. The Hong Kong venture capital industry, however, differs significantly from that of other East Asian countries and areas in a number of aspects. There has been no specific government support or tax incentive to encourage investment in high-technology projects and in start-ups in general. As a result, it is not surprising that venture capital invested within Hong Kong has focused on activities where the country has had comparative advantages, that is, in traditional manufacturing. It is estimated that only 10-30 per cent of the venture capital under management of Hong Kong firms have been invested there, with the remainder invested either in other Asian countries and areas, especially in China, or in developed countries, especially in the United States. While projects in the manufacturing sector have attracted Hong Kong venture capital for investment in China and Hong Kong itself, investments located in developed countries have been focused on high-technology projects and have been driven by transfer-of-technology incentives. The Hong Kong Venture Investment Trust, for example, is clearly following this investment strategy. Of its $22 million capital, 60 per cent is to be invested in Hong Kong and China and 40 per cent in the United States and Europe, in companies that have the potential to establish commercial production in Asia. The company had made, by the end of 1987, 15 investments, 9 of which were in the United States and Europe. The investments have gone to the following areas: photoresist technology, computer-aided process engineering products, health services, digital microprocessor-based appliance controls, protein analysis, telecommunications hardware and software, computer aided audio production and medical equipment.

4. Conclusions of country and area surveys and further considerations on venture capital

The experience of Hong Kong, Republic of Korea, Singapore and Taiwan Province are directly relevant to the potential of venture capital activities in other developing countries. All four countries and areas have provided a stable macroeconomic environment and have active stock markets, and the growth of their venture capital industries has been facilitated by the creation and growth of secondary stock markets. Substantial differences have been observed however in the roles of their Governments in directly initiating and developing the venture capital industry. On the one end of the spectrum are Republic of Korea, Taiwan Province and to a lesser extent Singapore, where Governments have taken a decisive role in establishing and promoting venture capital development, with government or government-assisted finance institutions establishing the venture capital model. In these three countries and areas Governments have strengthened the legal framework governing the venture capital business and provided favourable tax treatment and various forms of non-financial assistance. At the other end of the spectrum is Hong Kong, where practically no specific government support has been given as a means of encouraging vent· ·e capital investment in emerging businesses.

As in developed countries, there is a strong preference of venture capital to invest in the industrial sector, and especially in high-technology projects. Although comprehensive data on the sectoral structure of venture capital investment in the four countries and areas, accounting for about 60 per cent of the total venture capital pool of developing countries in 1989, are not available, information gathered from scattered sources suggests that, on average, roughly one half of total investments has gone for projects in the industrial sector. In the Republic of Korea, Singapore and Taiwan Province there has been a strong orientation of venture capital business towards high-technology industries, with the intention that such development would be a valuable catalyst in the restructuring of their domestic industries away from traditional labour-intensive industries and towards higher-value-added output. While the focus of the venture capital industry in the Republic of Korea has been the domestic development of technology and its commercialization, in Singapore and Taiwan Province more emphasis has been given towards investment in United States-based technology companies. Also, in Hong Kong one part of venture capital investment has been oriented into foreign high-technology-oriented firms, while the other segment of the venture capital flows of this area has consisted of investment in traditional manufacturing sectors within Hong Kong and in China. In recent years, Taiwan Province has also eased restrictions on investments outside the high-technology industry.

The issue of fostering high-technology small-firm start-ups, is common to the four surveyed countries and areas, to the United States and to Western Europe. The economic context of Hong Kong, Republic of Korea, Singapore and Taiwan Province is, however, different from that of mature economies of Western Europe, from the economies in transition in Eastern Europe and the USSR, and from developing economies elsewhere. Generally, in Western Europe, especially in the United Kingdom, a major issue was how to inject economic dynamism into mature, perhaps sleepy industrial and other economic structures in the 1980s. Venture capital has played a key role in facilitating this process, by acting as a mechanism for industrial structural change, that is, management buy-outs and management buy-ins, and more generally in applying financial engineering techniques in enterprise restructuring. In many developing countries as well as in the countries of Eastern Europe and the USSR, the high-technology issue is relatively minor, and less relevant. The major issue for them is making often heavily protected State-run industrial enterprises more efficient and dynamic. Many Governments have decided to accomplish this through privatization. There can be an important role for "venture-capital-like activities" in this process, using variations in management buy-out and management buy-in arrangements, with funding provided through finance engineering techniques. It is important that these variations incorporate measures to alleviate the valuation problem. In many of these countries markets are grossly distorted since there are often only a small number of buyers, and valuation of industrial assets poses difficult problems with little chance of perfect solutions; second-best solutions may be the most that can be hoped for. Many of these countries have begun to seek instruments through which efficient privatization can take place, and while "state-of-the-art" solutions will not be possible, venture-capital-like-activities can contribute to solutions that are realistic. What is at issue here is that in many countries there is a pressing need to restructure and privatize industry. State entities often require to be split up, some parts closed and other parts expanded, product designs and product process upgraded, new markets sought, new suppliers and trading partners identified and contacted etc. In this context, the employee-led buy-out in June 1990 of the fertilizer firm Exxon Chemical Pakistan Ltd. (with an annual capacity of 270,000 tonnes) has significance for the future, not only in Pakistan but also in other developing countries. Reportedly the first deal of its kind in the developing world, the parent company Exxon Chemical sold 27.8 per cent of its equity in its subsidiary to a group of investors led by employees and an employees' trust; IFC acquired 15 per cent; the Commonwealth Development Corporation, the United Kingdom development finance agency, acquired 10 per cent; the Asian Finance and Investment Corporation, 7.5 per cent; and Pakistani institutions, 14.7 per cent. The remainder of the equity holding is held by the public in Pakistan ([30], pp. 37-38). Reportedly also in Pakistan, as a result of this successful buy-out, the managers of the State-owned Allied Bank of Pakistan have made a buy-out proposal to the Government of Pakistan, and senior employees of a number of other State-owned enterprises are hoping to use the fertilizer buy-out as a privatization model ([30], p. 38).

Some managements in industrial enterprises in developing countries, and in countries of Eastern Europe and the USSR, do have the capability to own and efficiently manage productive structures split off from State-owned industrial conglomerates. In these countries privatization has been decided upon in principle, but the financial mechanisms and measures still have to be developed, that is, a financial infrastructure, comprising the network of specialized financial institutions, accountancy bodies, a regulatory regime, specialized legal services and codes etc. Technical assistance can play an import role in developing this financial infrastructure.

D. Lease financing

With the objective of mobilizing resources for industrial investment, developing countries have found equipment leasing as an attractive financing mechanism. Moreover, equipment leasing addresses a shortcoming of financial institutions and markets in developing countries: it provides a source of investment finance for smaller and less-well-established industrial enterprises often excluded from other sources. The private owners of such industrial enterprises are often the most dynamic entrepreneurs in developing countries, and it is largely upon their efforts, successes and failures that a country's industrial development achievements depend. Indeed, these entrepreneurs are often responsible for the foundation and growth of a productive industrial culture, as shown in the successful economies of East and South-East Asia.

1. Main forms of the leasing mechanism

Leasing refers to a transaction where the lessor (owner of the asset) conveys the use of equipment to a lessee (client) who has a contractual obligation to pay lease rentals at regular intervals to the lessor over a given period. The payments are usually fixed, but may be tailored to the needs of the lessee (for example, lower payments in the first years of the lease term). The main feature of a lease is that the lessor retains legal title to, that is, ownership of, a capital good, and that ownership is separated from operation. Leasing is especially attractive for small-scale industrial enterprises, since it reduces dependence on, or may altogether avoid, bank collateral requirements that discriminate against fast growing or less-well-established industrial companies. Leased assets include machinery and industrial equipment, computer and business machines as well as all types of transport equipment.

There are two principal forms of lease arrangement which have significantly different effects on accounting treatment, legal rights and price of rentals. The first one, financial leasing, is essentially a financial transaction with the economic substance of a secured loan. The main purpose of a finance lease is to provide term funding for the use of a capital good over the major part of its useful life. Thus leased equipment is fully amortized over the period of the lease, so that the lessor recovers the cost of equipment, interest, and a profit for services. The arrangement may embody an option for a lessee to purchase the leased equipment on expiry of the period, or to operate it further at a prearranged price. In all industrial use aspects, the lessee is effectively the owner and is responsible for insurance and maintenance. The lessee bears any risk for physical loss or economic and technical obsolescence. Thus the lessor retains legal ownership and the lessee economic ownership throughout the lease period.

In contrast, the operating lease is a short-term transaction whereby the lessee acquires the use of equipment for a portion of its useful life. Computers and cars are very often leased under operating leases. With operating leases, equipment is not fully amortized and the lessor's profit depends on rentals from several future leases or sale of the same equipment. Thus an operating lease is akin to a hiring transaction with the lessor responsible for maintenance, insurance and the risk of obsolescence. Usually the lessee has a right to cancel the lease and return the asset before the expiration of the agreed period, with this important provision providing protection against future risks. Such leases are of particular interest to lessees that prize marketing and technological flexibility. From the lessor point of view, operating leases are viable only where the asset has a clear secondary market value. Operating leases are not much used in developing countries, and in the following text the term "leasing" is used to mean financial leasing, except where the other form of leasing is explicitly addressed.

2. Advantages and disadvantages of leasing

Leasing provides close to 100 per cent financing for an industrial asset, and normally no deposit or advance payments is required. Leasing arrangements can be more flexible than contracts regulating loan transactions, particularly with regard to rental payments, which may be tailored to the lessee's cash flow. Moreover, a lessee can normally conclude the lease transaction far more simply and quickly than bank borrowing, which often requires lengthy and costly evaluation. In practice, in developing countries leases are granted normally for medium-term periods of up to about five years.

Tax advantages have played an important role in the attractiveness and growth of industrial leasing in many countries, since the lessee can gain access to investment allowances and the lessor can claim the tax-related incentives. This has encouraged high market penetration of leasing. In the United States for example, the market penetration of leasing calculated by dividing "total leasing volume" by "total private non-residential investment in producers' durable equipment" increased to 33 per cent in 1989. High market penetration is also a characteristic of some other countries, including Australia, at 30 per cent, Ireland, at 28.4 per cent, Spain, at 27 per cent, and United Kingdom, at 23.5 per cent ([31], p. 3).

In most countries with underdeveloped capital markets, leasing deepens the financial system by providing flexible and additional sources for medium- and long-term finance well suited to fast-growing, small- and medium-scale industrial enterprises that have difficulty in obtaining conventional bank credits. In the Republic of Korea, for example, an important policy objective has been to encourage leasing to small businesses, with guidelines requiring a minimum of 35 per cent of lease contracts to be with this sector. Among the group of more industrialized developing countries, leasing has supported the purchase of domestically produced capital goods, with guidelines in some countries requiring leasing companies to provide a minimum proportion of their contracts for the lease of locally made equipment and facilities. In the Republic of Korea this has assisted in the increase in the total value of contracts for locally produced equipment, rising from 160 billion to 606 billion won between 1984 and 1986 ([32], p. 105). Last but not least, leasing is in concordance with Islamic principles, which has been important for leasing industry development in Pakistan, and probably opens possibilities for its development in other Muslim countries.

However, there are also disadvantages to leasing. Leasing as compared with buying on credit, is normally more expensive, particularly with leases provided by specialized leasing companies that operate with nominal spreads higher than those of other lessors. Such companies build their competitiveness on superior skills in leasing techniques, on their quicker responsiveness to user needs, in particular rapid decisions on the lease transaction, and, generally, on their higher flexibility. It should be noted, however, that all these valuable attributes carry a price tag. Moreover, since leasing is often targeted to small industrial enterprises, a risk premium would have to be included in spreads to cover an increased risk of failure among such enterprises. Similarly a separate risk premium would have to be factored in for industrial enterprises that are new, or using new technology, or where no collateral separate from the asset is pledged. All these premiums contribute to interest spreads, so that it is entirely rational that lease financing is considerably more expensive than loan financing. However, for the entrepreneur in small industry in some developing countries, lease financing may well be the only feasible source of funding for equipment purchase. There is a further point: in some developing countries, property law and legal systems are somewhat underdeveloped. Bankers may find, in practice, that the value of collateral is merely an abstract concept, since courts are either unable or unwilling to transfer mortgaged property on loan default to creditors, except in the very long run. In this context, industrial entrepreneurs who in other countries would face little difficulty on 'feasibility-of-investment grounds' cannot depend on loans from their domestic bank sources. This consideration also underlines the fact that as economic development proceeds, many domestic reforms and changes in traditional practice become necessary, not least in law and practice governing property. It may well be the case that reform in this area would be the best solution, and that the introduction of equipment leasing may be a second-best solution. Unfortunately, second-best solutions in some countries are the only realistic solutions.

The experience in developing countries with leasing facilities is that Governments should consider the advisability of specific legislation and regulations governing leasing, and taxation and accounting treatment of leases. In the Republic of Korea, and more recently in Turkey, leasing development has been assisted by a body of leasing law, but Hong Kong and Malaysia, with highly developed leasing industries, have managed without such specific legislation. A detailed consideration of this issue would be country-specific, and would need to cover the applicability and usefulness of existing financial legislation. Tax benefits have been a major factor contributing to the growth of leasing in some developed countries. In most developing countries, however, there is still a lack of clarity, consistency and transparency in the fiscal treatment of leasing, and, as a result, there are various anomalies in the taxation of leasing operations, which often face discrimination in relation to other forms of financing. An important reason for discrimination seems to be that fiscal treatment of leasing transactions is often based on its form, that is, on its legal status, rather than on its economic and financial substance.

3. *Importance of leasing in different developing countries*

It was the influence of the United States leasing industry in the period immediately following the Second World War that helped to establish leasing operations in Western European countries and Japan in the 1960s, through either affiliated companies or joint ventures with local partners. At that time it was also initiated in Argentina, Brazil, Mexico, Philippines and Venezuela, as well as in Zimbabwe (then Rhodesia). Today leasing is a more or less established instrument of industrial finance in more than 30 developing countries at very different levels of economic development. Its success in this wide variety of countries indicates that it has a very considerable potential in facilitating industrial investment in other developing countries, including least developed countries.

The recently published *World Leasing Yearbook 1991*, which provides the most comprehensive statistical data of the world leasing business, indicates that in 1989 the industry, for the first time in its history, surpassed the global volume of $300 billion, with the main markets being in the United States ($122.40 billion), Japan ($53.94 billion), United Kingdom ($20.26 billion), France ($19.97 billion) and Germany ($18.26 billion). Given this volume, leasing ranks second among the financial instruments available on the international capital markets, with loan financing ($511 billion) being first ([31], pp. 3-4).

Table IV.10 shows that with $13.75 billion in leasing transactions, developing countries (data for 22 countries are available) participated with 4.5 per cent in the global leasing industry in 1989. Leasing data for a number of developing countries, including Argentina, Bangladesh, Costa Rica, Ecuador, Honduras, Iran (Islamic Republic of), Malawi, Panama and Sri Lanka, are not available, but UNIDO estimates that developing countries as a whole participated with around 5 per cent in the global volume of leased equipment in 1989. In terms of leasing volume, Asia leads in the developing world, with $10.96 billion of leased assets in 1989, including $3.1 billion, $2 billion, $2 billion and $1.5 billion for Republic of Korea, China, Hong Kong and Indonesia, respectively. Moreover, many of the countries in the Asian region enjoyed considerable growth in leasing in 1989, with Turkey reaching a growth rate of 400 per cent, albeit from quite a low base since leasing is relatively new there. In spite of problems of definition and other questions, table IV.11

Table IV.10. Volume of global leasing, 1989

Region or grouping	1989 (billion dollars)
Asia	10.96
Latin America	2.50
Africa	0.29
Developed countries	288.71
Developing countries	13.75
TOTAL	302.46

Source: *World Leasing Yearbook 1991*. (London, Euromoney, 1991), p.3.

Table IV.11. Volume of leasing in developing countries, 1989 [a]

Country or area	Volume (million dollars)	Growth 1988-1989 (percentage)
Botswana	70	62.4
Brazil	1 180	39.2
Chile	170	24.3
China	2 000	66.7
Colombia	110	52.4
Hong Kong	2 000	29.0
India	500	0.0
Indonesia	1 500	68.8
Malaysia	510	0.0
Mexico	520	33.3
Morocco	90	12.0
Nigeria	70	20.9
Pakistan	80	75.0
Peru	100	0.0
Philippines	70	42.7
Republic of Korea	3 100	13.3
Singapore	260	22.2
Taiwan Province	620	14.6
Thailand	80	109.4
Turkey	240	400.0
Venezuela	420	51.3
Zimbabwe	60	n.a.

Source: *World Leasing Yearbook 1991*. (London, Euromoney, 1991), p.3.

[a] The table covers only countries with a volume of leasing transactions over $20 million.

provides an indication of the uneven volume of leasing in different developing countries.

Among the more successful practitioners of leasing in Asia are Hong Kong, Malaysia and Republic of Korea, with fairly sophisticated levels of leasing industry and with leasing operations participating with a significant share in their equipment acquisitions. In Hong Kong, more than 40 per cent of the total value of equipment for domestic use was financed by leasing in 1989. This proportion was much lower in the Republic of Korea, but still higher than in a number of developed countries, such as Canada, Japan and Switzerland. Indeed, the development of leasing in the Republic of Korea over the last 20 years is instructive. Equipment leasing was introduced at the start of the 1970s, when the economy was in a process of rapid growth and financial resources were scarce. At that time, the domestic capital market was underdeveloped, and in order to limit overseas borrowing, the problem was addressed *inter alia* through lease financing. The country successfully adopted the Leasing Industry Promotion Act in 1973, and since then, bar the recessionary period 1979-1982, the leasing industry has grown constantly, and with an annual average rate of more than 50 per cent during the period 1983-1989 ([32], p. 249). Major factors cited for this rapid growth have included a strong demand for equipment investment above the country's capacity for conventional financing, the off-balance-sheet nature of the financing to companies with a high debt-equity ratio, a tight government monetary policy, government support to the leasing industry, the convenience of leasing, and favourable tax treatment of leasing. Another Asian country where leasing has become a significant contributor to equipment investments is Malaysia. During the first half of the 1980s leasing grew to 15 per cent of fixed capital formation, propelled by strong industrialization, lack of alternative credit facilities, and restrictions on new entrants to the financial sector. The number of companies acting as lessors rose to 250, with the leasing market almost doubling between 1982 and 1984 ([31], p. 258). The industry has recovered after the country's severe recession in 1985-1987, when leasing volumes declined sharply and many smaller and less-capitalized companies failed. While leasing has expanded without specific legislation, treatment has been favourable with respect to equipment write-offs.

Leasing in Latin America is as old as in developing Asian countries, but its volume, growth and development has lagged. In December 1989, the industry encompassed total leased assets of $5.5 billion*. In that year, new investment totalled only $2.5 billion, as shown in table IV.10. Brazil was the main player, followed by Mexico and Venezuela. During the 1960s and 1970s, industry in the region experienced gestation problems, but in 1979 reached a high volume and had become fairly well developed. However, under the impact of the 1980-1982 recession, the debt crisis and their consequences, leasing suffered a serious setback. While certain leasing techniques can alleviate the impact of macroeconomic instability on investment, the overall impact of such instability remains a central factor in the success of any financial innovation.

4. *Main patterns of leasing in developing countries*

Foreign participation can occur in leasing through the establishment of a subsidiary, or a joint venture with a local partner, with financial resources transferred initially as direct investment into a locally established entity, normally together with various managerial skills. Later on, such a leasing venture would expect to raise money mainly through domestic borrowing. Foreign participation may also occur through international or cross-border leasing, in which externally funded leasing services are provided directly to local lessees. The latter arrangements are rather similar to international bank lending, except that leasing precisely specifies the end-user and considers the purpose of the leased equipment; moreover, to date cross-border lease operations have never been rescheduled. Cross-border leasing is a very narrowly focused instrument, applied to financing items with a strong secondary market, in particular aircraft, and including ships, drilling rigs and construction equipment. Such leasing has grown considerably in recent years, with countries as diverse as Brazil, Mexico, Mozambique and Zambia involved in aircraft leasing. A considerable potential exists for an expansion of such activities in many other developing countries, as well as in Eastern Europe and the USSR.

Leasing has usually started with a small number of companies operating within an environment of legal, regulatory and fiscal uncertainty and with high fund-raising costs owing to the lack of funding instruments. Leasing normally takes about 5 to 10 years to become established, after which time it is accepted by the

*Information provided by Felalease (Federación Latinoamericano de Leasing).

regulatory authorities. A further stage of development occurs with the creation of new leasing institutions and increased market competition, decreasing fund-raising costs and generally high growth rates of leasing activities. Eventually the industry matures with substantial growth of the market through the development of efficient forms of fund-raising and through its recognition by Governments as a valuable mechanism of equipment financing for industry. This last stage has been achieved by only a few developing countries.

Leasing has been initiated in some developing countries by banks and finance companies (domestic and foreign) which have established leasing subsidiaries. In these countries, such subsidiaries can offer lease financing on better terms than specialized leasing companies without such links. Similar advantages can occur when such institutions undertake leasing as an in-house activity. However, such finance institutions tend to neglect leasing since it is relatively new and less well-known, preferring traditional loan operations. In contrast, independent leasing companies finance their activity, apart from owners' initial equity, through bond issues and bank credits, and in some cases also through the floatation of shares on the domestic stock exchanges. These companies tend to be more efficient, aggressive and flexible in providing services to their clients, winning competitive advantages over other lessors who may have easier and cheaper access to funds. Such specialized companies often tend to be simpler to manage, and tend also to deepen a country's financial structure. For these reasons, IFC has preferred to support the creation of specialized leasing companies rather than to promote leasing among existing financial institutions. Such independent leasing companies represent by far the most important group of lessors in the majority of developing countries, often dominating the leasing market. In the Republic of Korea, for example, specialized leasing companies cater to more than three quarters of leasing requirements, with six merchant banks and three venture capital firms accounting for the balance.

Specialized leasing companies have frequently been developed as joint ventures by major international banks, which have contributed part of the initial financing, technical expertise and management services, with the domestic partner contributing primarily a knowledge of local market conditions. Foreign lessors often prefer to establish joint ventures because of restrictions wholly owned companies face on the borrowing of domestic funds; moreover, there are often legal restrictions on sole ownership. There is a strong presence of foreign institutions, particularly banks, in the Asian region, where, for example, out of 60 specialized leasing companies in China, 25 are joint ventures, or where 34 out of 83 companies in Indonesia in 1988 incorporated foreign capital ([31], pp. 145 and 217). However, in some small countries, for example Botswana and Malawi, IFC is the most important foreign partner.

Users of lease services range from manufacturing and transport companies to agriculture and business service as well as Governments. Although there is considerable variation among lessees, table IV.12 shows that manufacturing is the dominant user, and the inference is that leasing is an important form of industrial financing in these countries. It should be noted that the same phenomenon is found also in developed countries. As shown in table IV.13, transport equipment, manufacturing and other industrial equipment, and office equipment (including computers and business machines), account for between two thirds and four fifths of the total lease transactions in most countries.

Some multilateral finance institutions, especially IFC, have assisted in setting up leasing companies, and provided technical assistance on policy issues related to leasing. Between 1977 and mid-1990, IFC was involved in the establishment of 24 leasing companies in 21 developing countries, ranging from Bangladesh and Malawi, on the one hand, to Brazil, Philippines, Republic of Korea and Turkey, on the other. In mid-1990, IFC had a leasing company portfolio consisting of $5.35 million in equity investments and $18.71 million in loans in these companies ([31], p. 34). In addition to financial participation, IFC performs a catalytic role in bringing together domestic sponsors and foreign partners and in introducing leasing to a country through initially founding leasing companies. In so doing, it also supports the introduction of a new financial mechanism into the financial market, thus contributing to a deepening of the financial structure. Furthermore, IFC provides assistance on the legal, tax and regulatory reforms required for the development of lease financing.

Table IV.12. Three leading sectors [a] of lessees in selected developing countries

Country	Sector	Percentage	Year
Bangladesh	Industrial	69	As of July 1990
	Transport	25	
	Services	2	
Brazil	Services	31	1988
	Processing industry	24	
	Commerce	10	
Indonesia	Manufacturing	35	1989
	Transport	34	
	Office equipment	13	
Republic of Korea	Manufacturing	75	1989
	Government, research, educational institutions and others	8	
	Finance, insurance, real estate and business services	5	
Malaysia [b]	Manufacturing and processing	35	1989
	Fishing and agriculture	13	
	Transport and communications	10	
Nigeria	Manufacturing	53	1989
	Transport	15	
	Services	12	
Sri Lanka	Manufacturing	33	1989/1990
	Transport	23	
	Trading	20	

Sources: *World Leasing Yearbook 1991* (London, Euromoney, 1991), and *A Survey of Equipment Financing in Malaysia 1989* (Kuala Lumpur, Equipment Leasing Association of Malaysia, 1990), p.20.

a/ Sectors are taken as they are presented in original sources.

b/ The structure is given for lease transactions of 25 members of the Equipment Leasing Association of Malaysia.

Table IV.13. Lease transactions by major types of equipment [a] in selected developing countries and areas

Country or area	Type of equipment	Percentage	Year
Brazil	Vehicles and related equipment	46	1989
	Machinery	33	
Colombia	Vehicles and rolling stocks	38	1989
	Industrial machinery and equipment	22	
	Heavy machinery	19	
Hong Kong	Vehicles	54	1989
Malaysia [b]	Heavy equipment	20	1989
	Plastics manufacturing equipment	14	
	Motor vehicles	16	
Nigeria	Plant and machinery	55	1989
	Cars and commercial vehicles	31	
	Ships, aircraft and production equipment	12	
Philippines	Motor vehicles	59	1989
	Heavy equipment	13	
	Business and office machines	12	
Republic of Korea	Industrial equipment	73	1989
	Office equipment	11	
	Transport equipment	6	
Singapore	Industrial equipment	40	1989
	Private and commercial vehicles	15	
	Computers and related equipment	16	
Taiwan Province	Manufacturing equipment	57	1989
	Business equipment	15	
	Transport equipment	12	

Sources: *World Leasing Yearbook 1991* (London, Euromoney, 1991), and *A Survey of Equipment Financing in Malaysia 1989* (Kuala Lumpur, Equipment Leasing Association of Malaysia, 1990), p.18.

[a] Types of equipment are taken as they are presented in original sources.

[b] The structure is given for lease transactions of 23 members of the Equipment Leasing Association of Malaysia.

5. *Further considerations on lease financing*

It is somewhat surprising that the concept of equipment leasing has not been taken up more extensively in developing countries. One reason may be that in some countries there is a cultural aspect to the ownership of industrial equipment. From a strictly legal perspective, industrial equipment funded by bank loans is owned by the purchaser, whose preference in terms of a somewhat perverse marginal utility may be for ownership rather than use: such preferences may be the result of specific historical and cultural conditions. Another possible reason may be found in the mobilization of financial resources through the tax system and the banks. In many countries, the first call on resources mobilized by the banks is the prerogative of the State, which uses borrowed funds for particular types of spending or investment; investment in small- and medium-scale industry often is not accorded a high priority. After the State as borrower has reduced the amount of resources available for industrial investment elsewhere in the economy, the banking system usually prefers to provide funds only to the safest borrowers. As suggested earlier in the discussion on developing-country stock markets, established firms, including those in the manufacturing sector, often find it cheaper to use bank loans rather then to issue equity or to acquire equipment through leasing. These established enterprises force lending away from small industrial enterprises and new industrial enterprises. There is borrowing competition, and small- and medium-scale enterprises often lose. Besides, where the banking sector is prepared to finance small- and medium-scale enterprises, it may prefer to do so through traditional bank loans, fully secured by collateral etc., rather than to engage in industrial leasing itself or to provide funds to be used for industrial leasing by rival financing institutions. Lastly, and this is the case in many countries, too little is known about the financing concept and techniques of industrial leasing. However, given the suitability of industrial leasing as a means of financing small- and medium-scale enterprises, and on the basis of the economic reforms of recent years, which emphasize both the efficiency of small- and medium-scale industrial enterprises and the private sector, an expansion of equipment leasing to industry can be feasible, but vigorous government action would be required. Government action to promote industrial leasing would focus, in essence, on the following areas: legal, regulatory and fiscal issues; funding of industrial leasing companies; and promotion, training and technical assistance in lease financing services for industry, particularly small- and medium-scale enterprises.

The difficulty is that successful Government action in these areas is hampered in many developing countries by a shortage of skills of crucial importance for the growth of financial infrastructure, including equipment leasing activities. For example, a recently published survey [33] of the accounting profession in Africa found that of 37 countries surveyed, 18 (one third of all African countries) have less than 50 fully qualified private-sector accountants each, and the public sector was even more understaffed. Moreover, only eight of the countries surveyed offered a national certifying examination at the professional level. The survey also found that national accounting standards are often in need of major overhaul, since in many countries standards had been lifted verbatim from outdated foreign prototypes without updating and adaptation. These lacunae in the standard accounting framework and professional practice underline some of the difficulties that must be overcome in promoting and facilitating leasing as a mechanism in mobilizing finance for industry.

Developing countries mobilized more than $13.75 billion in 1989 for use in leasing transactions, of which at least $7 billion was used for the leasing of industrial equipment. The rate of growth of equipment leasing has also been significant, with rates recorded at well over 10 per cent per annum during 1988-1989 for most developing countries using the leasing mechanism. Many Governments put in place various measures and incentives to facilitate the growth of leasing in general, and in some cases to ensure that small industry had access to industrial assets through the lease transaction. Early in this chapter, emphasis was given to forms of partnership between the private sector and the state, and to modifications to the financing mechanisms examined. In this context, a considerable stimulus in the provision of lease financing to small-scale enterprises, and indeed to cottage industries, would be to reduce the collateral requirement of lessees, particularly of cottage industries. As indicated earlier in this section, it is the case that collateral requirements in leasing contracts are much lower than in traditional bank lending contracts, with the leased equipment or asset itself sufficing in many lease transactions. However, smaller industrial enterprises and especially cottage industries may be required often to pledge some collateral as part of the leasing contract. A reduction in such collateral requirements would be facilitated through the provision of partial guarantees on the industrial equipment financed by leasing companies and other lessors. Government action to foster industrial equipment leasing and to assist the small and cottage industrial sector, could take the form of the funding of partial guarantees in leasing contracts to such industrial borrowers. Funding could also be obtained from multilateral and bilateral finance institutions, either through orthodox arrangements or, for example, in the DES arrangements envisaged in the new United States development initiative for Latin America and the Caribbean. Another route to the same objective of stimulating the small industries sector would be to follow the example used in the Republic of Korea, requiring a certain proportion of a lessors funding to be provided to small- and medium-scale enterprises. These and similar actions would facilitate the flow of lease finance to small private enterprises. There is wide recognition that the employment generation of such industrial enterprises in developing countries can be considerable, and that the success of small- and medium-scale enterprises and of cottage industries is essential to development.

E. Build-operate-transfer mechanism for project financing

It is well known that in many developing countries poor infrastructure development severely constrains manufacturing capabilities. In contrast to equity-based instruments or mechanisms such as DES, country funds and venture capital financing, which have served as channels for the transfer of a significant proportion of their total resources to investment in manufacturing, the BOT model is particularly well suited as a mechanism for financing infrastructure projects. The application of the mechanism in developing countries has attracted significant attention only in the last decade. As a result of the external debt crisis as well as a scarcity of funds in public budgets, in many countries there has been a growing interest in an increased involvement of the private sector in economic development. More than merely attracting funds and technology into their existing private sectors, many Governments in developing countries have gone further to initiate and to implement policies for privatization, including the private sector as a provider of infrastructure services. These services, traditionally a monopoly of the public sector, have been financed normally from domestic public resources, that is, through the budget or domestic borrowing, or sovereign borrowing on external markets. As finance from these sources has dried up, alternative financial mechanisms have been developed, to some extent driven by international civil engineering contractors facing significant business downturns. These mechanisms, and the BOT model is one among them, involve the private sector in improving infrastructure operating performance and in financing infrastructure investment while minimizing new sovereign debt.

In a way the BOT approach is more a rediscovery, since strictly speaking, there is nothing particularly innovative about the provision of infrastructure services through the private sector, at least in developed countries. In 1837, the United Kingdom had

1,100 turnpike trusts maintaining some 35,400 kilometres of toll roads, and currently in the United States there are some 200 suppliers of long-distance telephone services [34]. Reportedly, the average municipality in the United States contracts out 20 to 25 per cent of its services in whole or in part to the private sector. Services contracted out include airport operation, waste collection, transport operations, hospital management and road building and repair. Moreover, many municipalities have privatized many municipal services by contracting, by franchising, by vouchers and also by market-based private-public partnerships where the private sector finances, builds, owns and operates public infrastructure. For services of the same quality and quantity, cost savings reportedly are typically in the 20 to 30 per cent range [35]. Thus, some developing-country Governments have sought to overcome two difficulties by using BOT arrangements. First, difficulties associated with the financing of infrastructure investment through the public budget. Secondly, to increase efficiency levels in the operation of some infrastructure services. Some Governments are of the view that the operating losses of some public services constitute an unacceptable drain on the public budget, and that services of a given quantity and quality can be more economically supplied through forms of public- and private-sector partnership such as the BOT arrangement.

The current BOT model of project financing has evolved from two legal concepts, namely "concessions" and "limited-recourse project financing". Concessions, in use over 100 years ago, are legal agreements where private businesses are awarded the right to build and operate railways, tramways, waterworks and other infrastructure projects. Limited-recourse project financing techniques relate repayment of the capital costs of a project to the cash flow generated by the same project. In limited-recourse project financing, lending is provided against the anticipated cash flow of a project, with only limited recourse to project sponsors or to a host Government. In contrast to the traditional mode of project financing in developing countries, that is, fully government-guaranteed project funding, limited-recourse project financing leads to the uncoupling of financial elements and associated risks. Project financing is broken down into separate elements so that the risk associated with the project is distributed among the project partners. Limited-recourse project financing requires sophisticated project analysis and financial engineering, but it reduces recourse to project sponsors, and to public guarantees.

1. Main characteristics of the BOT model

The BOT model is a form of limited-recourse capital financing based on a concession-type arrangement which applies to those projects, executed under private-sector ownership and financing, in which the ownership of fixed assets and the right to earn revenues from these assets is transferred from the private owners to Government at the end of the concession period. The model is suitable for infrastructural projects, such as power generation plants, rapid mass transport systems, roads, tunnels, bridges, water supply and waste disposal facilities. Under a BOT arrangement, a project company is set up to "build" and "operate" a facility throughout a concession period, normally between 15 and 30 years, during which the project company hopes to make sufficient revenues to pay operating costs, to regularly service debts and to provide reasonable returns to shareholders. When the concession period expires, the ownership of the project and the right to operate it is "transferred" to the Government, which may choose either to grant a new concession or to operate the project through a public agency. This explains why the term "build-operate-transfer" was invented for this specific form of limited-recourse project financing at the beginning of the 1980s. It has a number of variants, such as "build-own-operate-transfer", "build-own-operate", "build-rent-transfer", or "build-own-operate-subsidize-transfer".

The BOT model of project financing normally involves an arrangement of the following type, using a power generation project as an example:

(a) At the beginning, a BOT project company is established. It typically has majority private-sector ownership, provided by companies with a commercial interest in the construction and the operation of the project (consortium of construction and supply companies, the operator of the plant) and minority ownership by a host Government, normally through the State-owned power agency. Members of the consortium are often from different countries, which helps to attract debt financing from several countries and to spread project risk. Usually the capital requirements of a BOT project are large, and since attracting a sufficient equity base is one of the challenges of each BOT arrangement, it is not unusual that portfolio investors in addition to project sponsors participate in the ownership structure of the project company;

(b) At the next stage, the contractual structure is determined, normally consisting of concession, revenue generating and fuel supply agreements between the project company and the respective partners. The concession agreement between the project company and government authorities defines the terms under which the project will be constructed and operated, determines the basic credit financing structure for the project and outlines the profit- and risk-sharing scheme. This agreement legally separates the right to earn revenue from the ownership of the underlying fixed assets;

(c) The source of revenue for a BOT project company is normally either a long-term contract with the Government (contract-tied revenues), or in other cases direct sales of a service to customers (market-tied revenues). The latter type of sales revenues imposes a higher risk to the project company. In the case of a power plant, the revenue stream has normally been sanctioned through the electricity sales agreement, which determines, in line with general provisions from the concession agreement, terms under which the electricity would be sold to the Government. This agreement has to be based on a tariff formula that would, under the assumption that the plant delivers power in the agreed quantity, schedule and price, provide the project company with sufficient cash flow to meet operating costs as well as obligations to its suppliers, lenders and shareholders. In the case of roads, tunnels, bridges or rapid mass transport systems, sources of revenues are normally toll payments, and often a

minimum level of traffic has to be guaranteed by the host Government. In practice, complex agreements between the Government and the project company are required to regulate tolls and ticket revenues; this is a consequence of a wide range of financial, technical and managerial issues which have to be addressed in the contract;

(d) The third main agreement in the case of a power generation plant, the fuel supply agreement, is aimed at ensuring a stable source of fuel that would supply the concession company with an agreed quantity and quality of fuel under an agreed pricing formula;

(e) Equity financing, although crucial for the whole financial package of a BOT project, participates with a relatively small share in the total capital budget. Although the debt-equity ratio of these projects varies from 90:10 in the case of the North-South highway project in Malaysia, to 75:25 in the case of the Hab River coal-fired power station in Pakistan, all are highly geared. The debt-equity ratio of BOT projects might be lower if subordinated debt is treated as equity. For the Eurotunnel (France—United Kingdom), for example, the debt-equity ratio was 83:17 when subordinated debt is taken as debt, and 80:20 if it is taken as equity ([36], p. 37). Loan financing in BOT projects is provided mainly by commercial banks, as well as by bilateral and multilateral finance institutions;

(f) In contrast to traditional project financing in developing countries where loans have been made to sovereign borrowers, in the BOT model the project company acts as borrower, and consequently lenders have no unconditional guarantor for servicing loans. Their recourse in the case of non-payment is limited to the project company and its assets.

There are four main advantages of the BOT arrangement for the Government of a developing country. First, infrastructure projects are financed with the mobilization of private sector resources and either without direct involvement or with limited involvement of the public budget. The BOT scheme allows the Government to define its position more precisely in terms of finance, risks and operating expenditures since the private sector is normally responsible for project commercial risks. Secondly, the Government does not have to issue a formal guarantee of repayment of the debt, and therefore the project debt does not raise public debt. Thirdly, the BOT scheme increases private sector involvement in the area of infrastructure services that have traditionally been a public sector monopoly. The presumption is that private investors take more care in carrying out projects through more efficient and economic construction and project operation. BOT project financing also provides a limited amount of foreign direct investment, although these projects are normally designed with high gearing. Fourthly, BOT projects allow the host Government to establish a benchmark that can be used to measure project implementation and operation costs of comparable projects in the public sector.

2. *BOT versus other limited recourse project financing*

Two specific elements make limited-recourse project financing in the directly productive sector and the infrastructure sector significantly different. First, in contrast to the directly productive sector, the ownership of fixed assets in the infrastructure sector and the right to earn revenues from these assets are normally vested in the Government. Consequently, private companies that have considered the possibility of entering into the infrastructure sector have normally been faced with a requirement by the host government for a concession-type of arrangement that includes the provision that the project has to be transferred back to the Government when the concession period expires. Secondly, in contrast to projects in directly productive sectors, which can involve selling goods or commodities in foreign currency on international markets, and where the prices of these products are not subject to government control, infrastructure projects in most cases generate only local currency revenues, and service prices are regulated. As a result of these two differences, projects in directly productive sectors are much easier to finance on a limited-recourse basis and the whole organization of the project can be made with a minimum involvement of the host Government. Besides lengthy negotiations, which can break down and cause delays and cost escalation, the main disadvantage of the scheme for a developing country is that it involves higher risk and higher costs than financing through government-guaranteed credits. Risk analysis by the various partners to BOT arrangements is of major importance. On the other hand, economic and efficient operations without subsidies, or with strictly limited subsidies, is found to be attractive by an increasing number of Governments. The close association of BOT with infrastructure projects indicates that the host Government is a crucial participant. The Government has to determine the need for the BOT project and has to enter into a concession agreement that usually involves special government approvals. The Government normally provides a part of the financing as equity and debt, and it may agree to purchase output, or to provide certain financial guarantees regarding revenues. The government also provides various types of support, and has the responsibility to take over the project when the concession period is over.

Experience has shown that the host Government has to provide an adequate political framework for a BOT project. Project sponsors have identified the political will of the host Government to "champion" the project, as well as the understanding by the host Government of the risk- and reward-sharing expectations of the project sponsor and lenders, as crucial ingredients for a successful BOT project development. In this context, project partners consider the provision by the host Government of sufficient decision-making authority to its negotiating team to be essential. Delays may be caused also by the lack of sufficiently trained and experienced government personnel involved in negotiations. Owing to the complexity of each BOT project scheme, the host Government is expected to involve outside technical, financial and legal advisers in structuring the arrangements, with these advisers considered by project sponsors and lenders as a credible commitment by the host Government. This commitment may be broadened with the provision of appropriate and timely legislation and tax support for the project, either through general legislation or through special provisions. Nevertheless, potential financiers of a BOT project must consider the usual country commercial risks, arising chiefly from inflation and currency depreciation, political risks, and project commercial risks consisting of development or pre-signing risks and contruction and operating risks*.

3. *Empirical evidence of selected BOT projects in developing countries*

There is no systematic collection of data on BOT projects in developing countries. According to scattered sources of information, BOT projects have been implemented, are under implementation or are under serious consideration in more than 10 developing countries. In the Box a brief examination is made of: the Shajiao "B" Station Coal Power Plant in China, where there was a strong market incentive for profit-oriented and efficient civil construction and power generation; the mass-transit system in Thailand, where part of the economic incentive arose from the creation of office and retail space; and the Private-Sector Energy Development Fund in Pakistan, where the World Bank was able to assist Pakistan in credibly mobilizing finance from domestic and external sources for power generation, including private sources.

The case-studies in the box and information available on other BOT projects in developing countries allows the identification of the following common features in the application of this mechanism in developing countries:

(a) BOT projects have been implemented, are under construction or are under serious consideration in a number of developing countries and areas, including China, Egypt, Hong Kong, India, Malaysia, Mexico, Pakistan, Philippines, Singapore, Thailand, Turkey, Viet Nam and Yugoslavia. From this list it appears that foreign lenders tend to favour the more industrialized among the developing countries. Within this group of countries, actual implementation of BOT projects seems to be higher in the relatively less indebted countries of Asia with strong recent economic growth. Structuring of a financial package for a BOT project in a highly indebted country with no access to voluntary lending has proved to be very difficult;

(b) Most BOT projects are either in the energy generation sector (China, India, Pakistan, Philippines and Turkey), or in the mass-transit and road transport sector (Hong Kong, Malaysia, Mexico, Thailand, Turkey, Yugoslavia), although there are also projects in telecommunications (Thailand, Viet Nam), water supply (Malaysia), as well as air terminal and business centre construction and operation (Turkey);

(c) Although total costs of BOT projects differ, they are generally very large. Among all the projects for which information has been gathered, in several total costs exceed $1 billion (the north-south highway in Malaysia comes to around $2 billion; four of the power plants in Turkey range between $1 billion and $1.3 billion each; Hopewell and Lavalin mass-transit projects in Thailand amount to $3.2 and $1.6 billion, respectively; and the Hab River power plant in Pakistan comes to $1.1 billion);

(d) BOT finance engineering arrangements have proved to be an extremely complex process which has to accommodate to a structure of security provisions satisfying lenders. Furthermore, serious negotiations over risk-sharing can begin only if the debt financing problem is solved. BOT project negotiations, especially in highly indebted countries, often break down at this stage of project development, as in the case of power generation in Turkey. The experience of Pakistan indicates that involvement of a multilateral institution not only can provide a financial contribution, but can also increase the confidence of foreign partners.

4. *Further considerations on BOT*

In essence, BOT arrangements consume much time of decision makers at a senior level in Government and private corporate structures, normally carry a higher rate of interest to reflect higher risk perceptions by lenders, and entail some loss of national sovereignty. The aggregate amounts of financial resources mobilized, placed against the total sums mobilized in developing countries, have been relatively modest so far. However, it has to be remembered that some of the individual projects are among the largest contemplated or implemented, and it is entirely normal that such projects have a prominent place in the work schedules of senior government officials. Moreover, the extensive planning and analysis involved in a consideration of various risks forces senior decision makers to focus on issues, difficult to be sure, that are best faced during the preliminary phases of these large and expensive projects. Other modes of financing might well permit delay and inadequacy in arriving at decisions about sensitive issues, and to the extent that large projects in developing countries have suffered from faulty planning and analysis, the procedures forced upon senior decision makers by BOT projects can only be welcomed.

Regarding the issue of national sovereignty, countries using the BOT mechanism either have a relaxed view of this issue, since they give strong support to the private sector and foreign direct investment, or they feel entirely comfortable that they can deal with possible infringements of sovereignty as these arise, as in the case of China. Many countries in the developing world have, in recent years, reassessed their policies with respect to the private sector and direct foreign investment, and among these countries increased interest can be expected in the BOT mechanism.

For example, in many developing countries, a serious barrier to further industrial development is the lack of a reliable electricity supply system. Not only is there a requirement for an increased installed power capacity, but there is an equally pressing requirement for reliability of operations. In such cases, a partnership between the public and the private sector might well have considerable attractions. However, an increase in the willingness of these countries to contemplate the BOT mechanism for power supply would not be enough to ensure credible implementation, since there are not crowds of foreign investors knocking on

*A detailed analysis of risks related to BOT project financing is given in David Suratgar, "Special risks and security issues in build, operate and transfer infrastructure projects" (unpublished paper)

Three BOT case studies

*China: Shajiao "B" Station Coal Power Plant**

To cope with the severe shortage of electricity resulting from expanded manufacturing, the private sector has been invited to support the huge investment burden of power projects in Guangdong Province. The Shenzhen authorities have established the Shenzhen Special Economic Zone Development Company with the sole purpose of forming a joint venture with the Hong Kong company, Hopewell Holdings Ltd., the main objective of which was to develop the second Shajiao Power Station on a BOT basis. Partners in the joint venture were Shenzhen Special Economic Zone Power Development Company ("Party A") and a limited liability company called Hopewell Power (China) Ltd. ("Party B") with the following shareholders: Hopewell China Development Ltd., 50 per cent; China Development Investment (HK) Ltd., 40 per cent; Kanematzu-Gosho Ltd., 5 per cent; Yue Xiu Enterprises Ltd., 2.5 per cent; and Shum Yip Development Co. Ltd., 2.5 per cent.

The parties agreed upon the following division of responsibilities:

(a) Party A assumed the following responsibilities:

- (i) To provide the land and arrange for special tax treatment for the project;
- (ii) To supply coal to Party B at a fixed price during the concession;
- (iii) To purchase a minimum quantity of electricity at a fixed price throughout the concession period ("take-or-pay" contract). This obligation is effective only if the plant is capable of delivery;

(b) Party B assumed the following responsibilities:

- (i) To arrange all foreign currency financing for the project;
- (ii) To arrange, together with Hopewell Construction Company, for construction of the project;
- (iii) To manage, operate and maintain the project for the relatively limited period of 10 years starting from 1 April 1988 During the concession period party B retains 100 per cent of project revenue resulting from the "take-or-pay" contract;
- (iv) To determine the joint venture at the end of the concession period and to transfer full operation and control to party A without compensation.

Total financing requirements of the project, which included a fixed construction price in respect of civil engineering and equipment delivery, as well as various other costs, were approximately $512 million. Funding was provided through a combination of equity, subordinated loans and debt financing. The main debt portion—50 billion yen—came as a fixed-rate suppliers credit supported by the Export-Import Bank of Japan (the main equipment suppliers were Toshiba and IHI). An interesting aspect of this loan is that a syndicate of commercial banks took over the project risk and provided a guarantee to the Japan Export-Import Bank. The remaining debt portion was raised from commercial bank sources (586 million Hong Kong dollars, 434 million yen and 720 million Yuan renminbi). All the financing facilities were executed by April 1986, when the plant construction began, and the first electricity was generated 22 months later.

Thailand: Bangkok mass-transit schemes

In recent years, the economy of Thailand has achieved a growth rate of 10 per cent per annum. One consequence of this economic boom which is centred in Bangkok is that the city is bursting at its seams, with an official population of more than 6 million, contributing around 50 per cent to the output of the country. The increase in the industrial base of Bangkok, together with residential expansion, has not been accompanied by adequate investments in the infrastructure of the city. The private sector is encouraged to share the costs of infrastructure development, *inter alia* through two mass-transit projects, known as the Hopewell and Lavalin projects, to be built on a BOT basis. The main features and current status of the Hopewell project are as follows:

A $3.2 billion concession contract between the Government of Thailand and the Hong Kong based Hopewell Holdings Ltd. to build and operate a 60.1-kilometres elevated-rail and toll-road system was signed in November 1990. The whole project is expected to be completed in eight years, while the first section, linking the airport with the centre of Bangkok, is planned to be opened in four years. The concession period for the project is 38 years, at the end of which time it will be handed over to the State Railway of Thailand [37]. The scheme includes the construction of transport infrastructure facilities and retail shopping space at

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*Based on the presentation of William Dykes, Managing Director of Citicorp International Limited, Hong Kong, at the Seminar on Private Power Generation through BOT, held at Manila on 5 October 1988, and on the Hopewell Power (China) Ltd. publication presenting the main features of the project.

four separate levels. The transport component comprises two lines, north-south and east-west, both of which follow the routes of existing State Railway tracks. Considerable quantities of valuable retail shopping space will be created with relatively little purchase of land for the whole project. In economic terms, some of the locational externalities created have been captured by the project owners. In this regard, it should be noted that transport infrastructure, that is, roads and railways etc., often give rise to very considerable externalities in conferring locational advantages to individuals, sometimes in a random manner and sometimes in a manner that is only apparently random, with insiders appropriating economic rents privately. In the case of the Hopewell project, a major part of the locational externalities were identified and transparently incorporated into the financial negotiations and commitments regarding market-related transactions.

The financial structure of the agreement is interesting. According to the contractor, who will provide $460 million in equity and arrange the debt financing, the Government of Thailand will not be required to take an equity share or to provide financial guarantees. Since non-subsidized mass-transit systems are very difficult to operate profitably, the Hopewell project includes real-estate development as an additional revenue source, and therefore as a mechanism to subsidize rail fares. The concession company has agreed to pay to the State Railway a minimum of $2.1 billion in exchange for the concession, which allows development of commercial and residential complexes near planned stations of the mass-transit network ([3], p. 14).

Pakistan: Private-sector financing scheme for electric power generation

The country has been faced with chronic power shortages, increasing seasonally to about 1,900 megawatts, or about 30 per cent of total demand ([38], p. 2). Against the background of budgetary constraints, the Government began encouraging the involvement of the private sector in power generation. According to a 1985 government decision, each private sector energy generation project was to be financed with 25 per cent equity participation in the total project cost. There was no specific limit for the ratio between local and foreign components of equity and debt financing. As a cornerstone of the programme to involve the private sector in power project financing, the Private Sector Energy Development Fund was created with the assistance of the World Bank. It is administered by the National Development Finance Corporation, a Pakistan Government body and one of the principal development finance institutions in the country. The Fund was established with money from the World Bank ($150 million), and was co-financed from bilateral sources, such as the United States ($170 million), the United States' Export-Import Bank ($150 million), Italy ($50 million), the Canadian International Development Agency ($50 million), United Kingdom ($50 million), Germany, Federal Republic of ($45 million), and the Nordic Bank ($13 million) ([39], p. 5). The resources for the Fund have been lent to the Government of Pakistan under sovereign guarantee. The main objective of the Fund is to provide long-term subordinated debt financing, covering up to 30 per cent of the total costs of energy projects to be built on a BOT basis. The subordinated debt financing from the Fund is expected to give sufficient security to commercial lenders participating in the project, since they will have priority over the Fund in debt servicing. The main attraction of the Fund for commercial lenders is therefore a significantly reduced risk in their lending to Fund-supported projects. The World Bank participation in the Fund has been important not only from the financial point of view, but it has given also an important stimulus to other foreign financial institutions and suppliers to enter into the Pakistan BOT energy project. From the perspective of the World Bank the interest of the scheme emerges from the fact that the Fund is an innovative measure to attract private sector investments in the Pakistan energy sector, which would be difficult under traditional arrangements.

The resources of the Fund are expected to be lent to BOT projects at prevailing market rates, with repayment terms of up to 23 years, including a grace period of eight years. The remaining 70 per cent of the project cost is to be provided in the form of equity (25 per cent) and debt financing from commercial banks and export credit agencies on a limited-recourse basis (45 per cent) ([40], p. 59). The structure therefore implies that for every $1 million provided by the Fund, an additional $2.3 million will be raised in the form of equity and debt financing. With such a financing structure, Pakistan is hoping to increase substantially its power generation capacities. By the middle of 1989 the Fund had helped to generate more than 10 private proposals to the Government of Pakistan for plants of different types located in various parts of the country. Among these, the Hab River project is the most advanced, and it aims at building four 323-megawatt power units, at a project cost of some $1.07 billion, structured along the following lines: some $240 million in private sector equity, 30 per cent of total costs from the Fund, and the balance from commercial loans. To build and operate the project, the Hab River Power Group has been set up with the participation of companies from six countries (Canada, Japan, Pakistan, Saudi Arabia, United Kingdom and United States) and with the main sponsorship of a major company from Saudi Arabia and from the United Kingdom. In April 1988, the Government of Pakistan and project sponsors agreed in general terms on the tariff level, the plant configuration, indices for adjusting tariffs to inflation and to changes in the value of local currency *vis-à-vis* an agreed basket of foreign currency, as well as on all other essential details. Problems have had to be overcome among the partners in finalizing contract terms, including a price-efficient tariff for electricity, which have caused delays and increasing project costs. According to recent information, the project should be completed in 42 months, and is expected to start power production in 1994.

doors in these countries, and since it is unlikely that banks would provide finance to many of these countries because of doubts about their creditworthiness. It is in this situation that the involvement of a multilateral finance institution can be of crucial importance. Indeed, it is possible to envisage an expansion of the risk-sharing and confidence building concept pioneered by the World Bank in Pakistan. To recall briefly, the Private Sector Energy Development Fund of Pakistan, having been created with World Bank cooperation, was able to obtain hard and soft credits from seven bilateral agencies, with which it can finance up to 30 per cent of project costs on a long-term subordinated loan basis. With less creditworthy Governments, feasible BOT arrangements might require that the proportion of project costs increase to more than 30 per cent, but for the poorer among these countries, it might be possible to engage a higher proportion of concessional financing for similar energy development funds. It should be emphasized that the impact of the World Bank went far beyond its financial contribution, since it was able to make the BOT concept credible to bilateral agencies in mobilizing their resources to invest in Pakistan. Further, the Energy Fund was the base on which the remaining 70 per cent of individual project investment costs was leveraged, through equity and loan injections by the domestic and foreign private sectors, with the further involvement of export credit and guarantee agencies.

It is possible to envisage other multilateral development finance institutions playing a similar sort of leading role in mobilizing resources from bilateral government agencies as well as domestic and foreign private sectors. Indeed, as the BOT concept becomes more widely understood and used in developing countries, it can be envisaged that a developing-country Government might obtain the assistance of a single experienced bilateral agency which might take the lead role in mobilizing finance and operating know-how from the sources cited above. It must be emphasized that traditional political and commercial risk factors have to be overcome in assessing whether the BOT route is realistic for a particular infrastructure project. Moreover, since negotiating BOT deals are expensive for the various partners, an equally important factor is the credibility of the government of a country as a committed, serious and reasonably reliable partner. If the government of a developing country has "put its house in order", then even if it is a very poor country, where perceptions of political and commercial risks are considerable, it can attract BOT external partners, as shown in the case of a telecommunications project in Viet Nam.

In the case of some least developed countries which would have the greatest difficulty in attracting finance from commercial lenders, it is possible to envisage BOT arrangements involving the private sector (domestic or foreign or both)—in construction and particularly in operations—in which the private partners receive limited guarantees not only from the developing-country Government, but also from bilateral export credit and especially bilateral development assistance agencies. These three sets of guarantees, together with the involvement of domestic and foreign private sector partners who would take the responsibility for plant construction, and particularly for facilities operations, could give rise to new types of viable BOT projects in some countries, including some least developed countries, that would otherwise not be able to provide types of infrastructure essential for development, including industrial development.

This section of the chapter has dealt only with the BOT innovation as applied to infrastructure projects in developing countries. However, given the increasingly wide perceptions of 'aid-fatigue' in developed countries, a pessimist might hold that the experience of a group of "dynamic" developing countries in using the BOT approach for infrastructure investment is not strictly relevant to the problems of directly productive investment in other developing countries, particularly the least developed countries. It should be stressed that there is nothing which in principle restricts the BOT approach to infrastructure investment. In countries where the BOT approach has been used, other actors, whether in the private sector or the public sector, have been capable of profitably operating directly productive industrial facilities. There has been no need to use the BOT approach. However, in some developing countries, it is possible to envisage a modified BOT approach aimed at investment and operations in industrial enterprises, and not merely infrastructure. In this context, BOT could be considered an alternative to State ownership and operation. Thus, a bilateral agency providing "soft finance", might be willing to provide a significant capital investment subsidy, perhaps 50 per cent of the cost of a project operated by a foreign partner in a BOT agreement with the government of a least developed country. A project that had a high identifiable priority, for example, because it earned or saved much foreign exchange, or provided benefits to the poorest groups of the population, but which otherwise could not be financed, might well command support. The essential aspect of such a project however is that the private sector would own, manage and operate, and, except for the capital subsidy, would do so according to accepted commercial industrial practice. At the end of a concession period, the enterprise could be transferred or sold to domestic investors or to the State. This suggestion is not necessarily as radical as it may sound, since in practice many developed-country Governments provide direct subsidies of many kinds to particular types of business, such as those in high-technology activities or in particularly depressed locations. A common sight in the financial press of OECD countries is that of advertisements to come to a particular region or province where government grants or soft loans to encourage growth and efficiency are available. It would be necessary to monitor very closely the operations of such subsidy arrangements to ensure that the objectives of economical and efficient production are not perverted in unforseen ways. For example, in providing a high capital subsidy, care would have to be taken that equipment prices are reasonable in a commercial sense, and are not inflated. But in some developing countries, the experience of some bilateral agencies with inefficient, costly and basically bankrupt State-run industries has been considerable, and these agencies may be willing to consider this type of BOT arrangement involving a direct capital subsidy as an alternative which might go some way towards combating aid fatigue.

V. A survey of selected manufacturing industries

Seven comprehensive industry surveys and six mostly shorter reviews of selected industries and industrial branches are presented in this chapter. Included among the seven comprehensive surveys are two high-technology industries, machine tools (ISIC 3823) and pharmaceuticals (ISIC 3522); two-mineral-resource-based industries, fertilizers (ISIC 3512 excluding 351216) and nickel processing (ISIC 372020); two agro-based industries, natural fibres (ISIC 3211) and wine-making (ISIC 3132); and one automotive components industry, automotive tyres (ISIC 355110). The six mostly shorter reviews all pertain to industrial raw materials. They cover crude steel (ISIC 371016 and 371019), cast metals (part of ISIC 3710 and 3720), advanced materials (part of ISIC 3513, 3610, 3620, 3710 and 3720), bulk chemicals (ISIC 3511-3513), pulp for paper and board (ISIC 341101-34116) and waste paper for paper and board (no ISIC number available).

In the comprehensive surveys, detailed statistical information is provided on each industry to illustrate current supply and demand conditions, trade patterns, profits and losses, production costs, capacity utilization and, where possible, employment at both country and company levels. The features of restructuring are examined using measures of overcapacity, of shortages, of changes in output composition of foreign direct investment and of the role of government. Manufacturing capacity in developing countries is given special emphasis; of particular importance are the build-up of productive capacity, project investment plans, profit potential and technological trends, as they affect the competitive position of those countries. Finally, the short- and medium-term outlook for demand, prices, employment, trade and investment is presented, within the context of the globalization of industrial structure and a changing international division of labour.

In the comprehensive surveys, the fertilizer and nickel industries are becoming important growth industries for developing countries in terms of domestic production and world exports, but their continued growth critically hinges upon the extent of fertilizer application in agriculture, on the one hand, and upon world market conditions for stainless steel, on the other. Automotive tyres and natural fibres have seen their market shares decline because of encroachments by synthetic materials and competing innovations. The cotton and wool sectors of natural fibres have regained some of their lost market shares, however, as consumer preferences have shifted towards natural fibre apparel. The machine tool and pharmaceutical industries are technologically sophisticated and still dominated by developed countries in world-wide production and trade. The development of these strategic industries poses a formidable challenge to developing countries. On the other hand, developing countries have a competitive advantage in wine-making because of low labour costs, but greater expansion of wine-making in developing countries has been so far hindered by fierce international competition, trade barriers and related marketing problems.

The six mostly shorter industry reviews are more specific in their focus. As expected in any industrial-raw-material-processing industry, their business condition depends critically on the ups and downs of other industries requiring their output. The bulk chemicals review describes an industry that has forward linkages to other industries such as automobiles, other finished chemicals, clothing and housewares, while competing with other new materials such as synthetic or advanced materials, particularly as technology shifts. Similarly, the review of pulp and waste paper for the paper and board industry deals with an industry of which the sales are closely linked to the business fortunes of other industries, such as those needing packaging. It also shows how rapidly rising environmental concerns can change an industry such as that of waste paper. The reviews of nickel processing and crude steelmaking illustrate the problems associated with heavy capital investment requirements at the initial stage of an industry, compounded by some uncertainty surrounding the future demand for steel at the final stage. The case of cast metals is that of an industry highly dependent on business fluctuations in the automotive industry and hence on business cycles in developed countries. The review of the advanced materials industry reveals the speed at which technological change relating to factor inputs is taking place in many industries. Advanced materials compete increasingly with steel, cast metals, chemical products and nickel in many areas of product manufacturing.

The surveys and reviews vary in scope and depth depending on the availability of data, which are still incomplete and inadequate for certain industries, particularly those related to developing countries. Nevertheless, the findings seem to point to a number of the common salient features, which are summarized below:

(a) Growth has levelled off in many industries, reflecting a general slow-down of the economy in the latter part of 1990 and its continuation in 1991. In some of the resource-based industries, notably nickel processing, fertilizers and bulk chemicals, capacity utilization has been high and stocks for certain products have become low. The crude steel industry has just gone through a period of retrenchment, and price levels are not yet sufficiently high to stimulate capacity expansion. In the case of fertilizers, demand increases have nudged

prices upwards, with capacity additions anticipated for developing countries. The high capacity utilization coupled with strong prices in the fertilizer and bulk chemicals industries suggests that capacity expansion may soon occur in these industries;

(b) A growing trend towards less government intervention and more deregulation and privatization is discernible. In the crude steel industry, the privatization of government-owned companies is occurring increasingly in both the North and the South. However, the converse is true in the fertilizer and bulk chemicals industries, where government involvement has increased;

(c) In international trade, the United States and Asia are of growing importance as export markets for other countries, the former because of more favourable production costs in exporting developing countries, and the latter because demand has far outstripped the capacity of local suppliers. The countries of Eastern Europe and the USSR are likely to provide markets eventually for high-technology products such as advanced materials;

(d) The machine-tool industry, which is usually characterized by long upward swings in new tool orders and production followed by downward swings resulting from the accumulation of idle capacity, has entered a rising phase of new orders and production. Industry changes also suggest the redeployment of machine tool capacity to the newly industrializing countries. Other industries that are sensitive to business cycles include those of waste paper and pulp, cast metals, automotive tyres and nickel;

(e) The rapid adoption of new technologies appears to be essential to the survival and expansion of many traditional industries. For example, the modernization of the machine-tool industry depends on new technologies such as automatic tool and process control operations, numerical-control systems, machinery centres, turning machinery, automation and computers, and flexible cells. Even the wine-making industry now has mechanical pickers and temperature-controlled fermentation tanks;

(f) Among the industries surveyed, fertilizers and bulk chemicals showed a marked improvement in capacity utilization. Conversely, the crude steel, ordinary table wine, waste paper, and market pulp industries continued to have problems of overcapacity;

(g) Not surprisingly, many transnational corporations located in the United States, Japan and Western Europe are increasingly moving towards global market integration and concentration, particularly in technology- and research-and development-intensive industries such as advanced materials, machine tools and pharmaceuticals. However, the location of such industries in many cases will continue to persist, partly because of their need for advanced technology, and partly because of geographic proximity to their respective end-using industries;

(h) Environmental concerns are having a growing impact on the technology choice and the location of highly polluting industries. For example, investment plans for the bulk chemicals, fertilizer, cast metals, crude steel, nickel processing, and pulp for paper and board industries are being markedly affected by more stringent environmental regulations and consequent higher costs of pollution abatement. There is thus likely to be a relocation of these and other industries to developing countries where pollution controls may be less stringent. In some cases, such as bulk chemicals, the production of lower-technology chemicals would also be more suited to production in developing countries. In other cases such as waste paper, the industry has expanded because of enhanced environmental concerns. The steel industry is also benefiting from scrap iron and other recycled materials;

(i) Rapidly increasing demand for manufactured output in developing countries has caused a renewed shift in manufacturing capacity to these countries. Some examples of the industries involved are waste paper and pulp for paper and board, bulk chemicals, and automotive tyres. In the case of fertilizers, the shift has been slower, but some attraction exists because of the ready availability of raw material feedstocks. An increase in the demand for such manufactured products is also expected in Eastern Europe and the USSR;

(j) Finally, many industries in developed countries have succeeded in delinking industrial production from energy use through a shift to less-energy-intensive, technologically sophisticated industries coupled with remarkable energy-efficiency improvements and conservation efforts. By contrast, a traditional positive link between industrial growth and energy consumption seems to be growing stronger in developing countries. In this connection, a detailed and systematic analysis of [illegible] relationship between industrial growth and energy consumption in both developed and developing countries is presented in chapter III of this report.

A. Machine tools (ISIC 3823)*

1. Recent trends and current conditions

Total world output of machine tools in 1990 is estimated to have been close to $47 billion, an increase of 11 per cent in current terms over 1989 and more than double its 1985 level. The significance of the machine-tool industry, however, lies not in its size but in the strategic role it plays in industrialization. All industrial production is accomplished either with machine tools or with machines and equipment that are products of machine tools. The importance of machine tools is fairly obvious in the case of products such as automobiles, aircraft, tractors and many consumer products. But it is less obvious that industries such as textiles, printing and food processing require special machinery produced with machine tools, and the same dependence exists for industries such as mining, petroleum processing and pharmaceuticals. Machine tools are not a single class of interchangeable machines. They are always power-driven and they change the shape of metal by cutting, eroding or shaping it. About three quarters of machine tools are cutting machines, including lathes (or turning machines), and boring, drilling, milling and grinding machines. Although all of these machines process

*UNIDO acknowledges the contribution made by Anderson Ashburn, Editor Emeritus, *American Machinist*

metal by a feeding action between tools and work with one or both rotating, they vary widely in the type of work they do and their applications.

A new class of cutting machines, called erosion machines, remove the metal by electrical discharge, by electrochemical action, or by ultrasonic, plasma, electron or laser beam. Other machines, such as forming machines, may shape either sheet material or heavy sections by pressing, bending, punching, shearing or forging. Each of these types may come in a variety of configurations for various specialized applications. Altogether there are more than a hundred different types of machine tools. Because they are capital equipment, and used in many cases to make other types of capital equipment, they are subject to much larger swings in industrial demand and national economic activity than are consumer products. Machine-tool builders thus also experience instability. In practice, the cycle in the production rate and shipment of machine tools does not swing up and down as much as the order rate. In periods of peak demand, the order backlog grows rapidly; in slack periods, however, there may be many cancellations of orders that reduce or eliminate the backlog.

Until recent years most machine-tool builders were small firms. The technology lent itself to individual innovation and research that could be performed on a small scale. During the past 30 years the combination of developments in control systems and the use of machines that work together in systems encouraged the growth of larger firms. In some cases, particularly in the United States, many small companies were acquired by large, diversified companies that became reluctant to provide the large working capital needed to sustain modernization, thus limiting new order capabilities [1].

(a) Production

Levels of world machine-tool production according to region are shown in table V.1, and the shares of the more important regions are shown in figure V.1 (see section 5 of this survey for further information on the production and consumption data). The most striking development in the past five years has been the remarkable growth in Western Europe, where the share of world production increased from 32 per cent in 1985 to more than 45 per cent in 1989. Most of this increase took place in 1990, and was shared by almost all the countries in Western Europe. This gain was made at the expense of Eastern Europe and the United States. In Eastern Europe, machine-tool output slipped from 23 per cent of world production in 1985 to 16 per cent in 1990. A number of ties (joint production, licensing, distribution) began to form in 1990 between companies in Eastern and Western Europe, the majority involving the Federal Republic of Germany and the German Democratic Republic. These may have a major influence on future production, but had little effect in 1990.

Output in the United States declined from 12 per cent of world output in 1985 to 7 per cent in 1990. Despite continued growth in value, the share of Japan in world production also declined slightly from 24 per cent in 1985 to 23 per cent in 1990, while that of the NICs in Asia (notably the Republic of Korea and Taiwan Province) continued to grow. All the producing countries of Asia, other than Japan, increased from a shared 5 per cent of world production in 1985 to 7 per cent in 1989, but then slipped to 6 per cent in 1990 because of output increases in Western Europe. More recent data on machine-tool production by country and area appear in table V.2.

Table V.1. World machine-tool production and consumption, 1985 and 1990

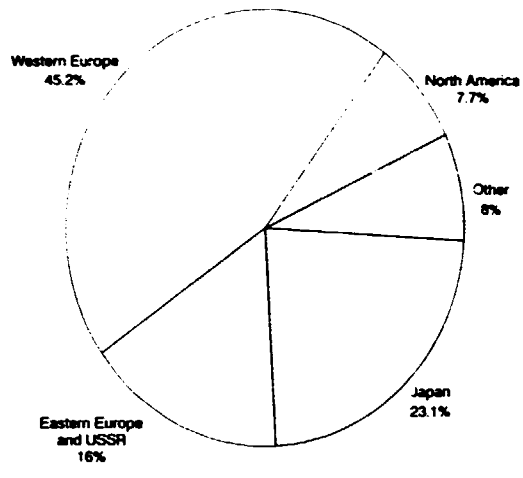
Region or country	Production 1985 (million dollars)	Production 1990 (million dollars)	Percentage share 1985	Percentage share 1990	Percentage change 1985-1990	Consumption 1985 (million dollars)	Consumption 1990 (million dollars)	Percentage share 1985	Percentage share 1990	Percentage change 1985-1990
North										
North America	2 916.7	3 588.9	13.27	7.67	23.0	4 431.8	5 384.9	20.17	11.51	21.5
Western Europe	7 095.0	21 152.9	32.28	45.20	198.1	5 381.7	17 842.5	24.49	38.13	231.5
Eastern Europe and USSR	5 123.7	7 474.4	23.31	15.97	45.9	5 431.9	7 775.4	24.72	16.61	43.1
Japan	5 316.7	10 832.1	24.19	23.15	103.7	3 350.0	7 476.3	15.24	15.98	123.2
Other developed countries a/	160.9	160.3	0.73	0.34	-0.4	606.1	433.0	2.76	0.93	-28.6
South										
Latin America	289.7	509.7	1.32	1.09	75.9	700.0	1 514.7	3.19	3.24	116.4
Africa	..	..	..	..	..	125.0	375.0	0.57	0.80	200.0
Asia b/	1 074.9	3 079.2	4.89	6.58	186.5	1 951.1	5 995.7	8.68	12.81	207.3
North	20 613.0	43 208.6	93.79	92.33	109.6	19 201.5	38 912.1	87.37	83.15	102.7
South	1 364.6	3 588.9	6.21	7.67	163.0	2 776.1	7 885.4	12.63	16.85	184.0
TOTAL	21 977.6	46 797.5	100.00	100.00	112.9	21 977.6	46 797.5	100.00	100.00	112.9

Source: American Machinist, various issues.

a/ Australia, Israel, New Zealand and South Africa.

b/ Including Western Asia.

Figure V.1. World machine-tool production, 1990



Source: American Machinist, February 1991, pp. 35-39.

Table V.2. Largest machine-tool producer countries and areas, 1990

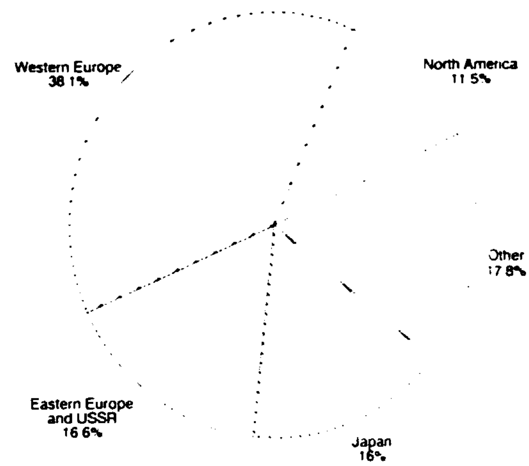
Rank	Country or area	Production (million dollars)	Percentage share
World			
1	Japan	10 832.1	23.42
2	Germany, Federal Republic of	8 826.5	19.09
3	USSR	4 580.0	9.90
4	Italy	3 966.0	8.58
5	United States	3 220.0	6.96
6	Switzerland	3 183.6	6.88
7	United Kingdom	1 719.7	3.72
8	France	1 364.8	2.95
9	German Democratic Republic	1 085.0	2.35
10	Taiwan Province	1 034.9	2.24
11	Spain	1 034.9	2.24
12	China	989.7	2.14
13	Republic of Korea	733.3	1.59
14	Yugoslavia	629.0	1.36
15	Romania	530.7	1.15
16	Brazil	450.0	0.97
17	Canada	368.9	0.80
18	Austria	280.5	0.61
19	Belgium	271.9	0.59
20	Sweden	251.7	0.54
21	India	243.5	0.53
22	Poland	200.0	0.43
23	Czechoslovakia	191.9	0.41
24	Bulgaria	160.0	0.35
25	Hungary	97.8	0.21
	TOTAL	46 246.4	100.00
South			
1	Taiwan Province	1 034.9	28.79
2	China	989.7	27.53
3	Republic of Korea	733.3	20.40
4	Brazil	450.0	12.52
5	India	243.5	6.77
6	Others	143.8	4.00
	TOTAL	3 595.2	100.00

Source: American Machinist, February 1991, pp. 35-39.

(b) Consumption

The pattern of world machine-tool consumption is shown in table V.1, and the most important regions are reflected in figure V.2. Between 1985 and 1990, consumption increased in the North by 103 per cent and in the South by 184 per cent. As a result, the percentage share of consumption in the South increased from 13 per cent of the world total to 17 per cent in 1990 (these estimates do not include machines made in those countries in the South which are not included as producers). Most of the increase in consumption occurred in those Pacific rim countries and areas which are rapidly industrializing and included among the producing countries (China, Republic of Korea and Taiwan Province).

Figure V.2. World machine-tool consumption, 1990



Source: American Machinist, February 1991, pp. 35-39.

Further disaggregation of the major consuming regions to the national level appears in table V.3. Eight of the top 10 consuming countries were also the major producing countries, although the order was somewhat different. Two of the principal consumers (China and Republic of Korea) were not top producers; on the other hand, two of the principal producers, the German Democratic Republic and Taiwan Province, were not among the top 10 consumers. It is not surprising that the five largest producing and consuming countries and areas in the South accounted for 96 per cent of its production and 55 per cent of its consumption.

There is some evidence that machine-tool consumption is a leading indicator of industrial development. Table V.4 shows consumption per capita in 1990, sometimes considered a proxy for investment intensity in machine tools. That Switzerland had more than double the investment per capita of any other country reflects both a concentration in manufacturing and an emphasis on the most precise and costly operations. The large increase in machine-tool consumption of Switzerland in 1990 (more than 28 per cent measured in Swiss francs and more than 50 per cent in dollars) might represent the response of that country to the challenge of the EEC.

After Switzerland, the Federal Republic of Germany has the most impressive investment per capita in new

Table V.3. Largest machine-tool consumer countries and areas, 1990

Rank	Country or area	Consumption (million dollars)	Percentage share
World			
1	Japan	7 476.4	17.81
2	USSR	5 900.0	14.06
3	Germany, Federal Republic of	5 780.7	13.77
4	United States	4 500.0	10.72
5	Italy	3 083.8	7.35
6	France	2 526.7	6.02
7	United Kingdom	1 800.1	4.29
8	Republic of Korea	1 461.3	3.48
9	Switzerland	1 302.4	3.10
10	China	1 289.7	3.07
11	Spain	1 081.1	2.58
12	Canada	884.9	2.11
13	Taiwan Province	747.9	1.78
14	German Democratic Republic	600.0	1.43
15	Romania	476.6	1.14
16	Brazil	460.0	1.10
17	Sweden	404.2	0.96
18	India	372.8	0.89
19	Austria	322.9	0.77
20	Belgium	302.5	0.72
21	Yugoslavia	272.5	0.65
22	Mexico	268.7	0.64
23	Netherlands	262.3	0.62
24	Poland	197.5	0.47
25	Finland	195.7	0.47
	TOTAL	41 970.7	100.00
South			
1	Republic of Korea	1 461.3	18.55
2	China	1 289.7	16.38
3	Taiwan Province	717.9	9.50
4	Brazil	460.0	5.84
5	India	372 8	4.73
6	Others	3 544.1	45.00
	TOTAL	7 875.8	100.00

Source: *American Machinist*, February 1991, pp. 35-39.

Table V.4. Estimated world machine-tool consumption per capita, 1990

Rank	Country or area	Consumption per capita (dollars)	Percentage share
1	Switzerland	200.1	19.54
2	Germany, Federal Republic of	95.6	9.33
3	Singapore	69.7	6.81
4	Japan	60.4	5.90
5	Italy	53.7	5.24
6	Sweden	48.4	4.73
7	France	44.9	4.39
8	Austria	43.1	4.21
9	Finland	39.3	3.84
10	Taiwan Province	36.6	3.57
11	German Democratic Republic	36.1	3.52
12	Canada	33.7	3.29
13	Republic of Korea	33.5	3.27
14	United Kingdom	31.4	3.07
15	Belgium	30.6	2.99
16	Denmark	28.8	2.82
17	Spain	27.3	2.66
18	USSR	20.5	2.00
19	Romania	20.5	2.00
20	Netherlands	17.8	1.73
21	United States	17.7	1.72
22	Bulgaria	12.8	1.25
23	Yugoslavia	11.4	1.12
24	Czechoslovakia	10.4	1.01
	TOTAL	1 024.1	100.00

Source: *American Machinist*, February 1991, pp. 35-39.

machine tools, the continuation of a trend that has been almost uninterrupted in that country for many years. Japan, though behind on a per capita basis, has been increasing tool investment at a faster rate. Another surprising aspect of table V.4 is the relatively low per capita investment found in both the United States and the USSR.

(c) *International trade*

Six countries—France, Germany, Federal Republic of, Italy, Japan, United Kingdom and United States—ranked among the top exporters and importers as shown in tables V.5 and V.6. Three of the top 10 in exports, but not in imports, were Belgium, German Democratic Republic and Taiwan Province (about one half of the imports into Belgium are not for domestic consumption but are re-exported to other countries in the EEC). Three of the top 10 importers not included among the top exporters were Canada, Republic of Korea and USSR.

(d) *Major companies in the global industry*

Comparison of individual machine-tool companies around the world on the basis of turnover value is difficult because of differences in accounting methods and time periods covered and currency fluctuations between countries. However, *American Machinist* prepares an annual survey of machine-tool companies in developed market economies. The 25 largest companies for the fiscal year ending in 1989 are shown in table V.7. Most of the companies have plants in several countries and all are active exporters. Among those shown, 15 are based in Japan, 4 in the United States, 4 in the Federal Republic of Germany, and 1 each in Switzerland and the United Kingdom. Because of the lack of comparative data, plants in the centrally planned economies are not included.

The largest company, Yamazaki Mazak of Japan, is privately owned, hence the data are unofficial. The firm has several highly automated plants in Japan, one of the largest plants in the United States, and a plant in the United Kingdom. Amada is primarily an engineering and marketing company that designs machine tools and contracts their manufacture to other firms. It owns a substantial interest in some of these firms, two of which (Amada Sonoike and Amada Wasino) also appear in table V.7. Fanuc produces machine tools, robots and plastics machinery, but most of its production is in the field of numerical controls, of which it is the world's largest producer. Its early development of controls using transistors and microprocessors was a major factor in the growth and success of the machine-tool industry of Japan.

Litton Industries, a large diversified company based in the United States, has acquired a number of machine-tool companies, but it has built its tool division around only Lamb Technicon, Landis Tool, and Gardner.

Table V.5. Machine tool exports of major trading countries and areas, 1985 and 1990

Rank in 1990	Country or area	Exports (million dollars)		Percentage share		Percentage change 1985-1990
		1985	1990	1985	1990	
1	Germany, Federal Republic of	1 970.4	5 159.1	20.88	23.77	161.8
2	Japan	2 186.7	3 996.6	23.17	18.42	82.8
3	Switzerland	836.4	2 749.5	8.86	12.67	228.7
4	Italy	707.6	1 983.0	7.50	9.14	180.2
5	United States	452.4	1 060.0	4.79	4.88	134.3
6	United Kingdom	341.4	835.3	3.62	3.85	144.7
7	German Democratic Republic	758.9	775.0	8.04	3.57	2.1
8	Taiwan Province	201.7	648.2	2.14	2.99	221.4
9	Belgium	132.6	568.6	1.41	2.62	328.8
10	France	208.6	534.8	2.21	2.46	156.4
11	Spain	151.5	461.2	1.61	2.13	204.4
12	Yugoslavia	142.7	451.5	1.51	2.08	216.4
13	USSR	210.2	380.0	2.23	1.75	80.8
14	Austria	93.0	353.5	0.99	1.63	280.1
15	China	14.4	248.0	0.15	1.14	1 622.2
16	Sweden	151.1	237.3	1.60	1.09	57.0
17	Canada	104.9	222.4	1.11	1.02	112.0
18	Netherlands	98.0	217.3	1.04	1.00	121.7
19	Czechoslovakia	252.9	187.7	2.68	0.86	-25.8
20	Romania	54.9	140.6	0.58	0.65	156.1
21	Singapore	83.6	120.5	0.89	0.56	44.1
22	Bulgaria	79.9	120.0	0.85	0.55	50.2
23	Republic of Korea	23.0	92.0	0.24	0.42	300.0
24	Hungary	138.0	88.0	1.46	0.41	-36.2
25	Denmark	42.0	70.6	0.45	0.33	68.1
	TOTAL	9 436.8	21 700.7	100.00	100.00	130.0

Source: *American Machinist*, February 1986, pp. 81-92, and February 1991, pp. 35-39.

Table V.6. Machine-tool imports of major trading countries and areas, 1985 and 1990

Rank in 1990	Country or area	Imports (million dollars)		Percentage share		Percentage change 1985-1990
		1985	1990	1985	1990	
1	United States	1 738.5	2 340.0	21.70	13.31	34.6
2	Germany, Federal Republic of	635.8	2 113.4	7.93	12.02	232.4
3	USSR	1 387.4	1 700.0	17.31	9.67	22.5
4	France	357.8	1 696.7	4.47	9.65	374.2
5	Italy	196.4	1 100.7	2.45	6.26	460.4
6	United Kingdom	613.7	915.7	7.66	5.21	49.2
7	Switzerland	169.7	868.3	2.12	4.94	411.7
8	Republic of Korea	229.0	820.0	2.86	4.66	258.1
9	Canada	333.9	738.4	4.17	4.20	121.1
10	Japan	220.0	640.8	2.75	3.64	191.3
11	Belgium	166.0	568.6	2.07	3.23	242.5
12	China	222.7	548.0	2.78	3.12	146.1
13	Spain	58.9	507.6	0.74	2.89	761.8
14	Austria	116.4	395.9	1.45	2.25	240.1
15	Sweden	174.3	389.8	2.18	2.22	123.6
16	Netherlands	191.9	381.7	2.39	2.17	98.9
17	Taiwan Province	75.6	361.2	0.94	2.05	377.8
18	German Democratic Republic	96.3	290.0	1.20	1.65	201.1
19	Mexico	146.0	258.0	1.82	1.47	76.7
20	Singapore	143.2	243.2	1.79	1.38	69.8
21	Finland	70.1	176.0	0.87	1.00	151.1
22	Czechoslovakia	67.2	158.5	0.84	0.90	135.9
23	Denmark	74.9	137.9	0.93	0.78	84.1
24	South Africa	365.9	116.3	4.57	0.66	-68.2
25	India	161.7	114.6	2.02	0.65	-29.1
	TOTAL	8 013.3	17 581.3	100.00	100.00	119.4

Source: *American Machinist*, February 1986, pp. 87-92, and February 1991, pp. 35-39.

Table V.7. The world's 25 largest machine-tool companies, 1989

Rank	Company and country	Turnover[a/] (million dollars)	Percentage change	Net profit[b/] (million dollars)	Percentage change	Margin[c/]	Number of employees
1	Yamazaki Mazak Corp. (Japan)	1 183.7	48.7	..	..	..	3 524
2	Amada Co., Ltd. (Japan)	1 153.0	29.3	92.4	184.3	8.0	1 513
3	Fanuc Ltd. (Japan)	1 079.2	16.2	194.8	33.9	15.7	1 894
4	Litton Industries, Inc. (United States)	730.1	21.6	178.3	6.8	3.5	50 700
5	Okuma Machinery Works (Japan)	665.3	20.7	28.4	129.0	4.0	1 810
6	Mori Seiki Co., Ltd. (Japan)	635.6	30.0	71.7	147.2	11.1	1 650
7	Komatsu Ltd. (Japan)	474.1	18.9	129.6	-4.7	2.1	15 297
8	Toyoda Machine Works (Japan)	466.5	11.6	26.1	103.9	2.1	4 435
9	Cross & Trecker Corp. (United States)	456.7	6.0	-46.5	-97.0	-10.2	3 900
10	Cincinnati Milacron (United States)	424.1	1.3	17.4	-53.1	2.0	7 683
11	Fuji Machine Mfg. (Japan)	392.2	62.8	40.2	142.2	10.2	832
12	Amada Sonoike (Japan)	390.7	27.0	16.8	-12.0	4.3	640
13	Ingersoll Milling Mach. (United States)	366.5	6.2	..	..	..	4 600
14	George Fischer (Switzerland)	364.7	16.8	48.7	42.4	3.0	14 294
15	Toshiba Machine (Japan)	359.5	40.5	28.1	806.5	2.7	3 373
16	Hitachi Seiki (Japan)	346.4	25.6	48.4	..	12.9	1 123
17	Trumpf (Germany, Federal Republic of)	340.7	12.6	17.3	2.4	5.1	2 599
18	Citizen Watch (Japan)	338.6	142.0	72.3	58.6	3.2	3 264
19	Makino Milling Machine (Japan)	318.2	17.8	18.6	64.6	4.9	996
20	Deckel Group (Germany, Federal Republic of)	284.6	-18.8	-23.9	..	-8.3	2 700
21	Amada Wasino (Japan)	284.6	-1.0	11.0	7.8	3.9	490
22	Maho Group (Germany, Federal Republic of)	283.2	22.1	6.7	13.6	2.4	2 312
23	Aida Engineering (Japan)	268.4	8.6	23.6	4.0	8.8	846
24	The 600 Group (United Kingdom)	251.9	-9.1	2.8	-72.3	1.1	2 771
25	Traub (Germany, Federal Republic of)	241.2	5.6	5.4	-37.9	2.2	2 705

Source: *American Machinist*, Blue Bulletin, August 1990.

a/ Turnover figures represent the portion of total sales accounted for by machine tools (including numerical controls and handling equipment).

b/ Net profit figures represent after-tax profit for the total turnover of the company.

c/ Calculated on total turnover.

2. *Capacity utilization and expansion plans*

(a) Japan

Japan is now responsible for more than 23 per cent of world machine-tool production on a per annum and value basis. Despite its large volume of exports, which has led to trade frictions with the United States, most of its growth has occurred to meet internal demand. In 1990 Japan added 16 per cent of total world production to its industrial base, more than any other single country. From 1985 to 1990 production increased by 104 per cent and consumption by 123 per cent measured in current dollars. In 1990 machine-tool consumption equalled 69 per cent of its production, and imports supplied less than 9 per cent of the machines. A relatively low level of imports continued, despite the continuing campaign by the Government to increase their volume. Persistently low import levels together with expanded exports have resulted in import quotas in both Western Europe and the United States.

Demand for new machines has spread across most manufacturing industries, but it has been particularly strong in the automotive industry. For many years, partly because of the rapid rate of expansion of industry in Japan, and partly because of a tendency to replace machines more frequently than in other countries, companies in Japan have had a much higher percentage of machines less than five years old than any other major industrial country. A recent study by the MITI indicates that 24 per cent of the machine-tool inventory is five years old or less. This percentage apparently peaked at 31 per cent in 1967 [2].

Machine-tool factories in Japan are among the most productive in the world. The tools produced are for the most part standard rather than special purpose and depend on a high degree of automation in factories. The companies are quick to adopt new ideas. In metal-cutting machines, for example, the emphasis is on numerical control. Production of numerical control machines exceeds 70 per cent of the total for metal-cutting machinery and at the 1987 Japanese International Machine Tool Fair about 86 per cent of the machines shown (435 of the total of 507) were equipped with numerical controls.

Resistance in Europe to imports from Japan together with a quota system imposed in the United States have become limiting factors preventing more rapid growth of the industry. Many of the larger exporters have responded by beginning to assemble machines in the United States. A combination of local purchase of components together with the production of some large parts in the plant could bring up the local content to at least one half the value of the machine, thus qualifying it as a "domestic" machine and exempting it from the quota.

Little change in exports and a modest 5 per cent growth in domestic consumption are expected in Japan in 1991, according to estimates made by the Mitsubishi Bank and the Institute of Research on National Economy, a research body in Japan.

(b) Germany

The Federal Republic of Germany increased its machine-tool production from 14 per cent to 19 per cent of world output, and its consumption from 8 per cent to 14 per cent of the world total, during the period 1985-1990. Its machine-tool exports were the largest in the world, accounting for about 58 per cent of production, in 1990. Although production amounted to 80 per cent of that of Japan, the industry employed more than twice as many people (about 98,000 workers). Although a few plants were as modern and productive as Japanese plants, most followed more traditional practices. The higher employment levels could have resulted from less reliance on suppliers for parts, from greater emphasis on the production of special-purpose machines and of machines of heavier or more complex design, and from a larger percentage of machines built to meet high precision standards [3].

The rapid moves in 1990 towards the unification of the Federal Republic of Germany and the German Democratic Republic brought major changes in manufacturing patterns in both countries. The German Democratic Republic, with a machine-tool production estimated as the eighth largest in the world in 1989, but less than one fourth that of the Federal Republic of Germany, had almost as many workers, about 70,000. As a State-controlled entity it comprised 44 companies organized into three categories (rotational-part machines, prismatic-part machines and forming machines). These were converted into stock companies in mid-1990 with the intention of privatizing as many as possible and of liquidating the remainder. Many of the individual factories have formed partnerships with firms producing similar products in the Federal Republic of Germany. The factories that survive are expected to reduce employment to roughly 50 per cent*.

About 70 per cent of the machine-tool exports of the German Democratic Republic were to the USSR and other CMEA countries. To compete in hard currency markets, the upgrading of machine-tool products is required. *Unternehmensberatung München GmbH Consulting*, predicts that production in the former German Democratic Republic, which declined by about a third in 1990, will continue to decline in 1991, but will then increase quickly, while other estimates suggest that the recovery will take longer.

(c) USSR

The USSR is supposed to have the third largest machine-tool industry in the world and to be the third largest importer and a minor exporter. On that basis it ranked as the world's largest machine-tool consumer before Japan became predominant in 1988. About a fifth of its imports came from the Federal Republic of Germany, another fifth from the German Democratic Republic, and much of the rest from other Eastern European countries. Although consumption and production both increased in the USSR until 1989, they declined in 1990, and its share of world production fell from 14 per cent in 1985 to less than 10 per cent of the world total in 1990. Consumption fell from 19 per cent to 14 per cent of the world total in the same period.

The productivity of most of its equipment is below the level of much of that found in industries of developed market economies. In recent years, companies have had difficulty meeting their planned targets. Although central planning is still in force, some of the enterprises have been given more independence in their operations. A number of joint ventures involving production and sales have been completed or are under discussion, although the conclusion of such arrangements has recently come to a standstill.

(d) Italy

Machine-tool production in Italy in 1990 was three times the level of 1985, and consumption showed a similar increase. Domestic orders declined by 33 per cent, however, and export orders increased slightly, giving a net decline of 17 per cent in orders for 1990. Exports have continued to grow and now account for about one half of production. The industry in Italy is made up of about 480 firms with 32,000 employees. Many of these firms concentrate on engineering and assembly, contracting most of the production of parts and components to other firms.

(e) United States

Machine-tool consumption in the United States declined in 1990, resuming a long-term decline that had been interrupted in 1989 by a sudden 30 per cent rise. The 1990 level of consumption was only 10 per cent above the 1985 level measured in current dollars, which means a decline in real terms. The United States is now the largest importer in the world, while its share of world production has fallen from 12 per cent in 1985 to less than 7 per cent in 1990. Despite the growth in imports, the United States share of world consumption fell from 18 per cent in 1985 to less than 11 per cent in 1990. This decline seems to stem from a combination of factors, including greater concentration on short-run profit performance than on planning for long-range product and market development. There are many small firms with average sales totalling less than $6 million and average employment levels of less than 150 workers [4].

Most United States machine-tool demand is for numerical-control machining centres, lathes and punch presses. The total number of numerical-control machines installed has doubled in the last six years and now amounts to about 220,000 machines, although the total number of machine tools in use has changed little during that period [5]. In 1989, numerical-control machines represented one third of United States production and two thirds of imports by value. Of metal-cutting machines produced that year, 45 per cent were numerical-control types. During the first half of 1990, the proportion of numerical-control types was even higher: 40 per cent of total machine tools and 49 per cent of metal-cutting machines.

(f) Taiwan Province

Production of machine tools in Taiwan Province climbed above $1 billion for the second straight year, making it the tenth largest producer in the world, with

*Information obtained from management of *Werkzeugmaschinen und Werkzeuge Handel AG* and from *Unternehmensberatung München GmbH Consulting*.

an increase of 270 per cent over its 1985 level. Even though almost two thirds of production is exported, consumption increased 390 per cent in 1985, and Taiwan Province now ranks thirteenth in world consumption. The rapid increase in consumption reflects a rapid rise in wage rates that is stimulating an increased use of computer-controlled machine tools. Quotas in the United States have restricted some exports, causing a shift in trade flows primarily towards Europe. In the meantime, the Government has been sponsoring a programme to speed up the development of high-precision machines.

(g) Czechoslovakia

The machine-tool industry of Czechoslovakia, once one of the more innovative in Europe, has continued to stagnate. *Trust Strojerenske Techniki*, which operated the machine-tool industry, has now reorganized into what is presented as a voluntary trade association with 26 members called *Svas Viropcu Dotavately Strojirenske Techniki*. The individual companies have a less stable future than those in the former German Democratic Republic. In the past, about two thirds of their production was exported to other Eastern European countries. It is expected that further trade with those countries will have to be on a barter basis for the next year or two. More than one third of the production planned for the domestic market has been affected by the adjustments required to meet the removal of most price controls in 1991. A number of the companies have reorganized as stock companies and sought investment from developed market economies. A number of discussions took place but no agreements were reached in 1990.

(h) Hungary

Machine-tool consumption in Hungary fell by one third in 1990, mostly through reduced imports. A small number of firms account for most of the output of the country. Csepel (45 per cent of output) and Szim (a combination of six smaller companies) have each made the transition to private stock companies. Szim has formed a 50-50 joint venture with Maho of the Federal Republic of Germany to produce Maho designs in Budapest. Csepel has been negotiating with another firm, and has had some success supplying numerical-control machines to China as well on a barter basis. One half of Hungarian production was formerly exported to CMEA countries, including 15 per cent to the USSR. In early 1990 all exports to those countries were stopped, because they could not be sold for hard currency.

3. Restructuring and deployment

The United States dominated the world machine-tool industry from its beginnings until the late 1960s and again in the late 1970s. Japan moved into the first position in industry volume in 1982, and has not only held but increased its market share in subsequent years. Although it is difficult to compare industries in the USSR with those of developed market economies because of the arbitrary pricing used in centrally planned economies, uncertainty about the quality of reported data, and the lack of currency convertibility, surveys by *American Machinist* have placed the USSR in third place among machine-tool-producing countries during most of the above-mentioned period, and occasionally in second.

The United States was a major exporter of machine tools through 1977 and has been a net importer since. Imports which accounted for less than 10 per cent of consumption during most of this time, now represent more than 50 per cent. The cyclical nature of the industry has been evident. Major downturns in the volume of new orders were experienced in 1957, 1966, 1970, 1974, 1980 and 1985. During the profitable periods immediately preceding these declines, a number of major machine tool companies, which had previously been independent, were acquired by large diversified corporations. During the subsequent unprofitable downturns, there was extensive restructuring. Many firms reduced capacity, acquired components from outside suppliers, either in the United States or abroad, or began to serve as distributors of imported machines. In some cases companies disappeared completely.

In 1986 the United States Department of Commerce estimated that domestic machine-tool capacity had declined by at least 25 per cent since 1982, and that the industry was operating at only 60 per cent of capacity. However, the problems of finding trained workers made it difficult to utilize idle capacity, as was demonstrated by a substantial increase in the rate of orders, starting in 1987. The level of shipments remained almost unchanged for more than a year, and then rose slowly until the backlog finally began to decline in 1989. Perhaps the most critical factor in the weakening of the United States machine-tool industry has been its change in emphasis; the industry seems to be more concerned with economic trends than technological ones. This shift in values has caused greater emphasis to be put on short-run economic performance than on long-term technical improvements. United States firms tend to view improved productivity primarily as an exercise in short-run cost reduction, which helps to explain the increasing reluctance of machine-tool builders to invest in advanced manufacturing processes.

By contrast, Japanese firms more often consider investments in manufacturing engineering as an important element both in improving product design and in enlarging international competitiveness. Major growth of machine-tool production in Japan began in 1967, following a decade of slower development that brought output to a volume comparable with that of France, Italy and the United Kingdom. This growth depended on the successful adoption of new technologies, notably the transistor and the microprocessor. It also was the result of the strategy of many Japanese to concentrate on the volume production of a limited number of standard models. Starting from a very low base, many Japanese firms had tried to use assembly lines for machine tools. However, this approach often failed for one of two reasons: the inability to sell enough of a model to justify an economic level of production; or the eventual demise of a model as it became technologically obsolete. Although Japanese firms continue to engage in volume production of a few models, they have abandoned many of their attempts at assembly-line production as impractical for so complex a product.

More recently, Japanese manufacturers have been quick to try improved technologies. In theory, flexible manufacturing systems can bring some of the advantages of automation, while retaining the ability to modify or upgrade the product. In 1984 there were at least 27 flexible manufacturing systems in operation in the plants of 15 Japanese machine tool builders. Some of these were evidently research projects and potential sales tools, but some were clearly intended as production tools. Other factors that manufacturers have recognized as important include product quality, the growth of the automotive industry, and adjustments to cyclical changes. A strong emphasis on quality first started with control systems, which were usually the most troublesome part of numerical-control machines. Generally, the rapid growth of the automobile and other industries in Japan, which created a domestic demand that grew rapidly from year to year, led the Japanese machine-tool industry to become the most highly automated in the world today.

There have been declines in shipments, of increasing amounts, first in 1971, and then in 1975, 1982 and 1986. During several of these downturns there were reductions in capacity, attempts at diversification, and in some cases substantial lay-offs of workers. When orders again increased, manufacturers managed to reassemble and expand the industry at an unprecedented rate of 27 per cent during the first half of 1988. Even so, machine-tool builders have not been able to keep pace with demand, and Japanese firms have begun to quote delivery times of up to 14 months for standard numerical-control machines.

Historically, the German machine-tool industry has been concentrated in the eastern part of the country. After the country became divided at the end of the Second World War, two separate industries developed. In the German Democratic Republic, industry structure was based primarily on the surviving plants and workers in the area. A new industry was developed in the Federal Republic of Germany by surviving owners and engineers who had moved there. Equipment and plans from some of the German plants were transferred to the USSR and used to start up companies there. For some time almost identical designs were thus being produced in three different countries.

The machine-tool industry expanded more rapidly in the Federal Republic of Germany and by 1960 production was at a level close to that of the United States and the USSR. Most of the companies were small, family-owned businesses. Although there have been reductions in numbers through failure or mergers, new companies have been started and the total number of machine-tool-building firms in Germany even today remains larger than in any other country. Although hundreds of small companies produce almost entirely for the domestic market, many other companies have focused on exports to such an extent that more than one half of .al production may be exported in any given year. One half of the exports go to Western Europe. Machine-tool imports into the Federal Republic of Germany have also been relatively large, though much smaller than its exports. In 1990, imports accounted for 37 per cent of consumption. Most imports have been from other countries in Western Europe, though this has recently declined with increasing imports from Japan.

A most important factor in the development of the machine-tool industry in the Federal Republic of Germany was the growth of research and development cooperation between industry and universities, with substantial government support. For example, the industry initially lagged behind the United States and Japan in both research into and applications of numerical controls. This position began to change in 1981, and by 1985 industry in the Federal Republic of Germany seemed to have retaken the initiative. This intensive development took place despite the fact that the intervening years were unprofitable. Because of large export sales, firms in the Federal Republic of Germany have had fewer periods of reduction in volume than those in most other countries. The most serious reductions occurred during the period 1981-1984.

The USSR with its centrally planned economy has maintained a more uniform level of growth than that of developed market economies, although in recent years the industry has had increasing difficulty in reaching planned targets. This has resulted from the usual problems with central planning in matching production to requirements and in obtaining desired levels of quality. Failure to develop adequate supplies of spare parts has also affected operations. New government policies have been encouraging joint ventures with developed market economies in order to stimulate modernization of the industry.

Italy had the fastest-growing economy in Western Europe after that of the Federal Republic of Germany before unification. In 1990 its consumption was five times the 1985 level and 53 per cent of that of the Federal Republic of Germany. The machine-tool industry has grown even faster than the economy as a whole, with exports now accounting for one half of production. As in the Federal Republic of Germany, most machine-tool builders in Italy are small, family affairs. Many concentrate on engineering and assembly and buy most of the parts and components from others. The number of firms is approaching that of the Federal Republic of Germany.

The machine-tool industry of Switzerland has occupied a unique position in the world. This small country has a reputation for producing specialized machine tools of great precision and exports most of its production. In 1989, its exports accounted for 88 per cent of production. Although individual companies in several other countries produce machines of comparable precision, the Swiss industry has moved ahead of those of France, German Democratic Republic and United Kingdom.

Taiwan Province has been the most successful exporter of machine tools among the NICs. With production valued at $1 billion in 1989, it ranked tenth in volume in the world and exported two thirds of its production. Most of the companies produce inexpensive standard machines, though there is a growing attention paid to numerical controls. Rising labour costs have stimulated demand for such machines from domestic companies. The industry has depended primarily on exports to the United States; although more recently it has been subject to a voluntary export restraint agreement.

The production of machine tools in the Republic of Korea more than tripled from 1985 to 1989, with most of the increase being used to meet domestic requirements. While exports account for only about 10 per cent of production, imports have grown rapidly and now account for more than one half of domestic consumption.

4. *Technological trends*

(a) *Manual versus automatic tool operations*

As the technology of metal-cutting machine tools developed, two broad classes began to emerge: those in which an operator manually controls the machine to produce a variety of different parts; and those in which cams and other mechanisms produce a large quantity of a single part. An example of how these variations can develop in a single type of machine tool is provided by turning machines, most of which are called lathes. With an engine lathe and a variety of tools a machinist can turn round or tapered surfaces, do facing, groove, bore, and thread to produce a part to match the given drawing with a precision that depends on skills as well as on the quality and condition of the machine and tools. The time required may range from minutes to several hours, depending on the size and complexity of the workpiece being turned.

In contrast, a multiple-spindle automatic bar lathe can produce millions of identical parts with only intermittent attention from an operator. Because the machine works on five or six different bar ends at once, rotating the spindle carrier at the end of each cycle, the machine produces a finished part at the end of each cycle, which may be only a few seconds. To manufacture a different part on the machine, however, will require hours to develop a sequence of operations, then days or weeks to design and fabricate the cams and tooling required, and finally hours or days to install, test and, if necessary adjust or revise them. Even when tested tools and cams are available, it can take several hours to convert the machine from the production of one part to the production of a different part.

When only a few pieces are to be produced it is often referred to as a small lot, while a great many identical pieces are referred to as a large lot. In extreme cases, a machine or group of machines may be built always to produce a single part, such as an automotive engine block. These terms are imprecise, and there are no data as to how the requirements differ in different countries. It is generally accepted in the United States, for example, that as many as 70 per cent of workpieces are produced in small- or medium-lot sizes. An attempt by *American Machinist* to compile data resulted in the discovery that one fuse company considered 1 million pieces a small lot and 10 million pieces a large lot, while an aircraft company considered 1 piece a small lot and 10 pieces a large lot. Requirements are known to vary from country to country. In most developing countries the requirements will be almost entirely for small lot production.

The examples of an engine lathe and a multiple-spindle automatic bar lathe represent extreme conditions. There are actually many different degrees of automation. A tracing lathe, for example, can copy a contoured master part and change it to a different part in minutes or hours, once the new master has been made. On the other hand, a transfer line of connected machines that automatically performs all the operations on one complex part (such as an automotive engine block) may require extensive rebuilding, requiring a year or more before it can handle a different type of engine block. It can only be partly salvaged if it is to be converted to a different part altogether, such as a transmission housing.

(b) *Process control operations*

The extent and manner of application of automatic tool operation has varied with each type of machine tool, depending on whether the control methods employed were mechanical, electrical or hydraulic. This began to change when developments in electronics made possible the digital control of machine tools. The result was a flexibility not previously possible. Digital control of machines has existed for a long time, but almost no commercial applications occurred until the development of electronics ([6] p. 469). It has had major effects on how machine tools are designed, built, and used. In the process, it has caused a major restructuring of the industry that builds machine tools and on the industries that use them.

(c) *Numerical-control system*

The first application of modern numerical-control systems that forced a restructuring of the world's machine-tool industries began only about 1950. The primary impetus came from a research project initiated by a small company in Michigan, financed by the United States Air Force, seeking a point-to-point control to make templates required in the inspection of helicopter blades. The project eventually ended up at the Massachusetts Institute of Technology (MIT) and was transformed into a programme to develop a continuous-path milling machine. This project produced a demonstration machine, surrounded by a control system containing thousands of vacuum tubes, proving the feasibility of the method. This resulted in a subsequent order by the Air Force for a hundred, five-axis, continuous-path milling machines from four firms that were to develop the machines and five companies that were to develop the controls. The wide attention attracted by this demonstration stimulated machine-tool builders and electrical firms all over the world to begin development work. Most of these sought simpler solutions, and some ultimately proved more commercially practical than the MIT approach, except for the most complex applications [7].

Initially there were many problems with numerical-control machines. Mistakes often occurred in hand-wiring the many connections inside the control. The shop-floor proved to be a harsh environment for delicate electronic equipment. Vibration, dirt, exposure to chemicals, high temperature, and electrical interference created by other equipment all took their toll [8]. Complex and expensive programming systems were a further complication; their difficulty contributed to programming errors that once introduced were hard to find and correct.

Within a few years, however, dozens of machine-tool builders in the United States were rushing the development of numerical-control machines, most of them simpler than the original types. Some firms were working to develop their own controls, but at the same time other companies were developing controls and seeking machine-tool builders to try them. Less than 10 years after the first demonstrations at MIT, a machine-tool show was held at Chicago with a hundred numerical-control machines on display [9].

That same year several companies in Japan were showing numerical-control machines with a number of different Japanese controls. In Europe there was less enthusiasm for the concept. Although about 30 numerical-control machines made in Western Europe were shown at Brussels in 1961, virtually none from Eastern Europe were shown at Leipzig. The general belief in Europe was that automatic programs could be provided more reliably and cheaply by using plug-boards that could be set up to provide particular cycles of operation.

(d) Machining centres

A totally new type of machine, the first specifically designed around the concept of numerical-control, changed everything. This type of machine, which came to be known as the machining centre, had a horizontal spindle, an indexing table for the work, and an automatic tool changer supplied by a rotary drum holding 30 tools.

Built by the Kearney & Trecker company of Milwaukee, Wisconsin, this first machining centre could do much of the work done by milling, drilling and boring machines. In other words, a machining centre could perform most of the operations normally performed by machine tools using a rotating tool. Later developments in programming made it possible to perform, though less efficiently, operations that would normally be done by turning. The machining centre could do all this on four sides of a workpiece in one sequence of operations. Then, with the work repositioned on a selected side, it would complete the top and bottom in a second sequence of operations.

Most machine-tool builders quickly recognized the potential of the machining centre to supplant existing machine tools, and soon all the companies that built milling, drilling and boring machines were busy developing machining centres. At the European Machine Tool Show held at Hanover in 1981, 200 firms exhibited machining centres. That was probably the peak. In 1982 a process of elimination began, and by 1985 only 160 firms exhibited machining centres at the European Machine Tool Show at Hanover, and by 1987 only 136 firms did so at the Show held at Milan.

(e) Development of vertical spindles

As machining centres developed, there was intense competition between companies producing them, and technical improvements came rapidly. The original machine had a horizontal spindle. Machining centres with vertical spindles soon appeared. Though less expensive than the horizontal machines, they lacked the ability to work on four sides of the workpiece. The number of tools in the magazine increased rapidly, with some machines providing a quick change of complete magazines. The workpiece was mounted on pallets that could be exchanged with one or more reserve pallets so that a machine could be loaded with several workpieces.

Fixtures were developed that could mount a number of small workpieces on a large slablike surface. These were called tombstone fixtures which, when placed on a rotary table, could mount workpieces on all four sides. This permitted a single pallet to carry a number of workpieces to be machined. These could all be for the same part, or for two or more different parts. The workpieces could be castings, forgings, or more simply pieces of metal cut from a plate or bar.

To broaden the applications of vertical spindle machines, tilting and angular tables were introduced. Some machines were provided with two spindles, one horizontal and one vertical. Others developed a universal spindle that could be converted from horizontal to vertical. In time the vertical machining centres overtook the horizontals both in quantity and in the total value of the machines sold, despite the fact that individual horizontal machines are likely to cost twice as much as verticals, several times as much in the case of large, five-axis machines. Horizontal machines must be heavier to provide the same spindle accuracy, and require more floor space for a given capacity.

(f) Development of turning machines

A development somewhat similar to the machining centre has taken place with turning machines. Originally, numerical-control systems were applied to existing lathe designs. The first applications were made to basic engine lathes. Next turrets were added to provide additional tools. Initially these were similar to the tool-holding turrets of standard turret lathes, but then they began to take varied shapes and to hold more tools. Gradually, special designs that took more advantage of the numerical-control capability were developed. Turning machines that incorporated methods to change workpieces and tools were often called turning centres.

Numerical control made it possible to convert the spindle (which holds and rotates the work in a turning machine) into an axis so that it could be stopped at a specified position. By maintaining small power-driven tools in the machine, it became possible to drill off-centre holes and perform other operations that are normally impossible on a lathe.

(g) Automation and computerization

Some of the broader implications of machining and turning centres were not realized immediately. Until the development of numerical-control, any move to make a machine tool automatic reduced its flexibility, and the more automatic it became, the more difficult it was to alter work. Once a program is written, and the tools and fixtures necessary for its use are prepared, it may be commercially practical to produce only a few parts, sometimes only one, before changing to a different program and part. However, this situation changed drastically with the addition of numerical control, which brought the quality and economy of production previously available only on special automatic machines to small-lot manufacturing. Contract machine shops (often called job shops) and other plants specializing in small lots soon began to discover the advantages of these machines. What was not realized at first was that numerical-control could also bring flexibility to large-lot production. As it did become evident, multiple-spindle automatic bar and chucking machines were one of the first types to become an endangered species.

The last major industry seriously to consider using numerical-control was the automotive industry, which had been a major user of the multiple-spindle automatics for small-turned parts and of elaborate automated transfer lines for the large castings that required many machining operations. It was gradually realized that in some instances a line of specialized machining centres connected together to form a transfer line could at the very least come close to the output of a conventional transfer line, with the important added advantage of being able to handle several similar parts in succession. It could also be quickly readjusted to fit changes caused by new models, changing customer preferences, or additional government regulations. Such regulations, particularly in the United States, placed closer limits on the permissible exhaust gases and rates of fuel consumption and required more frequent changes in manufacturing equipment and methods.

These technical trends became major factors in forcing restructuring on the industry in the past 10 to 15 years, and companies that failed to read the trends correctly, or were unable to adjust to the changes, have seen their markets vanish. Some of this rapid change has been driven by the development of numerical controls and the software that operates them. Early controls may have worked well in the laboratory but often collapsed when faced with the realities of dirt, vibration, temperature and shock they encountered on the manufacturing floor. The development of air conditioning of the control cabinets and the replacement of vacuum tubes with transistors helped greatly to reduce the heat build-up and the dangers of vibration.

Further progress in automation occurred with the availability of minicomputers. Such computers greatly increased the complexity of the calculations the control could handle, and, as a result, reduced the complexity of the programs required to operate them. Then the microprocessor, which in effect placed computing capability on a single chip, meant that every control process could be managed with a computer. Each new generation of microprocessors has been followed by a new generation of computer control possibilities. Controls based on 32-bit microprocessors operating with a 16-bit bus were introduced in 1984, and those with 32-bit microprocessors and a 32-bit bus followed in 1986. By 1989 these 32-bit controls had become virtually the standard and were offered by many companies.

(h) Flexible cells or systems

The technology that has combined developments in machine tools, controls and computers, and has come to dominate manufacturing in recent years, is the flexible cell or system. Machine tools had previously been either general-purpose machines that were extremely flexible (within the limitations imposed by their size) in what they could produce, or they were partly or fully automatic. The automatic machines were extremely inflexible. Each type had its advantages, and the choice of the proper type could be critical to the success of a manufacturer. This was particularly true if a competing firm possessed a balance of flexibility and automation that better met the requirements.

The development of numerical-control brought some of the advantages of special-purpose machines to manufacturers producing small lots of many different parts. The addition of tool changers and part-handling equipment added to the flexibility. With the development of controls that advanced computing capability and could handle complex programs with speed and reliability, the idea of building an automatic factory became a real possibility.

Utilizing control developments, machine-tool builders began to combine machining centres and turning centres with tool- and part-handling equipment into machining cells and systems. The basic idea is that all of the processing performed on a group of similar parts could be handled on a continuing basis, using a group of machines connected by a part-handling system. While the difference between a cell and a system is subject to many interpretations, in general a cell consists of one or two machines that completely process a group of related parts, a family of parts. A system that is larger and more complex may handle different families of parts on different machines in the system, and generally has a separate controlling computer to control system operation. At the European Machine Tool Show held at Hanover in 1985 there were 77 different exhibits showing such combinations for rotating parts, 68 exhibits of cells or systems for prismatic parts, 28 cells or systems for sheet-metal parts, and 10 for other types of forming.

First attempts to introduce such advanced technical changes were often followed by a period of disillusionment and adjustment, and many systems applications encountered difficulties, usually with the software (the control programs written for the system). Since that time, more emphasis has been placed on smaller cells. There has also been a growing utilization of machines that combine different applications on a single machine or a pair of machines.

5. *Note on production and consumption data*

The sources of data on machine-tool production and trade are the annual surveys conducted by *American Machinist*. For some countries the source is government reports, for others it is formal or informal industry sources. The tables presented in this survey are based on 36 countries that are the principal suppliers to the world market. The quality of the data varies from country to country, and the problem is complicated by the use of non-convertible currencies, which often have several different official rates for different purposes.*

The bulk of production (usually 90 to 95 per cent) is sold in the home country or to other producing countries. The remainder (9.1 per cent in 1990) is exported to countries not included as producing countries.

*Seen annual surveys of world machine tool production and trade in *American Machinist*, January or February issues, 1965 to 1991.

Most of these are developing countries, though a few are developed (New Zealand and Norway, for example).

The statistics probably understate the production of machine tools in the reporting countries and altogether omit that of non-reporting countries. While the value of production of virtually all the quality machines produced by firms that produce and market machine tools is reported, simpler machines that other industrial firms manufacture in their own machine shop either for their own use or for an occasional customer are not counted. Also missing are some of advanced or specialized machines that are designed and produced by firms in other industries for their own use.

Some countries that are not included in the tables do produce machine tools on a commercial basis. For example, in 1990 the United States imported more than $16 million in machine tools from countries not included in the *American Machinist* data. Notable examples were imports of machine tools worth $3.7 million and $1.6 million respectively from Thailand and New Zealand*. Total world production in 1990, including machine tools built by firms for their own use, was about $50 billion.

Rough estimates of machine-tool consumption by non-exporting developing countries are based on an analysis of export data of a few major developed producing countries. However, locally made machine tools would increase the consumption rate for developing countries.

B. Pharmaceuticals (ISIC 3522)**

1. Recent trends and current conditions

The world pharmaceutical industry is a highly important science-based manufacturing business with strong growth prospects, particularly because of its social implications in meeting health-care needs. It is also an extremely profitable industry, with many of the top companies achieving profit margins (percentage of profits to sales) of 20 per cent or more. During the 1990s these profits may come under pressure, since technical challenges facing the industry may increase the difficulty of finding new, best-selling drugs. Another factor that may limit growth is the increasing cost-awareness that is causing state health agencies and insurance groups to limit any major pharmaceutical price increases. None the less, growth potential worldwide is good, even though expansion of the industry will be less than that achieved during the 1980s. World sales are likely to grow by 5 per cent per annum in the 1990s, as against 10 per cent in the 1980s. However, growth in many developing countries will probably be greater.

(a) Technology and skill dependence

The drug industry employs the highest number of scientists and technicians, most of whom work on large-scale research and development programmes. Related development costs needed to bring new products to the market often account for about 15 per cent of the total sales of a drug company. The industry also requires highly developed marketing networks based on a skilled marketing staff who have to win confidence in the products of their companies. Most production and sales activities take place in developed countries, which account for roughly two thirds of total sales. However, the industry is also important to NICs. For example, Brazil, India, Republic of Korea and Taiwan Province view the pharmaceutical industry as strategically important, and are anxious to build up their domestic industry to compete with products from developed countries.

NICs, however, face several investment and technological barriers. Technical and scientific skills for new drug development are based overwhelmingly in developed countries. New drugs for illnesses such as acquired immunodeficiency syndrome (AIDS), heart disease, cancer and arthritis require high levels of scientific knowledge and specialized manufacturing techniques to produce highly valuable and complex chemical ingredients in an extremely pure form. These levels of capability cannot be created overnight; they involve years, often decades, of laboriously developed training infrastructures organized in universities and research organizations, hospitals, and companies with production expertise. As a result, NICs will probably have to consider strategies such as the following: selling indigenous medicines that are less technically advanced than those produced in developed countries; selling new products invented by transnational corporations under licensing agreements; or acting as strategic marketing and manufacturing centres for large companies with headquarters in developed countries.

(b) Production

The production of pharmaceuticals grew globally at around 10 per cent per year in the 1980s. However, many experts believe overall growth will slow to around 5 per cent per year in the 1990s for a number of reasons. First of all, the pharmaceutical industry is being continually pressured by government health agencies and insurance organizations that are the main buyers of drugs through a variety of publicly or privately funded social security schemes. These groups are in most countries trying to cut costs and see reductions in drug spending as one way to achieve this result. Secondly, the costs of guiding drugs through laborious development programmes is increasing, putting companies under heavy financial pressure. This, in turn, is likely to reduce the number of new products that come on the market. Thirdly, drug researchers have devised products to treat most of the relatively straightforward illnesses, leaving the more difficult ones such as cancer and AIDS to be tackled next. Such illnesses involve extremely tough scientific challenges, making it less likely that the large drug companies will keep up a steady flow of new products and increased revenues. As a consequence, competition in the industry is becoming more intense, with more companies attempting to develop and market products in specific areas such as heart disease. Such initiatives help to drive down drug prices and profit margins, putting a brake on the rate at which the industry expands.

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*Data drawn from compilations by the United States Bureau of the Census.

**UNIDO acknowledges the contribution of P. Marsh, editor, *Financial Times*.

Finally, there are relatively few opportunities for developing dramatically successful drugs with annual sales of $1 billion or more. Some products, such as Zantac and Tagamet (made by Glaxo of the United Kingdom and SmithKline Beecham of the United States and the United Kingdom), which treat ulcers, were extremely profitable for their developers in the 1980s. However, in the future the main therapeutic areas likely to benefit from new drug types could be the more narrowly specialized segments of medicine, such as those involving the treatment of various types of cancer, where the sales and profit potential is more limited.

(c) Sales and consumption

Total sales of the pharmaceutical industry amounted to about $180 billion in 1990. Western Europe accounted for about 30 per cent of total sales, the United States 25 per cent, and Japan about 18 per cent, leaving the rest of the world with just under 30 per cent. World pharmaceutical industry sales by country are provided in table V.8, which also gives the annual growth of the industry on a regional basis. Pharmaceuticals can also be regarded as a branch of the $1,000-billion-per-year world chemicals industry. Virtually all its products are based on specialized, low-volume chemicals that sell at relatively high prices. As such, it can be categorized as a part of the so-called speciality chemicals industry, which is one of the fastest-growing branches of the total chemicals industry.

Pharmaceuticals can be divided into the three major categories described below, each of which has different characteristics in terms of chemical ingredients, degree of research and development capability and marketing techniques.

Patented prescription drugs. This category, often called "ethical pharmaceuticals", constitutes the largest part of the world drug industry. Sales of such medicines added up to about $130 billion in 1990. All these drugs are protected by patents, which means that they were developed relatively recently, as patents in most countries last for no more than about 20 years. They are available to consumers only through prescriptions. This category of medicines can be broken down into two subcategories. One is that of mass-market drugs prescribed by general practitioners for relatively mild conditions that do not require concentrated spells of hospital treatment. Large numbers of widely sold products for treating ailments such as ulcers, bacterial infections and common types of heart disease such as hypertension and arthritis fall into this subcategory. Selling such mass-market drugs is highly labour-intensive for the pharmaceutical company involved. For example, to develop an effective marketing programme in the United States, a drug company selling products of this kind might need 1,000 to 2,000 sales and marketing representatives who visit medical doctors to persuade them that the products of their companies are worth prescribing to specific types of patients. The second subcategory accounts for perhaps only 20 per cent of the $130 billion per year sales in the overall area of patented drugs sold by prescription. It is aimed at life-threatening diseases of the kind treated in hospitals, such as AIDS, certain cancers and acute heart diseases (such as heart attacks). It also includes other medicines for changing the immunological characteristics of the body and for organ transplant operations. These much more specialized drugs add up to a "niche" in the pharmaceutical industry. They require far fewer sales persons, just a few hundred to cover the United States and a few dozen for a medium-sized European country.

Table V.8. World pharmaceutical industry sales, 1978, 1988, 1989 and 1990

Country or region	Sales				Percentage share			
	1978	1988 (billion dollars)	1989	1990	1978	1988	1989	1990
North America	8.6	28.1	78.2	39.2	16.70	19.97	45.81	21.89
United States	8.6	28.1	39.1	39.2	16.70	19.97	22.91	21.89
Canada	..	..	3.4	..	..	..	1.99	..
Western Europe	17.5	40.0	37.7	49.1	33.98	28.43	22.09	27.41
Germany, Federal Republic of	..	..	10.8	..	..	..	6.33	..
France	..	..	9.8	..	..	..	5.74	..
Italy	..	..	9.3	..	..	..	5.45	..
United Kingdom	..	..	4.2	..	..	..	2.46	..
Spain	..	..	3.6	..	..	..	2.11	..
Japan	8.0	26.6	27.2	33.4	15.53	18.91	15.93	18.65
Rest of the world	17.4	46.0	27.6	57.4	33.79	32.69	16.17	32.05
Republic of Korea	..	..	2.0	..	..	..	1.17	..
Other countries (excluding Eastern Europe and USSR)	..	..	25.6	..	..	..	15.00	..
TOTAL	51.5	140.7	170.7	179.1	100.00	100.00	100.00	100.00

Source: *Financial Times* database.

Over-the-counter drugs. These are medicines that do not require prescriptions from medical doctors and may be bought by consumers directly through retail outlets. Depending on the country, however, there may be specific rules regarding the kind of shop from which a particular medicine can be purchased. Thus, in the United Kingdom and several other countries, many over-the-counter drugs for treating mild illnesses such as headaches or rheumatism, can be purchased only at pharmacies. World-wide sales of over-the-counter drugs add up to about $20 billion per year.

Generic medicines. These are either off-patent drugs, for which the patent has run out, or non-patented products, for which patents have never been taken out. The former type includes a number of relatively old, established drugs invented in the 1950s and 1960s, to which no single company today holds the relevant intellectual property rights. As a result, the drug in question may be made and sold by large numbers of companies, as in the case of the many types of tranquillizers. Price competition for such drugs is often severe because no single corporate group has a monopoly on production. The second type of product, for which patents have never been in force, include large numbers of herbal-based medicines or drugs made from other natural products. These may be important in NICs and also in some specific markets in developed countries. Total sales of generic medicines, which may be prescription-only products or over-the-counter medicines, amount to about $20 billion per year.

(d) *Major companies in the global industry*

The world pharmaceutical industry possesses a reasonably concentrated structure. About two thirds of world output is provided by just 50 companies, with the top 15 companies accounting for roughly a quarter of output. All the top 100 drug companies in the world are based in the United States, Japan or Western Europe. The largest companies in the industry, ranked both by sales and profits, are given in tables V.9 and V.10. Table V.9 includes revenues for all kinds of pharmaceutical products, including non-prescription drugs. The United States is the most important country in terms of the number of large drug companies. Featuring among the top 15 companies are eight United States companies. There are two German companies (Hoechst and Bayer), three Swiss (Ciba-Geigy, Sandoz and Hoffmann-La Roche), one in the United Kingdom (Glaxo), and one United States/United Kingdom company (SmithKline Beecham). It will be seen from table V.10 that profitability as a percentage of sales for many large companies is extremely high. Merck, the United States group that is the biggest drug company, had a profit margin in 1989-1990 of 35 per cent, while some of the other industry leaders are not far behind.

Merck is examined in detail because of its dominant position in the drug industry, as reflected in figure V.3. It accounts for roughly 5 per cent of the world market for prescription drugs. Of the world's 50 best-selling drugs in 1990, Merck was responsible for six, the next most important company being Glaxo of the United Kingdom, which was responsible for four. In 1989, according to Merck's annual report, at least 18 drugs with world-wide sales of over $100 million spread across 10 therapeutical classes. This underlines the point that to reach the top in the world pharmaceutical industry, companies need strength across a range of drug types, including large resources in research as well as development and marketing.

For Merck, its largest-selling drug in 1990 was Vasotec, a heart product, with world sales estimated at $1.5 billion, the second biggest-selling medication after Zantac, made by Glaxo of the United Kingdom,

Table V.9. World's 15 largest pharmaceutical companies, 1989

Rank	Company	Pharmaceutical sales (million dollars)		Percentage share		Percentage change 1979-1989
		1979	1989	1979	1989	
1	Merck & Co.	1 257	4 154	8.78	11.41	230.5
2	Bristol-Myers Squibb	818	3 426	5.71	9.41	318.6
3	Glaxo	..	3 085	..	8.47	..
4	SmithKline Beecham	825	3 041	5.76	8.35	268.8
5	Ciba-Geigy	1 248	2 861	8.71	7.86	129.3
6	American Home Products	1 121	2 265	7.82	6.22	102.1
7	Johnson & Johnson	725	2 263	5.06	6.21	212.0
8	Hoechst	1 407	2 176	9.83	5.98	54.6
9	Bayer	749	2 158	5.23	5.92	188.2
10	Lilly	791	2 113	5.52	5.80	167.3
11	Sandoz	932	2 035	6.50	5.59	118.5
12	Pfizer	894	1 995	6.24	5.48	123.1
13	Hoffmann-La Roche	1 135	1 696	7.92	4.66	49.5
14	Schering-Plough	642	1 576	4.48	4.33	145.7
15	Upjohn	..	1 573	..	4.32	..
	Boehringer Ingelheim	922	..	6.44	..	..
	Warner Lambert	859	..	6.00	..	..
	TOTAL	14 324	36 416	100.00	100.00	154.2

Source: SmithKline Beecham, paper presented at the Conference on World Pharmaceuticals organized by the *Financial Times* and held in London in April 1990.

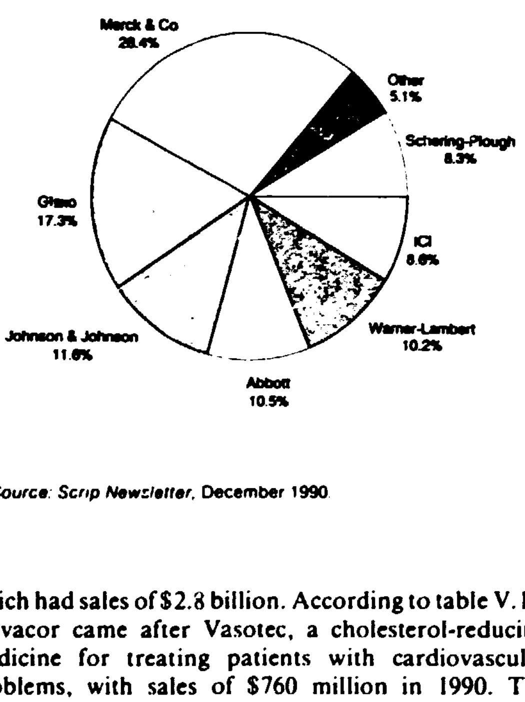
Table V.10. World's most profitable pharmaceutical companies, 1989-1990

Rank	Company	Profit (million dollars)	Percentage share	Sales (million dollars)	Percentage share	Margin a/
1	Merck & Co.	2 155.8 b/	28.40	6 058.1	24.45	35.60
2	Glaxo	1 313.3 c/	17.30	4 679.5	18.88	28.10
3	Johnson & Johnson	883.0 c/	11.63	2 652.0	10.70	33.30
4	Abbott	797.0 d/	10.50	2 785.0	11.24	28.60
5	Warner-Lambert	776.0 c/	10.22	2 694.0	10.87	28.80
6	ICI	654.2 c/	8.62	2 187.2	8.83	29.90
7	Schering-Plough	626.9 e/	8.26	2 432.3	9.82	25.80
8	Fisons	209.4 c/	2.76	775.5	3.13	27.00
9	Ares-Sereno	148.7 f/	1.96	420.8	1.70	35.30
10	Mylan	26.2 c/	0.35	95.4	0.38	27.50
	TOTAL	7 590.5	100.00	24 779.8	100.00	

Source: *Scrip Newsletter*, December 1990.

a/ Profit as percentage of sales.
b/ Pre-tax operating income. Figures for Merck relate to human and animal health products.
c/ Operating income.
d/ Trading profit.
e/ Activity profit.
f/ Net profit.

Figure V.3. World's most profitable pharmaceutical companies, 1989-1990



Source: Scrip Newsletter, December 1990

which had sales of $2.8 billion. According to table V.11, Mevacor came after Vasotec, a cholesterol-reducing medicine for treating patients with cardiovascular problems, with sales of $760 million in 1990. The other 4 Merck products among the top 50 were Pepcid, an ulcer product; Primaxin, an antibiotic; Timoptic, an eye product; and Zocor, another cholesterol-reducing medicine.

The story behind the success of Merck illustrates the long-term nature of product and research planning in the world drug industry, a significant fact for developing countries considering strategies for drug research and development and production. Merck spends approximately $600 million per year on research and development, employing 4,500 people in this activity, more than any other drug company. These employees are engaged in a number of activities, from long-term research that may lead to a new product in perhaps 20 years time, to nearer-term development programmes aimed at producing a new medicine that can be marketed earlier. The company has an extremely well-planned research and development programme comprising dozens of different projects ranging from long- to short-term studies in many different therapeutic areas. Scientists and development planners work side by side on these projects, in which research ideas and schemes for bringing products to the market through doctors' prescriptions are discussed as part of the same process. Table V.12 provides details on spending and personnel in research and development for some of the top drug companies in the world.

Another reason for the success of Merck is its sales and marketing strategies. Two factors are considered important for the drug industry as a whole. The first is that the main products of Merck (and indeed all the main products in the entire industry) are protected by patents. This gives the company a monopoly over production and marketing, which means that as long as Merck can gain the necessary approval for selling its drug in a specific country, it is free from competition from other companies attempting to sell the same drug. There will obviously be competition from companies selling similar products, but providing Merck can convince doctors that its product does the job better, it will be able to market its product with a great deal of success. The resulting market power means that Merck will be relatively free to set its own price for the drug, unimpeded by price competition from rival products. This assumes that the company can reach a reasonable deal on prices in those countries, which is the case in most European countries, but not in the United States, which requires agreements with drug companies on prices for specific pharmaceuticals. This relative freedom in price setting, which stems from the monopolistic aspects of the industry, is one of the reasons why drug companies generally are extremely profitable. The patent protection available for drugs also provides them with large reservoirs of cash, which they then productively spend on the research and development activities required for the next generation of drugs.

Table V.11. Estimated top 50 best-selling branded drugs, 1990

Rank		Brand	Category	Marketing company	Revenues (million dollars)[a]	Percentage share	Percentage change
1	Zantac	Ranitidine	Anti-peptic ulcerant	Glaxo/Sankyo	2 779	8.76	21.0
2	Vasotec	Enalapril	ACE inhibitor	Merck	1 530	4.82	26.0
3	Capoten	Captopril	ACE inhibitor	Bristol-Myers Squibb	1 470	4.63	20.0
4	Adalat	Nifedipine	Calcium antagonist	Bayer	1 210	3.81	10.0
5	Tenormin	Atenolol	Beta blocker	ICI	1 135	3.58	11.0
6	Tagamet	Cimetidine	Anti-peptic ulcerant	SmithKline Beecham	1 103	3.48	3.0
7	Voltaren	Diclofenac	NSAI	Ciba-Geigy	1 040	3.28	2.0
8	Ceclor	Cefaclor	Systemic antibiotic	Eli-Lilly	837	2.64	17.0
9	Ciprobay	Ciprofloxacin	Quinolone antibiotic	Bayer	800	2.52	33.0
10	Ventolin	Salbutamol	Bronchodilator	Glaxo	776	2.45	25.0
11	Omnipaque	Iohexol	X-ray contrast medium	Sterling/Daiichi/Schering/Nycomed	775	2.44	25.0
12	Prozac	Fluoxetine	Antidepressant	Eli-Lilly	765	2.41	119.0
13	Mevacor	Lovastatin	Lipid regulator	Merck	760	2.40	42.0
14	Cardizem	Diltiazem	Calcium antagonist	Marion Merrell Dow	746	2.35	12.0
15	Procardia	Nifedipine	Calcium antagonist	Pfizer	727	2.29	58.0
16	Augmentin	Amoxicillin/clavulanic acid	Combination antibiotic	SmithKline Beecham	710	2.24	42.0
17	Zovirax	Acyclovir	Antiviral	Wellcome	696	2.19	33.0
18	Naprosyn	Naproxen	NSAI	Syntex	686	2.16	6.0
19	Rocephin	Ceftriaxone	Hospital antibiotic	Hoffmann-La Roche	665	2.10	21.0
20	Feldene	Piroxicam	NSAI	Pfizer	643	2.03	5.0
21	Iopamiron	Iopamidol	X-ray contrast medium	Schering AG	600	1.89	25.0
22	Sandimmun	Ciclosporin A	Immunosuppressant	Sandoz	551	1.74	28.0
23	Seldane	Terfenadine	Anti-allergy	Marion Merrell Dow	550	1.73	39.0
24	Pepcid	Famotidine	Anti-peptic ulcerant	Merck	500	1.58	35.0
25	Zaditen	Ketotifen	Asthma prophylactic	Sandoz/Sankyo	490	1.54	1.0
26	Claforan	Cefotaxime	Hospital antibiotic	Hoechst	485	1.53	19.0
27	Calan	Verapamil	Calcium antagonist	Monsanto	467	1.47	28.0
28	Amoxil	Amoxicillin	Systemic antibiotic	SmithKline Beecham	442	1.39	13.0
29	Xanax	Alprazolam	Anxiolytic	Upjohn	441	1.39	5.0
30	Primaxin	Imipenem/cilastatin	Hospital antibiotic	Merck	425	1.34	16.0
31	Erythrocin	Erythromycin	Systemic antibiotic	Abbott Laboratories	421	1.33	17.0
32	Tarivid	Ofloxacin	Quinolone antibiotic	Daiichi/Hoechst	384	1.21	5.0
33	Orthonovum	Mestranol/norethisterone	Oral contraceptive	Johnson & Johnson	380	1.20	9.0
34	Trental	Pentoxifylline	Vasodilator	Hoechst	380	1.20	20.0
35	Losec	Omeprazole	Anti-peptic ulcerant	Astra	375	1.18	477.0
36	Nolvadex	Tamoxifen	Hormone antagonist	ICI	373	1.18	14.0
37	Fortum/Fortaz	Cetazidime	Hospital antibiotic	Glaxo	373	1.18	11.0
38	Premarin	Estrogen	Oestrogen replacement	American Home Products	363	1.14	27.0
39	Humulin	Human insulin	Hormone	Eli Lilly	360	1.13	20.0
40	Lopid	Gemfibrozil	Lipid lowerer	Warner-Lambert	354	1.12	24.0
41	Retrovir	Zidovudine(AZT)	Anti-viral	Wellcome	343	1.08	44.0
42	Lopresor	Metroprolol	Beta blocker	Ciba-Geigy	340	1.07	5.0
43	Becotide	Beclomethasone	Steroid	Glaxo	330	1.04	26.0
44	Proventil	Salbutamol	Bronchodilator	Schering-Plough	329	1.04	33.0
45	Nitrderm TTS	Glyceryl trinitrate	Anti-anginal	Ciba-Geigy	325	1.02	8.0
46	Timoptic	Timolol	Ophthalmic	Merck	310	0.98	11.0
47	Isovue	Iohexol	X-ray contrast medium	Bristol-Myers Squibb	305	0.96	39.0
48	Intal	Disodium cromoglycate	Asthma prophylactic	Fisons	302	0.95	17.0
49	Perdipine	Nicardipine	Calcium antagonist	Yamanouchi	290	0.91	-0.3
50	Zocor	Simvastatin	Lipid regulator	Merck	290	0.91	190.0
				TOTAL	31 731	100.00	

Source: Barclays de Zoete Wedd Research Limited, *Pharmaceutical Industry Perspectives*, 6 January 1991.

[a] At average exchange rates, January to December.

Table V.12. World's largest companies in terms of research and development, 1989-1990

Rank in terms of personnel	Company	Research and development personnel		Research and development expenditure		Research and development as percentage of sales
		Number	Percentage of total personnel	Million dollars	Percentage of total expenditure	
1	Merck & Co.	6 300	9.06	508	7.93	12
2	Hoechst	6 250	8.99	525	8.18	17
3	Ciba-Geigy	5 200	7.48	508	7.93	18
4	Glaxo	4 900	7.05	295	4.60	11
5	Hoffmann-La Roche	4 600	6.61	426	6.65	21
6	SmithKline Beecham	4 400	6.33	451	7.03	21
7	B Ingelheim	4 100	5.90	361	5.63	15
8	Lilly	3 600	5.18	344	5.37	18
9	Wellcome	3 400	4.89	213	3.32	18
10	Upjohn	3 200	4.60	328	5.12	14
11	ICI	3 100	4.46	238	3.71	13
12	Pfizer	2 900	4.17	311	4.86	18
13	Sandoz	2 700	3.88	377	5.88	14
14	Johnson & Johnson	2 700	3.88	328	5.12	15
15	Bayer	2 700	3.88	328	5.12	16
16	Rhône-Poulenc	2 600	3.74	230	3.58	15
17	Bristol-Myers Squibb	2 600	3.74	230	3.58	11
18	American Home Products	2 600	3.74	213	3.32	12
19	Schering AG	1 700	2.44	197	3.07	16
	TOTAL	69 550	100.00	6 410	100.00	

Source: *Scrip Newsletter*, 3 October 1989.

The second important factor in the marketing operations of Merck is its large sales staff, which again is illustrative of the drug industry as a whole. Marketing drugs requires intensive personal contacts with medical doctors in an effort to persuade them that specific drugs should be prescribed in particular circumstances to patients. Merck employs 6,300 sales people around the world, who spend nearly all their time making personal calls on doctors. Only those companies which can afford the resources to employ such large numbers of people on marketing will have the sales capability to rank among the top firms in the industry. Drug companies also use advertising techniques to sell the merits of their products to physicians, but these are employed generally only in specialist medical journals, rather than in the general media. That follows from the general lack of consumer involvement in decisions on drug consumption. It is normally doctors who choose which medicines patients should take, not the patients themselves (except in the case of over-the-counter medicines, for which the consumer chooses for himself or herself). Table V.13 shows the sales forces of some of the biggest drug companies, illustrating the resources they have to put into this part of their operations.

Table V.11 provided examples of the degree to which different companies have succeeded in converting research products into highly successful drugs that managed to reach the top 50 best-selling products worldwide. After Glaxo, with four drugs among the top 50 products worldwide, the next biggest companies, each with three such drugs, are SmithKline Beecham (United States/United Kingdom), Ciba-Geigy (Switzerland) and Eli Lilly (United States). These are followed by eight companies, each with two top-selling drugs: Bristol-Myers Squibb, Pfizer and Marion Merrell Dow (all United States); ICI and Wellcome (United Kingdom); Hoechst and Bayer (Federal Republic of Germany); and Sandoz (Switzerland). There are 14 companies with a single drug in the top 50: Monsanto, Syntex, Sterling Drug, Upjohn, American Home Products, Warner Lambert, Abbott Laboratories, Johnson & Johnson (all United States); Yamanouchi and Daiichi (Japan); Schering-Plough (Germany); Fisons (United Kingdom); Astra (Sweden); and Hoffmann-La Roche (Switzerland).

Table V.13. Sales forces employed by drug companies

Rank	Company	Sales force
1	Merck & Co.	6 300
2	Bristol-Myers Squibb	6 250
3	SmithKline Beechman	5 200
4	Hoechst	4 900
5	Glaxo	4 600
6	Bayer	4 100
7	Pfizer	3 600
8	Sandoz	3 400
9	Schering-Plough	3 200
10	Ciba-Geigy	3 100
11	Hoffmann-La Roche	2 900
12	Johnson & Johnson	2 700
13	American Home Products	2 700
14	Warner-Lambert	2 700
15	Upjohn	2 700
16	Marion-Merrell Dow	2 600
17	Lilly	2 600
18	ICI	2 600
19	Takeda	1 700
20	Wellcome	1 600

Source: Robert Gilbert and Jenny Harrison, *Pharmaceuticals in the 1990s*, (London, James Capel, 1990).

Regarding the concentration of drugs by country, of the top 50 medicines, 24 are sold by United States companies, 9 by United Kingdom companies, 6 by Swiss companies, 5 by German companies, 3 by a United States/United Kingdom company (SmithKline Beecham), 2 by Japanese companies, and 1 by a Swedish company, Astra.

Table V.9 showed how the ranking of the biggest companies in the industry have changed between 1979 and 1989. Many of the top firms that were important a decade ago have stayed among the leaders of the industry, underlining its relative stability, which is a result of the long-term nature of development and marketing activities. Merck moved from second place in 1979 to first place in 1989. Bristol-Myers Squibb, SmithKline Beecham, American Home Products, Johnson & Johnson, Hoechst, Bayer, Sandoz and Pfizer all stayed among the top 15 companies during this period. For Bristol-Myers Squibb and SmithKline Beecham, both the subject of recent mergers, the rankings take into account the positions in the league table of their constituent parts before the merger. Glaxo is the only one included among the current top companies which had a relatively low rank in 1979.

(e) Regulatory policies

The drug industry is one of the most highly regulated businesses in the world. Companies developing new drugs are subject to numerous controls and rules dealing with drug safety, price controls and patents. These regulations are set by government health departments and drug regulatory divisions, for example, the Food and Drug Administration (United States) and the Medicines Control Agency (United Kingdom). Companies are expected to manage their drug development in such a way that the pharmaceuticals pass through the process relatively efficiently. None the less, it often takes 10 years and up to $100 million in research and development efforts to take a new drug from the laboratory bench stage to marketing. The rules devised by these drug regulatory departments mainly involve hundreds, if not thousands, of tests that the chemicals in new drugs have to satisfy before they can be passed as safe and efficacious.

The tests can involve the following different procedures: laboratory experiments on basic chemicals in drugs to detect reaction changes that can indicate toxicity or particular therapeutic actions; trials on animals to monitor the effect of the product on a specific type of physiological condition; and clinical trials on patients (of whom there could be tens of thousands) once the drug has passed enough tests to convince regulators that it is not toxic but still needs human testing. Only after the drug in question has passed all these regulatory stages will it receive a product licence enabling doctors to prescribe it to patients and pharmacies to stock it (in the case of over-the-counter medicines) for sale to the public.

In the past decade, the number of new products appearing on the world market has stayed relatively constant (a new product being defined here as a new chemical entity, as opposed to a variation on an existing product or an existing drug aimed at a new therapeutic condition). The number has been generally in the range of 30 to 50 per year. Altogether, 55 new products appeared in 1981, 29 in 1982, 37 in 1983, 36 in 1984, 51 in 1985, 44 in 1986, 61 in 1987, 53 in 1988, 35 in 1989, and 43 in 1990. However, many in the drug industry believe that in the 1990s the number of new products to be developed by the industry will drop, because the increasing complexity of the regulations acts as a disincentive to conduct research and development.

In many countries, government health departments also become involved in regulating the industry from the point of view of price controls and patents. This subjects drug companies to extra stages of red tape and adds to the bureaucratic delays in obtaining the approval for the sale of new drugs. For example, EEC officials believe that harmonization of drug regulations will boost possibilities for eliminating trade barriers throughout the Community. However, producing a common code for regulating the industry in Europe has proven very difficult. The industry within the EEC is highly fragmented and regulated by a large number of rules and complex restrictions set by Governments and varying from country to country. The problem of unifying EEC rules for the drug industry is compounded by the fact that medical needs in the Community appear to vary widely, and hence the drug treatments to meet those needs and the regulations governing them vary from country to country. For example, in the area of pharmaceuticals licensing, it is proving highly difficult to create a set of licensing rules that can be quickly and effectively applied throughout the Community, and that satisfy both consumer safety needs and national aspirations in the 12 member States. The Commission of the European Communities wants to set up a new European agency for drug approvals which would work with existing national bodies for the licensing of pharmaceuticals. The European Medicines Agency is currently scheduled to begin operating in 1992-1993.

Another major regulatory area is product pricing. Under existing procedures, different countries in Europe set drug prices according to a range of criteria, which means that prices paid for the same medication across Europe can vary. The criteria are often related to local investment. Thus if a drug company has invested in large research facilities in a particular country, it will often be allowed to charge a higher price for its product because of the boost it has given to the economy of that country. To tackle specific medical complaints, different countries might adjust their prices for different drugs, depending on the volumes sold. Here is where controlled pricing comes in, since a company may produce a type of product which no other company sells. However, the involvement of the State is crucial. The position is different in the United States, where generally drug companies fix their own prices outside specific government social security schemes.

It might be thought that because of the range of prices, government health agencies would encourage pharmacists to shop around for drugs, buying from countries where the prices are lowest. In practice, however, this rarely happens because of the difficulty of ensuring that the licensing rules for a pharmaceutical at the production point are consistent with the regulations at the consumption point. Harmonizing pricing across the continent is proving extremely difficult because different countries are insisting on their right to choose their own price-setting frameworks, regardless of the wider European context. In patents, however, greater uniformity is seen across Europe, with equal legal protection being awarded to new drugs. Yet some countries, including Greece, Portugal and Spain, appear to be less rigorous in their patent laws than most countries in northern Europe.

2. *Market segmentation*

To understand the behaviour of the industry further, it is important to consider the major market segments for drugs. These segments follow the main areas of therapy for which medicines are appropriate, as reflected in table V.14. The two major market segments deal with cardiovascular diseases and infections, each with sales of about $26 billion in 1988. Together they accounted for more than one third of the entire world drug market. Next in importance was the internal medicine segment, which covers a range of products for such illnesses as ulcers, cancer and diabetes. Total sales for this market in 1988 was $21 billion. Pain control drugs, including anti-arthritics and analgesics, were next with sales of nearly $17 billion. Sales of products for respiratory diseases, asthma being one of the most important, and for nutrition were of about $22 billion. The other main segments are tropical medicines (mainly for skin complaints), mental health (for treating conditions such as depression and anxiety), and other therapeutic areas, which account for a huge range of conditions, including viral diseases such as AIDS, eye disorders and allergies.

These broad categories can be split into several, sometimes dozens of different types of drug, depending on their application to specific medical conditions or their mode of operation. Most of the very common drug types in the therapeutic area have been described above as mass-market products, prescribed by physicians and designed for use by people in their homes or as out-patients. Most types of anti-infective drugs (antibiotics) and cardiovascular products fall in this category. The same is true of medicines for pain control and certain types of internal medicine, such as those used to treat ulcers.

Of the total world drug market, a relatively small part is accounted for by "niche" hospital products, normally used by patients closely monitored by medical staff in clinics. Certain drugs of this type are also suitable for use by out-patients. These kinds of product are illustrated by various drugs for the treatment of cancer and immunosuppressants for use in organ transplants. However, because the number of niche areas in medicine is increasing as the need for new pharmaceuticals is discovered, this part of the market is relatively dynamic and fast-growing.

It is useful to go beyond the broad therapeutic types to look at some of the specific drug areas within each category. These can be broken down in terms of specific drug types by operation or by the nature of the particular therapy.

(a) *Cardiovascular disease*

Cardiovascular disease is the area with the broadest range of drug types. It covers a number of different kinds of heart and vascular ailments. The most important of these are the following: hypertension, or high blood pressure; angina, characterized by acute chest pain occuring when the heart's increased demand for oxygen is not met because of an inadequate blood supply; and congestive heart failure, where the heart is for some reason unable to pump blood around the body with the desired efficiency. Two other types of heart-related ailments for which there are important drug types are raised lipid levels (where an excess of cholesterol or other types of fat in the blood stream contribute to the clogging of arteries, causing a variety of vascular problems), and acute thrombosis, treated by the use of a number of medicines that act to dissolve the blood clots that form in such conditions. Major types of products used for treating cardiovascular diseases are described below.

Beta blockers. These slow down the movement of the heart to reduce overstimulation and the force of contraction that can narrow the blood vessels, leading to high blood pressure. The world market for beta blockers amounts to about $3 billion and is growing at about 7 per cent per year. Major beta blockers are

Table V.14. Major prescription drug types and market segments, 1978, 1988 and forecasts to 1993

Rank in 1993	Drug type	Sales (billion dollars)			Percentage share			Percentage growth	
		1978	1988	1993[a]	1978	1988	1993[a]	1978-1988	1988-1993
1	Cardiovascular	8.0	26.60	38.2	15.53	18.89	21.35	12.8	7.5
2	Anti-infective	9.3	26.00	34.4	18.06	18.47	19.23	10.8	5.8
3	Internal medicine	7.8	21.60	27.1	15.15	15.34	15.15	10.7	4.6
4	Pain control	7.2	16.90	19.1	13.98	12.00	10.68	8.9	2.5
5	Respiratory	4.2	11.20	14.2	8.16	7.95	7.94	10.3	4.9
6	Nutritional	3.6	10.60	13.1	6.99	7.53	7.32	11.4	4.3
7	Tropical[b]	3.7	9.10	10.3	7.18	6.46	5.76	9.4	2.5
8	Mental health	4.2	8.80	10.9	8.16	6.25	6.09	7.7	4.4
9	Other	3.5	10.00	11.6	6.80	7.10	6.48	11.1	3.0
	TOTAL	51.5	140.8	178.9	100.00	100.00	100.00	10.6	4.9

Source: *Chemical Week*, 13 June 1990.

[a] Projection.

[b] Mainly for skin complaints.

Tenormin (ICI), Inderal (ICI) and Lopressor (Astra and Ciba-Geigy).

Calcium antagonists. These act by relaxing the smooth muscle of the body to widen the channels through which blood passes around the body. They do this by interfering with the transport of calcium ions across the membranes of muscle cells. The market for these drugs is about $3.5 billion and is growing at about 20 per cent annually. Leading calcium antagonists are Cardizem (Tanabe/Marion Merrel Dow), Adalat (Bayer) and Perdipine (Yamanouchi).

ACE inhibitors. These act by inhibiting the action of angiotensin converting enzyme (ACE), a specific biological entity associated with high blood pressure and other heart conditions. ACE inhibitors are relatively new drugs. Sales are growing at about 25 per cent per year, a fast rate due to the relatively few side-effects of the drugs. Leading drugs of this type are Vasotec (Merck) and Capoten (Bristol-Myers Squibb). Total world sales are estimated at $3 billion per year.

(b) *Anti-infective drugs*

Anti-infectives are among the oldest types of product in the modern pharmaceutical industry. They encompass a range of antibiotics classified in a number of different ways, according to whether they are given orally or injected, and what type of chemical they are based on. They are aimed at a variety of bacteria-borne infections, ranging from common conditions such as mild inflammations to life-threatening diseases. As such they span both the mass market and niche product categories. Common anti-infectives are described below:

Cephalosporins. These can be either oral or injectable and add up to world sales of about $6 billion per year. They form a highly competitive area of the drug industry, with about 30 product types sold by different makers, with Shionogi (Japan), Eli Lilly (United States) and Glaxo (United Kingdom) among the major producers.

Penicillins. With total sales of about $3 billion per year, this category includes large-selling drugs such as Amoxil and Augmentin, both made by SmithKline Beecham.

Macrolides. Total annual sales of this drug amount to $1 billion, the leading product being Erythrocin (Abbott).

(c) *Internal medicine*

Internal medicine encompasses a large variety of therapies, of which the largest are ulcer treatment and cancer.

Ulcers. Until 10 to 15 years ago, ulcers were treated mainly by adjustments to diet or with pain relievers. Neither was wholly satisfactory. More recently, new drugs have been devised which have revolutionized treatment by interfering with the physiological processes in the stomach that cause ulcers. The leaders are Zantac (Glaxo), the world's biggest-selling drug, and Tagamet (SmithKline Beecham). Total sales amount to $6 billion, and are growing by about 20 per cent annually.

Cancer. Cancer is a major life-threatening disease for which drug therapies have been developed mainly in the past 30 years. Sales add up to about $3 billion and are growing at 20 per cent per year. The products may be categorized depending on their application to specific cancer types such as prostate or breast cancer. They may work in a variety of ways, including hormonal action or interference with the immune system to arrest the growth of cancer cells. Leading products include Krestin (Sankyo), Nolvadex (ICI), and Paraplatin and Platinol (Bristol-Myers Squibb).

(d) *Pain control*

A huge variety of drug types can be used to control pain, two of which are described below.

Arthritis control. Drugs to control arthritis constitute a large product area, especially for elderly people. Many of these drugs work relatively poorly and are associated with unpleasant side-effects. Leading medicines include Voltaren (Ciba-Geigy), Feldene (Pfizer), Naprosyn (Syntex), and Indocid and Clinoril (Merck). Sales are about $5 billion and are growing at 10 per cent per annum.

Analgesics. The analgesics industry records total annual sales of $4 billion, much of it accounted for by generic medicines that are off patent or have never been patented, aspirin being a good example. A leading branded analgesic is Tylenol (Johnson & Johnson).

(e) *Vaccines*

Vaccines do not form one of the largest areas of the drug industry in terms of sales, but are highly important in developing countries as a means of preventing common diseases from spreading. Total world vaccine sales, at about $1 billion, are growing at around 20 per cent per annum. Diseases for which vaccines exist include rubella, measles, diphtheria, tetanus, mumps and polio. Leading vaccine makers include Merck, American Cyanamid (both United States), Hoechst (Germany), SmithKline Beecham (United Kingdom and United States) and Rhône-Poulenc (France).

(f) *AIDS*

According to the World Health Organization, about 8 million poeple worldwide were infected in early 1991 by the human immunodeficiency virus (HIV) that causes AIDS. A substantial number of these people are likely to contract the disease and many will die within a few years. Until early 1991 only one drug, namely Tetrovir, made by Wellcome in the United Kingdom, was licensed worldwide for treating the full panopiy of AIDS symptoms. The problems involved in developing drugs to combat AIDS illustrate the difficulties generally of producing useful formulations against viral diseases. However, there are a number of potentially good AIDS drugs in the development pipeline, of which several may appear on the market over the next few years. These include Imuthiol (Rhône-Poulenc), Videx (Bristol-Myers Squibb), Hivid (Roche) and alpha interferon (Schering-Plough). Sales of AIDS drugs are fairly small at present, mainly being accounted for by Retrovir (about $300 million per year), but are likely to grow rapidly in the 1990s.

(g) Other drugs

Numerous other drugs exist for use in other therapeutic categories and market segments. They cannot be listed here, but can be found in various pharmaceutical journals.

3. Technological trends

(a) The research-to-marketing time lag

Technological trends in the pharmaceutical industry can be explained in terms of research and development activities. In the early 1960s, a new drug usually took about three years to go from the discovery stage to marketing. In the early 1990s, this process requires 10 to 13 years. The difference is partly due to the fact that more difficult therapeutic problems are now being tackled, requiring longer and more innovative periods of research. More significantly, however, has been the slow-down caused by the complicated regulatory process through which a drug has to be guided before it is marketed. This is mainly a result of increased public fears about drug safety, fuelled by some highly publicized incidents involving "rogue" drugs such as Thalidomide and Opren, which had severely damaging side-effects.

Longer delay times have greatly increased investment costs. The expense of a company's research and development programme is spread over many different areas of activity. It includes all research costs involved with testing dozens, if not hundreds, of compounds in different parts of a research and development programme, but which never make it into marketing, either because they do not have the desired impact in treating a condition or because they have undesirable side-effects. Even a large company such as Merck, Glaxo or Ciba-Geigy may bring two to three completely new drugs onto the market each year, while many other chemicals that are possible candidates for use in new products fall by the wayside. The large amounts of money spent on drug research and development that do not lead to successful products means that the average cost of bringing a new product to the market often amounts to from $100 million to $150 million. That compares with a figure of about $10 million in the mid-1960s. To some degree drug companies (especially the more successful ones) have been able to make up for these higher costs by charging more for their products, thereby boosting their profits. However, many in the industry fear that should costs escalate relative to declining prices, profitability growth could be harmed.

The other main problem for the industry arising from longer development times concerns patents. As already noted, patents play a vitally important role in the drug business by guaranteeing a monopoly for a specific product during a set period (normally 20 years) after the drug has been invented. That reduces the amount of competition for the product and lets the company involved charge relatively high prices. In the 1960s (when drug development times were short) a company might have had, on average, 15 to 17 years of competition-free marketing for a specific product after it had been invented. In the early 1990s, this period (owing to the greater time devoted to guiding medicines through the regulatory process) has been cut to perhaps eight years. This means that nowadays drug companies have to race frantically during the first years after a product gains licensing approval to accelerate sales before the patent runs out. After this happens, the drug is open to competition from generic products, which leads to a rapid decline in prices and hence profits. Most drug companies would prefer a return to the more leisurely days of the 1960s and 1970s when they had a much longer time to build up sales and profits. Given the general reluctance of Governments to relax the regulatory environment, however, such a situation is most unlikely to occur.

(b) Changes in the research and development process

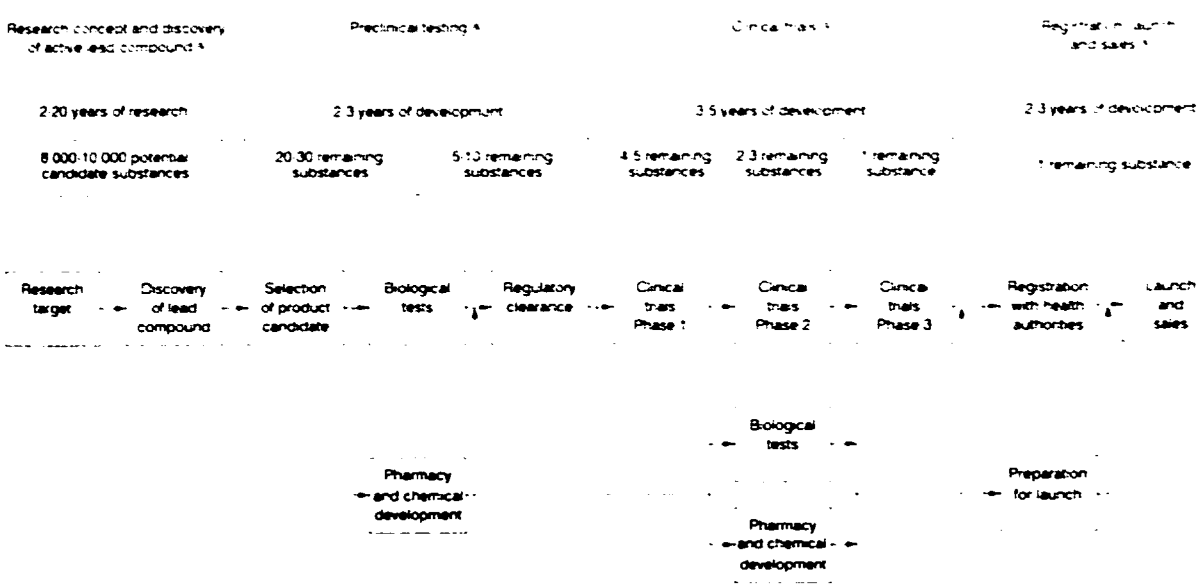
Most large drug firms are under pressure to find better research and development techniques that will cut both costs and the time interval between the research effort and product marketing. The research and development process normally encountered is outlined below.

Basic research. Representing about a third of the total research and development process, basic research can be divided into the following two parts: chemical and biotechnology synthesis and extraction of chemical and biological agents thought to be likely candidates for new drugs (13 per cent of total research and development costs); and biological testing in laboratory experiments to assess suitability (20 per cent of costs).

Development. The remaining two thirds of the total research and development bill is accounted for by development activities, which include nine components: toxicology testing (10 per cent); bioavailability studies to see the extent to which specific drugs channel through the body to particular sites (3 per cent); pharmaceutical development, which includes preparations for manufacturing and research needed to put the final product into the most suitable form such as a capsule or an injectable liquid (13 per cent); chemical development, involving the basic chemical building blocks of the drug in question (9 per cent); human volunteer studies to try out the drug in humans at a relatively early stage (3 per cent); pre-marketing clinical studies, which involve testing the drug on many patients prior to full marketing approval (12 per cent); post-marketing studies to carry out final checks on safety (5 per cent); administrative formalities relating to regulatory requirements (3 per cent); and miscellaneous administrative requirements and pre-manufacturing work (8 per cent).

Timing. The time span required to complete the research and development process as reflected in figure V.4, which can take as long as 12 years, may be divided into the following stages, which may sometimes overlap: chemical selection and early testing (two years); basic animal and chemical studies to look for toxic effects (one year); phase-one clinical trials in humans, based on possibly 20 volunteers (one year); phase-two trials involving larger numbers (several hundreds) of human patients (one year); phase-three trials involving up to 30,000 patients (three years); licensing approval requiring a company to submit a detailed dossier to the regulatory authorities (three

Figure V.4. Discovery and development of a new medical product



Source: Wellcome, internal document.

Note: a/ Figures given are approximations.

years); and gradually building up to full-scale production (one year).

New strategies. Drug companies have made changes in the research and development process in recent years in an attempt to minimize the time and costs involved in the process and to speed up compliance with regulating requirements. Those changes include the following:

(a) Greater attention to potential risks and benefits during the development phase. Managers nowadays spend much time considering the chances of success of a specific drug at each phase of its development. In this way they can balance the possibly large sums of cash that may be spent on the product during the entire research and development phase, and look forward to making large profits from the product should it emerge successfully. Marketing people, in addition to scientists, have to be very much involved in these discussions. This can lead to many more drugs being withdrawn during the research phase, not necessarily because a company thinks they will not emerge at the end of the programme, but because their potential to be highly profitable once they reach the market is thought to be relatively low;

(b) Niche research. Companies may abandon broad research programmes and concentrate resources on specific diseases or complaints, such as senile dementia, cancer and inflammation where benefits are reckoned to be high and competition low;

(c) Research and development agreements. Rather than trying to do everything by themselves, companies are increasingly spreading the risks (and costs) by carrying out their research under joint programmes with other companies. Another related option is to join forces with university research teams on basic science studies that lead to new drugs;

(d) Licensing. A company buys the basic research of another group and uses it in the development process to make a new product. This can be more cost-effective than doing the basic research and selling new ideas to large companies that have the marketing and development expertise to move the project into fully fledged new products. Several small companies have been set up with such a strategy in mind, including Xenova (United Kingdom) which specializes in specific biology-based research techniques, and CNS Research (United States), which concentrates on research into the body's central nervous system and the brain.

(c) Important research and development areas

A reasonable correlation might be expected to exist between resource expenditures and the therapeutic categories that account for the largest shares of revenues. That holds true, but only up to a point. Research and development aimed at cardiovascular diseases, infections, internal medicine and pain control (the four biggest-selling areas for drugs) are among the largest in terms of expenditure. Other areas include several therapeutic categories where existing drug sales are relatively small. Central-nervous-system drugs, products aimed at conditions such as anxiety, depression, migraine and schizophrenia, are a case in point. The conditions involved are difficult to treat with existing drugs, and the pharmaceutical sales are not particularly high. New scientific insight into the brain and central-nervous-system processes that influence such conditions are providing fresh strategies for researchers in the industry, opening up opportunities for the development of new drugs in the future. Another big area for drug research is that of respiratory diseases because of the large numbers of people who contract asthma and related conditions throughout the world, particularly in developed countries.

Other areas that take up large proportions of resources include viral ailments, cancer, various diseases relating to the immune system, hormonal malfunctions and gastro-intestinal conditions. This is particularly true in the case of research currently being conducted in the United Kingdom. According to one recent study, cardiovascular ailments accounted for 25 per cent of United Kingdom research and development spending; central-nervous-system drugs and anti-infectives, 17 per cent; respiratory ailments, 9 per cent; immunosuppressant and endocrinal drugs and related areas, 8 per cent; gastro-intestinal conditions, 6 per cent; musculoskeletal disorders, 3 per cent; and skin complaints, 2 per cent.

Biotechnology describes a set of biology-based processes linked generally to workings of the genetic system. Biotechnology enables drug industry researchers both to find new ways of making existing proteins and other natural molecules, and to obtain tools that will enable them to devise new substances. Biotechnology emerged from the idea of copying natural molecules and from successful efforts of several small companies set up in the United States in the 1970s and early 1980s. Among the leading companies in this field are Genentech (taken over by Hoffmann-La Roche of Switzerland), Cetus and Amgen. Most of the basic research concerns efforts to splice genetic segments into bacteria and cell cultures to modify the way these organisms make proteins (natural biological molecules essential to life). In this manner, genetically engineered copies of insulin (a naturally produced substance used to treat diabetes) or tissue plasminogen activator (TPA) (a protein that can be used to treat heart attacks) can be made. In both cases, the substances can be made in large quantities and in conditions of purity with far greater ease than using traditional extraction or fermentation techniques.

A second thrust of biotechnology has been aimed at using knowledge of the mechanisms governing the interaction of proteins and other natural materials in the body to design new drugs of a kind not found in nature. This involves tailoring new drugs to work in a specific way, and using a mixture of biotechnology methods and methods of chemical synthesis. Work of this kind is still in its infancy. A number of large drug companies, however, including Merck, Ciba-Geigy, Glaxo and Hoechst, are devoting large sums of money to the search for products that harness the new scientific understanding of genetic interactions in the body and of the mechanisms involved in cardiovascular disease and conditions of the central nervous system. It is too early to say what the effects of this work will be. Many in the drug industry are of the opinion that biotechnology methods will revolutionize research procedures in the pharmaceutical industry, but the full benefits are unlikely to be achieved before the year 2000.

Progress in biotechnology has not been as rapid as was expected when the importance of the subject was recognized in the early 1980s. In 1990 world sales of biotechnologically derived drugs were estimated at approximately $1.5 billion, or roughly one hundredth of total pharmaceutical industry revenues. Several companies from both the small biotechnology groups and the established drug industry have been important in selling biotechnologically derived drugs almost all of which have so far been in the shape of protein copies as referred to above. The biggest-selling biotechnological drugs in 1990, with estimated world sales, were as follows: Humulin, a synthetic insulin sold by Eli Lilly ($360 million); Epogen, a copy of erythropoietin, a protein made in the kidneys to stimulate the production of red blood cells ($280 million); Activase, a form of TPA, made by Genentech ($200 million); Intron A, made by Schering-Plough; a form of interferon, used for treating certain cancers ($180 million); and Protopin, made by Genentech, a copy of human growth hormone, a material secreted naturally in the body and which can be used to treat conditions of stunted growth, especially in children ($160 million).

Some observers believe that sales of biotechnology products will jump to about $10 billion per year during the 1990s. Behind this prediction lies the belief that the future of the biotechnology industry lies in harnessing its ideas to the classical research challenges of the pharmaceutical industry, rather than to the goal of copying natural molecules. This argument rests on three major assumptions. The first is that selling copies of proteins presents marketing problems. Proteins are large, complex molecules that are not taken orally, but are normally injected, an inconvenient procedure. Most conventional drug companies are mainly interested in making small, relatively compact molecules that can be taken orally, satisfying the need for "user-friendly" drugs.

The second assumption is that working with small molecules involves disciplines with which large drug companies are already expert. They are good at chemical synthesis, which is a vital part of such work, and have refined the methods of research and development vital to bringing products to the market.

The third assumption is that large proteins are much more difficult to patent than small molecules. This is because they can exist in nature or because rivals can, without too much trouble, invent a derivative that acts in essentially the same manner, but which can circumvent patent protection. Small molecules, however, can be engineered to be sufficiently different from other substances, making patenting relatively easy. In an industry in which patenting is extremely important, these points are highly significant. In the past few years, a number of costly and time-consuming legal disputes over biotechnology patents have broken out, such as those between Genetech and Wellcome over TPA, and between Amgen and Genetics Institute over erythropoietin. This has reduced the interest of a number of groups in protein copying.

Nevertheless, research programmes in biotechnology are mostly concerned with protein copying, including the development of monoclonal antibodies, which are natural substances capable of attacking diseases like cancer, and granulocyte colony-stimulating factors, a natural substance stimulating the production of white blood cells. The latter could be used in treating a host of ailments involving the immune system, including cancer and AIDS. Drugs of this type could possibly gain approval and go on sale over the next five years. Many other research programmes undertaken in the drug industry concern the use of bio-technological techniques in classical synthesis, but details of such programmes are not yet available.

4. Long- and medium-term industry outlook

Over the longer term, the profitability of the leading pharmaceutical companies may come under pressure in the 1990s because of government attempts to lower prices and the proliferation of pharmaceutical products. Pricing pressures, in particular, may cause profitability problems despite the monopoly pricing practices that characterize the business. The prospect of such negative influences have triggered a significant reshaping of the world pharmaceutical industry. Many of the top companies in the industry have merged or sought alliances with other firms, in order to cut costs or gain a tactical advantage in the face of the likely pressures ahead. These new groupings include the merger of Beecham of the United Kingdom with SmithKline Beckman of the United States to form SmithKline Beecham, and the combination of two other large drug firms in the United States, Squibb and Bristol-Myers, to form Bristol-Myers Squibb. The creation of these new business groupings has been driven largely by defensive factors. Companies are anticipating the financial squeeze likely to hit the industry during the 1990s, and have employed mergers to achieve economies of scale both in research and development and at the sales end of the business. Whether these strategies will work remains to be seen, as in most cases the new groupings have not yet been put to the test.

Other major industrial developments likely to occur in the medium term include the following:

(a) Research management methods in the drug industry, including the greater use of biotechnology, are likely to expand;

(b) NICs will have a part to play in the future of the industry. In many cases, however, they will have to focus initially on the development of science and technology skills, particularly in drug-related areas such as chemistry, biology and bio-chemistry;

(c) Developing countries will probably want to consider more joint ventures with some of the world's large drug companies, especially those with considerable scientific and technological resources. The ventures might involve production and research agreements. A research and manufacturing project set up in the past few years in Singapore by Glaxo, the large United Kingdom drug company is a case in point. Such ventures may stimulate the emergence of indigenuous, independent drug companies in the future;

(d) Drug regulatory processes will remain important. State health departments will need to maintain the appropriate balance between drug safety and a level of regulation that is not overly bureaucratic or likely to deter innovation;

(e) Finally, companies will probably need to pay more attention to the consumer aspects of pharmaceuticals. People using drugs will need to be told more about their possible side-effects. There needs to be closer scrutiny of the risks and benefits of pharmaceutical consumption, in particular the beneficial effects of many drugs on human health, as opposed to the risk of certain negative effects of drug use on the physiological system. In this connection, a vigorous effort should be made to address the health-care needs of NICS, which are still not being met by the world drug industry.

C. Automotive tyres (ISIC 355110)*

1. Recent trends and current conditions

The tyre industry enters the 1990s, as it entered the 1980s, in a very depressed situation. It did not remain so, however, throughout the 1980s. In particular, the period from 1986 to 1989 was one of exceptional growth at a quarterly rate of around 6 per cent per year in an industry long regarded as a highly mature one, with previous growth rates typically of the order of only 2 per cent per year. The mid-1980s saw not only a noticeable increase in the rate of growth of world demand, but also a comprehensive restructuring of the companies that account for the bulk of world production.

(a) World consumption and production

World consumption of replacement tyres is distributed in proportion to the spread of vehicle populations, while world consumption of original equipment tyres is distributed in proportion to shares of vehicle production. A regional breakdown of consumption and production of car and truck tyres is given in tables V.15 and V.16. By and large, purchasers of original equipment tyres prefer to have sources of supply that are geographically close to the points at which the vehicles are assembled. There are, however, two important exceptions to this. First, many Japanese vehicle manufacturers, in response to both political pressures and consumer preferences, fit tyres imported into Japan from the countries to which the vehicles will be exported. Secondly, the progress of European economic integration, and indeed of Canadian-United States economic integration, has led to large volumes of cross-border trade in original equipment tyres. International trade in replacement tyres is far more significant, and because of this, there are major differences between the shares of individual countries in both production and consumption.

As shown in table V.17, the United States, Japan and France are major car tyre producers. Together they represented 60.3 per cent of world production in 1989. Car tyre consumption is almost as concentrated among countries. With the addition of the Federal Republic of Germany to the three mentioned above, their share of total consumption in 1989 was 60 per cent. The concentration by country for truck tyres is slightly less. As shown in table V.18, Japan, United States and USSR together produced 50.2 per cent of the total in 1989; the consumption share of the same three countries was 48 per cent.

The demand for automotive tyres can be explained by considering its two components: original equipment demand and replacement demand. The first derives from the level of vehicle production and sales,

*UNIDO acknowledges the contribution made by C. Young, Director of Research, Landell Mills Commodity Studies, Oxford, United Kingdom.

Table V.15. World production and consumption of car tyres, 1986 and 1989

Region, country or economic grouping	Consumption 1986 (million units)	Consumption 1989 (million units)	Percentage share 1989	Percentage change 1986-1989	Production 1986 (million units)	Production 1989 (million units)	Percentage share 1989	Percentage change 1986-1989
North								
North America	216.2	219.8	32.3	1.6	183.1	194.5	30.9	6.2
Western Europe	165.2	186.4	27.4	12.8	185.9	214.1	34.0	15.2
Eastern Europe	37.7	44.2	6.5	17.1	38.4	41.8	6.6	9.0
Japan	73.9	84.1	112.4	13.8	88.1	101.8	16.2	15.6
Other developed countries	12.9	12.7	1.9	-1.6	8.5	7.3	1.2	-14.4
South								
Africa	3.0	5.4	0.8	80.0	0.3	0.5	0.1	66.7
Asia								
Western Asia	9.3	9.4	1.4	0.5	0.8	1.9	0.3	142.5
Centrally planned economies	0.8	3.6	0.5	373.5	1.3	4.1	0.7	223.6
Market economies	11.4	17.4	2.6	52.3	18.1	29.1	4.6	61.2
Latin America	27.4	30.6	4.5	11.6	30.8	35.1	5.6	13.8
North	506.0	547.2	89.2	8.1	503.9	559.5	88.8	11.0
South	51.9	66.3	10.8	27.7	51.2	70.7	11.2	38.0
TOTAL	557.9	613.5	100.0	10.0	555.1	630.2	100.0	13.5

Source: Landell Mills Commodities Studies, *World Tyre Service* (Oxford, various issues).

Table V.16. World production and consumption of truck tyres, 1986 and 1989

Region, country or economic grouping	Consumption 1986 (million units)	Consumption 1989 (million units)	Percentage share 1989	Percentage change 1986-1989	Production 1986 (million units)	Production 1989 (million units)	Percentage share 1989	Percentage change 1986-1989
North								
North America	41.7	47.8	22.5	14.6	34.8	39.9	17.8	14.7
Western Europe	22.2	29.5	13.9	33.0	24.0	29.1	13.0	21.5
Eastern Europe	31.5	29.3	13.8	-7.1	31.7	28.6	12.8	-9.8
Japan	33.6	38.1	18.0	13.4	44.0	50.0	22.4	13.6
Other developed countries	3.6	3.7	1.8	3.9	2.2	3.3	1.5	51.7
South								
Africa	2.8	2.9	1.4	5.8	0.5	0.5	0.2	0.0
Middle East	8.9	6.0	2.8	-32.6	1.2	1.1	0.5	-7.5
Asia								
Centrally planned economies	14.4	19.5	9.2	35.4	14.5	27.5	12.3	89.7
Market economies	15.3	17.7	8.4	15.8	22.9	25.9	11.6	13.1
Latin America	15.4	17.6	8.3	14.7	16.2	17.7	7.9	9.0
Total North	132.6	148.4	70.0	11.9	136.6	150.9	67.5	10.5
Total South	56.7	63.7	30.0	12.4	55.3	72.7	32.5	31.4
TOTAL	189.3	212.1	100.0	12.2	191.9	223.6	100.0	16.5

Source: Landell Mills Commodities Studies, *World Tyre Service* (Oxford, various issues).

which in turn depend, in the case of passenger cars, on the state of personal incomes, consumer confidence and interest rates, and in the case of commercial vehicles, on overall industrial conditions. In both cases, changes in the cost of other items of transport expenditure, notably fuel, have a marked effect on the sales of new vehicles. The depression of the vehicle industry at the beginning of the 1980s was mainly due to the rise in oil prices in 1979 to the plateau of $30 per barrel, at which they remained until 1986, when the sharp fall in oil prices stimulated a boom in vehicle sales that persisted until the end of the decade.

Changes in the production of the vehicle industry at the world level since 1975 are reflected in figure V.5. These changes fed through directly into demand for original equipment tyres, and had a profound effect on capacity utilization and investment in the tyre industry as a whole. Even without the Gulf crisis, the slow-down in demand for new vehicles that began in most areas during 1990 is one of the prime reasons for the current decline in tyre production and sales.

The other element of tyre sales is replacement demand, a function of the number of vehicles in use, the durability of the tyre in relation to the durability

Table V.17. Major car-tyre producing and consuming countries and areas, 1989

Rank	Country or area	Production (million units)	Percentage share	Rank	Country or area	Consumption (million units)	Percentage share
	North						
1	United States	175.0	31.8	1	United States	204.5	33.3
2	Japan	101.8	18.5	2	Japan	84.1	13.7
3	France	55.3	10.0	3	Germany, Federal		
4	Germany, Federal				Republic of	46.7	7.6
	Republic of	44.1	8.0	4	France	33.4	5.4
5	Italy	28.1	5.1	5	USSR	27.9	4.5
6	United Kingdom	28.1	5.1	6	Italy	24.8	4.0
7	USSR	27.5	5.0	7	United Kingdom	24.8	4.0
8	Spain	21.1	3.8	8	Spain	16.0	2.6
9	Canada	19.5	3.5	9	Canada	15.3	2.5
10	Yugoslavia	6.5	1.2	10	Australia	7.3	1.2
	South						
1	Brazil	20.0	3.6	1	Brazil	14.5	2.4
2	Republic of Korea	16.1	2.9	2	Mexico	6.6	1.1
3	Mexico	6.2	1.1	3	Republic of Korea	4.5	0.7
4	Taiwan Province	5.0	0.9	4	China	3.6	0.6
5	Turkey	4.4	0.8	5	Taiwan Province	3.3	0.5

Source: Landell Mills Commodities Studies, *World Tyre Service* (Oxford, 1990).

Table V.18. Major truck-tyre producing and consuming countries, 1989

Rank	Country or area	Production (million units)	Percentage share	Rank	Country or area	Consumption (million units)	Percentage share
	North						
1	Japan	50.0	22.4	1	United States	43.6	19.7
2	United States	37.8	16.9	2	Japan	38.1	17.2
3	USSR	24.4	10.9	3	USSR	24.6	11.1
4	France	6.1	2.7	4	Germany, Federal		
5	Germany, Federal				Republic of	5.5	2.5
	Republic of	5.4	2.4	5	United Kingdom	4.4	2.0
6	Spain	3.4	1.5	6	Canada	4.2	1.9
7	Italy	3.0	1.4	7	Italy	3.5	1.6
8	United Kingdom	3.0	1.3	8	France	3.5	1.6
9	South Africa	2.3	1.0	9	Spain	2.4	1.1
10	Canada	2.1	0.9	10	Australia	1.8	0.8
	South						
1	China	27.5	12.3	1	China	28.0	12.7
2	Republic of Korea	9.7	4.3	2	Brazil	5.8	2.6
3	Brazil	6.6	3.0	3	Mexico	5.0	2.2
4	India	5.7	2.6	4	Republic of Korea	5.0	2.2
5	Mexico	5.2	2.3	5	India	3.9	1.8

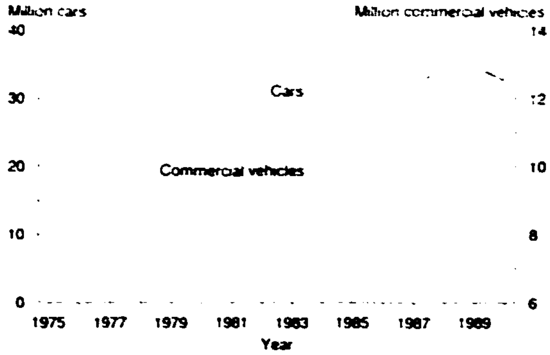
Source: Landell Mills Commodities Studies, *World Tyre Service* (Oxford, 1990).

of the vehicle to which it is fitted, and the distance driven per year. Sales of replacement tyres are also strongly affected by developments in fuel prices. On the one hand, distances driven per year may change in response to changes in cost per mile, though this effect has proved to be relatively mild. On the other hand, and perhaps more importantly, changes in one component of transport costs will have an impact on the willingness to spend money on other components, and hence on the postponement or bringing forward of purchases of replacement tyres. Moreover, when fuel costs are low, consumers may be willing not only to buy replacement tyres earlier, but also to spend more on higher-quality tyres. Concerning recent replacement sales, these too have weakened during 1990, adding to the effects of low original equipment sales on the world tyre industry.

(b) International Trade

The United States is by a large margin the major importing country. The other major tyre-importing regions are Western Asia, which has little capacity to produce tyres, and the European countries that are not members of the EEC, such as Austria, Finland, Norway, Sweden and Switzerland. Developing countries as a group are net importers of tyres, though some individual ones, notably Brazil and the Republic of Korea, are very significant exporters of tyres. France and Japan vie for the position of largest exporting country. If the EEC is considered as a single entity, ignoring intra-EEC trade, then it is the largest exporter. Brazil and the Republic of Korea are the largest exporters among developing countries. Import and export records of other countries that appear in

Figure V.5. World vehicle production, 1975-1990



Source: Society of Motor Manufacturers and Traders, *Motor Industry of Great Britain* and *World Automotive Statistics* (London, various issues).

tables V.19 and V.20 describe only "loose" tyres, and exclude tyres that enter into trade when already fitted as original equipment components of vehicles that are themselves traded.

Two factors which in themselves are interrelated affect trade flows in the tyre industry: oil prices and political developments. Regarding the first of these, the demand for tyres is sensitive to oil price changes. If oil prices rise, tyre demand falls. The main influence of developments in Western Asia thus depends on an assessment of their impact on oil prices. It should be noted that world oil demand and supply was in balance during the period from August 1990 until April 1991, in spite of no contribution from Iraq or Kuwait, so that an eventual return to previous supply volumes in those two countries would appear likely to depress oil prices. However, whether or not this assessment proves correct, the high level of uncertainty about the future has contributed to a decline in

Table V.19. Car tyre exports and imports of major trading countries, 1986 and 1989

Country	Exports 1886 (million units)	Exports 1989 (million units)	Percentage share 1989	Percentage change 1985-1989	Imports 1986 (million units)	Imports 1989 (million units)	Percentage share 1989	Percentage change 1985-1989
France	25.2	33.7	18.61	33.7	20.4	13.0	8.26	-36.3
Japan	17.6	27.4	15.13	55.7	12.0	11.6	7.37	-3.3
Germany, Federal Republic of	19.8	25.7	14.19	29.8	14.9	26.6	16.90	78.5
United States	4.3	14.8	8.17	244.2	4.2	44.0	27.95	947.6
United Kingdom	10.8	13.6	7.51	25.9	9.4	13.6	8.64	44.7
Republic of Korea	10.2	13.1	7.23	28.4	5.3	1.0	0.64	-81.1
Italy	9.5	12.9	7.12	35.8	8.1	11.6	7.37	43.2
Spain	6.0	9.5	5.25	58.3	5.2	4.8	3.05	-7.7
Netherlands	5.6	8.3	4.58	48.2	5.1	9.2	5.84	80.4
Canada	9.9	7.6	4.20	-23.2	9.7	8.8	5.59	-9.3
Brazil	1.9	5.2	2.87	173.7	3.7	0.4	0.25	-89.2
Belgium and Luxembourg	4.6	4.3	2.37	-6.5	4.4	9.1	5.78	106.8
Austria	1.6	3.5	1.93	118.8	2.4	3.7	2.35	54.2
Turkey	0.9	1.5	0.83	66.7	0.4	..	..	-100.0
TOTAL	127.9	181.1	100.00	41.6	105.2	157.4	100.00	49.6

Source: Landell Mills Commodities Studies, *World Tyre Service* (Oxford, 1990).

Table V.20. Truck tyre exports and imports of major trading countries, 1986 and 1989

Country	Exports 1986 (million units)	Exports 1989 (million units)	Percentage share 1989	Percentage change 1985-1989	Imports 1986 (million units)	Imports 1989 (million units)	Percentage share 1989	Percentage change 1985-1989
Japan	10.4	11.4	32.39	9.6	3.3	0.9	3.61	-72.7
France	3.5	4.1	11.65	17.1	2.3	1.6	6.43	-30.4
Republic of Korea	3.2	3.8	10.80	18.8	1.6	0.0	0.00	-100.0
Germany, Federal Republic of	2.6	3.5	9.94	34.6	2.0	2.9	11.65	45.0
United States	0.9	2.5	7.10	177.8	0.8	8.7	34.94	987.5
United Kingdom	1.9	2.3	6.53	21.1	1.6	2.4	9.64	50.0
Spain	1.0	1.8	5.11	80.0	0.7	0.7	2.81	0.0
Belgium and Luxembourg	1.0	1.6	4.55	60.0	0.9	0.8	3.21	-11.1
Italy	1.2	1.4	3.98	16.7	0.8	2.0	8.03	150.0
Austria	1.8	0.8	2.27	-55.6	0.5	0.3	1.20	-40.0
Brazil	0.3	0.5	1.42	66.7	0.2	0.1	0.40	-50.0
Netherlands	0.2	0.5	1.42	150.0	0.3	1.0	4.02	233.3
Canada	2.0	0.5	1.42	-75.0	1.8	3.5	14.06	94.4
Turkey	0.3	0.5	1.42	66.7	-	-	-	-
TOTAL	30.3	35.2	100.00	16.2	16.8	24.9	100.00	48.2

Source: Landell Mills Commodities Studies, *World Tyre Service* (Oxford, 1990).

consumer and business confidence, which has in turn depressed sales of items such as cars and commercial vehicles.

As significant to the tyre industry as the developments in the Western Asia have been the changes in the political structures in Central and Eastern Europe. Countries in this region have built up their own tyre and automotive industries. Although enterprises producing these goods are not now capable of competing on world markets (at least at prices that cover full production costs), they nevertheless may form the core from which internationally competitive enterprises could spring in the future. The attitude of the major tyre producers to the opening-up of Eastern Europe largely reflects the attitude of vehicle manufacturers. Some of these, such as Fiat and General Motors, have indicated great interest in building up production facilities in the region, in order to benefit from the lower labour costs and proximity to Western European markets, as well as the prospects of rapid growth of domestic markets. Similarly, in the tyre field, Pirelli has signed an agreement with Ciech Stomil, the Polish producer of tyres and synthetic rubber, to establish joint production facilities in Poland. One third of the output from the new investment being jointly undertaken will be marketed in export markets under the Pirelli name, one third will be sold on the domestic market, and the remainder will be disposed of in the light of market developments. In addition, Pirelli technology is to be used in a major tyre manufacturing facility in the USSR.

Other tyre producers have been less enthusiastic in their reactions to changes in Eastern Europe. With regard to motor vehicle production, Continental entered into discussions with Pneumant, a manufacturer based in the former German Democratic Republic, but later withdrew from the discussions, leaving a large question mark about the eventual survival of the Pneumant facilities. Continental has, however, pursued negotiations with Barum, the Czechoslovak tyre manufacturing group, at the same time as Volkswagen entered into an agreement with Skoda, the Czechoslovak vehicle manufacturer. Continental also has a stake in Sava, one of the tyre manufacturing companies in Yugoslavia.

By contrast, Michelin appears to view Eastern Europe more as a potential market than as a potential tyre manufacturing location, taking the view that there is already more than adequate tyre production capacity in Western Europe. Japanese tyre manufacturers have also held back so far from any involvement in Eastern Europe, as has Goodyear.

Perhaps the greatest significance of developments in Central and Eastern Europe is that this region has now become the focus of concentration for major tyre manufacturers thinking about new opportunities for market development and for sourcing. Interest in investment in the South has waned, at least temporarily, with the emergence of an alternative, which offers not only low wages, but also access to major markets, a skilled workforce sharing (at least in the case of European and even North American producers) the same cultural traditions and educational background, and the hope of rapid economic growth. Whether this hope is rapidly fulfilled remains to be seen.

(c) Major companies in the global industry

The 1980s have seen a continuous process of concentration, and of globalization, of the world tyre industry, and a full understanding of this process is perhaps the most important single component of an assessment of the chances for change in the international division of labour. Two factors have led to this concentration. First, the vehicle industry itself, which began to be international in the early decades of the twentieth century, when Ford and then General Motors acquired large production facilities outside the United States, has moved further in this direction, with the rapid growth of offshore production by Japanese vehicle manufacturers in North America, and more recently also in Europe. Secondly, and perhaps even more importantly, the task of keeping up with the requirements of major vehicle manufacturers, and retaining a position in the original equipment market, has required massive research and development capability. While profitable businesses can be built on the replacement market alone, purchasers of replacement tyres show preference for purchasing the unit originally fitted, other things being equal. The other thing that may not be equal is the price, so the replacement market tends to segment into a low-price part, and a part bearing the brand names of the original equipment manufacturer. It may be hypothesized that this tendency to segment will rise as the life-span of original equipment tyres increases, and therefore the age of the vehicle to which the replacement tyres are fitted is greater, and its value lower. This consideration does not, however, apply to the commercial vehicle market, where costs play a major role at all stages.

The first development in the dramatic consolidation of the world tyre industry came with the collapse of Dunlop in 1983, and the acquisition of most of its tyre manufacturing capacity by Sumitomo, which had had a long technical association with Dunlop. Thereafter, there was a pause before a series of mergers during the period 1987-1990, which had the effect of reducing the number of United States-owned original equipment tyre manufacturers to only Goodyear. General Tire was acquired by Continental, the leading German manufacturer. BF Goodrich, which had bowed out of the original equipment market some years previously, sold its tyre operations to a joint venture with Uniroyal, which had itself undergone a management buy-out, forming the Uniroyal-Goodrich Tire Corporation. Uniroyal's European capacity, and its brand name in Europe, had already been sold to Continental.

Firestone, which had been reducing its manufacturing capacity throughout the 1980s, was acquired by Bridgestone, the leading Japanese manufacturer, which had to increase its offer price to fight off a competing bid from Pirelli, the leading Italian manufacturer (though the company is now incorporated in the Netherlands). After the failure of this bid, Pirelli acquired Armstrong Tire, which, though not a supplier of original equipment tyres, had a strong niche in agricultural tyres and in the replacement market. In a category similar to the Pirelli-Armstrong acquisition comes Yokohama's acquisition of Mohawk, a very small United States manufacturer. Goodyear successfully fought off a take-over attempt from the United Kingdom, but, in the process, saddled itself with a debt burden that has restricted its room to manœuvre ever since.

Meanwhile Michelin, which has a share of the European market of the same magnitude as Pirelli and Continental combined, had been steadily building up its production facilities in North America, and to a lesser extent in East Asia. Although it had expanded mostly by investment in the capacity to produce Michelin-brand tyres, rather than by acquisitions (with the exception of its earlier acquisition of Kléber, a smaller French manufacturer), Michelin acquired in 1990 the Uniroyal-Goodrich Tire Corporation, which was clearly unable to survive over the long term as a major tyre manufacturer without some such tie-up. More recently, Pirelli has instigated negotiations for the merger of its tyre operations with those of Continental, a move which was opposed by the management of Continental. The final outcome of this proposal remains uncertain.

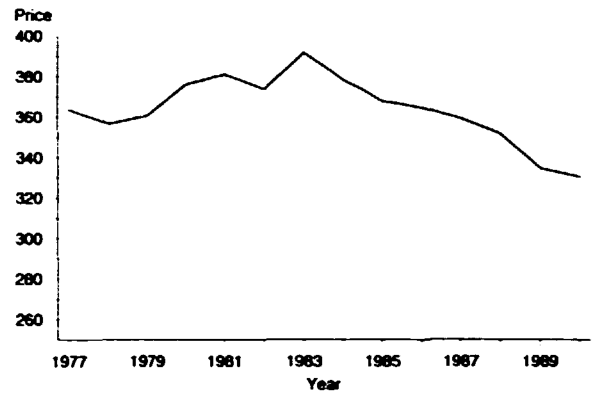
At the end of this series of mergers, there remain three major world manufacturers: Michelin in Europe, Bridgestone in Japan, and Goodyear in North America, as shown in table V.21. Behind these three come three other world-class manufacturers: Pirelli, Continental and Sumitomo. These six companies account for approximately 75 per cent of world tyre sales (excluding sales in China and Eastern Europe, for which value data are not available). Yokohama, a major Japanese manufacturer, could however claim to be in the same category as the above six, though it has at present only a minor presence in North America and none in Europe. These other companies are confined either to the replacement market, or to certain well-defined geographical patches, or in some cases to both.

(d) *Reasons for changes in sales and profits of major companies*

Undoubtedly, the prime determinant of the profitability of major companies is the intense competition, in terms of both technical performance and prices, for the original equipment market. Prices of tyres have steadily declined in real terms throughout the 1980s, as shown in figure V.6. Vehicle manufacturers themselves have been facing intense competition, as industry adjusts to the dramatic growth of the competitive power of a group of companies that could be described as Japanese manufacturers, or as "lean" manufacturers, distributing a superior system of production that is spreading not only beyond Japan, but also beyond the Japanese companies that pioneered it. Faced with this competitive pressure, vehicle manufacturers need annual price reductions from their component manufacturers, including the tyre manufacturers.

Figure V.6. Real price of typical car tyre in France, 1977-1990

(1989 French francs)



Source: Bulletin Mensuel de Statistique (Paris, various issues).

Nearly all major manufacturers bear heavy financial burdens associated with either their recent investments or their acquisitions, or both (and in the case of Goodyear, with the cost of fighting the Goldsmith bid). With low margins on the original equipment business, they are very vulnerable to volume fluctuations in the original equipment market, where margins are more substantial.

2. *Manufacturing capacity of developing countries*

It has already been shown that the tyre industry, under the influence of increasingly intense competition for original equipment sales, has become highly con-

Table V.21. Major tyre manufacturing companies, 1989

Rank in sales	Company	Country	Sales (million dollars)	Profits (million dollars)	Sales per employee (thousand dollars)	Employees
1	Bridgestone	Japan	8 471	70	90.9	93 193
2	Goodyear	United States	7 881	207	71.7	109 899
3	Michelin	France	7 732	417	62.2	124 408
4	Continental	Germany, Federal Republic of	3 274	121	82.0	45 400
5	Pirelli	Italy	2 955	234	42.6	69 329
6	Sumitomo	Japan	2 732	49	136.6	20 000
7	Uniroyal Goodrich	United States	1 905	1	105.2	18 100
8	Yokohama	Japan	1 734	65	160.7	10 750
9	Toyo	Japan	1 051	..	..	..
10	Cooper	United States	720	58	119.5	6 041

Source: Rubber and Plastic News, August 1990.

centrated in a small number of companies. These companies also operate the manufacturing capacity in developing countries. Major companies in the South are listed in table V.22. Indeed, it must be admitted that most of the tyre manufacturing companies operating in developing countries are either operating behind protective (tariff or non-tariff) barriers, with very limited ability to compete internationally, or are subsidiaries of major companies already mentioned. There are, however, some very significant exceptions to this generalization. The two Republic of Korea-based manufacturers, Kumho and Hankook, are massive exporters of tyres, fully able to compete with any international companies in their selected market segments. Their dependence on original equipment sales to the domestic vehicle manufacturers is much smaller than is the case for most major tyre manufacturers. They have a strong position in the North American market and in the tyre markets of Western Asia and many other developing countries. They appear to have greater success in building up exports than the automotive industry of the Republic of Korea, which, although it has grown very rapidly, has begun to encounter difficulties in increasing its market share in important export markets. In addition, and in part offsetting the stagnation of vehicle exports, the domestic market for both vehicles and tyres within the Republic of Korea is growing at a great speed.

Another exception is the Indian industry. While tyre exports possess a very insignificant share of Indian tyre manufacture, the size of the Indian market and the obstacles to import penetration are such that it is possible for companies to flourish, especially those companies that are more or less independent of the global manufacturers (though most have at least technical collaboration agreements). The obstacles to import penetration consist not only of substantial tariff barriers (non-tariff barriers have been dismantled), but also of the peculiar nature of the Indian market, characterized by poor roads and overloaded vehicles, making technical demands that cannot be met by the type of tyre that is mainly suitable under better conditions. As time goes on, these technical barriers may diminish. It remains to be seen whether, and to what extent, tariff protection will persist. However, the large Indian tyre companies may by now have acquired a critical mass that will enable them to remain international competitors, even when they begin to compete in a less segmented part of the global market.

Many developing countries that are significant tyre exporters are building up internationally competitive industries on the basis of investment by the global companies. The tyre exports of Brazil have increased rapidly as a result of investments made through Firestone by Pirelli, Goodyear, Michelin and Bridgestone. Indonesia, Thailand and Turkey are also developing as exporters, with manufacturing increasingly controlled by the same group of companies.

World tyre manufacturing capacity is summarized in the two tables presented in section 8 of this survey.

3. *Capacity utilization and expansion plans*

The capacity to produce tyres is very difficult to define, since there are choices to be made about how many shifts to work, and whether to keep plants running at weekends. It is also necessary to specify the type of capacity that is being discussed. Capacity to produce non-radial tyres is no substitute for radial tyre capacity. Still more importantly, capacity to produce car tyres cannot meaningfully be added to capacity to produce truck tyres, if a coherent measure of total capacity in physical terms is to be produced.

The switch over to radialization (long since complete in Europe) has in fact been an important influence on capacity utilization. North American demand for radial tryes was changing rapidly in the early 1980s, at a time when the international value of the dollar was well above its long-run average in real terms. Because of this, the attractiveness of importing tyres into the North American market outweighed that of setting up new radial-tyre plants in the region. The large North American trade deficit in tyres, which is only now beginning to be reduced, dates from this time. As the dollar declined during the period 1985-1987, the establishment of new production capacity within North America became more profitable. When the 1986 oil price decline brought about a period of strong demand and profitability, the response by the major companies was intense investment in expansion and modernization of manufacturing capacity in North America. As this capacity begins to come on-stream, in the context of a world market that is once again weakening, the effect on capacity utilization is not

Table V.22. Major manufacturing companies in the South, 1986-1989
(Million dollars)

Rank in 1989	Company	Country	Sales			
			1986	1987	1988	1989
1	Hankook	Republic of Korea	523	466	405	300
2	Kumho	Republic of Korea	512	498	409	367
3	Modi	India	..	386	257	251
4	MRF	India	324	299	238	209
5	Dunlop India	India	267	223	232	275
6	Ceat Tyres	India	256	261	244	213
7	BRISA	Turkey	174	170	133	114
8	JK Industries	India	174	158	167	164
9	Hulera Euzkadi	Mexico	148	154	137	128
10	Vikrant	India	137	125	106	123

Source: *Rubber and Plastic News*, August 1990.

confined to North America alone, but has spread to other manufacturing centres, which are finding their net export position declining as the North American trade deficit declines.

Existing expansion plans derive for the most part from those set in motion during the 1986-1989 period of strong growth. Some of them have been scaled back in the light of the current weakness in demand, while others are already in production. A particularly significant expansion plan is the major investment by Kumho, which will virtually double passenger-car-manufacturing capacity in the Republic of Korea. While a proportion of this will meet domestic demand, it would appear to herald a further substantial growth in the volume of exports by the Republic of Korea, and is not matched in any other developing country.

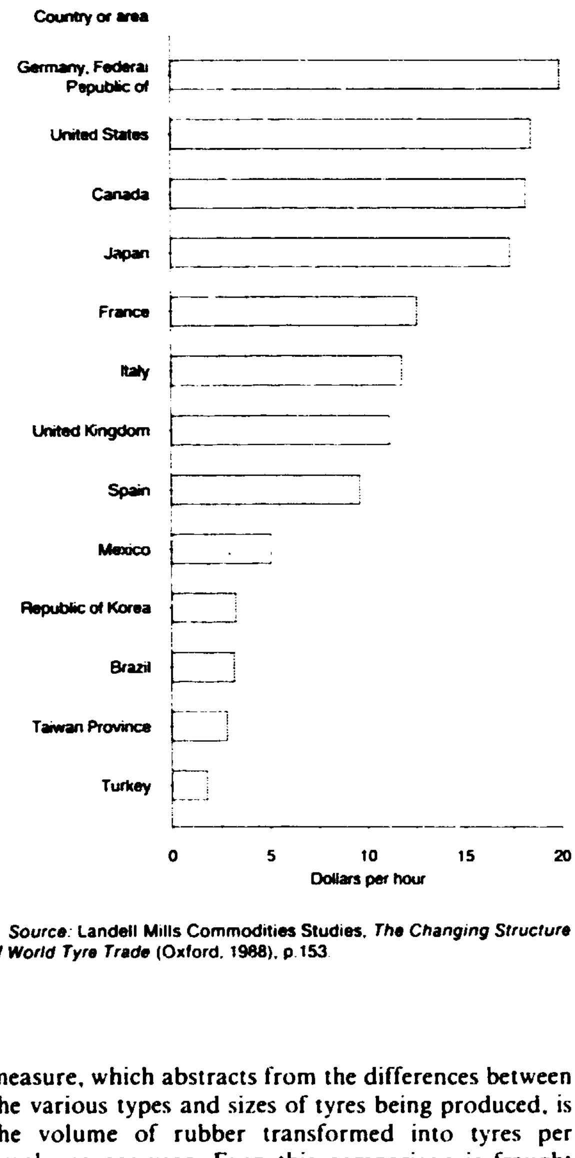
4. *Restructuring and redeployment*

(a) *Structure of the cost of production*

Unit Costs. The cost breakdown of two typical tyres set out in table V.23 is based on United States wage rates and capital charges. The tyres selected represent a typical passenger car tyre, the kind used in the compact size of tyre (average tyre size in North America would be somewhat larger), and a typical heavy-radial truck tyre.

Wages and fringe benefits. Figure V.7 below gives estimates of labour costs per unit of output for a range of major tyre-producing countries and areas. A notable feature is the enormous gap between labour costs in the Republic of Korea and those in Europe. This is not just a result of lower average earnings in the Republic of Korea; it also appears that labour productivity rates in the Republic of Korea compare favourably with those in Japan, North America and particularly Europe.

Figure V.7. Wage costs and fringe benefits in selected tyre-producing countries and areas, 1987



Source: Landell Mills Commodities Studies, *The Changing Structure of World Tyre Trade* (Oxford, 1988), p.153.

(b) *Adjustment of overcapacity*

The finding that labour productivity rates in countries such as the Republic of Korea and Turkey appear to compare favourably with those in Europe may seem surprising. In fact, there are difficulties in measuring labour productivity. One appealing physical measure, which abstracts from the differences between the various types and sizes of tyres being produced, is the volume of rubber transformed into tyres per employee per year. Even this comparison is fraught with problems, since employment figures are not collected on a comparable basis in different tyre-producing countries. However, despite reasonable allowances being made for these differences, it still appears that labour productivity rates in leading tyre-exporting countries match those elsewhere in the world.

Table V.23. Typical tyre costs (Dollars)

Item	Car tyre	Truck tyre
Natural rubber	1.0	11.0
Synthetic rubber	1.0	4.9
Carbon black	0.4	2.4
Chemicals	1.4	3.1
Tyre cord and bead wire	2.9	22.9
Energy	0.7	2.6
Labour	5.2	35.5
Capital	7.3	42.2
TOTAL	20.8	124.5

Source: Landell Mills Commodities Studies, *The Changing Structure of World Tyre Trade* (Oxford, 198?).

The explanation for this fact probably lies in the age of the production facilities. Since the conversion to radial tyres was completed earlier in Europe than in other parts of the world, much of the radial-tyre production capacity was of an earlier vintage than in countries such as Japan, United States or Republic of Korea, where the conversion to radial tyres was more recent. These more modern facilities make greater use of automated and labour-saving techniques. European producers have been able to offset this disadvantage by achieving higher unit values for their output, as a result of the premium quality image held by their brands. Nevertheless, bringing productivity rates into line with those elsewhere was a prime objective for European tyre manufacturers in the late 1980s.

Thus, while recent years have seen a significant increase in production capacity in North America and in a range of countries in the South, the investment that has taken place during the past five years in Western Europe and Japan has for the most part focused on the reduction of production costs by automation and on the improvement of the organizational flow of the production process. A modern tyre plant with a capacity of 25,000 car tyres per day may cost over $250 million to construct, but will have a labour force of no more than around 500. A similar facility some years ago might have employed at least five times as many personnel. The combination of very slow growth in demand with steadily rising labour productivity has dramatically reduced employment in the industry in the North.

A strategy of remote sourcing of components has been adopted in other industries to offset competitive disadvantage. In the tyre industry, this avenue does not present itself. Tyre manufacture does not require semi-manufactured parts; instead, it starts from raw materials such as rubber, carbon black, extender oil, tyre cord and rubber chemicals. There is a high volume of international trade in each of these, but trade is essentially between countries in the North, in response to changes in raw material and energy prices, technical advances and exchange rates. It does not represent a way of making use of low-cost labour available in the South in order to reduce the costs of the labour-intensive parts of the manufacturing process. In the case of tyre manufacturing, in contrast to, for example, footwear or electronics manufacturing, labour-intensive operations are essentially at the core of the manufacturing process, rather than in the making of components.

(c) *Possible reasons for excess capacity*

The imbalances that have emerged between tyre production capacity and demand are due to the unexpected changes in the nature and volume of world-wide tyre demand. At the beginning of the 1980s, tyre manufacturers were still adjusting to the drastic slow-down of tyre demand brought about by the two oil price increases of 1973-1974 and 1979, and which had been compounded by the increase in average tyre lifetimes following the spread of radial tyres. At that time, considerable excess capacity existed to produce bias-ply tyres, particularly in North America. Changes in the location of vehicle production also led to the emergence of excess capacity. Part of the problem faced by Dunlop, and leading to its ultimate absorption by Sumitomo, lay in the collapse of vehicle production in the United Kingdom, not only depriving Dunlop of original equipment outlets, but also, given the propensity of consumers to purchase replacement tyres with the same brand name, cutting into its share of the replacement market.

While excess capacity was endemic in the early 1980s, and has recently re-emerged, there was a period, approximately between 1987 and early 1989, when capacity shortages began to emerge in some branches of the industry, which had not anticipated the upturn in tyre demand that started in 1986. Investment expenditures that were committed in response to these capacity constraints is coming on stream at a time when demand has once more slackened.

5. *Environmental considerations*

The main environmental considerations affecting the world tyre industry relate not to the manufacture of the tyre, but to its use, its disposal, and its raw materials. Because of this, environmental considerations do not exercise a strong independent influence on the competitiveness of different tyre-producing countries. Summarizing the basic environmental issues, tyres could be considered as being consumed jointly with petroleum. When gasoline or diesel fuels are burnt, tyres are simultaneously being used up. There is an increasing awareness of the environmental effect of the exhaust gases given off by these fuels, and in particular of the effect of carbon dioxide on possible global warming. As a result of this awareness, interest is growing in measures that could have the effect of limiting this form of pollution, for example, by taxing the carbon component of fuels, thus raising the cost of motor vehicle utilization. Any steps in this direction would clearly have an effect on the level of demand for tyres. Other environmental concerns directed at the use of the automobile, such as urban congestion, may also have an impact on the demand for tyres.

A further major environmental concern related to the tyre industry involves the disposal of used tyres. Dumps for used tyres, apart from being unsightly, form breeding grounds for mosquitoes and constitute a major fire hazard. Since tyres contain so many diverse materials, recycling is unattractive. Methods of incineration are being developed, but are only viable as sources of electric power if their revenue from energy sales is supplemented by subsidies related to the environmental improvement from removing the tyres. To provide the subsidies needed to make these steps viable, taxes are being imposed on sales of new tyres in some areas, and similar measures may need to be adopted more widely.

In the manufacturing process itself, the rubber compounding step can give rise to air pollution, if care is not taken to prevent carbon black being dispersed into the air. Such steps are mandatory in most developed countries. However, environmental concerns do not have a major impact on the economics of locating tyre manufacture in different regions of the world.

6. *Technological trends*

The principal technological revolution in the tyre industry in the last 50 years has been the introduction of the radial tyre. This revolution, long complete in Western Europe, is at last approaching completion in North America and Japan. However, significant numbers of non-radial tyres continue to be manufactured, particularly for light trucks, in both these two regions.

Radial tyres are not well adapted to poor road conditions, so the demand for non-radial tyres persists in many developing countries. The much longer lifetime of the radial tyre, and the possibility of retreading radial truck tyres two or three times, have significantly lowered world demand for tyres by reducing replacement demand. Radial tyres for passenger cars can now be expected to last for approximately

64,000 kilometres, so that one set of replacement tyres may be all that is needed in the lifetime of the vehicle.

Tyre technology involves balancing the competing requirements of durability, adhesion and low-rolling resistance, along with other requirements such as comfort and quietness. The balance that is struck depends on local conditions. Adhesion is thus given more importance in Europe, where speed limits are high or non-existent on motorways, as in Germany, and where roads are often winding; while in North America, roads are straighter and speeds lower. Low-rolling resistance has become very important as a result of United States fuel economy legislation. In recent years, low-profile, high-performance tyres, in which adhesion is emphasized at the expense of other qualities, have become popular. In principle, this development could stimulate tyre demand by reducing durability, though little clear statistical evidence of this trend currently exists.

The tyre-manufacturing process is a complex one, and its automation has been difficult. However, great emphasis has been placed by the major tyre manufacturers on improving labour productivity, and the average size of tyre plants has tended to become larger. It is generally considered that an economic size for a world-class tyre plant is around 25,000 passenger-car tyres per day, or 5,000 truck tyres per day. At the same time, considerable research and development has been invested in trying to develop technologies that will reduce the minimum economic size of tyre plants, given the proliferation of tyre sizes and types. It is becoming quite common for vehicles to have different tyre sizes and designs for the front and rear wheels, and in some cases for each wheel. The focus of this research has been on the development of modular tyre-manufacturing technologies, which has been pursued both by Goodyear and, prior to its acquisition, by Firestone, as well as by other major companies. Most companies are, however, very secretive about the production technologies they are adopting.

The threat of replacement of the rubber tyre by a polyurethane tyre, which could be cast in a single manufacturing step, was considered real during the early 1980s, but it has so far not proved possible with the present polyurethane technology to maintain the high performance standards required. These tyres occupy at present only a very minor market niche in agricultural tyres, and do not seem likely to pose a threat to traditional tyre compounds in the near or medium-term future.

Considerable effort has been devoted to the development of run-flat tyres, so as to avoid the need for a spare tyre. In North America, mini-spares are popular, though they have not caught on elsewhere. Run-flat tyres have so far not gained a major market share. Continental has for some time been promoting a novel tyre design, in which the tyre is wrapped around, rather than inserted in, the rim. This tyre has run-flat capabilities as well as certain other claimed performance advantages, but it has not yet been adopted as original equipment by any vehicle manufacturer.

Research and development is being most actively undertaken, on a global basis, by the limited number of tyre manufacturers mentioned earlier. It is not clear, however, whether this type of research and development has any major impact on the competitive position of the North *vis-à-vis* the South. The competitive position of the group of manufacturers already noted (including those in the Republic of Korea) is in any event unchallenged. On the other hand, tyre manufacture is likely to remain a fairly labour-intensive process, and the economics of locating production in developing countries remain attractive, regardless of the type of tyre being produced.

A common trend is to shift non-radial tyre production to developing countries, where the demand for such tyres is likely to persist for longer, and where technical requirements are less demanding. For example, Goodyear has shifted an entire non-radial tyre factory from North America to Indonesia. Bridgestone has also recently decided to source a major proportion of its production of truck tyres for Western Asian markets from Indonesia, instead of from Japan.

7. *Short- and medium-term outlook*

The short-term outlook is for an immediate period of industry stagnation or even decline, followed by a period of slow growth. Regardless of developments in oil prices, the demand for vehicles has eroded in most major markets. With no clear trend in the number of miles driven per vehicle per year or in the durability of tyres, demand for tyres must be expected to increase at the same rate as the world motor vehicle population, that is, approximately 3 per cent per year for cars, and 4 per cent for commercial vehicles.

An important uncertainty relates to the future development of the pattern of international trade in tyres. It has already been shown that the United States is the largest single import market. Unlike manufactured products such as footwear, where the industry has shifted towards low-wage countries, only a minor proportion of United States tyre imports emanates from developing countries, and the pattern of imports has more to do with comparative costs, and with the perception of quality, as between the tyres made in other developed countries. More recently, United States net imports have fallen sharply; this trend is likely to be maintained, as the new capacity that has been installed, principally in North America, in the past five years comes on stream, and as the dollar remains low against the deutsche mark and the yen.

The globalization of the industry in the past few years means that the international division of labour does not depend so much on competition *between* companies in different countries, but instead on decisions made *within* the major companies about the optimal sourcing policy. These decisions seem likely to lead to a reduction of the share of Western Europe and Japan in total world tyre production, but to an increase in the share of North America.

The share of production in developing countries will continue to increase as a result of sourcing decisions by the major tyre companies, and also as a result of the rapid increase in vehicle populations in certain developing countries. This increase will be particularly rapid in Asia, where income distribution is fairly even, and where large sections of the population are simultaneously reaching levels of income at which vehicle ownership becomes viable. As developing countries gradually catch up with the levels of vehicle ownership typical of the North, demand for tyres will grow, and it is likely that most of this demand will be satisfied by production within developing countries (though not necessarily the same developing countries where the demand arises).

Location near markets is an important consideration in determining the site of tyre production facilities. The shape of a tyre influences transport costs: tyres cannot be densely packed. Location is even more important in the case of original equipment supplies, particularly given the trend towards "just-in-time" supplying of components for the automotive industry. By comparison, access to raw materials is of relatively minor significance. Some developing countries emerging as important producers of tyres—India, Indonesia and Thailand—are also producers of natural rubber. However, in the case of India all input and output prices bear little relationship to world prices. Natural rubber is purchased at prices around 1.5 to 2 times the world price, and the various types of synthetic rubber also sell at multiples of their world market price. Tyre exporters are, however, able to reclaim the difference between the world price and local input prices. Hence, in the case of India, access to raw materials is not a factor favouring the location of the industry. Similar considerations apply to some other developing countries producing tyres. China and Brazil, for example, have a protected natural rubber industry selling at prices well above the world price.

Those other natural rubber-producing countries that are also exporters of natural rubber do derive some advantage from this fact, but the extent of this advantage should not be overestimated. In the case of passenger-car tyres, technical considerations favour the use of synthetic rubber for many parts of the tyre, and natural rubber is normally around half of total rubber content. The larger the tyre, the higher the proportion of natural rubber used, particularly as the resistance to heat build-up offered by natural rubber becomes increasingly important. However, certain types of synthetic rubber, such as polybutadiene used for blending natural rubber with butyl rubber for the tube or inner liner, are still required in significant quantities for commercial vehicle tyres. Thus any advantage derived from access to natural rubber at prices below the c.i.f. prices paid by developed countries may well be cancelled by higher local prices for synthetic rubber. Synthetic rubber capacity exists in Argentina, Brazil, China, India, Mexico, Republic of Korea and Taiwan Province, but as yet in no other developing countries or areas.

The extent of the advantage derived from local production of natural rubber is greater where exports are subject to an export tax or replanting costs, which is the case in Malaysia and Thailand, though not in Indonesia. In such countries, local manufacturers of rubber products, including tyres, pay prices that differ from those paid in developed countries, not only by the freight cost, but also by the extent of taxes. However, of these three countries, Indonesia has emerged as the largest producer and exporter of tyres.

Apart from synthetic rubber, other materials needed include carbon black, tyre cord, rubber chemicals and extender oil. Access to supplies of these materials of predictable and consistent quality is a precondition for the ability to produce tyres of an internationally competitive quality. Even countries that have established local production facilities for such materials may have problems in ensuring that their quality is of adequate standard.

Access to technology is clearly a prime requisite. However, this factor has contributed to the drastic reduction in the number of independent, world-class tyre manufacturers in recent years. Production of radial tyres, especially of radial truck tyres, requires a very high level of technical expertise. Most tyre producers in developing countries, particularly producers of radial tyres, have technical agreements with one or other of the international major tyre producers. The existence of these agreements is likely, in most cases, to place constraints on the ability of technology recipients to compete in international markets with the companies supplying the technology.

The brand names of major tyres are of great importance in marketing, particularly in the replacement market. Premium prices will be paid only for brands recognized by the customer as being those of world-class manufacturers, and these higher prices are necessary for such manufacturers to recoup the costs of the research and development needed to compete in the original equipment market. While consumers will normally be aware of the company that produced the tyre, they are unlikely to be conscious of the country in which it is manufactured. Global manufacturers often own distribution networks to service the replacement market, and can make their own decisions on cost-of-production grounds about how to source their own brand tyres that are sold through these or other channels into the replacement market. However, replacement tyres are also distributed through a multitude of other outlets, which provide an opportunity for tyres produced by other manufacturers to compete. They may compete under their brand name, or they may be sold under the retailers own brand label. However, they will not command prices similar to the recognized brand names of the major manufacturers.

While considerations of technology and branding will restrict the ability of manufacturers in the South to market in the North independently of the major global producers, their advantage in terms of labour costs remains a significant factor. The substantial exports from Brazil and Mexico testify to the willingness of global manufacturers to source from the South where this is viable. However, it is not labour costs alone that are important, but the combination of low labour costs with a sufficient infrastructure of technically qualified personnel and a network of reliable raw materials suppliers.

8. Data on world tyre manufacturing capacity

The following tables summarize data on tyre manufacturing capacity.

Table V.24. Tyre facilities in the North

Country or area	Company	Location	Type	Capacity	Employees
Israel	Alliance Tire	Hadera	All	30 700 t/y	400
		Petach-Tikva	CV,Ag,EM,Ind	1 100 t/m	130
United Kingdom	Avon	Melksham	Car,LCV,CV,Ag,MC,Ind	2 000 t/w	800
South Africa	BTR-Dunlop	Durban	Car,LCV,CV,Ag,EM,Ind,Ac	2 800 t/m	1 430
South Africa		Ladysmith	Car	1 125 t/m	670
Czechoslovakia	Barum	Otrokovice	Car,LCV,Ag,MC	229 000 u/m	6 000
		Prague	Car,LCV,CV,Ag	250 t/d	4 000
		Puchov	Car,LCV,CV	166 600 u/m	5 000
Yugoslavia	Borovo	Borovo	CV	40 000 t/m	..
Australia	Bridgestone	Salisbury	Car	8 400 u/d	2 141
Japan		Amagi	CV	9 000 u/d	959
Japan		Hikone	Car	42 000 u/d	1 303
Japan		Hofu	Car,EM	17 000 u/d	636
Japan		Kurume	Car,LCV,CV	33 000 u/d	2 038
Japan		Nasu	Car,Ag,MC	38 000 u/d	885
Japan		Shimonoseki	EM	300 u/d	662
Japan		Tochigi	Car,CV	23 000 u/d	1 043
Japan		Tokyo	Car,LCV,CV	33 000 u/d	3 254
Japan		Tosu	Car	30 000 u/d	1 017
Canada	Bridgestone/ Firestone	Joliette	Car	12 500 u/d	820
France		Béthune	Car,LCV	21 800 u/d	1 420
Italy		Bari	Car,LCV,CV	12 300 u/d	1 045
New Zealand		Christ Church	Car,LCV,Ag	4 200 u/d	385
Portugal		Alcochete	Car,LCV,CV	5 300 u/d	475
Spain		Bilbao	CV,Ag,EM	2 000 u/d	1 800
Spain		Burgos	Car	21 000 u/d	1 275
Spain		Puente San Miguel	LCV,CV,Ag,Ind	5 100 u/d	1 045
United States		Decatur	Car,LCV	25 000 u/d	1 970
United States		Des Moines	Car,CV,Ag,EM	14 000 u/d	1 795
United States		La Vergne	Car,LCV,CV	12 000 u/d	1 700
United States		Oklahoma City	Car,LCV	30 000 u/d	1 770
United States		Warren Co.	CV	4 000 u/d	750
United States		Wilson	Car	28 000 u/d	1 990
Portugal	CNB	Santo Tirso	Car,LCV,CV,Ag	58 500 u/m	500
United States	Carlisle	Carlisle	Ind	22 500 u/d	750
Poland	Ciech Stomil	Debica	Car,LCV,CV,Ag	5 500 u/d	6 800
Poland		Olsztyn	Car,LCV,CV,Ag	3 300 u/d	3 300
Poland		Poznan	CV,Ag,EM,Ind		2 000
Austria	Continental	Traiskirchen	Car,CV	18 540 u/d	1 660
Belgium		Herstal/Liège	LCV,CV	3 300 u/d	700
France		Clairoix	Car	24 000 u/d	860
France		Sarreguemines	Car,CV	15 050 u/d	620
Germany, Federal Republic of		Aachen	Car,LCV	16 320 u/d	770
Germany, Federal Republic of		Hanover	Car,LCV,CV,Ag,Ind	19 800 u/d	1 610
Germany, Federal Repubic of		Korbach	Car,Ag,Ind	27 600 u/d	1 322
Ireland		Dublin	Car	11 500 u/d	461
United Kingdom		Newbridge	Car	14 000 u/d	620
Portugal	Continental Mabor	Lousada	Car,LCV,CV,Ag,Ind	5 225 u/d	800
United States	Cooper	Findlay	Car,LCV,CV	20 000 u/d	950
United States		Texarkana	Car,LCV	30 000 u/d	1 500
United States		Tupelo	Car	28 000 u/d	700
Romania	Danubiana	Bucharest	Car,LCV,CV,Ag	4 600 u/d	4 100
Romania		Drobeta	Ag,EM	156 u/d	825
United States	Denman	Warren	Car,LCV,C,Ag,Ind	1 056 u/d	350

Table V.24. (continued)

Country or area	Company	Location	Type	Capacity	Employees
United States	Dico Tire Inc.	Clinton	Ind	15 500 u/d	385
United States	Dunlop	Buffalo	CV	850 u/d	900
United States		Buffalo	Car,LCV,CV,MC	9 000 U/D	938
United States		Huntsville	Car,LCV	30 000 u/d	1 255
Yugoslavia	FAG	Krusevac	Car,LCV	5 700 u/d	760
Yugoslavia		Oblicevo	Ag,MC,Ind	16 700 u/d	1 000
United States	Fidelity Tire Manufacturing Company	Natchez	Car,LCV,CV,Ag	10 000 u/d	550
South Africa	Firestone S.A. Pty	Port Elizabeth	Car,LCV,CV,Ag,EM	8 000 u/d	2 600
South Africa	GenTyre Industries	Port Elizabeth	Car,LCV,CV,Ag,EM	150 t/d	2 050
Canada	General (Continental subsidiary)	Barrie	Car,LCV,CV	12 300 u/d	900
United States		Bryan	Ag,EM,Ind	260 u/d	370
United States		Charlotte	Car	25 000 u/d	1 700
United States		Mayfield	Car,LCV,CV,Ag	24 000 u/d	2 200
United States		Mount Vernon	Car,CV	21 800 u/d	1 450
United States	General Motors, Toyota Yokohama Joint Venture	Mount Vernon	LCV,CV	880 000 u/y	450
Norway	Gislaved	Askim	Car,LCV,MC	167 000 u/m	490
Sweden		Gislaved	Car,LCV	217 000 u/m	716
Canada	Goodyear	Medicine Hat	Car,CV	6 380 u/d	228
Canada		Napanee	Car,CV	8 000 u/d	300
Canada		Valleyfield	Car	20 380 u/d	1 645
France		Amiens	Car,Ag	20 000 u/d	1 550
Germany, Federal Republic of		Fulda	Car,LCV,CV	16 4000 u/d	1 400
Germany, Federal Republic of		Philippsburg	Car	15 500 u/d	950
Greece		Salonika	Car,LCV,CV,Ag	3 175 u/d	500
Italy		Latina	Car,Ag	15 240 u/d	975
Luxembourg		Colmar/Berg	Car,CV,EM,AC	8 858 u/d	1 725
United States		Akron	Car	12 070 u/d	100
United States		Danville	CV,AC	12 000 u/d	2 165
United States		Gadsden	Car,LCV,CV,Ag	38 000 u/d	2 370
United States		Lawton	Car	53 000 u/d	2 200
United States		Madisonville	Ind	12 000 u/d	300
United States		Topeka	CV,EM	8 370 u/d	2 040
United States		Union City	Car,LCV	51 000 u/d	3 100
United Kingdom		Wolverhampton	Car,LCV,CV,Ag	27 000 u/d	3 275
United States	Goodyear (Kelly Springfield)	Fayetteville	Car,LCV	54 000 u/d	2 900
United States		Freeport	Car,LCV,Ag	23 000 u/d	1 465
United States		Tyler	Car	27 000 u/d	1 400
United States	Hoosier	Lakeville	Car	500 u/d	..
Switzerland	Maloya	Gelterkinden	Car,LCV	2 200 u/d	300
Italy	Marangoni	Anagni	Car,LCV,Ag	2 400 u/d	190
United States	McCreary	Indiana	LCV,CV,Ind,AC	2 700 u/d	300
Canada	Michelin	Bridgewater	Car,LCV,CV	11 000 u/d	1 300
Canada		New Glasgow	Car,CV	9 000 u/d	2 000
Canada		Waterville	CV,EM	2 000 t/m	700
France		Bourges	LCV,CV,Ag,EM,AC	3 545 t/m	2 345
France		Cholet	Car,LCV,CV	4 025 t/m	2 040
France		Clermont-Ferrand	All	6 725 t/m	20 325
France		Le Puy	EM	1 835 t/m	622
France		Monteeau-Les-Mines	Car,CV,EM	3 000 t/m	1 610

Country or area	Company	Location	Type	Capacity	Employees
France		Orléans	CV	2 085 t/m	745
France		Poitiers	CV	3 020 t/m	860
France		Roanne	Car	1 625 t/m	625
France		Toul	Car,LCV		839
France		Tours	Car,CV	6 700 t/m	3 080
France		Troyes	Car,Ag		1 447
Germany, Federal Republic of		Bad-Kreuznach	Car	28 000 u/d	2 600
Germany, Federal Republic of		Bamberg	Car	11 500 u/d	1 100
Germany, Federal Republic of		Homburg	Car,LCV	..	2 100
Germany, Federal Republic of		Karlsruhe	LCV,CV		2 000
Germany, Federal Republic of		St. Ingbert	Car,Ag	175 000 u/m	740
Italy		Turin, Cuneo, Alessándria	Car,LCV,CV	81 000 u/d	11 000
Netherlands		's Hertogenbosch	CV	7 000 u/d	900
Spain		Lasarte	Car,LCV,CV,Ag,EM	..	3 500
Spain		Valladolid	Car,Ag	--	
Spain		Vitoria	Car,CV	967 000 u/m	4 000
United States		Dothan	Car,LCV	4 500 u/d	900
United States		Greenville	Car	23 000 u/d	2 000
United States		Lexington	Car	15 000 u/d	1 000
United States		Norwood	AC	12 500 u/m	400
United States		Spartanburg	CV	5 000 u/d	1 400
United Kingdom		Ballymena	CV	..	1 100
United Kingdom		Burnley	CV	..	800
United Kingdom		Dundee	Car	6 000 u/d	1 400
United Kingdom		Stoke	Car	22 000 u/d	3 500
Japan	Michelin/Okamoto	Gunma	Car,LCV	350 000 u/m	450
United States	Mohawk	Salem	Car,LCV	16 000 u/d	500
Japan	Nippon	Tatsuno	EM	112 t/m	260
Finland	Nokia	Lieksa, Nokia	Ag,MC		1 000
Japan	Ohtsu	Miyazaki, Izumi	Car,LCV,CV,Ag,Ind	39 500 u/d	1 090
Germany, Federal Republic of	Pirelli	Breuberg/Odenwald	Car,Ag	465 000 u/m	1 200
Germany, Federal Republic of		Breuberg/Odenwald	MC	6 000 u/d	350
Greece		Patras	Car,LCV,CV,Ag,MC,EM	1 200 t/m	500
Italy		Milan, Tivoli, Villafranca	Car,LCV,CV,Ag,MC	35 000 u/d	5 500
Spain		Manresa	Car,LCV,CV,Ag,MC	380 000 u/m	1 600
United Kingdom		Burton, Carlisle	Car,CV	20 800 u/d	1 580
United States	Pirelli Armstrong	Des Moines	Car,LCV,CV,Ag,EM	13 000 u/d	1 100
United States		Hanford	Car	17 000 u/d	650
United States		Nashville	Car	16 500 u/d	700
Yugoslavia	Rekord	Belgrade	Ag,EM	1 850 u/d	800
Yugoslavia	Ruma-Guma	Ruma	Ag,Ind	950 u/d	1 178
Yugoslavia	Sava Kranj	Kranj	Car,LCV,CV,MC	2 240 u/d	45
Yugolsavia	Sava Semperit	Kranj	Car,LCV,CV	11 500 u/d	892
New Zealand	South Pacific	Wellington	Car	4 400 u/d	335
Australia	South Pacific Tyre	Granville	LCV,CV	1 100 u/d	420
Australia		Thomastown	Car	9 170 u/d	585
Australia		West Footscray	LCV,CV,Ag,EM,AC	4 500 u/d	860
France	Sumitomo	Amiens	Car	900 t/m	730
France		Montluçon	Car,CV,Ag,Ind	1 300 t/m	1 650
Germany, Federal Republic of		Hanau	All	21 600 u/d	1 910
Germany, Federal Republic of		Wittlich	Car,LCV,CV	7 200 u/d	624

Table V.24. (continued)

Country or area	Company	Location	Type	Capacity	Employees
Japan		Nagoya	Car,LCV,CV	4 600 t/m	1 170
Japan		Shirakwa	Car,LCV,CV	5 300 t/m	1 160
United Kingdom		Birmingham	Car,LCV,CV,MC	1 500 t/m	1 600
United Kingdom		Washington	Car	9 700 u/d	500
Hungary	Taurus	Budapest	CV	3 000 u/d	2 000
Hungary		Nyiregyhaza	Ag	1 200 u/d	1 000
Yugoslavia	Tigar	Pirot	Car,LCV,CV,Ag,Ind	11 700 u/d	1 000
Japan	Toyo Tire	Itami	LCV,CV	3 300 t/m	800
Japan		Kuwana	Car		480
Japan		Sendai/Miyagi	Car,LCV	4 800 t/m	1 100
Sweden	Trelleborg	Trelleborg	Ag,MC,EM,Ind	7 t/d	300
Sweden		Viskafors	Ag,Ind	1 800 u/d	120
South Africa	Tycon	Uitenhage	Car,LCV,CV,Ag,EM	2 400 u/d	2 400
Canada	Uniroyal Goodrich	Kitchener	Car,LCV,CV	12 000 u/d	700
Canada	(Michelin subsidiary)	Kitchener	Car,LCV,CV	20 000 u/d	1 200
United States		Ardmore	Car	32 000 u/d	2 250
United States		Fort Wayne	Car,LCV,CV	29 000 u/d	1 650
United States		Opelika	Car,LCV	26 000 u/d	1 800
United States		Tuscaloosa	Car,LCV	30 000 u/d	2 400
Canada	United Tyre	Rexdale	EM,Ind	1 000 u/d	60
Romania	Victoria	Caracai	Car	3 000 u/d	930
Romania		Fioresti	Car,LCV,CV,Ind,AC	10 300 u/d	4 900
Romania		Zalau	CV	1 175 u/d	1 560
Netherlands	Vredestein (car tyre operations acquired by Michelin)	Enschede	Car,CV,AG	16 300 u/d	850
Japan	Yokohama	Ageo	Car,LCV,MC	550 t/m	201
Japan		Hiratsuka	CV,AC	3 000 t/m	2 347
Japan		Mie	Car,LCV,CV,Ag,Ind	5 200 t/m	1 142
Japan		Mishia	Car,LCV	2 700 t/m	711
Japan		Onomichi	EM	750 t/m	185
Japan		Shinshiro	Car,LCV	3 600 t/m	759

Source: Bruce Davis, "Special report: global tyre market", *Rubber and Plastics News*, 20 August 1990, p.18.

Note:

Ac = aircraft	t/d = tonnes per day
Ag = agricultural	t/m = tonnes per month
CV = commercial vehicle	t/w = tonnes per week
EM = earthmover	t/y = tonnes per year
Ind = industrial	u/d = units per day
LCV = light commercial vehicle	u/m = units per month
MC = motor-cycle	u/y = units per year

Table V.25. Tyre facilities in the South

Country or area	Company	Location	Type	Capacity	Employees
Ethiopia	Addis Tire	Addis Ababa	Car,CV,LCV	10 000 u/m	716
Turkey	Anlas	Bolu/Duzce	MC	5 000 u/d	200
India	Apollo	Perambra	Car,LCV,CV,Ag	44 500 u/m	1 200
Pakistan	Atlas Tyres	Lahore	..	..	..
Turkey	BRISA	Izmit	Car,LCV,CV,Ag,EM	19 000 u/d	1 353
Nigeria	BTR-Dunlop	Lagos	Car,LCV,CV,Ag,EM	1 800 u/d	340
Trinidad and Tobago		Port Fortin	Car,LCV,CV	1 219 t/m	183
Zambia		Ndola	Car,LCV,CV,Ag,EM	950 u/d	229
Zimbabwe		Bulawayo	Car,LCV,CV,Ind	1 100 t/m	990

Country or area	Company	Location	Type	Capacity	Employees
Ghana	Bonsa Tyre	Bonsasa	Car,LCV,CV	1 200 u/d	..
Indonesia	Bridgestone	Jakarta	Car	7 200 u/d	832
Taiwan Province		Hsiu-chu	Car,LCV,CV	110 000 u/m	600
Thailand		Bangkok	Car,LCV,CV	6 600 u/d	566
Argentina	Bridgestone/Firestone	Buenos Aires	Car,LCV,CV,Ag	5 800 u/d	820
Brazil		Sao Paulo	Car,CV,Ag	21 400 u/d	4 060
Mexico		Cuernavaca	Car,LCV,CV	2 800 u/d	550
Mexico		Mexico City	Car,LCV,CV,Ag,EM	1 900 u/d	633
Venezuela		Valencia	Car,LCV,CV,Ag,MC,EM	8 300 u/d	1 015
India	CEAT	Bombay, Nasik	Car,LCV,CV,Ag,MC,Ind,AC	216 500 u/m	2 278
Zaire	CIPX	Kinshasa	Car,LCV,CV	1 200 u/d	460
Taiwan Province	Cheng Shin	Yuanlin	Car,LCV,CV,Ag,MC,Ind	280 000 u/m	2 644
Mexico	Continental	Mexico City	LCV,CV	2 100 u/d	609
Mexico		San Luis Potosi	Car,LCV	3 600 u/d	609
Morocco		Casablanca	Car,LCV,CV,Ag	33 500 u/m	570
Malaysia	DMIB	Selangor	Car,LCV,CV,EM,AC	1 250 t/m	1 700
Pakistan	Delta	Islamabad	Car,LCV,MC	..	..
Iran (Islamic Republic of)	Dena Tire	Shiraz	Car	1 850 t/m	..
India	Dunlop India	Calcutta	Car,LCV,CV,Ag,MC	1 480 t/m	4 052
India		Madras	Car,LCV,CV,Ag,MC	1 320 t/m	1 788
Philippines	Dura Tire	Manila	Car,LCV	300 u/d	80
Ecuador	Ecuadorian Rubber	Cuenca	Car,LCV,CV,AG	3 400 u/d	800
Uruguay	FATE	Montevideo	Ind	1 700 u/m	300
India	Falcon	Mysore	Car,MC	100 000 u/m	600
Argentina	Fate	Buenos Aires	Car,CV,Ag	250 t/m	900
Taiwan Province	Federal	Taipei	Car,LCV,CV	7 000 u/d	460
Kenya	Firestone East Africa	Nairobi	Car,LCV,CV	1 600 u/d	439
Costa Rica	First Boston Investment	San José	Car,CV,Ag	1 500 u/d	475
Malaysia	Fung Keong	Kelang	Ag,MC,Ind	..	..
Uruguay	Funsa	Montevideo	All	59 000 u/m	1 400
Taiwan Province	General	Taipei		1 800 u/d	..
Pakistan	General Tire	Karachi	Car,LCV,CV,Ag	62 500 u/m	1 000
Argentina	Goodyear	Buenos Aires	Car,CV		1 025
Brazil		Americana	Car,LCV,CV,EM	24 450 u/d	2 225
Brazil		Sao Paulo	Car,LCV,CV,EM,AC	7 300 u/d	2 275
Chile		Santiago	Car,LCV	3 650 u/d	550
Colombia		Cali	Car,LCV,CV,Ag	4 380 u/d	900
Guatemala		Guatemala City	Car,LCV,CV	2 250 u/d	400
India		New Delhi	Car,LCV,CV,Ag,EM	2 575 u/d	1 740
Indonesia		Bogor	Car,LCV,CV,Ag,EM	6 500 u/d	900
Jamaica		Morant Bay	Car,LCV,CV,Ag	1 450 u/d	290
Malaysia		Selangor	Car,LCV,CV,Ag,MC	6 420 u/d	615
Mexico		Mexico City	Car,LCV,CV,Ag	11 850 u/d	2 100
Morocco		Casablanca	Car,LCV,CV,Ag	1 700 u/d	500
Peru		Lima	Car,LCV,CV,Ag	3 240 u/d	410
Philippines		Manila	Car,LCV,CV,Ag,EM	2 675 u/d	500
Taiwan Province		Taipei	Car,LCV,CV,Ag,EM	2 675 u/d	335
Thailand		Bangkok	Car,LCV,CV,AC	2 600 u/d	395

Table V.25. (continued)

Country or area	Company	Location	Type	Capacity	Employees
Turkey		Adapazari	Car,LCV,CV,Ag	7 550 u/d	1 080
Turkey		Izmit	CV,Ag	1 285 u/d	825
Venezuela		Valencia	Car,LCV,CV,Ag,EM	10 930 U/D	1 150
Republic of Korea	Hankook	Taejeon	Car,LCV,CV	45 000 u/d	2 100
Republic of Korea		Yong Dungpo	Car,LCV,CV,EM,Ind	8 000 u/d	815
India	Hindustan	Ludhiana	Car,MC,Ag	..	1 200
Mexico	Hulera Euzkadi	Guadalajara	Car,LCV,CV	12 500 u/d	1 044
Mexico		Mexico	Car,LCV,CV,Ag,EM	2 750 u/d	623
Taiwan Province	Hwa Fong	Yuanlin	MC,Ind	18 000 u/d	1 150
Colombia	Icollantes	Bogota	Car,LCV,CV,Ag	3 300 u/d	900
India	Incheck	Kankinara	Car,LCV,CV,MC	10 250 u/m	1 500
Thailand	Inoue	Bangkok	MC	..	..
Sudan	International Tyre Manufacturing	Port Sudan	Car,LCV,CV,Ag,EM	1 500 u/d	1 500
Iran (Islamic Republic of)	Iran Tire	Savah	Car	1 350 t/m	..
Iraq	Iraq State Enterprises	Diwaniya	Car,LCV,CV,Ag,MC	176 000 u/m	..
India	J.K. Industries	Kankroli	Car,LCV,CV,MC	7 300 U/D	1 110
Taiwan Province	Kenda Rubber	Yuanlin	Ag,MC,Ind	20 000 u/d	300
Taiwan Province		Yuanlin	LCV,Ag,nc,Ind	900 t/m	1 330
Iran (Islamic Republic of)	Kian Tire	Tehran	Car,CV,Ag	1 200 t/m	
Pakistan	Kings Tyre Industries	Lahore		..	..
Republic of Korea	Kumho	Kwangju	Car,LCV,CV	7 000 t/m	1 300
Peru	Lima Caucho	Lima	Car,LCV,CV,Ag	1 500 u/d	430
India	MRF	Goa, Madras, Kottayam	Car,LCV,CV,Ag,MC	290 000 u/m	4 000
Angola	Mabor	Luanda	Car,Ind,Ag,	..	..
Mozambique		Maputo	Car,LCV,CV,Ag	850 u/d	400
Pakistan	Master Tyres	Karachi	Car,CV	44 800 u/m	
India	Metro	Ludhiana	LCV,Ag,MC	2 700 u/d	3 423
Pakistan	Mian Tyre	Lahore		..	..
Algeria	Michelin	Algiers	Car	..	..
Brazil		Rio de Janeiro	CV	41 700 u/m	..
Nigeria		Port Harcourt	Car,LCV,CV	2 000 u/d	..
Thailand	Michelin Siam	Laem Chabang	Car,LCV	6 100 u/d	..
India	Modi Rubber	Bombay	Car,LCV,CV,Ag,MC,AC	3 324 u/d	1 372
India		Modipuran	Car,LCV,CV,Ag,MC	155 000 u/m	2 300
Taiwan Province	Nankang	Hsin Fung	Car,LCV,CV,Ag,MC,Ind	..	600
Taiwan Province		Taipei	Car,LCV,CV,Ag,MC,Ind	1 300 t/m	963
Taiwan Province	Natier	Changua	MC,Ind	163 000 u/m	600
Chile	Neumaticos de Chioe	Coquimbo	All	1 700 u/d	194
Venezuela	Neumaven	Valencia	Car,LCV,CV,Ag,EM,Ind	4 100 u/d	600
Indonesia	P.T. Gadjah Tunggal	Pakmurg	Car,LCV	400 u/d	439

Country or area	Company	Location	Type	Capacity	Employees
Indonesia	P.T. Intirub	Jakarta	Car,LCV,CV	800 u/d	733
Turkey	Petlas	Kirsehir	Car,LCV,CV,Ag,EM,AC	102 000 u/m	2 346
Philippines	Philtread	Makati	LCV,CV,Ag,EM	2 500 u/d	660
Argentina	Pirelli	Buenos Aires	Car,LCV,CV,MC	1 800 t/m	620
Brazil		Various	CV	17 500 t/m	5 100
Turkey		Izmit	Car,LCV,CV,Ag	200 000 u/m	1 000
India	Premier	Cochin	Car,LCV,CV,Ag	1 281 u/d	1 281
Colombia	Productora Nacional	Cali	Car,LCV,CV	3 250 t/m	892
Sri Lanka	S.L. Tire	Kelaniya	Car,LCV,CV,Ag,Ind	1 500 u/d	665
Tunisia	SONAP	Menzel-Bourguibal	Car,LCV,CV,AG	4 000 t/y	440
Tunisia	STIP	Sousse	CAr,LCV,CV	42 000 u/m	500
Thailand	Siam Tire	Bangkok	Car,LCV,CV,EM	3 100 u/d	500
Thailand	Siamese Rubber Company	Bangkok	MC	..	..
Malaysia	Silverstone Tire	Kamunting	Car,LCV,CV	750 000 u/y	..
Philippines	Sime Darby	Makati	Car,LCV,CV,Ag,EM	375 t/m	288
Malaysia	Sime Tyres	Alor Setar	Car,LCV,CV,MC	3 900 u/d	500
India	Srichakra	Madurai	Car,MC	75 000 u/m	225
India	Stallion	Hyderabad	mc	40 000 u/m	..
Syrian Arab Republic	Syrian Government	Maha	Car,LCV,CV,Ag,EM	2 700 u/d	..
Libyan Arab Jamahiriya	Tajoura Tyre	Tripoli	Car,LCV,CV,Ag	37 500 u/m	800
Mexico	Tornel	Mexico City	Car,LCV,CV,Ind	3 550 u/d	450
Mexico		Tutlitlan	Car	550 u/d	450
Egypt	Trenco	Alexandria	Car,LCV,CV,MC	12 500 u/m	3 000
Mexico	Uniroyal Goodrich	Queretaro	Car,LCV	4 500 u/d	550
Mexico		Tacuba	Car,LCV,CV	3 200 u/d	550
India	Vikrant	Mysore	Car,LCV,CV,Ag,MC	2 300 u/d	2 529
Republic of Korea	Wuon Poong	Pusan	Car,LCV,CV,Ag,EM	83 000 u/m	400
Republic of Korea		Yang San	Car	5 600 u/d	300

Source: Bruce Davis, "Special report: global tyre market", *Rubber and Plastics News*, 20 August 1990, p.18.
Note: See table V.24 for key to abbreviations.

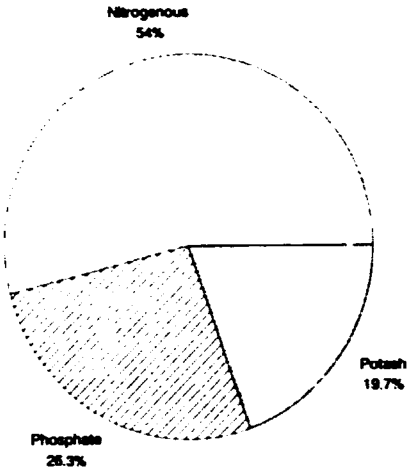
D. Fertilizers (ISIC 3512, excluding 351216)*

1. *Recent trends and current conditions*

The fertilizer industry involves the production, distribution and use of the three primary plant nutrients—nitrogen (*N*), phosphorus (*P* or P_2O_5) and potassium (*K* or K_2O). Figure V.8 shows the proportions by which these types of fertilizers were produced worldwide in 1989. Fertilizer products consist of the three following main categories: simple fertilizers containing only one of the three major nutritive elements; compound fertilizers containing two (binary) or three (ternary) major nutritive elements; and mixed fertilizers that are obtained by mixing simple fertilizers without any chemical reaction. In terms of structure, the fertilizer industry as referred to here comprises the intermediate chemical manufacturing or mixing industry and excludes the production and extraction of the raw materials (unless applied directly to the ground as fertilizer).

*UNIDO acknowledges the contribution of B. Bocoum, Department of Mineral Resource Economics, West Virginia University.

Figure V.8. World production of fertilizers by type, 1989



Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

The world fertilizer industry has historically been subjected to market fluctuations in quantities and prices. Quantity changes resulted from the accelerated fertilizer demand of the 1960s and 1970s, a consequence of food demand which increased to meet the rapid growth in world population. More recently, regional patterns of demand for fertilizers have significantly affected consumption in different parts of the world. Increasing concern over the environment, which has led to legislation in some industrialized countries, has had a definite adverse effect on demand for fertilizers. Other important factors affecting fertilizer demand include: changes in the economic system in Eastern Europe and the USSR; reductions in fertilizer subsidies in developing countries; and policies adopted to reduce crop production surpluses in Western Europe.

Market prices for fertilizer products have always responded most significantly to economic conditions prevailing in buyer's markets. Major price swings for fertilizers have been associated with hyperinflation or hyperdisinflation in related national economies. After a prolonged period of low prices, international fertilizer prices have increased steadily since 1987, a result of strong demand from importing countries and gradually declining fertilizer surpluses. Moreover, the present average fertilizer price of $120 per tonne [10] is expected to rise constantly until the late 1990s as a result of the expected stronger demand. Current higher fertilizer prices are expected, in turn, to stimulate investment in new production capacity that would enable output to keep pace with consumption.

The production of fertilizers has increased each year since 1987, reflecting higher prices and the growing participation of developing countries seeking to improve their patterns of fertilizer production and use. The increase in production by developing countries originates mainly in the expanding production of countries with abundant raw materials, particularly in the case of phosphate fertilizers. With regard to other fertilizer types, a strong movement started in the early 1980s towards producing nitrogenous fertilizers in those countries having plentiful and inexpensive natural gas supplies. Nitrogenous fertilizer plants, particularly those in Western Asia and the USSR, have since then increased production at an average rate of 2.3 per cent per annum. Also, since the mid-1980s, potash fertilizer production, once dominated by European producers, is now being led by Canada.

The structure of fertilizer trade has changed in recent years with the increasing use of countertrade, particularly with centrally planned countries. About 25 per cent of trade is conducted through various types of barter deals, counterpurchasing or buy-back arrangements. This situation is said to have been caused by the deteriorating trade and debt relationships between producers and consumers. Trade flows between supplying and consuming countries have been influenced by variations in international exchange rates and interest rates.

(a) Production

World production of fertilizers increased by nearly 10 per cent in 1989 over the 1988 level, reaching 157.8 million tonnes. This figure is 31.6 per cent higher than the 1982 output, indicating a steady recovery in the fertilizer industry from the slump of the early 1980s. Data on total fertilizer production in various countries ranked according to the level of combined production for nitrogenous, phosphate and potash fertilizers are presented in table V.26. With regard to the 1988 to 1989 increases, India had the largest at 25.6 per cent, followed by Canada at 4.6 per cent, China at 4.2 per cent and Poland at 3.9 per cent. Surprisingly, several notable decreases occurred particularly in the Federal Republic of Germany, at −5.1 per cent, Brazil at −4.4 per cent, France at −3.9 per cent, Israel at −3.4 per cent and Japan at −3.3 per cent. Since 1982, the strongest increases have taken place in Indonesia at 113.5 per cent, Canada at 47.1 per cent and China at about 36 per cent. Major declines were recorded in Japan at −16.2 per cent, France at −12.2 per cent and United Kingdom at −9.6 per cent.

The extent to which the reported production increases have changed the market shares of developed and developing countries is clear from table V.26. The total fertilizer market share of the North, excluding centrally planned economies, declined from 42.8 per cent in 1982 to 38.3 per cent in 1989, while the share of the South increased from 13.5 per cent in 1982 to 18.6 per cent in 1989. The share of centrally planned economies decreased slightly, from 43.6 per cent in 1982 to 43 per cent in 1989. The developing countries of East Asia saw their share increase from 6.9 per cent to 9.7 per cent. Elsewhere in the South, increases were also reported. In developed countries, reported decreases could be attributed to the low fertilizer prices of the early 1980s, which led to the closure of many factories with inherently high production costs. It is estimated that approximately 10 million tonnes per year of fertilizer capacity were closed between 1980 and 1986. The decline in output in developed countries mainly resulted from government policies on crop production controls, such as those in the farm bill of 1985 in the United States and the introduction of the quota system in the EEC.

Data on fertilizer production is further ranked by type of fertilizer (nitrogenous, phosphate and potash)

Table V.26. World production of fertilizers, 1982 and 1989

Rank in 1989	Country, region or economic grouping	Production in 1989 (thousand tonnes)	Percentage change		Percentage share	
			1982-1989	1988-1989	1982	1989
1	USSR	36 060	38.06	2.25	21.78	22.85
2	United States	23 324	29.70	2.62	14.99	14.78
3	China	17 774	35.99	4.15	10.90	11.26
4	Canada	11 553	47.06	4.65	6.55	7.32
5	India	9 002	103.11	25.57	3.69	5.70
6	German Democratic Republic	5 192	11.20	1.43	3.89	3.29
7	France	3 801	-12.24	-3.87	3.61	2.41
8	Germany, Federal Republic of	3 526	-6.60	-5.06	3.15	2.23
9	Romania	2 620	1.08	0.54	2.16	1.66
10	Indonesia	2 585	113.46	2.05	1.01	1.64
11	Poland	2 584	19.30	3.94	1.64	1.81
12	Netherlands	2 167	17.20	3.63	1.54	1.37
13	Brazil	2 156	42.59	-4.39	1.26	1.37
14	Spain	2 144	11.61	-1.65	1.60	1.36
15	Italy	1 869	7.23	0.65	1.45	1.18
16	United Kingdom	1 793	-9.63	0.79	1.65	1.14
17	Mexico	1 735	31.44	-0.57	1.10	1.10
18	Guatemala	1 735	-	-0.57	0.02	1.10
19	Japan	1 467	-16.22	-3.30	1.46	0.93
20	Israel	1 437	33.80	-3.43	0.90	0.91
North America		34 877	34.98	3.28	21.54	22.10
Western Europe		20 582	-0.62	-1.87	17.26	13.04
Oceania		1 330	18.75	10.74	0.93	0.84
Other developed economies a/		3 728	-0.16	0.35	3.11	2.36
Africa		2 781	135.28	41.38	0.99	1.76
Asia						
Western Asia		6 091	94.60	8.23	2.61	3.86
East Asia		15 379	86.28	14.74	6.88	9.74
Latin America		5 134	42.41	-3.24	3.01	3.25
Other developing economies a/		10	-62.96	-50.00	0.02	0.01
Centrally planned economies		67 922	29.75	2.45	43.64	43.03
North a/		60 516	17.73	1.44	42.85	38.34
South a/		29 396	81.46	11.67	13.51	18.62
	TOTAL	157 834	31.58	9.95	100.00	100.00

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).
a/ Excluding centrally planned economies.

for various countries as shown in table V.27. World production of nitrogenous fertilizers was the highest among all three types at about 85 million tonnes. Total production of phosphate fertilizers was almost 42 million tonnes, while that of potash fertilizers was 31 million tonnes. In both the nitrogenous and phosphate fertilizer markets, three countries, namely China, United States and USSR accounted for over half of world output in 1989. The USSR was also the leading producer of potash fertilizers with a market share of about 36 per cent, followed closely by Canada at about 26 per cent in 1989. North America was the leading producer in all three categories in 1989 at 18.46 per cent, 24 per cent, and 29.5 per cent for nitrogenous, phosphatic and potash fertilizers, respectively. The North ranked first in output in all but one category, nitrogenous fertilizers, in which it was preceded by centrally planned economies at 43.8 per cent. The share of developing countries was the lowest in 1989. Their share of the global fertilizer market was most insignificant in the case of potash fertilizers, at only 2.7 per cent in that year.

Table V.28 shows data on fertilizer production by major economic groupings, which are disaggregated to include specific fertilizer types. Among the nitrogenous fertilizers, urea led output in 1989. Developing market economies accounted for over 52 per cent of total world production of urea, which represented the only subcategory where the South led in output. Production of other nitrogenous fertilizers (except ammonium nitrates where the leading producer was the centrally planned economies with 57.2 per cent) was mostly dominated by the developed market economies, which had by far the biggest market share of all nitrogenous fertilizer types in 1989.

With regard to the phosphatic fertilizers, ammonium phosphates led output in 1989. As far as regional distribution is concerned, North America,

Table V.27. World production of fertilizers by type, 1989

Rank	Nitrogenous fertilizer			Rank	Phosphate fertilizer			Rank	Potash fertilizer		
	Country, region or economic grouping	Production (thousand tonnes)	Percentage share		Country, region or economic grouping	Production (thousand tonnes)	Percentage share		Country, region or economic grouping	Production (thousand tonnes)	Percentage share
1	USSR	15 604	18.33	1	United States	9 520	22.92	1	USSR	11 300	36.28
2	China	13 954	16.39	2	USSR	9 155	22.04	2	Canada	8 089	25.97
3	United States	12 691	14.90	3	China	3 766	9.07	3	German Democratic Republic	3 510	11.27
4	India	6 712	7.88	4	India	2 289	5.51	4	Germany, Federal Republic of	2 268	7.28
5	Canada	3 000	3.52	5	Brazil	1 395	3.36	5	France	1 411	4.53
6	Indonesia	2 032	2.39	6	Morocco	969	2.32	6	Israel	1 218	3.91
7	Romania	1 920	2.25	7	Poland	962	2.32	7	United States	1 113	3.57
8	Netherlands	1 800	2.11	8	France	940	2.26	8	Jordan	780	2.50
9	Poland	1 622	1.91	9	Australia	810	1.95	9	Spain	747	2.40
10	France	1 450	1.70	10	Tunisia	747	1.80	10	United Kingdom	445	1.43
11	German Democratic Republic	1 382	1.62	11	Romania	700	1.69	11	Italy	159	0.51
12	Mexico	1 360	1.60	12	Turkey	634	1.53	12	Brazil	55	0.18
13	Italy	1 297	1.52	13	Indonesia	552	1.33	13	China	54	0.17
14	Pakistan	1 124	1.31	14	Japan	490	1.18				
15	United Kingdom	1 100	1.29	15	Republic of Korea	488	1.18				
16	Japan	977	1.15	16	Canada	464	1.12				
17	Spain	955	1.12	17	Spain	441	1.06				
18	Germany, Federal Republic of	918	1.08	18	Iraq	414	1.00				
19	Bulgaria	824	0.97	19	Italy	412	0.99				
20	Turkey	725	0.85	20	South Africa	384	0.92				
	North America	15 691	18.46			9 983	24.04			9 202	29.54
	Western Europe	11 015	12.96			4 535	10.92			5 030	16.15
	Oceania	300	0.35			1 030	2.48			..	..
	Other developed economies [a]	1 490	1.75			1 218	3.91			1 218	3.91
	Africa	887	1.04			2 095	5.04			..	..
	Asia	15 350	18.06			5 210	12.55			780	2.50
	Latin America	3 187	3.75			1 891	4.55			56	0.18
	Centrally planned economies	37 228	43.79			15 829	38.11			14 864	47.72
	North [a]	28 497	33.52			16 568	39.89			15 451	49.60
	South [a]	19 425	22.85			9 207	22.17			835	2.68
	TOTAL	85 151	100.00			41 604	100.00			31 151	100.0

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1988)

[a] Excluding centrally planned economies.

Table V.28. Production of selected fertilizers by region, 1989
(Percentage)

Region or economic grouping	Nitrogenous fertilizer: Urea	Ammonium nitrates	Nitrogen ammonium sulphate	Ammonium phosphate	Calcium cyanamide	Ammonium sulphate nitrate	Phosphate fertilizer: Single super-phosphate	Concentrate super-phosphate	Basic slag	Ammonium phosphate	Ground rock	Potash fertilizer: Potassium sulphate	Muriate 1[a]	Muriate 2[b]	Crude salts	Other potash	Complex[c] potash fertilizer
Developed market economies	21.4	30.1	45.5	52.8	100.0	100.0	30.1	33.8	83.6	50.0	45.2	89.1	55.9	..	5.6	68.9	100.0
North America	13.1	7.5	17.5	51.7	..	..	1.5	20.8	0.0	49.8	0.0	25.9	34.8	..	..	11.4	..
Western Europe	6.6	22.6	17.0	1.1	50.1	100.0	5.0	12.3	83.6	0.3	45.2	63.2	16.4	..	5.6	57.5	100.0
Oceania	0.3	..	..	..	..	..	22.1	..	..	..	..	..	..	-	..	..	..
Other	1.4	0.1	11.0	..	49.9	..	1.4	0.7	..	..	..	..	..	-	..	..	..
Developing market economies	52.3	12.7	19.6	27.1	..	..	26.6	41.6	..	21.7	35.1	.	3.2	..	..	..	..
Africa	1.0	6.6	..	2.1	..	..	5.1	11.7	..	2.2	3.4	..	..	..	..	..	..
Asia	44.2	4.1	9.5	21.4	..	..	9.1	9.7	..	3.1	17.5	..	3.0	..	..	..	..
Latin America	7.2	2.1	10.1	3.6	..	..	12.4	20.2	..	16.6	12.1	..	0.2	..	..	..	..
Other	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Centrally planned economies	20.1	57.2	34.9	20.1	..	..	43.3	24.6	16.4	28.3	19.7	10.9	40.9	..	94.4	31.1	..
Asia	..	..	..	..	..	..	1.3	..	..	..	2.5	..	..	..	..	..	..
Eastern Europe and USSR	20.1	57.2	34.9	20.1	..	..	42.0	24.6	16.4	28.3	17.2	10.9	40.9	..	94.4	31.1	..
Total Percentage	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	..	100.0	100.0	100.0
Thousands of tonnes	24 425	13 801	3 197	4 891	56	563	4 662	4 [illegible]29	240	13 153	456	878	25 732	..	638	280	59

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39, Rome, 1989.

a/ Over 45 per cent potassium.

b/ From 20 to 45 per cent potassium.

c/ Mixed fertilizer with potash as dominant nutrient.

which produced about one half of world output of ammonium phosphates, also led in the output of concentrated superphosphates at 20.8 per cent. Production of basic slag was largely controlled by Western Europe at 83.6 per cent, which also dominated the production of ground rock phosphate for direct application at 45.2 per cent. Centrally planned economies were leading producers of single superphosphate (SSP), whereas the developing market economies share of concentrated superphosphates was the highest at 41.6 per cent, greater than that of developed market economies as a whole (including North America), at 33.8 per cent, and of centrally planned economies, at 24.6 per cent. However, the share of the South was insignificant in the global production of basic slag, and is still lagging far behind that of the North and centrally planned economies in the case of ammonium phosphates and single superphosphate.

With regard to potash fertilizer production, muriate with a potassium nutrient exceeding 45 per cent of its total composition (referred to as muriate 1 in table V.28) led output of all potash fertilizers in 1989 by a large margin. In 1989 the North dominated production of muriate, at 55.9 per cent, as well as all other potash fertilizers, except for crude salts, by a very wide margin. The production of crude salts was almost entirely controlled by centrally planned economies, with 94.4 per cent of total output. The contribution of developing countries to world potash fertilizer production was in almost all cases negligible and sometimes nonexistent. Apart from their dominance in the production of crude salts, centrally planned economies ranked second to developed market economies in the global production of all the potash fertilizer types reported in table V.28.

(b) International trade

Fertilizer production has not always developed in the same region as fertilizer consumption. This has resulted in considerable fertilizer trade, increasing from about 2 million tonnes per year in the 1950s to 47.7 million tonnes in 1989. Today, international trade in nitrogen and phosphate fertilizers is between 20 and 25 per cent of production, and in potash approximately 70 per cent. There has been a considerable increase in trade in fertilizer intermediates such as phosphoric acid and ammonia, which are not considered here. Table V.29 shows that both developed and developing countries have significantly increased their exports of all fertilizer types since 1982. World exports of fertilizers reached 47.7 million tonnes in 1989. This figure is 41.7 per cent higher than in 1982. Morocco had the largest increase at 141.5 per cent during the period considered. Significant increases were also recorded in Italy with 106.9 per cent and the United Kingdom with 80 per cent. Most impressive were the increases recorded in the South, at 193.8 per cent between 1982 and 1989. Western Asia showed the largest increase, at 263.5 per cent. The increases that occurred in the North, particularly in Western Europe were of less significance. The United States lost part of its share in total fertilizer exports to Canada, which became the world's leading fertilizer exporter. The USSR maintained its position as the third most important exporter in the global fertilizer trade, followed by the German Democratic Republic, Germany, Federal Republic of, and the Netherlands. Morocco had the largest increase from 1988 to 1989, at 134.5 per cent, followed by Iraq at 101 per cent. Surprisingly, several countries recorded notable decreases, in particular Tunisia, −8.4 per cent, Federal Republic of Germany, −6.2 per cent, Canada, −4.7 per cent, United States, −4.2 per cent, German Democratic Republic, −3.6 per cent and Israel, −3.2 per cent.

Changes in market shares of fertilizer exports of the main world economic groupings are shown for all fertilizers in table V.29. The industrialized countries of the North and the centrally planned economies experienced losses in their shares of the world fertilizer export market to the rapidly growing fertilizer producers of developing countries during the period 1982-1989. The share of the South in global fertilizer exports increased from 7.7 per cent in 1982 to 16.0 per cent in 1989. Table V.30 presents the market shares in global exports for three major fertilizer types. While the United States was the leading exporter of nitrogenous and phosphatic fertilizers in 1989, it was only sixth in world exports of potash fertilizers. Canada, on the other hand, was the leading exporter of potash fertilizers and the third most important exporter of nitrogenous fertilizers in 1989. The USSR ranked second in both the nitrogenous and potash fertilizer categories, but only sixth in the export of phosphatic fertilizers. Morocco was the second largest exporter of phosphatic fertilizers in 1989, at 7.8 per cent. The United States continued to control the export market for phosphatic fertilizers with 42.4 per cent of the total. Regarding distribution, developed market economies dominated the export market for nitrogenous, phosphatic and potash fertilizers in 1989, with 52.5 per cent, 66.1 per cent and 61.8 per cent, respectively. The shares of the export market accounted for by the centrally planned economies in 1989 were 26 per cent, 7.4 per cent, and 33.9 per cent for nitrogenous, phosphatic and potash fertilizers, respectively, while the corresponding shares of developing countries' were 21.5 per cent, 26.4 per cent and 4.3 per cent. In terms of quantity, world exports of nitrogenous fertilizers were the largest of the three types, at 19.3 million tonnes, followed by potash fertilizers, at 18.2 million tonnes, and phosphatic fertilizers, at 10.3 million tonnes.

World imports of fertilizers also grew significantly between 1982 and 1989. As shown in table V.31 for that period, total fertilizer imports increased by 56.5 per cent. Among developing countries, the strongest import increases occurred in Thailand, at 52.9 per cent; Malaysia, at 48.4 per cent; and India, at 29.9 per cent. Among developed countries, the strongest import increases occurred in Spain, at 95.7 per cent; Australia, at 48 per cent; and the Netherlands, at 38.9 per cent. Among the centrally planned economies, China showed the strongest increase, at 62.7 per cent. Significant decreases occurred in Poland, at −19 per cent, and Czechoslovakia, at −7.9 per cent, between 1982 and 1989.

From 1988 to 1989 India had the largest increase in fertilizer imports, at 39.1 per cent, followed by Australia, at 29 per cent, and Spain, at 22.2 per cent. Major declines were recorded in Turkey, at −70.3 per cent, Brazil, at −22 per cent, and Poland, at −17.2 per

Table V.29. World exports of fertilizers, 1989

Rank in 1989	Country, region or economic grouping	Exports in 1989 (thousand tonnes)	Percentage change 1982-1989	Percentage change 1988-1989	Percentage share 1982	Percentage share 1989
1	Canada	8 629	52.27	-4.72	16.83	18.08
2	United States	7 482	24.60	-4.16	17.83	15.68
3	USSR	6 093	28.73	4.78	14.05	12.77
4	German Democratic Republic	3 250	5.42	-3.56	9.15	6.81
5	Germany, Federal Republic of	2 104	9.98	-6.16	5.68	4.41
6	Netherlands	2 018	26.20	9.38	4.75	4.23
7	Belgium and Luxembourg	1 500	7.37	8.62	4.15	3.14
8	Romania	1 500	20.77	0.27	3.69	3.14
9	Israel	1 331	42.96	-2.28	2.76	2.79
10	Jordan	1 184	-	8.13	0.18	2.48
11	France	1 026	9.85	1.28	2.77	2.15
12	Morocco	978	141.48	134.53	1.20	2.05
13	Tunisia	775	47.34	-8.39	1.56	1.62
14	Italy	770	106.99	14.93	1.10	1.61
15	Spain	627	13.79	8.67	1.64	1.31
16	Indonesia	483	-	2.33	0.13	1.01
17	Republic of Korea	465	2.20	9.93	1.35	0.97
18	Norway	450	-1.32	4.41	1.35	0.94
19	United Kingdom	450	80.00	0.22	0.74	0.94
20	Iraq	414	-	100.97	-	0.87
	North America	16 111	38.03	-4.46	55.72	33.77
	Western Europe	10 256	22.78	2.81	23.08	21.49
	Oceania	46	-	17.95	0.05	0.10
	Other developed economies[a/]	1 732	25.69	-0.35	1.15	3.63
	Africa	2 021	164.88	49.26	5.54	4.24
	Asia					
	Western Asia	3 513	263.29	8.53	1.47	7.36
	East Asia	1 474	145.73	-0.54	4.16	3.09
	Latin America	629	156.73	4.49	1.05	1.32
	Other developing economies[a/]	10	-62.96	-50.00	0.59	0.02
	Centrally planned economies	11 922	23.26	1.97	28.72	24.99
	North[a/]	28 145	31.48	-1.64	63.56	58.99
	South[a/]	7 647	193.78	14.22	7.73	16.03
	TOTAL	47 714	41.66	1.51	100.00	100.00

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

[a/] Excluding centrally planned economies.

cent. A decline of less importance was recorded for the United States, at −1.5 per cent. The United States is still the world's leading importer of fertilizers, with 16.2 per cent of all such imports, followed by China, which increased its share from 8.3 per cent in 1982 to 15.7 per cent in 1989, and France, with 6 per cent of all fertilizer imports in 1989. With regard to economic groupings, the North continued to account for the largest share of imports, with 50.8 per cent in 1989, followed by the South with 28 per cent. The share of centrally planned economies declined from 25.2 per cent to 21.2 per cent between 1982 and 1989. Total world imports of fertilizers were estimated at 49 million tonnes in 1989. Total fertilizer imports of the North showed a marginal decrease from the 1988 level, and imports were also increasing at a slower rate in developing countries. The most significant increase from 1988 import levels, 16.6 per cent, occurred in centrally planned economies.

As shown in table V.32, China had the strongest market share, 23.1 per cent, of imports of nitrogenous fertilizers, followed closely by the United States with 18.8 per cent. As regards geographic area in the distribution of nitrogenous fertilizers, Western Europe was the leading importer in 1989 with 24.8 per cent of the total, followed by North America with 19.9 per cent. Among the three large groups, the North led in imports of nitrogenous fertilizers at 46.9 per cent, compared with 28.1 per cent for centrally planned economies and 23.7 per cent for the South as a whole. Western Europe also led in imports of phosphate fertilizers, at 26.4 per cent, and potash fertilizers, at 23.9 per cent, making the shares of the North 35.1 per cent and 49.9 per cent, respectively. Developing countries, however, were leading importers of phosphatic fertilizers with 37.1 per cent of the total in 1989, and the second largest, behind the North, for potash fertilizers, at 27.2 per cent, but ahead of the centrally planned economies, which had 22.8 per cent of the total. World imports of nitrogenous fertilizers totalled 19.9 million tonnes in 1989, immediately followed by imports of potash fertilizers at 19.5 million tonnes, with phosphatic fertilizers a distant third, at 9.7 million tonnes.

Table V.30. World exports of fertilizers by type, 1989

Rank	Nitrogenous fertilizer: Country, region or economic grouping	Exports (thousand tonnes)	Percentage share	Rank	Phosphate fertilizer: Country, region or economic grouping	Exports (thousand tonnes)	Percentage share	Rank	Potash fertilizer: Country, region or economic grouping	Exports (thousand tonnes)	Percentage share
1	United States	2 754	14.30	1	United States	4 365	42.43	1	Canada	6 682	36.79
2	USSR	2 427	12.60	2	Morocco	800	7.77	2	USSR	3 317	18.27
3	Canada	1 889	9.81	3	Tunisia	635	6.17	3	Israel	1 176	6.47
4	Netherlands	1 577	8.19	4	Belgium and			4	Jordan	783	4.31
5	Romania	1 200	6.23		Luxembourg	570	5.54	5	Spain	382	2.11
6	Belgium and			5	Netherlands	440	4.28	6	United States	363	2.00
	Luxembourg	930	4.83	6	USSR	348	3.38	7	United Kingdom	296	1.63
7	Italy	500	2.60	7	Romania	300	2.92	8	Italy	157	0.87
8	Indonesia	481	2.50	8	Jordan	288	2.80				
9	Germany, Federal			9	Turkey	257	2.50				
	Republic of	453	2.36	10	Republic of Korea	240	2.33				
10	German Democratic			11	Iraq	239	2.32				
	Republic	417	2.17	12	Norway	160	1.55				
11	Kuwait	406	2.11	13	Yugoslavia	126	1.23				
12	Bulgaria	379	1.97	14	Israel	125	1.22				
13	Qatar	373	1.94	15	Denmark	115	1.12				
14	France	294	1.53	16	Italy	112	1.09				
15	Norway	290	1.51	17	Philippines	104	1.01				
16	Hungary	270	1.40	18	South Africa	100	0.97				
17	United Arab Emirates	262	1.36	19	France	91	0.89				
18	Trinidad and Tobago	250	1.30	20	Austria	90	0.87				
19	Saudi Arabia	243	1.26								
20	Republic of Korea	225	1.17								
North America		4 642	24.11			44 422	42.98			7 046	38.79
Western Europe		5 130	26.63			2 177	20.58			3 008	16.56
Oceania		46	0.24			..	..			..	..
Other developed economies a/		291	1.51			265	2.58			1 176	6.48
Africa		550	2.85			1 470	14.30			..	..
Asia		3 017	15.66			1 186	11.53			..	..
Latin America		577	3.00			51	0.50			..	..
Centrally planned economies		5 008	26.00			764	7.43			6 150	33.86
North a/		10 111	52.49			6 805	66.14			11 230	61.83
South a/		4 145	21.52			2 719	26.43			783	4.31
TOTAL		19 263	100.00			10 288	100.00			18 162	100.00

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

a/ Excluding centrally planned economies.

Table V.31. World imports of fertilizers, 1989

Rank in 1989	Country, region or economic grouping	Imports in 1989 (thousand tonnes)	Percentage change		Percentage share	
			1982-1989	1988-1989	1982	1989
1	United States	7 949	17.70	-1.48	18.98	16.22
2	China	7 670	62.70	25.23	8.30	15.65
3	France	2 962	35.55	0.47	5.54	6.04
4	India	1 615	29.91	39.07	3.28	3.29
5	Germany, Federal Republic of	1 600	12.06	-12.75	4.84	3.26
6	Brazil	1 588	23.11	-21.98	3.54	3.24
7	Italy	1 299	30.64	1.54	2.61	2.65
8	Belgium and Luxembourg	1 155	30.65	-0.61	2.32	2.36
9	United Kingdom	1 137	30.61	-1.58	2.29	2.32
10	Poland	1 132	-18.99	-17.23	3.91	2.31
11	Hungary	1 062	17.42	16.57	2.54	2.17
12	Japan	1 011	16.52	-12.76	2.45	2.06
13	Iran (Islamic Republic of)	921	5.43	-0.65	2.53	1.88
14	Czechoslovakia	843	-7.95	1.66	2.64	1.72
15	Malaysia	802	48.38	12.72	1.20	1.64
16	Thailand	794	52.90	14.99	1.09	1.62
17	Netherlands	707	38.90	10.89	1.25	1.4[illegible]
18	Spain	604	95.70	22.19	0.08	1.23
19	Australia	600	48.00	29.00	0.91	1.22
20	Turkey	592	74.49	-70.27	0.44	1.21
21	Ireland	585	21.37	4.10	1.33	1.19
	North America	8 404	18.27	-1.56	19.93	17.15
	Western Europe	12 744	29.48	0.71	26.08	26.09
	Oceania	732	33.33	23.09	1.42	1.49
	Other developed economies a/	1 152	-1.04	-16.15	3.38	3.38
	Africa	1 141	10.69	-5.00	2.33	2.96
	Asia					
	Western Asia	2 559	39.27	-9.14	5.22	4.51
	East Asia	5 452	29.57	17.53	11.12	11 14
	Latin America	4 457	27.78	-6.28	9.09	9.34
	Other developing economies a/	41	48.78	7.32	0.08	0.06
	Centrally planned economies	12 335	40.81	16.60	25.16	21.19
	North a/	23 032	23.98	-0.25	46.99	50.80
	South a/	13 650	29.28	2.84	27.85	28.01
	TOTAL	49 017 b/	56.51	16.88	100.00	100.00

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

a/ Excluding centrally planned economies.

b/ The difference between fertilizer exports and imports as reported in these tables may be caused by errors in reporting data, by under-invoicing by exporters, or by other measurement problems.

The position of the United States as the second leading importer and the first exporting country for nitrogenous fertilizers can be explained by the fact that the country imports large quantities of ammonia, most of which is processed and re-exported as ammonium phosphate (diammonium phosphate). Latin America is currently the fastest-growing region in terms of exports of nitrogenous fertilizers. Gas-rich countries, such as Mexico, Venezuela and Trinidad and Tobago are increasingly expanding production for export.

World imports of phosphatic fertilizers as a proportion of world consumption have increased significantly in the last two decades. This change reflects the transition in world production and trade towards greater processing of raw materials by developing country producers. The market share of developed countries, especially the United States, has been steadily decreasing to the benefit of exporters in the South. This decline is mainly due to competition from developing-country producers such as Morocco, Tunisia and Jordan.

Exports of potash fertilizers are dominated by a few countries, in particular Canada, Israel, Jordan and USSR. Because Canada possesses large reserves of potash, its position as the unrivalled top exporter has been secure since the mid-1980s. The USSR remained the second largest exporter of potash fertilizers in 1989, despite the agricultural restructuring within its territory, which reduced consumption and hence tended to increase the volume available for export.

(c) *Consumption*

Since fertilizers are used in the production of agricultural goods, their demand is derived from changes in production activity as well as in surrounding political and economic factors. Fertilizer consumption, for example, slowed as the global economic recession in

Table V.32. World imports of fertilizers by type, 1989

Nitrogenous fertilizer

Rank	Country, region or economic grouping	Imports (thousand tonnes)	Percentage share
1	China	4 586	23.07
2	United States	3 740	18.81
3	France	1 380	6.94
4	Germany, Federal Republic of	906	4.56
5	United Kingdom	477	2.40
6	Thailand	454	2.29
7	Belgium and Luxembourg	430	2.16
8	Turkey	424	2.13
9	Iran (Islamic Republic of)	418	2.10
10	Viet Nam	405	2.04
11	Philippines	381	1.92
12	Spain	367	1.85
13	Hungary	334	1.68
14	Italy	299	1.50
15	Ireland	234	1.18
16	Denmark	226	1.14
17	Canada	220	1.10
18	Malaysia	219	1.10
19	India	219	1.10
20	Sweden	194	0.97

Phosphate fertilizer

Rank	Country, region or economic grouping	Imports (thousand tonnes)	Percentage share
1	China	1 453	15.04
2	France	641	6.64
3	Iran (Islamic Republic of)	496	5.13
4	Italy	468	4.85
5	India	407	4.21
6	Belgium and Luxembourg	350	3.62
7	Pakistan	318	3.29
8	USSR	289	2.99
9	Japan	288	2.98
10	United Kingdom	265	2.74
11	Canada	221	2.29
12	Saudi Arabia	220	2.28
13	Thailand	210	2.17
14	Hungary	185	1.91
15	Bangladesh	174	1.80
16	Spain	164	1.70
17	Ireland	154	1.59
18	Malaysia	150	1.55
19	Bulgaria	146	1.51
20	Syrian Arab Republic	145	1.50

Potash fertilizer

Rank	Country, region or economic grouping	Imports (thousand tonnes)	Percentage share
1	United States	4 136	21.23
2	China	1 630	8.37
3	Brazil	1 312	6.74
4	Poland	1 115	5.73
5	India	989	5.08
6	France	940	4.83
7	Hungary	542	2.78
8	Czechoslovakia	538	2.76
9	Japan	536	2.75
10	Italy	531	2.72
11	Malaysia	433	2.22
12	Republic of Korea	414	2.12
13	Romania	399	2.05
14	United Kingdom	395	2.03
15	Belgium and Luxembourg	375	1.92
16	Yugoslavia	343	1.76
17	Netherlands	336	1.72
18	Germany, Federal Republic of	295	1.52
19	Indonesia	278	1.42
20	Denmark	267	1.37

Region or economic grouping	Nitrogenous: Imports (thousand tonnes)	Nitrogenous: Percentage share	Phosphate: Imports (thousand tonnes)	Phosphate: Percentage share	Potash: Imports (thousand tonnes)	Potash: Percentage share
North America	3 960	19.93	295	3.05	4 149	21.30
Western Europe	4 935	24.83	2 554	26.43	4 659	23.92
Oceania	236	1.19	258	2.67	254	1.31
Other developed economies [a]	199	1.00	289	2.99	664	3.41
Africa	728	3.67	366	3.79	358	1.84
Asia	2 681	13.49	2 362	24.44	2 637	13.54
Latin America	1 298	6.53	858	8.88	2 298	11.80
Centrally planned economies	5 580	28.08	2 309	23.90	4 445	22.82
North [a]	9 331	46.95	3 396	35.14	9 727	49.94
South [a]	4 708	23.69	3 587	37.12	5 294	27.18
TOTAL	19 875	100.00	9 663	100.00	19 478	100.00

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

[a] Excluding centrally planned economies.

the early 1980s depressed demand for agricultural commodities. Future use depends on the availability of substitutes generated by biotechnology and crop genetics.

Table V.33 shows that world consumption of fertilizers grew by 18.6 per cent between 1982 and 1989. Consumption stood at 145.6 million tonnes in 1989. Much of the total fertilizer consumption is shown to have taken place in the centrally planned economies, which accounted for 44 per cent of world consumption in 1989, up slightly from 41.3 per cent in 1982. Developed consuming countries with the largest shares in 1989 were the United States at 12.8 per cent and France at 4.2 per cent. Among developing countries, India had a 6.3 per cent share, followed by Brazil at 2.7 per cent. The sharpest increases in consumption in 1988-1989 took place in India at 21 per cent, China at 10.4 per cent, and Poland at 9.6 per cent. Over the longer period 1982-1989, India reported the strongest increase at 72.6 per cent, followed by China at 57.9 per cent and Indonesia at 56.3 per cent.

In the USSR, consumption in 1989 decreased by 0.8 per cent from the 1988 level, but increased by 35 per cent over that of 1982. In other centrally planned economies, more specifically in China, consumption in 1989 grew by 10.4 per cent over the 1988 level, and by 57.9 per cent over that of 1982. The third largest consumer of fertilizers, the United States, showed only a moderate increase in fertilizer use at 8.3 per cent over that of 1982. This level was also −0.1 per cent down from that of 1988. Demand for fertilizers in the agricultural industry has indicated a growing correlation between the total area planted with five major crops (maize, sorghum, wheat, soya beans and cotton) and the total volume of fertilizer nutrients consumed, at least in the United States, implying high saturation levels in the markets of most developed countries. Fertilizer usage in the North has

Table V.33. World consumption of fertilizers, 1989

Rank in 1989	Country, region or economic grouping	Consumption in 1989 (thousand tonnes)	Percentage change		Percentage share	
			1982-1989	1988-1989	1982	1989
1	USSR	27 187	34.96	-0.79	17.51	19.64
2	China	25 322	57.91	10.40	13.94	16.26
3	United States	17 772	8.26	-0.11	14.27	12.75
4	India	11 052	72.55	20.97	5.57	6.26
5	France	5 998	7.66	3.00	4.84	4.17
6	Brazil	3 729	36.64	-0.80	2.37	2.69
7	Poland	3 625	13.92	9.60	2.77	2.35
8	Germany, Federal Republic of	3 071	-5.39	-2.44	2.82	2.25
9	United Kingdom	2 416	-5.07	-2.81	2.21	1.78
10	Indonesia	2 393	56.30	5.31	1.33	1.62
11	Canada	2 159	8.17	-1.90	1.74	1.58
12	Italy	2 093	4.44	-10.03	1.74	1.55
13	Spain	1 994	34.28	-1.35	1.29	1.45
14	Japan	1 943	-2.12	-4.84	1.73	1.42
15	German Democratic Republic	1 805	28.20	7.81	1.22	1.39
16	Mexico	1 758	-3.67	-5.75	1.59	1.33
17	Pakistan	1 740	39.87	1.15	1.08	1.27
18	Turkey	1 614	10.55	-10.16	1.27	1.23
19	Czechoslovakia	1 593	-8.55	2.32	1.51	1.12
20	Hungary	1 463	-4.25	6.15	1.33	0.98
	North America	19 931	8.25	-0.31	16.01	14.33
	Western Europe	21 341	2.61	-1.73	18.08	15.56
	Oceania	1 828	13.97	5.96	1.39	1.23
	Other developed economies [a/]	2 871	-10.08	0.80	2.78	2.04
	Africa	1 694	28.04	-1.95	1.15	1.24
	Asia					
	Western Asia	5 091	33.24	5.34	3.32	3.45
	East Asia	19 237	63.32	14.59	10.24	11.78
	Latin America	8 807	36.48	-0.50	5.61	6.34
	Other developing economies [a/]	41	95.24	7.32	0.02	0.03
	Centrally planned economies	64 712	35.91	5.15	41.30	44.00
	North[a/]	46 061	4.67	-0.45	38.36	33.16
	South[a/]	34 870	49.04	8.61	20.34	22.84
	TOTAL	145 642	18.60	4.20	100.00	100.00

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

a/ Excluding centrally planned economies.

now more than ever become very susceptible to changes in basic crop economics [11]. Recent declines in consumption have been attributed to the deliberate curtailing of applications by growers in the North as a means of minimizing fertilizer costs. In some developed countries, increasing environmental concern has brought about legislation that has increased production costs and adversely affected the demand for fertilizers.

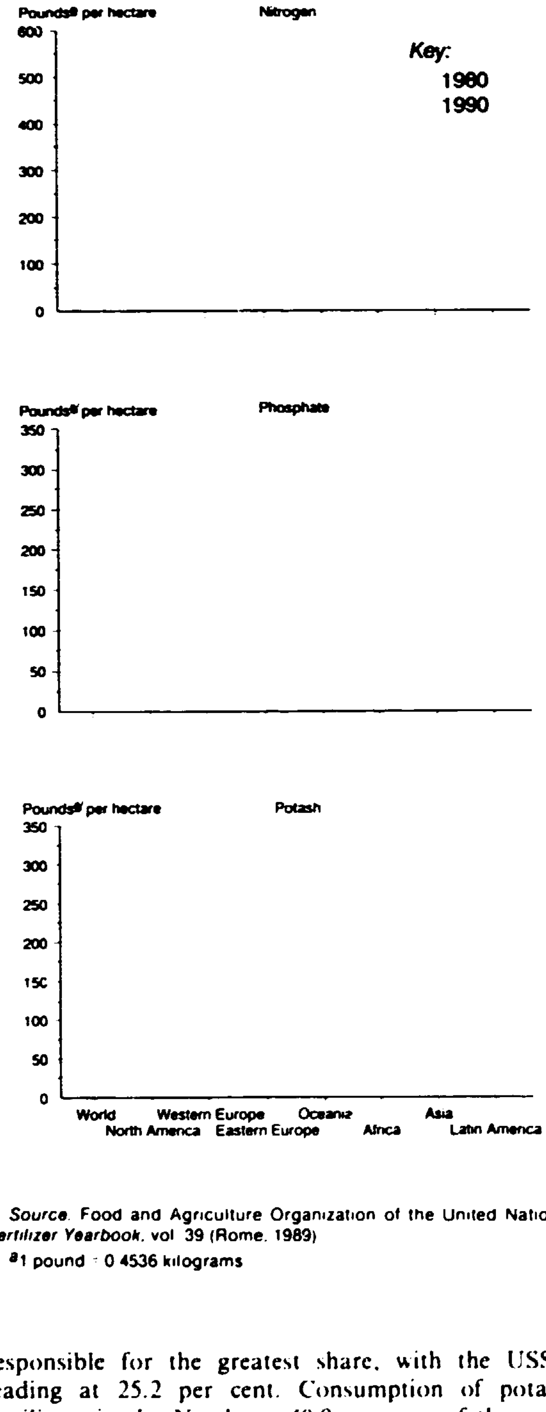
Consumption in the Federal Republic of Germany thus decreased by 5.4 per cent between 1982 and 1989 while that of Japan decreased by 2.1 per cent during the same time period. In the United Kingdom, demand decreased by 5.1 per cent from 1982 to 1989 and by 2.8 per cent between 1988 and 1989. Consumption of fertilizers in Italy also decreased by 10.1 per cent between 1988 and 1989. Among developing countries, the rise in fertilizer consumption was strongest in East Asia, which recorded a 63.3 per cent increase in the period 1982-1989, with Indonesia showing the highest growth rate.

To obtain a better understanding of the above-mentioned changes in fertilizer consumption, it is helpful to examine consumption by fertilizer type and by region, as reflected in tables V.34 and V.35. As illustrated, in figure V.9, differences in application rates exist in the major regions since 1980. World consumption of nitrogenous fertilizers reached 79.6 million tonnes in 1989. This increase represents an average annual growth rate of 2.3 per cent [10]. Consumption in developed countries represented 29.1 per cent of total world consumption of nitrogenous fertilizers. Environmentalist attempts to reduce nitrates in groundwater have had a depressing effect on nitrogenous fertilizer use in the EEC and to a lesser extent in the United States over the past few years. In Japan, the area planted has decreased, contributing to slower growth in fertilizer applications in the North. For the above reasons, consumption has been growing faster in developing countries, at 3.1 per cent per annum [10], as compared with an annual growth rate of only 1 per cent in developed countries. Other comparisons can be drawn from table V.36. China and India accounted for most of the increase owing to increasing grain production. The centrally planned countries of Eastern Europe and the USSR are gradually losing their share of nitrogenous fertilizer consumption as their economies adjust towards a market economy.

World consumption of phosphatic fertilizers reached 38.1 million tonnes in 1989. The fastest growth rates in consumption have been recorded in developing countries. Lately, China has made efforts to increase phosphatic fertilizer use in order to improve the balance of its nutrient applications [12]. In other developing countries great efforts are being made at improving imbalances between nitrogenous and phosphatic fertilizer use in favour of phosphatic fertilizers. Consumption in developed countries is declining, partly because of environmental legislation affecting all branches of the fertilizer industry, while consumption in centrally planned economies (except China) has been stagnating over the past few years owing to restrictions in the already high application rates.

World consumption of potash fertilizers was the lowest of all three categories in 1989, at about 28 million tonnes. Centrally planned economies were responsible for the greatest share, with the USSR leading at 25.2 per cent. Consumption of potash fertilizers in the North, at 40.9 per cent of the total market in 1989, came close to that of centrally planned economies. The developing-country share of total potash consumption, at 19.7 per cent, was the lowest of all three fertilizer nutrient types. Brazil, France, United States and USSR, have remained major users of potash fertilizers, with a combined share that exceeds 50 per cent of the entire market. Consumption of potash fertilizers, however, has increased in developing countries. A good example is offered by the rice-growing countries of Asia, where intensive farming with high application rates of nitrogenous fertilizer is slowly depleting the potash content of the soil. Once

Figure V.9. Fertilizer application rates by region, 1980 and 1990



Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

[a] 1 pound = 0.4536 kilograms

Table V.34. World consumption of fertilizers by type, 1989

Rank	Nitrogenous fertilizer: Country, region or economic grouping	Consumption (thousand tonnes)	Percentage share	Rank	Phosphate fertilizer: Country, region or economic grouping	Consumption (thousand tonnes)	Percentage share	Rank	Potash fertilizer: Country, region or economic grouping	Consumption (thousand tonnes)	Percentage share
1	China	18 515	23.26	1	USSR	8 556	22.48	1	USSR	7 044	25.16
2	USSR	11 587	14.56	2	China	5 162	13.56	2	United States	4 384	15.66
3	United States	9 646	12.12	3	United States	3 741	9.83	3	France	1 935	6.91
4	India	7 246	9.11	4	India	2 737	7.19	4	China	1 646	5.88
5	France	2 604	3.27	5	Brazil	1 507	3.96	5	Brazil	1 406	5.02
6	Germany, Federal Republic of	1 540	1.94	6	France	1 460	3.84	6	Poland	1 160	4.14
7	Poland	1 520	1.91	7	Poland	944	2.48	7	India	1 068	3.81
8	Indonesia	1 495	1.88	8	Japan	726	1.91	8	Germany, Federal Republic of	887	3.17
9	United Kingdom	1 462	1.84	9	Italy	715	1.91	9	German Democratic Republic	583	2.08
10	Pakistan	1 325	1.66	10	Germany, Federal Republic of	643	1.88	10	Japan	577	2.06
11	Mexico	1 270	1.59	11	Canada	614	1.69	11	United Kingdom	521	1.86
12	Canada	1 187	1.49	12	Indonesia	610	1.61	12	Czechoslovakia	484	1.73
13	Spain	1 121	1.40	13	Spain	530	1.60	13	Hungary	465	1.66
14	Turkey	1 081	1.36	14	Iran (Islamic Republic of)	493	1.39	14	Italy	454	1.62
15	Italy	925	1.16	15	Turkey	490	1.29	15	Canada	357	1.27
16	German Democratic Republic	873	1.10	16	Czechoslovakia	467	1.29	16	Spain	343	1.22
17	Brazil	815	1.02	17	United Kingdom	433	1.23	17	Malaysia	312	1.11
18	Egypt	799	1.00	18	Romania	400	1.14	18	Indonesia	287	1.02
19	Romania	720	0.91	19	Mexico	395	1.05	19	Yugoslavia	251	0.90
20	Hungary	650	0.82	20	Pakistan	390	1.04	20	Romania	235	0.84
	North America	10 834	13.61			4 356	11.44			4 741	16.93
	Western Europe	10 833	13.61			5 087	13.36			5 511	19.69
	Oceania	450	0.56			450	1.18			450	1.61
	Other developed economies [a]	1 075	1.35			1 053	2.76			743	2.65
	Africa	1 731	2.18			1 027	2.70			322	1.15
	Asia	14 517	18.24			6 716	17.64			2 948	10.53
	Latin America	3 808	4.79			2 751	7.23			2 245	8.02
	Centrally planned economies [a]	36 161	45.44			16 733	43.96			11 818	42.21
	North [a]	23 193	29.14			10 946	28.75			11 445	40.88
	South [a]	20 057	25.20			10 495	27.57			5 514	19.70
	TOTAL	79 581	100.00			38 067	100.00			27 994	100.00

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

[a] Excluding centrally planned economies.

Table V.35. Consumption of selected fertilizers by region, 1989
(Percentage)

Region or economic grouping	Nitrogenous fertilizer						Phosphate fertilizer					Potash fertilizer					
	Urea	Ammonium nitrates	Nitrogen ammonium sulphate	Ammonium phosphate	Calcium cyanamide	Ammonium sulphate nitrate	Single super-phosphate	Concentrate super-phosphate	Basic slag	Ammonium phosphate	Ground rock	Potassium sulphate	Muriate 1[a]	Muriate 2[b]	Crude salts	Other potash	Complex[c] potash fertilizer
Developed market economies	34.6	70.1	46.0	37.8	100.0	73.9	32.9	38.8	99.9	36.1	82.4	72.7	68.0	96.5	100.0	96.5	69.6
North America	18.4	8.8	8.4	..	..	..	..	9.0	..	18.5	..	5.0	45.7	..	..	68.7	..
Western Europe	10.2	53.8	15.5	4.8	3.9	16.1	9.6	13.1	23.4	3.4	5.0	6.6	7.1	6.1	1.2	9.3	42.5
Oceania	4.4	5.6	21.4	33.0	91.3	57.7	23.4	15.0	76.6	14.2	72.9	48.8	7.7	90.5	98.8	18.5	25.7
Other	1.7	1.9	0.7	..	4.9	..	..	1.6	..	..	4.4	12.2	7.5	..	..	..	1.4
Developing market economies	63.5	13.5	41.0	31.1	..	26.1	34.2	56.6	0.1	57.3	17.6	23.3	15.6	..	..	..	20.1
Africa	2.2	2.8	1.5	2.9	..	1.0	11.6	2.5	..	5.5	2.0	1.9	1.3	..	..	..	6.5
Asia	42.0	7.1	14.5	14.4	..	25.0	1.0	35.8	..	30.7	2.5	6.2	0.4	..	..	..	8.5
Latin America	19.2	3.5	25.0	13.8	..	..	21.7	18.3	0.1	21.0	13.1	15.1	13.9	..	..	..	5.1
Other	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Centrally planned economies	1.9	16.4	13.0	31.1	..	..	32.8	4.6	..	6.7	..	4.0	16.4	3.5	..	..	10.3
Asia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eastern Europe and USSR	1.9	16.4	13.0	31.1	..	..	32.8	4.6	..	6.7	..	4.0	16.4	3.5	..	..	10.3
Total percentage	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Thousands of tonnes	10 170	8 068	2 106	1 362	493	779	19 251	2 991	588	3 177	617	922	5 850	497	455	2 426	1 746

Source: Food and Agriculture Organization of the United Nations, *Fertilizer Yearbook*, vol. 39 (Rome, 1989).

[a] Over 45 per cent potassium.

[b] From 20 to 45 per cent potassium.

[c] Mixed fertilizer with potash as dominant nutrient.

Table V.36. Fertilizer application rates by region, 1980, 1985 and 1990

Region	Year	Nitrogen (pounds [a] per hectare)	Phosphate	Potash	Total crop area harvested (million hectares)	Population (millions)
World	1980	163.0	85.0	68.0	775.5	4 450.0
	1985	193.0	91.0	73.0	767.3	4 837.0
	1990	213.0	99.0	77.0	765.8	5 246.0
North America	1980	197.0	91.0	99.0	134.3	321.2
	1985	211.0	81.0	89.0	135.5	342.4
	1990	209.0	78.0	89.0	125.2	364.2
Western Europe	1980	109.3	309.0	290.0	41.5	349.1
	1985	552.6	276.5	288.3	40.3	352.4
	1990	574.6	276.0	288.7	39.3	355.6
Oceania	1980	20.3	95.1	17.3	30.8	440.5
	1985	26.2	75.0	19.4	32.4	487.8
	1990	26.2	67.6	18.7	33.2	537.9
Eastern Europe	1980	372.1	254.8	250.7	29.5	106
	1985	386.4	237.8	251.5	29.3	108.5
	1990	429.0	252.7	271.9	29.1	110.9
Africa	1980	45.7	28.5	10.8	72.2	412.8
	1985	54.1	35.0	12.3	75.1	478.6
	1990	62.2	37.8	13.9	77.3	557.8
Asia	1980	145.6	44.0	18.8	295.7	2 278.0
	1985	210.1	70.8	24.9	292.6	2 476.0
	1990	232.0	74.8	26.7	297.0	2 683.0
Latin America	1980	83.6	107.3	98.7	48.2	276.0
	1985	87.9	102.4	97.5	50.3	309.5
	1990	98.7	89.1	88.8	54.1	345.2

Source: Bureau of Mines, *World Demand for Fertilizer Nutrients for Agriculture* (Washington, D.C., Government Printing Office, 1988).

[a] 1 pound = 0.4536 kilogram.

again, environmentalist pressures in the North combined with already high application rates have greatly affected potash fertilizer usage in the North.

A further disaggregation of the consumption of fertilizer by subtypes for major economic regions in 1989 is provided in table V.35. Among nitrogenous fertilizers, urea is the most commonly consumed type, at least in developing countries of Asia, where it is the preferred fertilizer for the cultivation of wet paddy. Ammonium nitrates are the second most commonly used nitrogenous fertilizer worldwide, followed by nitrogen ammonium sulphate, a distant third. Developed countries accounted for the largest demand of all types of nitrogenous fertilizers covered in table V.35, with the exception of urea, as mentioned above. Among phosphatic fertilizers, single superphosphate is still the most commonly used type, with developing countries accounting for the biggest share of demand in 1989. Ammonium phosphate and concentrated superphosphate are the two next most commonly used phosphatic fertilizer types. Developing countries, especially those of Asia, accounted for the largest share of world consumption of concentrated superphosphates and of ammonium phosphates. Developed market economies were the only significant consumers of basic sl · and of ground rock phosphate. Among potash fertilizers, muriate with over 45 per cent potassium was the most commonly used type, at 5.8 million tonnes. This potash fertilizer was mostly consumed in North America, with 45.7 per cent in 1989. Developed market economies led the demand of all potash fertilizer types. Crude salts were consumed mainly in Oceania in 1989. Developing-country consumption of potash fertilizers was significant only in the cases of potassium sulphate and complex potash fertilizers. Centrally planned economies were the second largest users of muriate with over 45 per cent potash, but were only marginal users of other types of potash fertilizers in 1989. Fertilizer application rates by region 1980, 1985 and 1990 are also shown in Table V.36.

(d) Impact of genetic engineering

The question often raised is whether biotechnology and genetic engineering will have an impact on future fertilizer use. Considerable progress is being made in crop genetics, and new, higher-yielding varieties resistant to disease and insects are being developed. However, like current varieties, these new varieties still require high rates of fertilization. Developments in this area are not likely to affect fertilizer use significantly in the short or medium term [13].

Other developments still in their early stages could create new plant varieties that will require less fertilizer use. Examples include varieties that have greatly increased efficiency in the utilization of phosphate or potassium in the soil, and plants that can fix atmospheric nitrogen. Theoretically, it is possible to make root-associated organisms that are especially efficient in utilizing soil phosphate reserves and rock phosphate with minimal treatment. It is possible to make such micro-organisms absolutely dependent on special substances excreted by plant roots. Such traits may be introduced into plants by means of current genetic engineering techniques [10]. The study of nitrogen-fixing organisms is probably one of the most active fields in current genetic research.

The impact on fertilizer use of current research on soya bean nodules and legumes is not likely to be significant. In developed countries, it is currently more profitable for the farmer to use fertilizers to maximize yields rather than to use plants with a nitrogen-fixing property that would result in a lower yield. However, such nitrogen-fixing plants could be of benefit in some developing countries.

Another long-term possibility may be the genetic engineering of plants that fix nitrogen in the leaves rather than in the roots. In this case, the leaves would usually have sufficient energy to fix the nitrogen, but because the presence of oxygen makes nitrogen-fixing enzymes inactive, such a long-term solution may not be possible unless oxygen-tolerant enzymes can be developed [13]. Much effort has gone into nitrogen-fixing enzymes, but there are still many fundamental problems to be solved before the technique can have a significant impact on fertilizer use. The techniques are still very much at the laboratory stage of experimentation. Even if major breakthroughs occur in the next few years, it will take many years for them to be widely applied in practical farming, significantly reducing the need for chemical fertilizers. There is no doubt that the success of these developments will depend to a great extent on their rate of adoption in agriculture.

It is unlikely that these developments will be so rapid as to make obsolete new investments in conventional fertilizers. Today, however, low inputs and sustainable agricultural movements are becoming more influential; the technologies employed emphasize optimal production with minimal external inputs and suggest an "alternative agriculture" approach derived from conventional agronomic practices and livestock husbandry ([14], [15]). Since these movements place less emphasis on the heavy use of fertilizers, they could have a significant impact on fertilizer use in the future.

2. *Capacity utilization and expansion plans*

Data on nitrogenous fertilizer capacity, as presented in table V.37 is measured in terms of ammonia, and phosphatic fertilizer capacity in terms of phosphoric acid. Regarding the distribution of capacity, table V.37 shows that in 1990 about 25 per cent of total nitrogenous fertilizer capacity was found in North America and Western Europe, 20.1 per cent in Asia and 48.3 per cent in centrally planned economies (mainly Eastern Europe and the USSR). The strongest increases in nitrogenous fertilizer capacity were recorded in Latin America at 21.7 per cent, Asia at 10.1 per cent, and Oceania at 8.2 per cent.

Almost a half of total phosphatic fertilizer capacity was accounted for by developed market economies. Shares were highest in North America, at 33.3 per cent in 1990. Centrally planned economies possessed about 24.5 per cent of world capacity, mostly located in Eastern Europe and the USSR. The share of phosphatic fertilizer capacity accounted for by Africa was the highest of the three fertilizer nutrients at 14.9 per cent in 1990. The most remarkable change between 1987 and 1990 occurred in centrally planned economies in Asia, with a 220 per cent increase. The phosphatic fertilizer capacity of developed market economies decreased slightly between 1987 and 1990.

Regarding new fertilizer manufacturing plant construction and expansion, the following activities have been reported for 1990 [16]. There are plans for several new nitrogenous fertilizer plants to be built over the next five years: 1 in Bangladesh, 3 in Indonesia, 4 in India and 10 in China. The investment projects in China might be delayed because of reduced foreign borrowings. There are plans for several new plants based on low-cost natural gas to be built in Western Asia, although these might now be reconsidered. The fastest growth in nitrogenous fertilizer capacity is expected in Latin America. Expansion plans in the USSR, which was planning to increase capacity by about 2 million tonnes by the mid-1990s, may be temporarily postponed in light of the current economic situation in that country.

New investments in phosphatic fertilizer plants will take place in North Africa and China. The latter plans to increase its phosphate fertilizer capacity by 2 million tonnes by the year 2000. Construction of the Hubei phosphate project has begun, with an anticipated production of 2.5 million tonnes of the fertilizer in 1995. Jordan has a new phosphatic fertilizer project, the Shidiya Integrated Phosphate Project. Morocco also plans to increase its output of phosphatic fertilizers from the large complex at Jorf Lasfar and to build two more plants, thus increasing its capacity by about 1 million tonnes by 1995. Tunisia has a long-term plan to build a large new mine at Sra Quertane, which could be on stream in the mid-1990s. In Western Europe and Japan, capacity is expected to decline because of increasing dependence on raw material imports. Very little capacity expansion is foreseen in the United States, and its relative position as the world's leading producer will suffer from keen competition by major producers in developing countries. In the formerly centrally planned economies of Europe, capacity may decrease as the number of closures of old and inefficient plants in the region increases.

As regards potash fertilizer capacity, developed countries accounted for over a half of total capacity in 1990, with North America alone providing 33.1 per cent and Western Europe 16.6 per cent. The centrally planned economies accounted for almost all the remaining world capacity in potassium fertilizers. In 1990, their share of the market was 43.5 per cent, with Eastern Europe and the USSR accounting for most of

Table V.37. World fertilizer capacity, 1990

Region or economic grouping	Nitrogenous fertilizer			Phosphate fertilizer			Potash fertilizer		
	1990 capacity (thousand tonnes)	Percentage change 1987-1990	Percentage share 1990	1990 capacity (thousand tonnes)	Percentage change 1987-1990	Percentage share 1990	1990 capacity (thousand tonnes)	Percentage change 1987-1990	Percentage share 1990
Developed market economies	31.2	0.6	27.0	17.5	-0.4	48.2	18.2	-1.5	53.8
North America	15.8	-	13.7	12.1	-	33.3	11.2	12.7	33.1
Western Europe	12.4	0.5	10.7	3.5	-1.5	9.6	5.6	1.2	16.6
Oceania	0.6	8.2	0.5	0.1	-	0.3	-	-	-
Other [a/]	2.4	3.8	2.1	1.8	-	5.0	1.4	9.5	4.1
Developing market economies	31.1	12.1	26.9	11.8	2.6	32.5	2.3	14.6	6.8
Africa	1.8	-	1.6	5.4	-	14.9	-	-	-
Asia	23.2	10.1	20.1	1.8	-	5.0	0.1	-	0.3
Latin America	6.1	21.7	5.3	4.6	7.3	12.7	2.2	16.7	6.5
Centrally planned economies	55.8	5.4	48.3	8.9	10.3	24.5	14.7	0.4	43.5
Asia	19.7	5.0	17.0	0.2	220.0	0.6	0.1	140.0	0.3
Eastern Europe and USSR	36.1	5.6	31.2	8.7	7.6	24.0	14.6	0.0	43.2
TOTAL	115.6	5.5	100.0	36.3	2.8	100.0	33.8	-0.3	100.0

Sources: World Bank, *Improving the Supply of Fertilizer to Developing Countries*, World Bank Technical Paper No.97, Industry and Energy Series (Washington, D.C.,1989); and International Fertilizer Industry Association, "Summary of world fertilizer capacities" (Paris, 1991).

a/ Israel, Japan and South Africa.

it. The strongest capacity increase during the period 1987-1990 was recorded in the centrally planned economies of Asia, with 140 per cent. North America also increased its share by 12.7 per cent during the same period. Potash capacity expansion will come on stream in the next few years with an increase of 1.5 million tonnes expected in the USSR. Jordan plans to increase capacity by 240,000 tonnes by 1995. There are also plans for capacity expansion in Canada, China and Thailand towards the end of the century [10]. China is planning a project to produce 800,000 tonnes of potassium chloride by extracting potash in its Qinghai Province. Thailand plans to extract potash from large domestic deposits by the end of the 1990s. With the exception of the above-mentioned potash capacity expansion plans, no new expansion project is expected in the foreseeable future, at least not in developing countries.

3. *Manufacturing capacity of developing countries*

Because the agricultural sector plays an extremely important role in the process of economic development, developing countries have given high priority to self-sufficiency in food production to alleviate hunger and improve nutrition. The development of the agricultural sector requires, above all, improvements in land productivity through the application of farming technology, which in turn usually depends heavily on the use of fertilizers. Although developing countries have considerably expanded their manufacture of fertilizers, gaps in capacity still exist between the volumes of fertilizer currently produced and the volumes that could be produced if all raw materials were domestically processed [17]. Abundant raw material resources consisting of natural gas and phosphate rock in several developing countries provide considerable scope for fertilizer production and opportunities for setting up production facilities in favourable locations within those countries.

While the consumption of fertilizers in developing countries has risen nearly fifteenfold in 35 years, their production is still currently concentrated in developed countries. Production in developing countries, while expanding, has consistently been in deficit relative to consumption, as shown in table V.38. The growth of fertilizer production facilities in developing countries during the last two decades has been attributed mainly to nitrogenous and phosphatic types. Production of ammonia and phosphoric acid has increased significantly in recent years. However, constant improvements in energy consumption in new ammonia plants in developed countries and lower energy prices generally reduce the comparative advantage of locating plants in developing countries near sources of cheap gas, particularly where high investment in infrastructure is required. For potash, because known resources are limited in developing countries, potassic fertilizers have to be obtained from the producing developed market economies (mainly Canada) and the USSR.

The most significant recent increases in fertilizer capacity have taken place in Asia, particularly in Bangladesh, China, India and Indonesia. Govern-

Table V.38. World fertilizer supply[a/] and demand balances, 1990

Region or economic grouping	Nitrogenous fertilizer: Supply	Demand (million tonnes of nitrogen)	Surplus	Phosphate fertilizer: Supply	Demand (million tonnes of phosphate)	Surplus	Potash fertilizer: Supply	Demand (million tonnes of potash)	Surplus
Developed market economies	21.9	23.4	(1.6)	18.5	11.9	6.5	16.9	11.7	5.1
North America	11.2	11.0	0.2	10.2	4.5	5.7	10.5	5.2	5.3
Western Europe	9.9	10.8	0.9	4.9	5.0	(0.1)	5.2	5.4	(0.2)
Oceania	0.4	0.5	(0.1)	1.6	1.2	0.4	-	0.2	(0.2)
Other developed[b/]	0.4	1.1	(0.8)	1.8	1.2	0.6	1.3	0.8	0.5
Developing market economies	19.8	20.8	(0.9)	9.4	10.5	(1.1)	0.8	5.2	(4.4)
Africa	0.6	1.0	(0.4)	4.1	0.8	3.3	10.0	0.4	(0.4)
Asia									
Western Asia	4.2	3.3	1.1	1.2	2.0	(0.8)	0.8	0.2	0.6
East Asia	10.4	12.1	(1.7)	1.9	4.7	(2.7)	-	2.3	(2.3)
Latin America	4.6	4.3	0.3	2.1	3.5	(0.9)	c/	2.1	(2.1)
Centrally planned economies	38.4	35.1	3.3	13.8	16.6	(2.8)	13.8	11.9	1.9
Eastern Europe and USSR	24.2	17.8	6.4	10.4	12.4	(2.0)	13.7	10.4	(3.3)
Asia	14.2	17.3	(3.0)	3.3	4.2	(0.4)	c/	1.5	(1.4)
TOTAL	80.1	79.3	0.9	41.6	39.0	2.6	31.5	28.9	2.6

Source: World Bank, *Improving the Supply of Fertilizers to Developing Countries*, World Bank Technical Paper No.97, Industry and Energy Series (Washington, D.C., 1989).

Note: Values in parentheses represent deficits.

a/ Supply potential, which is derived from supply capability, less industrial uses and processing and distribution losses.

b/ Israel, Japan and South Africa.

c/ Less than 100,000 tonnes.

ments in those countries have been increasingly active in the acquisition of foreign technology and know-how in the fertilizer sector. Ensuring adequate fertilizer supplies has necessitated major investments in domestic fertilizer production in many developing countries. Also, growing opportunities to import intermediate products have greatly extended the opportunities for individual countries to establish or expand their own fertilizer industries. Most developing countries have installed fertilizer mini-plants for local agricultural usage [18]. Some of these have been expanded for the export market. Countries in Western Asia have recently expanded nitrogen capacity, mainly for export markets. The important producers of Latin America are undertaking expansion of their capacity of nitrogenous fertilizers for export (especially Brazil, Mexico, Trinidad and Tobago and Venezuela). The low-cost producers of East Asia are also gradually expanding their nitrogenous fertilizer capacity.

More than 75 per cent of the increase in world phosphatic fertilizer capacity in recent years have occurred in developing countries. In order to save transport costs, there is a growing trend among traditional rock exporters towards integrating mining and processing operations. Most new investments in phosphate fertilizer plants have taken place where there are phosphate rock deposits. The major raw-material abundant countries are expanding capacity. China, for example, in seeking to correct the imbalance in its fertilizer nutrient applications, has recently made large investments in phosphate processing capacity to meet domestic needs. Developing countries currently account for only about 3 per cent of global potash fertilizer production. However, as previously stated, China and Thailand have capacity expansion plans.

While considerable potential exists for the growth of fertilizer production in developing countries, there are several constraints that need to be handled effectively [19]. To begin with, there are very limited research and development facilities in most developing countries, except in a few notable cases such as India. There is also a lack of infrastructure. Where capacity increases are significant, equipment and machinery are largely imported (except in Brazil, India and Mexico), and indigenous manufacturing facilities are heavily dependent on imports of spare parts and components. There is almost total dependence on imports of catalysts, except in India. While the technological capability to ensure adequate and efficient manufacture of fertilizers may still be insufficient in many developing countries, considerable progress is being made in several of them.

4. *Restructuring and redeployment*

The fertilizer industry plays a key role in food security, which is why the industry is politically sensitive and permeated by government intervention. The most common modalities of government intervention today include State-owned plants and the control of prices, trade and transport systems [13]. Despite the growing influence of State-owned industrial plants in developing countries where fertilizer manufacturing and distribution are often accompanied by State monopolies, private-sector operations are still dominant in the global fertilizer industry, and tend to be closely regulated or oligarpolistic in some developed countries. Oligopolistic producer, trader and buyer organizations dominate the global fertilizer business today. Despite the above-mentioned limitations, it appears that the global fertilizer market operates like a free market at least in the long term, and prices generally respond closely to demand and supply forces.

About 400 major firms produce fertilizers on a global basis. There is a high degree of specialization not only between the three basic fertilizer types, but also within each category [19]. Another ologopolistic trait of the industry concerns the high barriers to entry confronting potential newcomers. Easy entry to the industry is inhibited by the following: the very large investment cost required for new fertilizer plants; difficulties associated with acquiring the requisite technology, since producers in major developed countries own technical know-how; and the existence of large integrated petrochemical companies, at least in the case of nitrogenous fertilizers, which seem to operate more economically than separate operations. Moreover, industry associations in developed market economies have a decisive influence on regulating the global fertilizer industry. These associations, for the most part, tend to act as cartels, exercising a considerable influence on price setting and other market conditions. Generally located in the North, they have proven capable of expanding fertilizer market protection. Producers and buyers in developing countries have historically been in no position to influence these major market forces, even though this trend is currently changing.

Concerning specific fertilizer trading organizations, nine major Western European producers are members of NITREX, which handles all export sales of nitrogen fertilizers outside Europe and the United States. PHOSCHEM manages international sales of concentrated phosphates and acid for eight United States companies representing about one half of the country's total sales. Similarly, the marketing of potash from Canada, the world's leading exporter, is handled by CANTOPEX, a Canadian trading company. The operations of the latter are coordinated in such a manner that there is no major conflict of marketing interests with Western European members of the International Potash Institute, which promotes the agricultural use of potash overseas.

(a) Largest companies in the North

The production of fertilizers generally forms part of a much broader industrial complex in the North, embodying chemicals, petrochemicals and a wide range of other products. Table V.39 provides a ranking of fertilizer capacity for the 20 largest companies in the North, which now account for 33.1 per cent of fertilizer capacity worldwide.

In the United States, 6 of the major corporations engaged in fertilizer production are among the top 20 in the North. These include IMC Fertilizers, CF Industries, Farmland Industries, Freeport Chemical, Terra International and Agrico Chemical Company. In 1990, IMC Fertilizers, a publicly owned company, accounted for about 6 per cent of total world fertilizer capacity and was the second largest fertilizer company

Table V.39. The largest fertilizer companies in the North, 1990

Company and country	Capacity	
	(thousand tonnes)	Percentage share
Duelo Sala: Chemike Zavody (Czechoslovakia)	18 311	5.91
IMC Fertilizer Group, Inc. (United States)	18 000	5.81
CF Industries Inc. (United States)	8 600	2.77
Potash Corporation of Saskatchewan (Canada)	8 600	2.77
Société chimique de la grande Paroisse (France)	4 700	1.52
VEB Stickstoffe Pietsteritz (German Democratic Republic)	4 320	1.39
Fertilizantes Espanoles SA, FESA (Spain)	4 300	1.39
Farmland Industries, Inc. (United States)	3 900	1.26
Freeport Chemical Co. (United States)	3 400	1.10
VEB Kombinat Kali (Germany, Federal Republic of)	3 300	1.06
DSM Agro BV (Netherlands)	3 100	1.00
Terra International (United States)	3 000	0.97
Enichem Agriculture SPA (Italy)	2 800	0.90
Cominco Fertilizers (Canada)	2 800	0.90
Combinatul de Ingrasaminte Chimice Turn Magurele (Romania)	2 800	0.90
Kali und Salz AG (Germany, Federal Republic of)	2 700	0.87
Pulanske Prezedsiebiorstwo Budowr.ctwa (Poland)	2 430	0.78
AGRICO Chemical Company (United States)	2 400	0.77
BASF Aktiengesellschaft (Germany, Federal Republic of)	2 300	0.74
ICI Fertilizers PLC (United Kingdom)	2 300	0.74
TOTAL	104 061	33.55
World	310 167	100.00

Source: British Sulphur Corporation Limited, *World Directory of Fertilizer Manufacturers* (London, 1990).

in the world as well as the leading producer of phosphate chemicals and compound fertilizers. CF Industries was the leading producer of ammonia and nitrogenous fertilizers in the United States. Other major producers of fertilizers in the United States in 1990 included Arcadian Corporation, Gardinier, the Potash Company of America and Seminole. Farmland Industries plans to expand phosphate mining and processing in the future. In Canada, sales of fertilizers are dominated by the Potash Corporation of Saskatchewan, the world's leading producer of potassium chloride and the fourth largest producer of fertilizers, and by Cominco, a major producer of nitrogenous and phosphatic fertilizers. Other important producers in Canada include Esso Chemical Canada, Noranda Minerals, the Potash Company of America and C-I-L Inc. Agriculture.

Compared with North America, Western European countries have the capacity to produce almost the same quantity of fertilizers. Historically, the structure of the Western European fertilizer industry has been less competitive than in the United States, with two or three companies often dominating production in each country. The French Société chimique de la grande Paroisse was the largest Western European producer in 1990, followed closely by VEB Stickstoffe Pietsteritz of the German Democratic Republic. In Spain, Fertilizantes Españoles SA, which was established in 1988 as a result of a merger between FOSFORICO Español and the fertilizer divisions of SA Cros and Union Explosives Riotinto, was the seventh largest fertilizer producer in the North in 1990. Other important producers in the North included: in the Netherlands, DSM Agro BV, a major producer of nitrogenous fertilizers; in the Federal Republic of Germany, VEB Kombinat Kali, Kali und Salz AG, and BASF Aktiengesellschaft; in Poland, Pulanske Prezedsiebiorstwo Budownictwa; in Italy, Enichem Agriculture Spa; and in the United Kingdom, ICI Fertilizers Plc.

In Japan, the fertilizer industry is highly competitive, with about 17 major companies involved. The larger of these in 1990 included: Mitsubishi-owned Chemical Industries and Gas Chemical Company; Ube Industries, a publicly owned company; and Mitsui Toatsu Chemicals, a public shareholding company. A major producer of fertilizers in Scandinavia is Norsk Hydro (Norway) in which the Government of Norway has a 5 per cent holding. While its first fertilizer product was calcium nitrate, its production capacity has now extended to ammonia, ammonium nitrate and compound fertilizers. That company acquired 80 per cent of the shares in the French fertilizer company, Cofaz, in 1986 and the remaining 20 per cent in 1987. Also, in 1982, Norsk Hydro acquired Fisons Fertilizer, the fertilizer division of Fisons Ltd. in the United Kingdom. The great number of take-overs undertaken by Norsk Hydro throughout its history were all part of its strategy to establish a significant position in the major fertilizer markets of Western Europe [20].

In the USSR, the fertilizer industry was recently placed under the control of an independent State organization, Soyuzagrochim, representing the first stages of *perestroika*. That country aims at giving its fertilizer industry more autonomy in the immediate future. The major fertilizer companies in the USSR in 1990 included Gorlova Chemical Combine, the largest nitrogenous fertilizer producer; Kemerovo Nitrogen Fertilizer Plant; and Novokemerovo Chemical Combine, the second largest nitrogen producer. That country had about 39 independent fertilizer companies in 1990.

(b) *Largest companies in the South*

With growing domestic demand in several developing countries, a great number of fertilizer projects were undertaken during the 1960s and the 1970s in these countries. Some of this expansion activity is still continuing today. The 20 largest fertilizer companies in the South in 1990 are ranked in table V.40. Together they account for only 13.8 per cent of total capacity. The largest of the 20 is Fertilizantes Mexicanos, a publicly owned Mexican firm that plans to double its fertilizer capacity in the 1990s. The second largest company is located in India. The Indian Farmers Fertilizer Co-operative was a major world producer of nitrogen, phosphorus and potassium fertilizers, urea and diammonium phosphate in 1990. Four other companies in India were listed among the 20 largest in the South in 1990, including the National Fertilizers Corporation, Hindustan Fertilizer Corporation, Krisshah Bharati Co-operative Ltd., and Fertilizers and Chemicals Travancore Ltd. The Turkish Fertilizer Industry Co. ranked third among the 20 largest in the South in 1990. That company plans to expand its ammonia, nitrophosphate and NPK fertilizer capacities by the end of the 1990s. Another Turkish fertilizer company, Gubre Fabrikalari AS, was listed among the 20 largest in the South in 1990.

Among other developing countries in East Asia, three Indonesian firms, P.T. Pupuk Kaltim, P.T. Petrokimia, and P.T. Pupuk Sriwidjaja, together had a significant share of the total fertilizer capacity of the South in 1990. In North Africa, the Office Chérifien des phosphates (OCP) of Morocco, the Groupe Chimique Tunisien of Tunisia, Asmidal Fertilizers and Phytosanitary of Algeria, and Société El-Nasr d'engrais et des industries chimiques of Egypt were among the top 20 in the South. In Morocco, OCP plans to expand its phosphoric acid and fertilizer capacities with the construction of two new fertilizer plants, Maroc Phosphore V and VI by 1992 at Jorf Lasfar, and six more fertilizer complexes by the end of the decade.

(c) *Significance of State-controlled enterprises*

There has been considerable growth of production facilities for fertilizer production in developing countries during the last two decades, most of them government-controlled. The role of government in almost all developing countries has had a steadily growing effect on the fertilizer business. One source estimates that by the mid-1990s, roughly 80 per cent of the world fertilizer industry will be State-owned or controlled [11]. In fact, virtually all of the recent growth in world productive capacity has been occurring under some type of State ownership programme.

Table V.40. The largest fertilizer companies in the South, 1990

Company and country or area	Capacity (thousand tonnes)	Percentage share
Fertilizantes Mexicanos SA (Mexico)	5 198	1.68
Indian Farmers Fertilizer Co-operative Ltd. (India)	2 967	0.96
Turkish Fertilizer Industry Co. Inc. TUSAS (Turkey)	2 929	0.94
Office Chérifien des phosphates (Morocco)	2 800	0.90
Petrofertil (Brazil)	2 567	0.83
Groupe Chimique Tunisien (Tunisia)	2 500	0.81
Petroleos Mexicanos SA, PEMEX (Mexico)	2 461	0.79
National Fertilizers Corp. Ltd. (India)	2 400	0.77
Copebras SA (Brazil)	2 250	0.73
Hindustan Fertilizer Corp. Ltd. (India)	2 048	0.66
Gubre Fabrikalari AS (Turkey)	1 812	0.58
National Fertilizer Corp. of Pakistan Ltd. (Pakistan)	1 767	0.57
P.T. Pupuk Kaltim (Indonesia)	1 710	0.55
P.T. Petrokimia Ltd (Indonesia)	1 655	0.53
Asmidal Fertilizers and Phytosanitary Co. (Algeria)	1 457	0.47
Krisshah Bharati Co-operative Ltd. (India)	1 452	0.47
P.T. Pupuk Sriwidjaja (Indonesia)	1 400	0.45
Taiwan Fertilizer Co. Ltd. (Taiwan Province)	1 250	0.40
Fertilizers and Chemicals Travancore Ltd. (India)	1 190	0.38
Société El-Nasr d'engrais et des industries chimiques (Egypt)	1 167	0.38
TOTAL	42 980	13.85
World	310 325	100.00

Source: British Sulphur Corporation Limited, *World Directory of Fertilizer M* (London, 1990).

Whereas the nature and impact of State-controlled enterprises varies according to whether they reside in developing or developed countries, when considered as a group they have had the general effect of changing the market structure by increasing or decreasing the degree of competition in the fertilizer industry [11].

Today, State-controlled enterprises account for approximately 21 per cent of total fertilizer capacity and 32 per cent of ammonia capacity worldwide. The 20 largest are listed in table V.41, and together they account for 16.2 per cent of the total. In some countries, such as India, which recently undertook a major expansion of fertilizer production capacity, increased national ownership of fertilizer plants has become a common feature, particularly through State-owned enterprises such as the Fertilizer Corporation of India. The present pattern, in terms of ownership of fertilizer plants in developing countries, indicates the growing importance of the State.

Available statistics point to the presence of State enterprises, though of less importance, in the North. In particular, Duelo Sala: Chemike Zavody and Severococeske Chemike Zavody of Czechoslovakia and Agrolinz Agrarchemikalien GmbH of Austria are listed among the 20 largest in the world. The Turkish Fertilizer Industry Co. and Petroleos Mexicanos SA, owned by PEMEX, the Mexican State-owned oil company, ranked as the second and third largest State-owned fertilizer companies in the world, respectively. The government-controlled fertilizer plants of India are the next most important State-owned plants worldwide. These include the National Fertilizers Corporation, Hindustan Fertilizer Corporation, and Fertilizers and Chemicals Travancore Ltd. In Indonesia, P.T. Pupuk Kaltim, formely known as P.T. Pupuk Kalimantan Timur, which has expanded its production capacity in recent years, now accounts for the greatest share of the Indonesian market, and is also listed among the top 20 State-owned fertilizer enterprises in the world.

In Western Asia, the State Enterprise of Fertilizers of Iraq, which plans to increase its ammonia and urea capacity at Baiji and Mosul, may have to delay construction because of the current political instability. The State-owned General Fertilizer Company of the Syrian Arab Republic has projects to construct new ammonia, urea and sodium phosphate plants in the near future. In North Africa, the Office chérifien des phosphates of Morocco is now the world's largest exporter of phosphoric acid and plans to expand its production capacity of finished fertilizers in the 1990s. The National Petrochemical Company of the Libyan Arab Jamahiriya, one of the larger State-owned fertilizer companies in the world, is currently examining the feasibility of production facilities for complex fertilizers.

Ensuring adequate fertilizer supplies has necessitated major investments, both government and private, in domestic fertilizer production in a number of countries. Even in countries where State-owned enterprises have been established and grown rapidly, private participation has also been encouraged, generally in the form of joint ventures.

5. *Environmental considerations*

The environmental aspects of fertilizer production and use have always received attention, and their importance is intensifying and expanding because of

Table V.41. The largest State-owned enterprises in the fertilizer industry, 1990

Company and country or area	Capacity (thousand tonnes)	Percentage share
Duelo Sala: Chemike Zavody (Czechoslovakia)	18 311	5.91
Turkish Fertilizer Industry Co. (Turkey)	2 929	0.94
Petroleos Mexicanos SA, PEMEX (Mexico)	2 461	0.79
National Fertilizers Corp. Ltd. (India)	2 400	0.77
Fertilizer Corporation of India Ltd. (India)	2 400	0.77
Office Chérifien des Phosphates (Morocco)	2 300	0.74
Hindustan Fertilizer Corp. Ltd. (India)	2 048	0.66
Agrolinz Agrarchemikalien GmbH (Austria)	1 930	0.62
National Fertilizer Corp. of Pakistan Ltd. (Pakistan)	1 767	0.57
P.T. Pupuk Kaltim (Indonesia)	' 710	0.55
Mines de potasse d'Alsace, MDPA (France)	1 600	0.52
Asmidal Fertilizers and Phytosanitary Co. (Algeria)	1 457	0.47
P.T. Pupuk Sriwidjaja (Indonesia)	1 400	0.45
Severococeske Chemike Zavody (Czechoslovakia)	1 280	0.41
Taiwan Fertilizer Co. Ltd. (Taiwan Province)	1 250	0.40
Fertilizers and Chemicals Travancore Ltd. (India)	1 190	0.38
State Enterprise of Fertilizers (Iraq)	1 167	0.38
National Petrochemical Co. (Libyan Arab Jamahiriya)	908	0.29
General Fertilizer Co. (Syrian Arab Republic)	886	0.29
Petroquimica of Venezuela SA, PEQUIVEN (Venezuela)	815	0.26
TOTAL	50 209	16.17
World	310 507	100.0

Source: British Sulphur Corporation Limited, *World Directory of Fertilizer Manufacturers* (London, 1990).

increased sensitivity to environmental considerations [21]. Over the last two decades extensive research has been conducted to develop technologies that minimize environmental damage from fertilizer production processes and soil applications. More specifically, the following three broad areas of environmental concern have received most attention by the fertilizer industry: groundwater and surface water contamination; air quality; and heavy metal concentrations in certain fertilizer products.

The industrial processes that produce fertilizer also produce liquid, solid and gaseous effluents that usually have to be treated to reduce their harmful effects on the environment. Producers are motivated to treat these effluents when the economics of nutrient recovery justify such treatment. In most cases, legislation and monitoring are necessary to see that standards are met. The expense of meeting these standards can add significantly to the overall costs of producing fertilizers. The use of double absorption by sulphuric acid plants, the removal of fluoride compounds, the safe disposal of phosphogypsum from phosphoric acid plants, and the removal of nitrogen oxides from nitric acid plants are typical examples of additional investments required to deal with effluents.

In addition, there are some problems associated with the storage and handling of fertilizer materials. For example, ammonia, an extremely toxic product, can, when stored in large quantities as a liquid either under pressure or at low temperature, represent a major safety hazard. Great care must be used in the design and location of large-scale ammonia storage facilities to protect local inhabitants. Ammonium nitrate, a major fertilizer in Europe and the United States, must be produced, stored and transported under controlled conditions to avoid explosive decomposition.

Several other major problems associated with the use of fertilizers are receiving the attention of environmentalists. When fertilizers are applied at high rates and in an unbalanced manner, excess nutrients may be leached out of the soil and contaminate groundwater supplies. Another more serious problem relates to the build-up of nutrients in drinking water. High levels of nitrates in drinking water have been known to cause rare diseases not only in infants but in the general population as well. The problem is therefore being taken very seriously in certain parts of the world, particularly where nitrogen fertilizer application rates are high and there is a danger of nitrates leaking into drinking water.

In EEC countries recommendations have been made that nitrate in drinking water should be maintained below a certain level. These recommendations include limiting total nitrogen fertilizer applications in both organic and inorganic fertilizers to well below traditional levels. Similar legislation is being discussed in the United States. In the EEC, consideration is also being given to limiting the use of some phosphate fertilizer produced from phosphate rock containing high quantities of cadmium. It is believed that there may be a danger that cadmium, a toxic heavy metal, will enter the food chain and eventually harm consumers.

There may be a long-term impact in the increasing use of nitrogen fertilizers if, as some believe, they contribute to the emission of nitrous oxide, one of the greenhouse gases responsible for depleting the ozone layer. It seems likely that further investigation of this subject may call for recommendations for a better choice of fertilizers and better placement at the crop roots to reduce such emissions. Fertilizer producers and consumers generally have a built-in self-interest in preventing environmental damage. However, existing production and transport facilities are causing pollution and the costs of plant restructuring can be high. Financial and technical assistance may be needed to help owners install waste-prevention systems. Excessive fertilizer use is not yet a major problem in developing countries, but may become so in future, requiring environmental regulations.

6. *Technological trends*

Since the original work of Justus von Liebig in 1840, the manufacture of fertilizers has involved transforming raw materials that mainly contain phosphorus (natural phosphates), potassium (potassium salts) and nitrogen (air). Today the technology of fertilizer production is reacting to a much wider range of issues than has been considered in the past [22]. Apart from the technical feasibility of a given process, there are also concerns for long-range energy supplies, purity and availability of raw materials, transport costs and various environmental problems.

There are a number of new technologies, along with significant advances in agronomic research and fertility-related crop production practices, that are positively affecting both fertilizer production and application efficiencies. Latest developments in fertilizer production technology have concentrated on the improvement of existing processes to reduce production costs and increase efficiency. How best to comply with increasingly strict environmental regulations and still produce fertilizers that are competitive on the world market has been the major concern of most producers in developed countries over the last decade. Concerning the industry as a whole, major technological improvements have centred on ways to improve the concentration of plant nutrients in finished products to cut shipping and storage costs; to employ chemical mixing instead of dry mixing to increase the homogeneity of the mixed fertilizer; and to select binary or ternary mixtures over single-nutrient types in order to improve effectiveness. Major new processes under development are granular urea-nitric phosphates, ammonia polyphosphate suspensions and nitrogen-sulphur suspensions [21].

Ammonia synthesis is the basic step of all nitrogen fertilizer production. The ammonia thus produced is further processed, either to urea or ammonium nitrate, the two most popular nitrogen fertilizers. The problem of the nitrogen fertilizer industry is really that of the fixation of atmospheric nitrogen, a process involving substantial energy consumption process. For the preparation of the hydrogen-nitrogen mixture for subsequent compression and ammonia synthesis, the steam reforming process based on natural gas (essentially methane) or on light hydrocarbons (naphtha) is the most commonly used process worldwide because of the reduction in investment and operating costs.

Ammonia synthesis is carried out under high pressure obtained in either of two types of compressor, depending on the plant scale. For smaller plants, compression and ammonia synthesis are performed in reciprocating compressors, while centrifugal compressors have been found to be the most modern and economical technique for medium- to large-sized plants. The oil crisis of the mid-1970s was responsible for significant improvements in the design of ammonium synthesis loops and the inclusion of physical chemistry developments like cryogenic and membrane hydrogen recovery which led to a big reduction, of between 6 and 7 per cent according to one source [22], in energy consumption. Other advances in catalytic steam reforming have led to a better use of high pressure steam.

More recently, new trends have emerged in the nitrogen fertilizer industry, in particular in the manufacture of ammonia. Apart from the outright return to old methods of gas synthesis using feedstocks like coal or electrolytic hydrogen, process owners are developing less sophisticated processes and equipment. The general tendency worldwide is simplification, and some well-known old methods are being renewed. For the ammonia mini-plants which are emerging everywhere, mostly in developing countries, the most popular processes* are as follows: ammonia-synthesis from natural gas, either an ICI-AMV or PSA-based process; the BENFIELD low-heat process for carbon dioxide; coal-based ammonium synthesis; and ammonium synthesis gas plants based on air gasification [18].

Among other new fertilizer manufacturing technologies, some attention has been given to processes replacing formaldehyde as a conditioning and hardening agent in urea, granulation of small ammonium sulphate crystals into a size that will not segregate in bulk blends, production and evaluation of granular impure urea phosphates, and improved methods of producing solid ammonium polyphosphates. In the United States, the Tennessee Valley Authority (TVA) recently patented process improvements for the cone mixer for producing triple superphosphates, the drum granulator for producing granular ammonium phosphates, and the pipe reactor for producing ammonia polyphosphate fluid fertilizer [22]. The new ammonium polyphosphate suspension from the merchant-grade acid process, primarily designed to be energy-efficient, has been well received because of its versatility and ease of application in the fluid fertilizer industry.

In the industrial-scale manufacture of urea, all the known processes (Stamicarbon, Snam Progetti, Toyo, Montecatini) are still popular. However, new processes such as the TVA "falling-curtain" process have received acclaim because the process is estimated to be slightly less expensive to introduce and operate than the fluid-bed granulation process. Other advantages of the new process include its low energy consumption, relatively low equipment costs, superiority of product quality, less pollution abatement needed because of the inherently low dust evolution in the process, and its unusual versatility in making a large variety of particle sizes. A new process developed by TVA in collaboration with the Fertilizer Institute to provide a suitable replacement for formaldehyde is currently being used by a large segment of the urea industry.

The toxic nature of formaldehyde is expected to prompt early enactment of protective environmental legislation to prohibit its use. Granular urea LS™ was recently developed using calcium lignosulphate as the conditioning and hardening agent. A process was further developed by the National Fertilizer and Environmental Research Center of the Tennessee Valley Authority for coating soluble urea LS™ granules with sulphur to produce controlled-release fertilizers.

In order to reduce sulphur deficiencies in farm soils, the above-mentioned Center has been studying methods for including sulphur in both solid and fluid fertilizers. This has resulted in the recent development of nitrogen-sulphur suspensions, urea-ammonium nitrate-ammonium sulphate suspensions, and high-sulphur urea-ammonium sulphate suspensions. They are made of ammonium sulphate crystals which seem to grow very little during long-term storage. Control of nitrogen losses resulting from hydrolysis of urea and ammonia volatization has recently been achieved in the making of urea-nitric phosphate, a new fertilizer product whose acidity could reduce nitrogen losses. However, urea-nitric phosphate has been criticized because of its relatively low concentration (36 per cent total plant food) which increases shipping and handling costs, and its relatively low critical humidity reaction level (55 per cent) compared with ammonium nitrate (59 per cent) and urea (70 per cent). Because heat is essential in producing polyphosphate from orthophosphate, emphasis has been directed to more effective use of the chemical heat reaction generated by ammoniation of the acids. Also, a process that transforms crystalline ammonium sulphate (a by-product of both the synthetic polymer and coke-oven processes) into a granular product that can be applied directly to soil surfaces eliminates the chance of losing nitrogen to the atmosphere as in the case of surface application of urea. Another potential use of granular ammonium sulphate is in direct applications on soils deficient in sulphur or nitrogen.

Technological innovations are also important in fertilizer manufacturing methods. In the last few years, drum and pan granulation techniques have gained more and more acceptance in the nitrogen industry. While the considerable improvements made in pan granulation have been applied mainly for making granular ammonium nitrate and urea, the process of drum granulation can now be combined with ammoniation of mixed fertilizer and of phosphates such as SSP and TSP. In the manufacture of complex fertilizers, the "hot spherodizer" process was designed for granulation and improvement of product quality. The spherodizer process is said to be able to combine granulation and drying into a single processing step. Also, where granulated fertilizers should be blended, bulk blending is becoming more widespread. Potash processing is still currently performed by flotation and crystallization of salts. Muriate of potassium is still the most important potassic fertilizer, and no significant improvements in technology have been reported recently. Further technological developments in the fertilizer industry include the use of nitric acid instead of sulphuric acid to digest phosphate rock,

*ICI-AMV: Imperial Chemical Industries—ammonia version 5; PSA: Pressure swing absorption.

which eliminates the need for sulphur and offers environmental advantages [22]. These considerations cannot be overlooked under current industry conditions.

7. *Short- and medium-term outlook*

The world fertilizer industry has experienced a series of performance fluctuations since the early 1980s. These have resulted from macro events that were increasingly broad-based and complex in their interactive combinations. The causes of the downturns were attributed mainly to secular shifts in world demand and creation of over capacity. Special problems exist for developed countries today because of environmental regulations that affect not only the costs of production but also agricultural usage. The participation of developing countries has increased significantly, mostly in the phosphate and nitrogen branches of the industry.

Over the short to medium term, the demand for fertilizers is largely dependent on economic activity and agricultural policies in both developed and developing countries. Thus, supply factors (as a function of capacity) should become less likely to contribute to market imbalance than demand factors. One source [11] estimates that there may be brief periods of perceived shortages which may lead to short-term price jumps during the next two to four years. However, a sufficient number of new projects are being actively pursued or planned to enable world markets on the whole to be adequately supplied.

(a) *Consumption*

Increasing concerns about the environment, which have led to legislation in some industrialized countries, will continue to have an adverse effect on world demand for fertilizers. Moreover, changes in the economic systems in Eastern Europe and the USSR, the reductions in fertilizer subsidies in developing countries, and policies adopted to reduce crop production surpluses in Western Europe are all expected to depress fertilizer demand in the short term. Total world fertilizer consumption is expected to increase at an average annual rate of 2.1 per cent [10]. Growth is expected to be highest in developing countries, at 3.1 per cent per annum until the year 2005. Developed countries are expected to increase consumption at the moderate annual rate of 1.3 per cent. Consumption of fertilizers is expected to increase even more slowly in centrally planned economies over the same period. The annual growth rate in centrally planned economies should be a low 1 per cent for the next 15 years [10]. Fertilizer application rates are also expected to decline in developed countries. Application rates in developing countries and in centrally planned economies are expected to continue to grow, although at slower rates because of the expected slow-down in crop area expansion. The main source of expected growth of fertilizer consumption in developing countries is crop area expansion, while it is mainly the growth in fertilizer application per unit of crop area in developed countries [10].

Consumption of nitrogen is expected to grow fastest in developing countries, at 3.1 per cent during the period 1990-2005, which will account for most of the 2.3 per cent increase expected worldwide during the same period. Environmentalist attempts to reduce nitrates in groundwater will have a depressing effect on nitrogenous fertilizer use in the EEC and in the United States. Continued decreases in the area planted in Japan and stagnation in the EEC crop area will also contribute to slower growth in the nitrogenous fertilizer industry. Most of the increase in developing-country consumption of nitrogenous fertilizers is expected to occur in China and India. World consumption of phosphatic fertilizers is expected to increase at an annual rate of 1.8 per cent during the same period (compared with a 4.3 per cent increase during the period 1961-1988). China alone is expected to account for one third of the increase in developing countries.

Attempts are being made in other developing countries to improve the imbalances in fertilizer nutrient use, and phosphatic fertilizers offer the advantage of being able to reduce nitrogen run-off. As high application rates have been attained in the countries of Eastern Europe and the USSR, no growth in phosphatic fertilizer consumption is expected in the short term. The declining trend in the EEC and the United States is expected to continue, though at a slower rate, because of pressures arising from environmental concerns, unless new technological breakthroughs emerge in the near future. For potash consumption, there are concrete indications that the largest growth will take place in Asia, particularly in the rice-growing regions. On a global scale, consumption is expected to increase at an annual rate of 2 per cent between 1990 and 2005, which would represent more than twice the growth experienced during the period 1961-1988. Environmentalist pressures to reduce the impact of fertilizers on water systems is expected to depress usage in the North. Consumption in the centrally planned economies is currently declining, but is expected to return to historical peaks by 2005.

(b) *Production*

Table V.42 summarizes fertilizer capacity projections by economic regions for the year 1995, with expected annual changes for the period 1990-1995. Nitrogenous fertilizer capacity is measured in terms of ammonia, and phosphatic fertilizer capacity in terms of phosphoric acid.

World production capacities for nitrogenous fertilizers are projected to increase to about 122 million tonnes in 1995, representing an average annual growth rate of 1.5 per cent as shown in table V.42. The fastest growth is expected in Asia at 4.3 per cent, followed by Africa at 3.5 per cent and Latin America at 3.2 per cent. World capacity of phosphatic fertilizers is projected to increase from 36 million tonnes in 1990 to 39.8 million tonnes in 1995, at an average annual growth rate of 1.9 per cent. Significant increases, at 59.2 per cent per annum, are expected in centrally planned economies of Asia, primarily in China. Capacity is expected to increase from 156,000 tonnes in 1990 to about 1.6 million tonnes in 1995. Other important increases are expected in North Africa which is planning to increase its capacity, at an average annual rate of 4.4 per cent to 5.3 million tonnes by 1995. Production capacities are expected to

Table V.42. Projected world fertilizer capacity, 1995

Region or economic grouping	Nitrogenous a/ fertilizer: Projected capacity (thousand tonnes)	Nitrogenous a/ fertilizer: Annual percentage change 1990-1995	Phosphate b/ fertilizer: Projected capacity (thousand tonnes)	Phosphate b/ fertilizer: Annual percentage change 1990-1995	Potash a/ fertilizer: Projected capacity (thousand tonnes)	Potash a/ fertilizer: Annual percentage change 1990-1995
North America	16 007	0.3	12 177	0.1	11 151	..
Western Europe	12 542	0.3	3 396	0.6	5 535	..
Oceania	619	0.0	204	1.9	..	..
Eastern Europe	36 286	0.1	8 945	0.6	15 618	1.8
Africa						
North	..	..	5 325	4.4	..	..
Other	2 080	3.5	1 247	2.1	..	..
Asia						
Western Asia	7 920	2.7	2 546	2.9	..	..
Centrally planned	22 199	2.4	1 595	59.2	84	..
Other	20 136	4.3	2 651	2.1	2 460	2.1
Latin America	7 096	3.2	1 682	-0.5	..	..
TOTAL	124 885	1.5	39 768	1.9	19 146	0.3

Sources: World Bank, *Price Prospects for Major Primary Commodities*, vol. II (Washington, D.C., 1988 and 1990); and International Fertilizer Industry Association, "*Summary of world fertilizer capacities*" (Paris, 1991).

a/ Ammonia capacity only.

b/ Wet phosphoric acid capacity.

decrease only slightly for Western Europe and Latin America through the mid-1990s. Worldwide, increases in potash productive capacities are expected to be marginal at an average growth rate below 0.1 per cent during the same period. Concerning geographic capacity shifts, Asia will increase its potash capacity most significantly, at an average annual rate of 1.8 per cent, to 2.5 million tonnes by 1995. No further capacity changes or decreases of any significance in potash capacity are expected elsewhere in the world during the period considered.

(c) *Market equilibrium and prices*

Future prospects for fertilizer prices and industry expansion depend on the relative growth rates of crop prices, crop production and expected movements in exchange rates and interest rates. On the subject of projected market equilibrium, the World Bank [10] anticipates that there will be a tendency for fertilizer production to lag behind consumption and for fertilizer prices to increase and generate incentives for extra production capacity. Prices are expected to increase steadily until the late 1990s and then decline slowly through 2005, after new capacity comes on stream. Over the short term, urea prices should increase substantially and are expected to exceed $200 per tonne by the mid-1990s (owing to expected upward shifts in grain production and fertilizer consumption over the next few years) [10]. Phosphate prices should increase if the current tight supply situation persists through the mid-1990s. In particular, sodium phosphate prices should rise to about $194 per tonne by 1995, which would represent a 34 per cent increase over current levels. This will be due to increased demand in East Asia. Potash prices, which have somewhat weakened recently because of declining demand in Eastern Europe and additonal availability of potash from the USSR in the export market, are expected to gather momentum once again as demand in the rice-growing countries of East Asia continues to grow.

Given the expected growth rates in fertilizer consumption and production over the period 1990-2005, supply-demand projections for nitrogenous fertilizers show North America, Western Europe and Eastern Europe and the USSR as the major surplus regions, while developing countries will be the major deficit regions, particularly those of Asia and Africa. Developed countries are expected to continue to be the major exporters of phosphatic fertilizers, despite an expected reduction in the market share of the United States from the current level of 42 per cent to 34 per cent by 2005, mainly due to competition from developing-country producers in Western Asia. Continuing large gaps are expected between production and consumption of potash fertilizers in developing countries. China and Brazil are expected to be the major importing countries in the South. In the North, surpluses are expected to continue as the market share of Canada increases from 37 to 41 per cent over the next 15 years, according to current projections. In the fertilizer industry as a whole, market forces, currently stronger than ever, are also at play and threaten to reduce production by closing uneconomic manufacturing facilities worldwide. Current "conventional wisdom" suggests that the fertilizer industry may now have returned to a period of increased volatility.

E. Nickel (ISIC 372020)*

1. *Recent trends and current conditions*

The nickel industry, with its frequently changing prices, costs and producer strategies, appears to be in a state of constant flux. The key issues facing the industry relate to future nickel demand and prices, the prospects for and expected level of future output, and the costs likely to be incurred by producers, both old and new, under various market and economic scenarios.

After 10 years of steadily declining prices and production costs, the nickel market abruptly shifted from a situation of chronic oversupply of capacity and stocks to one characterized by shortages. In mid-1988 nickel prices were below $1.80 per pound** and no surviving primary nickel producer was receiving a positive return on investment. By late 1988 and early 1989, nickel prices had increased to over $10 per pound before falling back to the still high level of around $7 per pound. Since then, nickel prices have declined to about $4 per pound as new and expanded production has been brought on stream and demand has somewhat slackened.

The result of this precipitous turnabout has been the re-evaluation of numerous new nickel projects and the enlargement of old ones. New mining participants are now entering the nickel production industry through joint ventures utilizing existing or enlarged smelter and refinery facilities. This marginal expansion of existing processing plants has been sufficient to discourage the development of new and highly capital-intensive, greenfield nickel mines and plants.

Most projects that have contributed to increased production have been based on sulphide ore deposits, contrary to the prevailing wisdom of only a few years ago that only laterite deposits offered the potential for significant increases in nickel production. This trend has been of particular significance for developing countries, where the bulk of the world's laterite nickel deposits can be found. Not only have sulphide deposits been brought on stream, but they have been brought on more rapidly than what was previously thought possible.

The current nickel price of below $4 per pound was not thought to be sufficient to induce investment in new nickel capacity. However, continual investment has led to a marginal expansion in production, even when nickel prices were below $2 per pound. This illustrates that the marginal cost required to expand existing capacity is often half that of constructing a new plant. Also, since returns on investment were not certain when the nickel price was below $2 per pound, the present investment expansion suggests that nickel producers have specific long-term market prospects in mind.

(a) *Production of primary nickel*

Sources of supply of primary nickel to market economies include production by those economies as well as net exports from formerly centrally planned economies. The total supply of refined nickel from

*UNIDO acknowledges the contribution of T. Torries, Torries & Associates, West Virginia, United States.

**1 pound = 454 grams.

Table V.43. Refined nickel supply and demand balance, 1986-1990

Country, region or economic grouping	1986	1988	1990	Average annual growth rate 1986-1990
	(thousand tonnes)			
Production by market economies				
Canada	112	147	143	6.30
Europe	111	128	136	5.21
Japan	93	101	101	2.08
Oceania and other Asia	82	80	82	-
Central and South America	54	59	61	3.09
Africa	41	47	48	4.02
United States	2	-	4	18.92
Total	495	562	575	3.82
Exports of centrally planned economies				
USSR	52	70	90	14.70
Cuba	8	15	18	22.47
Eastern Europe	1	1	3	31.61
China	3	5	-	-
Total	64	91	111	14.76
Imports of centrally planned economies				
Eastern Europe	6	2	9	10.67
China	1	12	-	-
Total	7	14	9	6.48
Net exports of centrally planned economies	57	77	102	15.66
Total supply to market economies	552	639	677	5.24
Consumption by market economies				
United States	128	135	136	1.53
Europe	232	273	276	4.44
Japan	125	160	156	5.69
Other	87	85	98	3.02
Total demand	572	653	666	3.88
Supply-demand balance	-20	-14	11	-

Source: Metallgesellschaft AG, *Metallstatistik* (Frankfurt, various issues).

1986 to 1990 is shown in table V.43. The largest increases in production have occurred in Canada and Europe, because their producers had reduced nickel production the most during the period of oversupply in the mid-1980s. Almost all increases in production were from increased capacity utilization. The only new nickel production to come on stream as a result of capital expansion was at P.T.INCO in Indonesia.

In recent years, nickel exports by the USSR and Cuba have become a major factor in the nickel supply and demand balance of market economies. In the late 1970s and up to the mid-1980s, USSR nickel exports to developed market economies averaged 35,000 tonnes per year, and combined USSR and Cuban exports fluctuated between 50,000 to 60,000 tonnes per year. In 1986, the supply from the USSR increased to about 60,000 tonnes, rising to over 100,000 tonnes in 1989. The causes of this large increase have not been adequately explained. Forecasting the very significant quantities of nickel supplied to developed market economies from centrally planned economies, current and former, is fraught with uncertainties.

Table V.43 also shows nickel consumption and the supply and demand balance in market economies. Demand outstripped supply in 1986 without affecting prices because of the large nickel stocks available. As nickel demand increased and stocks decreased, nickel production and imports of developed market economies grew.

(b) *Stocks, scrap and recycled materials*

Nickel industry scrap flows are important when forecasting nickel demand and are unlike those of many other metals, principally because 50 per cent or more of the input in stainless steel production is derived from nickel scrap. The nickel scrap input is divided into the three categories described below:

Revert scrap is material discarded in a steel plant during the production process and recycled in its own plant. In the 1950s, about 45 per cent of ingot production was recycled as revert scrap. Today this percentage has dropped below 20 per cent owing to more efficient practices in ingot production and rolling mills. Nevertheless, if a stainless steel plant reduces operating rates, it can for some time use the created excess revert-scrap inventories for its feed.

Industrial scrap is generated by manufacturing and fabricating plants and sold to steel producers. The normal percentage of this scrap in stainless steel production is 10 per cent. However, this percentage can also increase or decrease depending on the previous level of fabricating activities in relation to current stainless steel production.

Reclaimed scrap is old scrap reclaimed from buildings, plants, equipment, and similar sources built 5 to 30 years ago. Significantly less nickel-bearing material was used 20 to 30 years ago than today. The continued growth in nickel consumption will result in more and more reclaimed nickel scrap becoming available.

As the growth of nickel consumption continues, more scrap of all forms becomes available, even with the increasing efficiency of nickel product manufacture. The increase in nickel scrap consumption is reflected in table V.44, which shows that consumption of reclaimed scrap has grown on the average by about 8.9 per cent per year over the last 17 years. Reclaimed scrap is not generally considered to be an important source of nickel, but could become a significant factor in the future supply and demand balance of the nickel industry.

(c) *International trade*

Nickel is traded in most of the forms in which it is found or made, including ore, concentrates, matte, oxide, ferronickel, utility nickel, anode and nickel metal. The higher the degree of processing, the higher the nickel content and the lower the transport costs. However, low energy prices may offer reasons for transporting lower-grade ore over large distances. Wet laterite ore is transported by vessel from the very large laterite resources in Indonesia, New Caledonia and the Philippines to eastern Australia, Japan and the west coast of the United States. Although laterite ores contain 25 to 40 per cent moisture, it is not feasible to dry at the mine because of the resulting dusting problems. Not all nickel smelters or refineries can treat ore, but in general, ferronickel furnaces and hydrometallurgical plants are able to do so.

Concentrates of all grades are also transported internationally. Since there is generally a trade-off between concentrate grade and metal recovery, there is an economic upper limit to the grade of concentrate produced. High-grade concentrates from smaller mines or mines in remote locations are commonly transported to large nickel sulphide smelters for processing. This is the basis for a number of new projects being considered in western Australia and Canada, involving the shipment of nickel sulphide concentrates to existing processing facilities in Canada and Europe.

Nickel matte is also transported from smelters to nickel refineries on an international basis. For example, nickel matte is transported from Botswana and Canada

Table V.44. Scrap consumption changes in stainless steel, 1970-1987

Item	1970 (thousand tonnes)	1987 (thousand tonnes)	Average annual growth rate 1970-1987
Austenitic stainless steel			
Production	3 490	6 900	4.1
Consumption	2 350	5 430	5.0
Yield (percentage)	67.0	79.0	-
Scrap use for stainless steel			
Revert scrap	1 140	1 470	1.5
Industrial scrap	350	690	4.1
Reclaimed scrap	250	1 070	8.9
Total	1 740	3 230	3.8
Production from new materials	1 750	3 670	4.5
Percentage of scrap use in production	49.8	46.8	-
Nickel consumption in stainless steel	184	352	3.9
Average nickel content in austenitic stainless (percentage)	10.3	9.6	-

Source: Database of Torries and Associates, Morgantown, West Virginia.

to the Falconbridge refinery complex in Norway. Copper-nickel matte is transported from the large flash smelter of WMC in western Australia to refineries in Japan, Canada and Europe. Also, nickel laterite is processed by P.T. INCO in Indonesia to make a sulphide nickel matte that is processed in facilities controlled by P.T.INCO in Japan, Republic of Korea and Taiwan Province. The production and transport scheme of P.T. INCO is determined more by marketing than by technological factors.

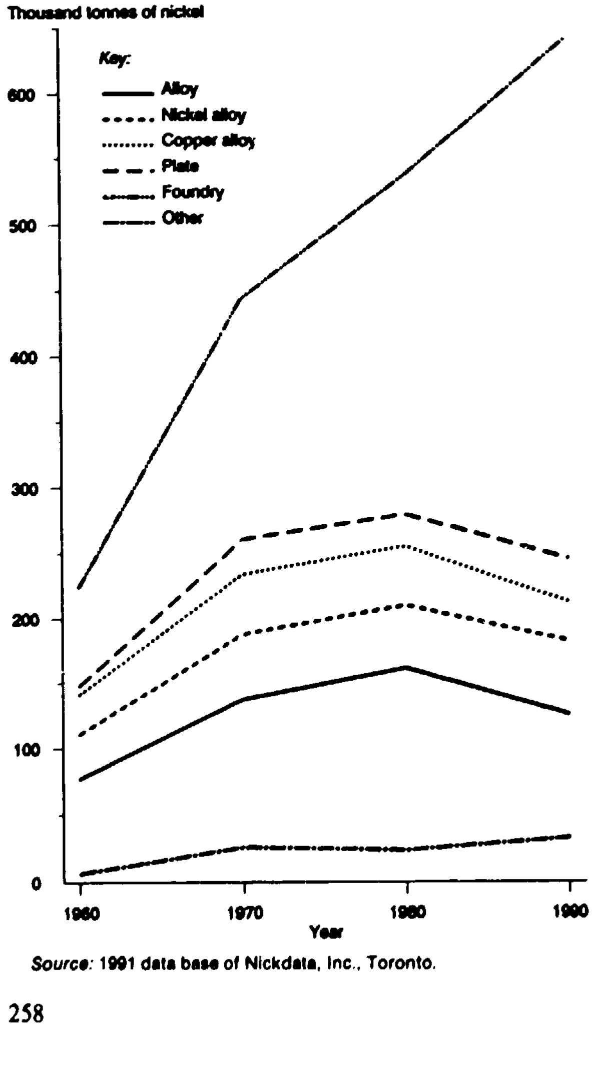
Finished nickel is transported and used in a number of physical and chemical forms, including ferronickel, nickel oxide, briquettes, rondelles, sinter, utility nickel and nickel metal. The forms may not be interchangeable at the users plant. It is therefore possible for nickel overcapacity to exist in general, but not for specific types of nickel, as in the case of the 1988 shortage of ferronickel.

As with many other mineral commodities, most nickel is consumed in developed countries, some of which also produce large quantities of both mined and refined nickel, for example in Australia, Canada and Europe. In addition, large supplies of nickel come from the USSR and China.

(d) Consumption of primary nickel

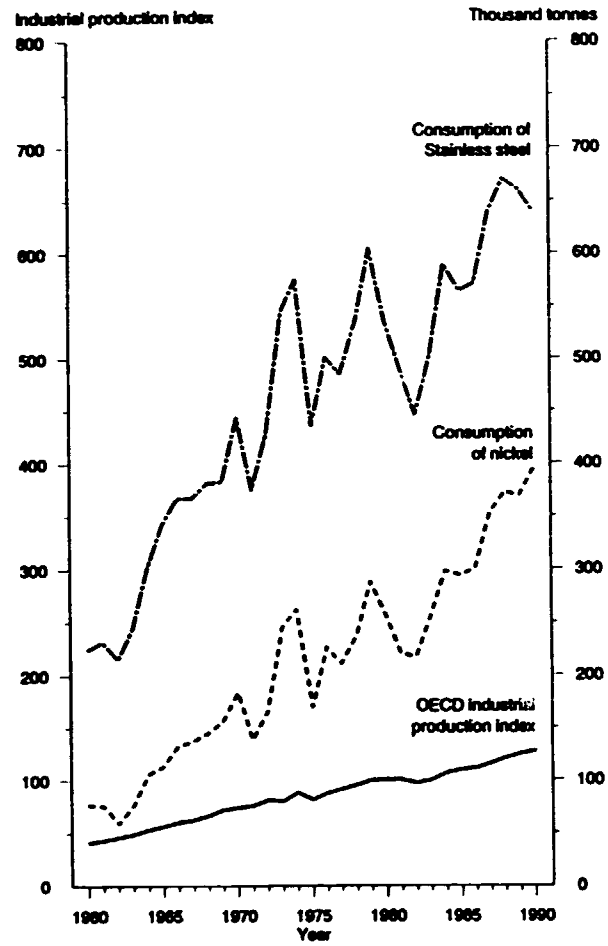
Nickel is primarily used in the manufacture of various metal alloys to impart strength, toughness or resistance to corrosion and heat. The single largest use of nickel, which accounts for over 60 per cent of total nickel consumption, is in the manufacture of stainless steel. Nickel is also used as nickel plate in the manufacture of other nickel and copper alloys, and in a number of other minor applications associated with consumer durables. The pattern of consumption of nickel by first use is reflected in figure V.10, which shows that all growth in nickel consumption over the past 10 years has been due to the increased production of stainless steel, a trend likely to continue.

Figure V.10. Nickel consumption by first use, 1960-1990



Source: 1991 data base of Nickdata, Inc., Toronto.

Figure V.11. OECD industrial production and consumption of nickel and stainless steel, 1960-1990



Source: 1990 database of WEFA, Inc., Bala Cynwyd, Pennsylvania.

Stainless steel and nickel consumption in developed countries since the Second World War has been closely dependent on industrial production. As is shown in figure V.11, nickel consumption closely follows the weighted average OECD index of industrial production, which indicates the level of capital expenditure on new plant and equipment. Approximately 50 to 60 per cent of all nickel consumption in developed countries results from economic activities relating to capital expenditures. The balance is consumed in a wide range of products, mostly consumer durables.

Stainless steel consumption has grown since 1982 at a phenomenal rate, outstripping the growth in both nickel demand and industrial production. Nickel consumed in stainless steel increased from 218,000 tonnes in 1982 to an estimated 395,000 tonnes in 1990, an annual growth rate of 7.7 per cent. Stainless steel currently represents about 62 per cent of total nickel consumption in developed market economies. Many analysts have suggested that stainless steel consumption will continue to grow at average annual rates of 3 to 5 per cent, depending on which year is taken as a starting-point.

As shown in figure V.10, all other nickel uses have achieved little or no growth, and in some cases have declined. The two potential categories that may show some future growth are the nickel-based alloys and alloy steels. Nickel-based alloys are to a large extent used in the aerospace industry, particularly in jet engines. In the next 5 to 10 years, there will be significant new requirements for jet engines, since the airlines of the world will need to replace their fleets. The other promising category is alloy steels, which has shown a relatively low but steady growth in nickel consumption. Alloy steels are used in a wide range of applications, such as gear assemblies, bearings, axles and boilers. Alloy steels containing nickel are also increasingly used in the construction industry to reduce dead weight and increase payload. Nevertheless, the annual growth rate for this use may be only 1 to 2 per cent per year.

Consumption of stainless steel and nickel has gone through three separate growth phases since 1960. These phases are clearly reflected in figure V.10. The reasons for the changing patterns of stainless steel and nickel consumption are based on the three phases of world economic activity that have evolved since the Second World War. In the early post-war period, the industry in the United States retooled from military to civilian production and the consumer economy caught up with civilian demand after many years of war shortages. Very large capital expenditures were made during this period in the United States and other parts of the world. In the 1950s and 1960s, there was a massive reconstruction of Japanese and European war-devastated economies with a drive towards consumer goods production. In addition, there was a military build-up during the conflicts in the Republic of Korea and Viet Nam. During this period growth in nickel consumption averaged 7 per cent per year.

During the economic slow-down in the 1970s and early 1980s, a pent-up demand developed for capital expenditure. For many years, capital expenditure levels were very low in the mining, construction, pulp and paper, chemical, aerospace and many other industries in which stainless steel is used in plant and equipment. When significantly higher capacity utilization rates were attained worldwide by all industries in the early 1980s, a major capital expenditure boom ensued. Capital expenditures for OECD non-residential fixed investment rose by 11 per cent in 1986 and 6 per cent in 1987, which explains the rapid growth in stainless steel demand.

Another factor contributing to the increase in nickel consumption was that stainless steel and nickel prices were relatively low between 1971 and 1986 because of depressed conditions in the industry, compared with those for other competitive materials. Figure V.12 shows that plastics, aluminium, and even iron and steel prices have experienced increases significantly greater than those of stainless steel. This growth advantage may be reduced or eliminated with the recent price increases for stainless steel and nickel.

The growth of nickel consumption has not been equal in all areas of the world. In Asia, where nickel consumption grew very rapidly during the 1980s, the growth was predominantly due to increased use of stainless steel. As shown in table V.45, the demand for nickel in Asia grew by 5.2 per cent per year from 1980 to 1988, compared with 3.1 per cent for the world as a whole, excluding centrally planned economies.

Some individual countries and areas experienced phenomenal growth in nickel demand, such as India at 10 per cent, Republic of Korea at 9.1 per cent and Taiwan Province at 27.6 per cent. In these countries and areas there has been a significant increase in disposable income, which has boosted the demand for consumer durables. There has also been a growth of fast food and chain restaurant outlets, such as McDonald's, throughout the South-East Asian countries. Significant amounts of stainless steel are required for each outlet.

Table V.46 provides a comparison of per capita nickel consumption in selected market economies in 1988 with that of centrally planned economies. Since Japan and the Federal Republic of Germany have highly developed stainless steel industries geared for the export market, their per capita nickel consumption was extremely high. Similarly, it seems reasonable to assume that the nickel consumption levels in Czechoslovakia, German Democratic Republic and USSR reflected relatively large armaments and heavy equipment production.

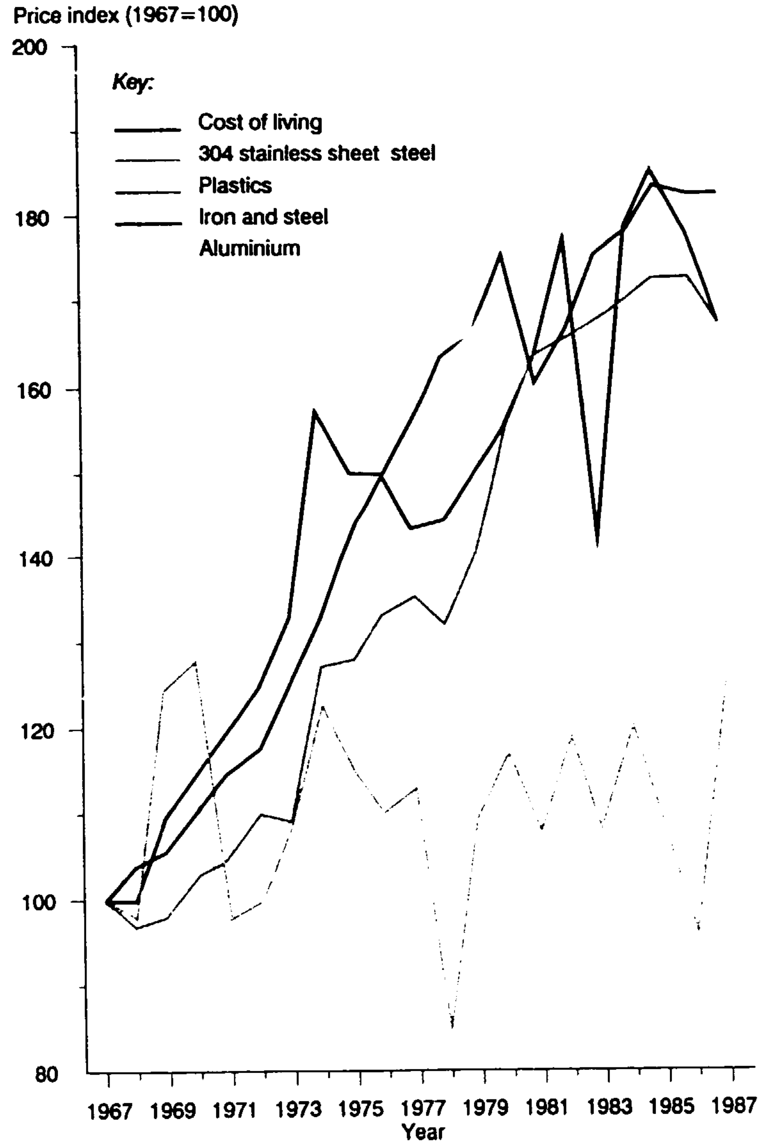
(e) *Cyclical market conditions*

The demand for nickel is characterized by cyclical fluctuations, since stainless steel and nickel demand closely follow the cycle of world economic activity. However, nickel consumption cycles are more volatile than economic cycles for a number of reasons. As previously discussed, stocks required during the normal making and fabricating of nickel products are large as compared with other industries. Increases in demand are therefore significantly expanded by the increased requirements to replenish nickel stocks. The opposite is true during declines in nickel demand.

2. *Manufacturing capacity and industry structure*

A distinguishing feature of the nickel industry is the small number of primary sources of nickel and the resulting small number of producers. Before 1970, large integrated (mining and processing) nickel operations were limited to Canada, China, Cuba, Finland, New Caledonia, United States and USSR. Since then, new integrated operations have been developed in Asia, Australia, the Caribbean, Europe and Latin America. Much of the new output (as opposed to output that replaces depleted reserves) has been from lateritic oxide deposits located in tropical developing countries. The distinction between integrated and non-integrated operations is now less meaningful, since an increasing number of facilities process a variety of feedstocks from multiple sources, including imported laterite ore or nickel matte.

Figure V.12. Comparative price index for the cost of living and various industrial materials, Federal Republic of Germany, 1967-1987



Source: Heinz H. Pariser and Thomas Shaffer, paper presented at the Global Market Development Forum for Stainless Steel, held in London in May 1988.

Table V.47 shows the number of nickel production units at each stage of processing. The international character of the data suggests that trade in intermediate nickel products among operations in different countries is common. Tables V.48 and V.49 provide further details on intermediate trade. Australia, Botswana, Canada and Indonesia produce matte or impure nickel products, which are shipped to nickel refining plants in Europe, North America, Africa and Asia. These plants reduce the intermediate products to final commercial forms such as nickel metal or utility nickel. For example, WMC produces in Australia nickel matte that is shipped to Canada, Japan and Finland for conversion to nickel metal. The only nickel refinery located in a developing country that receives imported nickel for processing is the Empress plant in Zimbabwe. As shown in table V.47, the INCO-controlled plants in the Republic of Korea and Taiwan Province also receive imported material for processing, but these are classified as NICs rather than developing countries or areas. In addition, nickel laterite ore is mined and shipped to other countries for processing. For example, ore from Indonesia, New Caledonia and the Philippines is mined and shipped to Australia and Japan where it is converted into nickel metal or ferronickel.

Total world nickel production capacity in the Western World (excluding net exports by centrally planned economies) is about 575,000 tonnes per year. An accurate capacity estimate for the world nickel

Table V.45. World[a] primary nickel consumption, 1980-1988
(Thousand tonnes)

Region, country or area	1980	1982	1984	1986	1988	Average annual growth 1980-1988
Western Europe	206	180	232	230	270	3.5
North America	153	132	150	136	158	0.4
Oceania	5	3	4	3	4	-3.9
Africa						
South Africa	4	4	8	9	9	10.7
Other	1	1	1	1	1	-
Total	5	5	9	10	10	9.1
Asia						
India	7	11	16	16	15	10.0
Japan	124	108	145	128	161	3.3
Republic of Korea	3	3	3	7	6	9.1
Taiwan Province	3	3	5	15	18	27.6
Other	2	2	6	8	8	17.5
Total	139	127	174	173	208	5.2
Latin America						
Brazil	11	7	10	13	15	3.3
Other	6	5	5	6	6	0.6
Total	17	13	16	19	21	2.4
TOTAL	524	459	584	571	670	3.1

Source: Metallgesellschaft AG, *Metallstatistik* (Frankfurt, various issues).
[a] Excluding centrally planned economies.

Table V.46. Nickel consumption of selected countries, 1988

Country or economic grouping	Consumption (thousand tonnes)	Population (millions)	Per capita nickel consumption (pounds)[a]
Market economies			
United States	140.6	247.5	1.25
Japan	161.7	123.2	2.89
Germany, Federal Republic of	89.4	60.2	3.27
France	39.6	55.8	1.56
United Kingdom	33.1	56.6	1.29
Italy	28.0	57.4	1.08
Spain	16.8	39.8	0.93
Total	509.2	640.5	1.75
Centrally planned economies			
USSR	130.0	287.0	1.00
Other	47.3	113.6	0.92
Total	177.3	400.6	0.98

Source: Metallgesellschaft AG, *Metallstatistik* (Frankfurt, various issues).
[a] 1 pound = 454 grams.

industry is difficult to determine for several reasons. First, capacity depends on the price of nickel at any given time, and the price of nickel fluctuates. Capacity can be marginally increased in the short run in response to high nickel prices by changing operating procedures, such as mining higher-grade ore or postponing scheduled maintenance shut-downs. Secondly, industry capacity depends on the capacity of the limiting processing stage. For example, the sum of capacity of individual refineries does not determine the amount of nickel that can be produced, if bottlenecks occur in the mines or smelters. In addition,

Table V.47. Nickel production units

Production unit	Product	Mine or mill	Smelter	Refinery
Sulphides				
INCO 1	Carbonyl	Sudbury (Canada)	Sudbury (Canada)	Wales (United Kingdom)
INCO 2	Utility nickel Carbonyl	Sudbury (Canada)	Sudbury (Canada)	Sudbury (Canada)
INCO 4	Nickel oxide	Sudbury (Canada)	Sudbury (Canada)	Republic of Korea
INCO 5	Nickel oxide	Sudbury (Canada)	Sudbury (Canada)	Taiwan Province
INCO 6	Nickel oxide	Thompson (Canada)	Thompson (Canada)	Sudbury (Canada)
INCO 7	Electrolytic nickel	Thompson (Canada)	Thompson (Canada)	Thompson (Canada)
INCO 9	Carbonyl	Namew (Canada)	Thompson (Canada)	Sudbury (Canada)
Scherritt 1	Briquettes	Namew (Canada)	None	Sherritt (Canada)
Scherritt 2	Briquettes	Redstone (Canada)	None	Sherritt (Canada)
Scherritt 3	Briquettes	Kambalda (Australia)	Kalgoorlie (Australia)	Sherritt (Canada)
Falconbridge 1	Electrolytic nickel	Sudbury (Canada)	Sudbury (Canada)	Norway
Falconbridge 2	Electrolytic nickel	Botswana	Botswana	Norway
Empress-BCL	Electrolytic nickel	Botswana	Botswana	Zimbabwe
WMC 1	Briquettes	Kambalda (Australia)	Kalgoorlie (Australia)	Kwinana (Australia)
WMC 2	Briquettes	Leinster (Australia)	Kalgoorlie (Australia)	Kwinana (Australia)
Outokumpu 1	Briquettes	Various (Finland)	Finland	Finland
Outokumpu 2	Electrolytic nickel	Kambalda (Australia)	Kalgoorlie (Australia)	Finland
Bindura	Briquettes	Zimbabwe	Zimbabwe	Zimbabwe
Sumitomo-WMC	Electrolytic nickel	Kambalda (Australia)	Kalgoorlie (Australia)	Niihama (Japan)
Laterites				
Sumitomo-INCO	Electrolytic nickel	Soroako (Indonesia)	Soroako (Indonesia)	Niihama (Japan)
Tokyoni-INCO	Nickel oxide	Soroako (Indonesia)	Soroako (Indonesia)	Matsuzaka (Japan)
SLN 1	Electrolytic nickel	SLN (New Caledonia)	Doniambo (New Caledonia)	Le Havre (France)
SLN 2	Ferronickel	SLN (New Caledonia)	Doniambo (New Caledonia)	None
QLN JV	Nickel oxide	Greenvale (Australia)	None	Yabulu (Australia)
QLN JV-Imp Ore	Nickel oxide	Imp Lat Ore	None	Yabulu (Australia)
Falcondo	Ferronickel	Dominican Republic	Dominican Republic	None
Cerro Matoso	Ferronickel	Colombia	Colombia	None
Tocantins	Electrolytic nickel	Tocantins (Brazil)	Tocantins (Brazil)	São Paulo (Brazil)
Codemin	Ferronickel	Codemin (Brazil)	Codemin (Brazil)	None
Morro	Ferronickel	Morro (Brazil)	Pratapolis (Brazil)	None
Sumitomo	Ferronickel	New Caledonia (Indonesia) Philippines	Hyuga (Japan)	None
Nippon Yakin	Ferronickel	New Caledonia (Indonesia) Philippines	Oeyama (Japan)	None
PAMCO	Ferronickel	New Caledonia (Indonesia) Philippines	Hachinohe (Japan)	None
Aneka Tambang	Ferronickel	Aneka (Indonesia)	Pomalaa (Indonesia)	None
Larco	Ferronickel	Euboea (Greece)	Larymna (Greece)	None
Kosova	Ferronickel	Kosova (Yugoslavia)	Glogovac (Yugoslavia)	None
Nonoc	Briquettes	Surigao (Philippines)	None	Nonoc (Philippines)
Riddle	Ferronickel	Riddle (United States)	Riddle (United States)	None
Riddle-Imp Ore	Ferronickel	New Caledonia (Indonesia) Philippines	Riddle (United States)	None

Source: Database of Torries and Associates, Morgantown, West Virginia.

since not all smelters and refineries can accept all types of nickel feedstocks, there may be a shortage of feed to a particular type of smelter, although on a world basis sufficient ore production capacity exists. The best measure of capacity is the observed maximum amount of nickel produced in times of robust nickel demand.

(a) Largest companies in the North

The largest nickel producer in the world, excluding centrally planned economies, is INCO, which has mines and processing operations at two locations in Canada and one in Indonesia, and either wholly or partially owned processing plants in Japan, Republic of Korea, Taiwan Province and United Kingdom. INCO currently commands about a third of the world nickel market with a total annual output of over 180,000 tonnes of nickel per year, of which 140,000 tonnes originate in Canadian mines. Production in its Sudbury operations is constrained by environmental regulations aimed at reducing atmospheric sulphur emissions. The company plans to increase total production to 205,000 tonnes per year by 1992, largely through increases in its Indonesian operations. INCO is also an important fabricator of nickel metal products.

Table V.48. World exports of nickel intermediate products, 1980, 1987 and 1988

Rank in 1988	Country, territory or economic grouping	Exports 1980 (thousand tonnes)	Exports 1987 (thousand tonnes)	Exports 1988 (thousand tonnes)	Annual percentage change 1980-1988	Annual percentage change 1987-1988	Percentage share 1980	Percentage share 1988
1	Canada	42.6	56.6	65.3	5.5	15.4	20.09	27.70
2	Australia	57.0	37.4	50.0	-1.6	33.7	26.89	21.21
3	Indonesia	30.5	31.0	39.7	3.4	28.1	14.39	16.84
4	Botswana	15.4	16.5	22.5	4.9	36.4	7.26	9.55
5	Cuba	16.7	17.0	18.3	1.2	7.6	7.88	7.76
6	New Caledonia	16.4	7.4	10.3	-5.6	39.2	7.74	4.37
7	USSR	0.9	0.1	6.0	26.8	6 000.0	0.42	2.55
8	United Kingdom	2.9	1.3	0.8	-14.9	-38.5	1.37	0.34
9	Myanmar	0.1	0.1	0.1	..	..	0.05	0.04
10	Germany, Federal Republic of	0.3	1.2	..	..	..	0.14	..
11	Italy	..	0.1	..	..	..	..	..
12	France	0.2	0.1	..	..	..	0.09	..
13	Netherlands	3.0	..	..	..	..	1.42	..
14	Finland	1.4	..	..	..	..	0.66	..
	North America	42.6	56.6	65.3	5.5	15.4	20.09	27.70
	Western Europe	7.8	2.7	0.9	-23.7	-66.7	3.68	0.38
	Oceania	73.4	44.8	60.3	-2.4	34.6	34.62	25.58
	Other developed economies	9.1	..	..	..	..	4.29	..
	Africa	15.4	16.5	22.5	4.9	36.4	7.26	9.55
	Latin America	16.7	17.0	18.3	1.2	7.6	7.88	7.76
	Asia	30.6	31.1	39.8	3.3	28.0	14.43	16.89
	Other developing economies	15.4	16.6	22.6	4.9	36.1	7.26	9.59
	Eastern Europe and USSR	0.9	0.1	6.0	26.8	6 000.0	0.42	2.55
	TOTAL	212.0	185.4	235.7	1.3	27.1	100.00	100.00

Source: *UNCTAD Commodity Yearbook*, (United Nations publication, Sales No. E.90.II.D.9), New York, 1987 and 1990.

Table V.49. World imports of nickel intermediate products, 1980, 1987 and 1988

Rank in 1988	Country, area, region or economic grouping	Imports 1980 (thousand tonnes)	Imports 1987 (thousand tonnes)	Imports 1988 (thousand tonnes)	Annual percentage change 1980-1988	Annual percentage change 1987-1988	Percentage share 1980	Percentage share 1988
1	Norway	57.7	48.8	63.2	1.5	29.5	28.30	30.41
2	Japan	42.8	42.9	47.0	1.2	9.6	20.99	22.62
3	United Kingdom	24.8	27.3	30.0	2.4	9.9	12.16	14.44
4	Taiwan Province	..	9.0	14.0	..	55.6	..	6.74
5	Germany, Federal Republic of	11.1	10.5	11.7	0.7	11.4	5.44	5.63
6	France	14.1	9.2	10.8	-3.3	17.4	6.92	5.20
7	Italy	2.1	8.7	9.4	20.5	8.0	1.03	4.52
8	United States	31.5	3.8	5.0	-20.6	31.6	15.45	2.41
9	Finland	6.0	3.6	4.6	-3.3	27.8	2.94	2.21
10	Canada	3.7	2.8	4.5	2.5	60.7	1.81	2.17
11	Belgium and Luxembourg	0.3	1.8	4.4	39.9	144.4	0.15	2.12
12	Sweden	3.5	2.8	1.8	-8.0	-35.7	1.72	0.87
13	Netherlands	2.9	5.8	1.0	-12.5	-82.8	1.42	0.49
14	Austria	1.0	0.3	0.5	-8.3	66.7	0.49	0.24
15	Denmark	..	..	0.5	..	..	..	0.24
16	Spain	0.1	0.3	0.1	-	-66.7	0.05	0.05
17	Pakistan	..	0.2	..	..	..	..	..
18	Turkey	0.2	0.3	..	..	.	0.10	..
19	Australia	2.0	..	..	..	..	0.98	..
20	Yugoslavia	0.1	0.8	..	..	..	0.05	..
	North America	35.2	6.6	9.5	-15.1	43.9	17.26	4.57
	Western Europe	123.6	115.5	137.3	1.3	18.9	60.62	66.07
	Oceania	2.0	..	..	..	..	0.98	..
	Asia	43.0	52.4	61.0	4.5	16.4	21.09	29.36
	Eastern Europe and USSR	0.1	0.8	..	..	..	0.05	..
	TOTAL	203.9	175.3	207.8	0.2	18.5	100.00	100.00

Source: *UNCTAD Commodity Yearbook* (United Nations publication, Sales No.E.90.II.D.9).

Falconbridge, also of Canada, is a major miner and processor of nickel, with mines and plants in Canada and the Dominican Republic and a nickel refinery in Norway that processes matte from Canada and Botswana. Falconbridge has had a number of ownership configurations during the past few years, and is currently owned as a joint venture by Noranda Mines Ltd. of Canada and Trelleborg AB of Sweden. The Sudbury operations have a capacity to produce 34,000 tonnes per year and the Norway refinery can produce 56,700 tonnes per year of refined nickel. Falconbridge is currently evaluating the feasibility of opening a new mine in northern Quebec that would provide an additional 13,000 to 18,000 tonnes of nickel in concentrates to its Norway refinery. Production is envisioned to start around 1995.

The third large Canadian nickel producer is Sherritt Gordon Mines Ltd., which operates a large mineral processing facility at Fort Saskatchewan, Manitoba. The nickel plant at Fort Saskatchewan is an ammonia leach plant that can accept a wide variety of feedstocks and produce 25,000 tonnes of nickel per year. Sherritt no longer operates its own mines but purchases concentrates and matte from a number of sources in Canada and Australia. Production has recently been less than capacity because of lack of plant feed. Sherritt is currently attempting to obtain reliable sources of feed for the facility, and is investigating possible joint ventures in various regions of the world.

Western Mining Corporation is an Australian company with mines, a smelter and a refinery in Western Australia. The company produces more matte from its flash smelter than its ammonia leach refinery can treat, and markets the matte to Sumitomo of Japan, Sherritt Gordon of Canada and Outokumpu of Finland. The Queensland Nickel Joint Venture of Australia was formed from the old Greenvale Nickel Project by distributing the ownership, 83.5 per cent to Dallhold Investments Ltd., an Alan Bond company, and 12.5 per cent to the Government of Queensland. Subsequently, Dallhold went into receivership and a clause in the agreement between Dallhold and the Government of Queensland allowed the Government to increase its ownership share to 28 per cent. This move is being contested by Alan Bond in court. Laterite ore has been obtained from an open pit mine 225 kilometres west of Townsville, Queensland, but this reserve is now almost depleted. The company has been seeking new ore reserves in New Caledonia and Indonesia that have higher nickel and cobalt content to replace domestic ores to be processed in the Townsville ammonia leach refinery. Ore is now being purchased from P.T. Aneka Tambang in Indonesia and a number of independent miners in New Caledonia. Other sources of ore are also being investigated.

Sumitomo Metal Mining Company mines no ore directly, except through its partnership with P.T. INCO in Indonesia, but imports ore and matte for processing in Japan. Matte from P.T. INCO and Western Mining are imported and processed at the Niihama plant to produce 21,000 tonnes of electrolytic nickel per year. The company also imports 600,000 tonnes of wet laterite ore per year from Indonesia, New Caledonia and the Philippines to produce 15,000 tonnes of nickel contained in ferronickel. Two other Japanese companies import laterite ore to manufacture ferronickel in Japan. These are Nippon Yakin and Pacific Metals Co. (PAMCO). Wet ore from Indonesia, New Caledonia and the Philippines is imported by the companies to produce a total of about 41,000 tonnes per year of nickel contained in ferronickel.

(b) *Largest companies in the South*

Société métallurgique de Nickel S.A. is controlled by the Government of France and has mines and plants in New Caledonia and a nickel refinery in France. Laterite ore is mined and processed at the SLN operations in New Caledonia. Most of the ore is processed into ferronickel for direct export. A small amount of material is further upgraded and sent to the SLN Le Havre refinery, where electrolytic nickel and cobalt is recovered. The current economic capacity of SLN in New Caledonia is about 48,000 tonnes of contained nickel. Of this, only 15,800 tonnes per year are sent to the Le Havre plant because of the very high cost of this manufacturing process. The company has an investment programme to increase the capacity of the New Caledonia facilities to 56,000 tonnes of nickel contained in ferronickel.

Until 1988, INCO of Canada had a 98 per cent share in P.T. INCO of Indonesia. Since then 20 per cent has been sold to Sumitomo Metal Mining Company of Japan, and an additional 20 per cent to investors through the Jakarta Stock Exchange. Approximately two thirds of the shares offered were purchased by Indonesian investors. Laterite ore is mined and processed in the electric furnace smelter in Sulawesi, Indonesia, to produce matte containing 75 per cent nickel. All matte from P.T. INCO is refined in Japan by Sumitomo to electrolytic nickel. P.T. INCO capacity has recently increased from 36,300 to 47,600 tonnes per year of contained nickel.

P.T. Aneka Tambang is owned and operated by the Government of Indonesia. The company mines laterite ore and makes ferronickel in Sulawesi, Indonesia. Higher-grade ore is mined and shipped to several smelters in Japan for the production of ferronickel. Lower-grade ore is used for ferronickel production at the Pomaala plant in Indonesia. Current capacity of the mine and ore exporting facilities is about 2 million tonnes of wet ore. The smelter capacity is currently 5,900 tonnes per year, but plans are being made to double this capacity.

Falconbridge Dominicana (Falcondo), owned 85 per cent by Falconbridge and 15 per cent by the Government of the Dominican Republic and private individuals, has produced as much as 32,500 tonnes of nickel in ferronickel from ore mined and processed in the Dominican Republic. Falcondo pays a tax to the Dominican Republic based on the price of nickel and a "deemed" profit. In 1989 the tax rate was 58 per cent of total Falcondo earnings of $232.4 million.

Cerro Matoso S.A. is owned and controlled by the Instituto de Fomento Industrial (IFI) of Colombia (49 per cent), Billiton Overseas Ltd. (51 per cent), which is owned by Royal Dutch Shell, and Comicoe (5 per cent), which is owned by Hanna Mining Company. The company mines relatively high-grade nickel laterite ore in Colombia and processes it into ferronickel. It is planning to increase production from the current level of 18,000 tonnes to 23,000 tonnes of contained nickel per year.

Cia. Niquel Tocantins is owned by Vororantim, one of the largest industrial groups in Brazil. The company mines and processes nickel laterite in Brazil to produce 5,000 tonnes of nickel metal per year. Expansion is under way to double output and possibly to enter the nickel export market. Empresa de Desenvolvimiento de Recursos Minerals S.A. (Codemin) is a Brazilian corporation owned by the Bosana-Siemence Group of Brazil (29.6 per cent), Anglo American Corporation do Brasil (35 per cent), and Morro do Niquel (25.4 per cent). Laterite nickel deposits are mined and processed in Goias to produce 7,000 tonnes per year of nickel contained in ferronickel. Codemin is investigating the feasibility of increasing its production to 11,000 tonnes per year. Morro do Niquel S.A. Mineraçao (Morro) is owned by a number of partners, including Anglo American, Imetal S.A., Banque de l'Indochine et de Suez, and a private estate. Morro mines laterite nickel ore and produces ferronickel in western Minas Gerias. This is the oldest nickel operation in Brazil, producing 2,300 tonnes of contained nickel per year.

The Hellenic Mining and Metallurgical Co. of Larymna (Larco) is currently owned by the Government of Greece, although there has been considerable discussion about privatizing the company, which mines low-grade nickel laterite ore and produces from 16,000 to 17,000 tonnes of nickel contained in ferronickel at its operations in Greece. By accounting methods used in market economies, Larco is one of the highest-cost nickel producers still in operation.

The Kosova nickel operation in Yugoslavia is owned and operated by a local State corporation. Low-grade nickel laterite ore is mined and processed into ferronickel at a rate of about 4,500 tonnes of contained nickel per year.

3. *Production costs*

Nickel production costs have declined significantly since 1982 as producers have striven to reduce costs to gain a larger share of an oversupplied market. However, since nickel demand finally exceeded supply in 1989, nickel production costs have been rising. Such increases depend on a number of factors, such as the following: size of labour force and labour rates; ore grades mined, mining characteristics and metal recoveries; technical characteristics of the processes used; type and costs of fuels, supplies and labour used; transport methods, distances, and grades of materials transported; local taxes and royalties; plant and infrastructure capital costs, debt and interest payments; exchange rates; by-product prices; and operating rates. It is not unusual for costs of various production units to change significantly from one year to the next as a result of the interactions among this complex set of factors.

(a) *Effects of changing costs*

For the third consecutive year average nickel production costs have increased. However, the cost structure of the industry is significantly different from that of previous years. While production costs for the sulphide producers increased, those of the major laterite producers decreased. As a result, total production costs for the major laterite producers are lower than those of the major sulphide producers for the first time in many years. The reasons for this change in cost structure are due to relatively minor differences in current operating costs and to major differences in capital costs. The major sulphide producers are making much larger capital investments than are the laterite producers.

Mine development, which is now a major cost item in all sulphide operations, have been neglected by many producers over the past few years of low nickel prices and profits. This is understandable since these operations were struggling for survival and did not have resources for normal reinvestment. Not only must mine development expenses increase to make up for past deficiencies, but sulphide mine development is much more expensive than laterite development. Although total costs of the major laterite producers are less than those of sulphide producers owing to major increases in depreciation and overhead charges, net operating costs for the sulphide producers remain lower. However, the average difference in operating costs of sulphide and laterite producers is shrinking, and now stands at less than 40 cents per pound of nickel.

The prices of nickel, its by-products and energy greatly affect net production costs of all nickel producers. As shown in table V.50, average prices experienced by the nickel industry for oil and metals changed significantly from 1989 to 1990. These price changes caused producers with high copper credits, such as INCO Sudbury, Falconbridge and Outokumpu to benefit, but only to the extent that gains were not offset by lower cobalt and precious metal prices. Producers with lower labour rates, significant matte or ore purchases, or royalties tied to the price of nickel benefited because of lower nickel prices. Exchange rate differences were significant for only a few producers during the past year, after having been highly significant in previous years.

Table V.50. Average commodity prices in the nickel industry, 1986, 1989 and 1990

Commodity	Units	1986	1989	1990	Percentage change 1989-1990
		(dollars per unit)			
Nickel	pounds	1.86	5.49	4.17	-24.0
Copper	pounds	0.63	1.18	1.19	0.8
Cobalt	pounds	7.26	7.51	8.42	12.1
Gold	ounces	358	383	382	-0.3
Platinum	ounces	438	506	462	-8.7

Source: Falconbridge Ltd., *1990 Annual Report* (Toronto, 1990).
Note: 1 pound = 16 ounces = 454 grams.

(b) *Costs versus prices*

In times of excess demand, the price of nickel is influenced by considerations other than nickel production costs, such as speculation and the potential revenues lost by nickel consumers, if their nickel-containing products are not manufactured. Clearly this was the case in 1988 and 1989. Price forecasts based on cost projections are not applicable in conditions of severe nickel shortages, but do indicate the levels to which nickel prices might fall, if supply were again to exceed demand.

Current nickel prices in the range of \$3.80 to \$4.15 per pound have been sufficient to induce new nickel investment and capacity, as shown by current plans for capacity additions. This can be further illustrated by an example based on a new greenfield nickel plant of 45,400 tonnes, or 100 million pounds sterling, per year, with the following capital and operating costs:

Capital expenditure	*Million dollars*
Underground mine with 15-year life	250
Concentrator	200
Smelter	250
Refinery	300
Total (\$10 per pound of annual capacity)	1 000
Net operating cost	\$2 per pound of nickel

On a constant dollar basis, a required return on investment of 10 per cent is assumed, which is equivalent to a 16 per cent return with 6 per cent inflation. In this case \$1.31 per pound of nickel is required for capital recoupment and return on investment. If net operating costs are \$2 per pound of nickel, a price of \$3.81 per pound would cover all operating and capital costs plus a constant 10 per cent dollar rate of return.

The above example may understate the capital costs required for a new plant in a remote location where construction is more expensive and more infrastructure is required. Such a situation might increase capital costs by a third or more. The high cost of large operations in remote locations is a major reason why these types of projects are not being more seriously considered at present.

4. *Restructuring and redeployment*

Nickel occurs in nature as both primary sulphide and weathered oxide ore. The nickel sulphide ores have accounted for most of the nickel mined in the world, with the Canadian nickel-copper sulphide mines being by far the most productive. Other major nickel-sulphide-producing countries include Australia, Botswana, China, Finland and USSR. Additional unmined resources of nickel sulphide are also know to exist in these countries, as well as in Brazil, United Republic of Tanzania, United States and Zaire. However, a much larger quantity of oxide or nickel laterite ore exists in the world and represents a huge resource base for future nickel production.

Much of the oxide ore in the world occurs in tropical developing countries and territories such as Brazil, Colombia, Cuba, Dominican Republic, Guatemala, Indonesia, New Caledonia and the Philippines. Unproven resources thought to have potential also occur in Bolivia, Burundi, Côte d'Ivoire, India, Myanmar and a number of Latin American and African countries. Large quantities of lower-grade and less economic laterite deposits also exist and are sporadically mined in Greece, Yugoslavia and neighbouring countries. In view of the present resource availability, the main investment question concerns which of the deposits can be developed the most economically, given the uncertainties concerning metal markets and energy costs.

Since the nickel price increased dramatically in 1988, numerous new and previously known but unmined projects have been considered for future development. Table V.51 lists the more important new projects or those most likely to be undertaken during the next 10 years. The annual production shown for each project is based on the best information available, but the actual production rate, if and when a project comes on stream, may be significantly different. The total number of potential deposits and projects that exist in the world exceeds those presented in the table. For example, numerous large high-grade laterite deposits exist in Indonesia and New Caledonia that could be profitably developed at nickel prices in the range of \$4 to \$5 per pound. Because of their remote location and high capital costs, it is likely that any development of these deposits would be on a large scale to take advantage of economies of scale. The Gag Island and Tiebaghi projects fall into this category.

There are many nickel deposits that could be brought on stream at nickel prices exceeding \$5 per pound. Undoubtedly, projects that are not now being seriously considered could be brought into production by the year 2000. In addition, high nickel prices also provide the inducement for exploration. Although the result of future exploration cannot be known in advance, past experience with all metals suggests that there are still significant undiscovered nickel deposits to be found. Also, if economic and political conditions in the USSR allow the involvement of private foreign companies within the next five years, nickel production in that country could increase significantly because of its undeveloped nickel resource base.

Table V.51. Possible additions to nickel production capacity

Producer	Possible additions (thousand tonnes)
Sulphide	
Mt. Keith (Australia)	26.0
Forrestania (Australia)	9.0
Bulong (Australia)	10.0
Yackabindie (Australia)	20.0
Radio Hill (Australia)	3.0
Forteleza (Brazil)	8.0
New Quebec Raglan (Canada)	15.0
Wellgreen (Canada)	15.0
Jin Chuan (China)	13.0
Barbican (South Africa)	17.0
Pechenga (USSR)	15.0
Crawford Pond (United States)	15.0
Munali (Zambia)	3.0
Laterite	
Las Camariocas (Cuba)	30.0
Punta Gorda (Cuba)	30.0
Gag Island (Indonesia)	45.0
Tagaung Taung (Myanmar)	10.0
Tiebaghi (New Caledonia)	20.0
Nonoc (Philippines)	24.0
Kavadarci (Yugoslavia)	18.0

Source: 1991 database of Torries and Associates, Morgantown, West Virginia.

5. *Technological trends*

The recovery of nickel is a multi-stage operation commencing with mining and followed by a series of metallurgical processes. Processing at a given plant is usually designed for a specific ore. Numerous mining and processing technologies have been developed, and in many cases the methods are unique to a specific operation. However, real advances have been made in a number of areas in a more general sense.

Major improvements in the winning of nickel have involved a number of innovations, including the increased use of less expensive bulk underground mining methods (such as those being used by INCO at Sudbury), the reduction of energy use and cost through the introduction of the flash smelter, and the substitution of coal for oil wherever possible. Improvements in energy use and cost are being made by almost all producers. Also, there has been a move to produce and treat bulk higher-grade concentrates from sulphide ore rather than to make separate copper and nickel concentrates. Lastly, the recovery of by-products has improved.

Reverberatory furnaces have been used for many years to smelt sulphide nickel concentrates to form matte. These types of furnace require external sources of heat and the use of converters to upgrade the matte quality. Since the off-gases from the reverberatory furnaces and converters contain diluted quantities of sulphur that are difficult and expensive to collect, sulphur emission is a major environmental concern with this type of process, which is gradually being replaced by the use of the flash smelter both to improve energy efficiency and to reduce environmental problems.

Improved methods used to separate sulphide nickel minerals from gangue materials have led to a serious re-evaluation of projects previously thought to be uneconomic. In western Australia, the Mount Keith and Yackabindie projects are now being evaluated for start-up in the next two years. These projects are based on producing high-grade bulk concentrates with good metal recoveries from low-grade sulphide ores. The concentrates are high enough in nickel to be used economically as feed to a wide variety of nickel smelters and refineries that currently exist in other countries. These deposits, or others like them, may provide sources for existing smelters and refineries that are short of feed because of depletion of their own reserves. In this manner, the cost of replacing capacity lost through depletion can be kept very low.

6. *Short- and medium-term outlook*

There exist major uncertainties that make it difficult to provide a reliable forecast of future nickel supply-and-demand balances. To the usual uncertainties of the nickel market, the level of world economic activity and known and possible expansions of producers in market economies should be added those relating to actions taken by China and the USSR. Major economic changes could take place in these countries and overwhelm other factors affecting future nickel supply-and-demand balances.

The potential ability of the USSR to increase nickel exports is significant. It is possible that, as a result of cuts in military spending, additional nickel will become available for civilian markets in the USSR as well as in market economies. If this happens, exports from the USSR could flood the market and cause nickel prices to drop. Such an increase in exports might be larger if the USSR economy experienced a recession.

The USSR also has the potential to become a larger producer of nickel in the longer run. As part of the economic decentralization programme in that country, authority is being given to regional organizations to develop business directly with firms in market economies. This could lead to the development of ore bodies that have been identified by geological exploration in the USSR but not considered for production for various reasons. A typical example is the recent Outokumpu and Pechenga Collective Combine joint venture, which was designed to develop the nickel deposit in the Pechenga area of the Kola Peninsula.

Another potential source of nickel after 1993 is China, which is currently doubling output from its large nickel operation in Gansu province. Chinese officials have claimed that all the new capacity will be required for domestic use. However, China has exported nickel in the past, and may again come into the market if capacity cannot be absorbed by domestic consumption.

If the demand for nickel increases as expected and existing mines are depleted as expected, the world might require from 400,000 to 500,000 tonnes of new nickel production capacity in the next 15 to 20 years. Since this capacity cannot be met from small sulphide deposits, several mega-projects will be needed, probably based on currently known lateritic deposits in Brazil, Indonesia, New Caledonia, Philippines, and perhaps Cuba. The enormous land mass of the USSR may also hold large and as yet undiscovered nickel sulphide deposits, but this subject must be approached with caution because the present and potential quality of Soviet deposits has been questioned from time to time.

If nickel demand remains strong and prices stay around $4 per pound during 1991 and 1992, some of the new nickel projects listed in table V.51 and probably others will be financially committed. As the experience of the nickel industry in the 1970s shows, once a project is financially committed a major financial disaster is required to shut down any existing production capacity. The nickel industry is therefore warily looking at possible new projects and future nickel demand to see if future supply might again significantly exceed demand.

Notwithstanding the short-term uncertainty and a possible world-wide recession, the nickel industry appears to be entering a major long-term growth phase. Stainless steel consumption is likely to continue to grow at a rate exceeding 3.5 per cent per year. Other uses of nickel are also likely to increase if the price of nickel can be kept low enough to be competitive with alternative materials. The major unsolved questions therefore revolve more around nickel supply than nickel demand.

In summary, the nickel industry is repeating the surplus-shortage-surplus cycle that it has experienced in the past. This is also happening in the case of many other metals, which all have a long history of cyclical change in production and prices. The swings in the nickel industry should therefore come as no surprise.

F. Natural fibres (ISIC 3211)*

1. *Manufacturing process and fibre selection*

The basic requirement for the commercial success of any fibre is conformity to meet certain established textile end-use criteria. The fibre content in all textile products, in shirts, blouses, blankets, tyre cord etc., must meet the established end-use performance criteria. If a particular fibre type does not meet those criteria then the fibre in question could not be used successfully in such applications. Examples of the necessary characteristics or attributes include colour-fastness, dimensional stability and resistance to staining.

The identification of the required end-use attributes is a function of textile engineering analysis and marketing research assessment, and serves two basic purposes. First, it provides an evaluation of fibre potential for a particular end-use. That is, if a fibre meets the established performance criteria, such as, in the case of slacks, colour-fastness, good dimensional stability and drape, then that fibre has a good chance to qualify for the end-use in question. If it fails to meet the acceptance test, then the fibre would have a limited potential for consumption in that application. Secondly, identification of required end-use attributes helps in judging managerial performance with regard to the following: the technical and economic aspects of the process of converting the fibre into a yarn and fabric; the availability of machinery to process the fibre; continuity of technological improvements in the make-up of the fibre, in the machinery used and in the processing methods; the marketing skill and resources of the firm committed to the promotion of the fibre; and the perceptual position of the fibre in the mind of the consumer.

Natural fibres that could be selected to meet the required characteristics and which constitute the basis of the global fibre industry include cotton, wool, jute, linen and silk. Competition to these fibres comes from chemical fibres such as rayon, acetate, nylon, polyester, acrylic, polypropylene and spandex. Fibre consumption in apparel, home furnishings and for industrial purposes in the United States in 1986 is reflected in table V.52. There appears to be a high rate of substitution of synthetics for natural fibres, and strong correlation has been found between consumption of specific fibre types and a number of variables such as climate, temperature and population characteristics of developed or developing countries [23]. In particular, two major fibres, cotton and wool, are not uniquely preferred by any major country grouping.

2. *Fibre consumption*

Understanding the substitution process between key fibres is important in interpreting overall natural fibre demand. This approach also helps in establishing the boundaries of a given fibre market. For any given time period, it could be said that the size of a market is created through the interaction of various forces (economic, political and demographic) during that period. For instance, the demand for bed sheets in 1986 reflected the use of 234.6 million kilograms of fibre. Within that market, a number of various types of fibre competed for a market share. If the size of the market remains fixed, at, for example, 234.6 million kilograms for bed sheets, then a particular type of fibre can gain a share only at the expense of another fibre. This attempt to replace a given fibre fully or partially by another has led to what is called interfibre competition. To illustrate such competition, table V.52 provides a breakdown of total textile fibre demand in the United States in 1986 into three major groups, apparel, home furnishings and industrial applications. All types of fibre used are identified. The market share of each fibre in relation to total consumption is also indicated. Even though the breakdown of major end-use and fibre type is not applicable to every country, the indicated fibre distribution provides a broad framework for understanding fibre consumption patterns elsewhere.

As reflected in table V.52, the largest use of total fibre was for apparel (42.7 per cent), with home furnishings (42.3 per cent) a close second, and industrial applications third (15.1 per cent). The major fibres consumed, in relation to total fibre use, were cotton (29.6 per cent), nylon filament (13.6 per cent), polyester staple (13 per cent) and polyester filament (10 per cent). Combined, these fibres represent 66.2 per cent of consumption. The remaining key natural fibres were jute (2.3 per cent), wool (1.8 per cent), linen (1.2 per cent) and silk (0.14 per cent), which played only a minor role. In terms of interfibre competition within major markets, it appears that cotton had the dominant share in apparel (18.1 per cent) and home furnishings (8.8 per cent), while nylon (3.1 per cent) and polyester (2.83 per cent) had the dominant position in industrial uses, with cotton (2.75 per cent) a close third.

In terms of replacement of one fibre by another, rayon, acetate and nylon filaments have traditionally competed with silk. Synthetics have now replaced silk in many end-uses, such as women's hosiery and dresses. The primary synthetic fibres competing against cotton are rayon and polyester staples. End-uses that affect these markets include men's shirts, slacks and bed sheets. The predominant threat to wool comes from acrylics, polyester staple, and to some degree from polyester- and nylon-textured filaments. Specific wool end-use markets that have been affected are sweaters, hosiery, blankets and carpets. The major competitive threat for jute has been polypropylene filament affecting mostly the carpet backing market. Linen has met its major competition from rayon and polyester staple fibres in various types of apparel and home furnishings.

Fibre consumption patterns for various countries in selected years between 1976 and 1989 are shown in table V.53 for key natural fibres (cotton, wool, jute, linen and silk), for aggregates of chemical fibres (rayon and acetate), and for synthetic filament and staple. The following two general conclusions can be drawn from the various trends reflected in table V.53.

(a) On a world-wide basis, cotton, wool, linen and silk showed modest growth, while jute experienced a slight decline. Among synthetic fibres, rayon and acetate declined, while non-cellulosic fibres showed stronger growth (in relation to natural fibres);

*UNIDO acknowledges the contribution of Jordan P. Yale, President, Statistikon Corporation.

Table V.52. Consumption by fibre type and major end-use, United States, 1986

Fibre type	Apparel		Home furnishings		Industrial applications		Total	
	Weight (million pounds)	Percentage share	Weight (million pounds)	Percentage share	Weight (million pounds)	Percentage share	Weight (million pounds)	Percentage share
Rayon								
Filament	5.0	0.04	3.4	0.03	25.9	0.22	34.3	0.29
Staple	98.4	0.84	107.8	0.92	157.1	1.34	363.3	3.09
Acetate								
Filament	145.8	1.24	13.4	0.11	0.6	0.01	159.8	1.36
Staple	0.5	..	0.5	..	..	..	1.0	0.01
Nylon								
Filament	303.3	2.58	921.9	7.84	369.0	3.14	1 594.2	13.56
Staple	25.0	0.21	924.7	7.86	12.5	0.11	962.2	8.18
Polyester								
Filament	721.3	6.13	129.7	1.10	332.5	2.83	1 183.5	10.07
Staple	844.8	7.18	526.6	4.48	155.2	1.32	1 526.6	12.98
Acrylic								
Staple	478.0	4.07	67.7	0.58	8.3	0.07	554.0	4.71
Polypropylene								
Filament	..	..	661.5	5.63	199.5	1.70	861.0	7.32
Staple	..	..	206.2	1.75	46.0	0.39	252.2	2.14
Spandex								
Filament	25.0	0.21	..	..	..	..	25.0	0.21
Cotton	2 125.3	18.08	1 031.8	8.78	327.0	2.78	3 481.1	29.61
Wool	157.9	1.34	33.4	0.28	14.7	0.13	206.0	1.75
Linen	80.0	0.68	60.0	0.51	..	..	140.0	1.19
Jute	..	..	270.0	2.30	..	..	270.0	2.30
Silk	16.0	0.14	..	..	..	..	16.0	0.14
Other	..	..	4.0	0.03	124.0	1.05	128.0	1.09
TOTAL	5 026.3	42.75	4 962.6	42.21	1 772.3	15.07	11 758.2	100.00

Source: Statistikon Corporation, "The global natural fibre industry" study prepared for UNIDO (1991).

(b) Even though the indicated growth trends are not significant, world-wide consumption of natural fibres has stabilized, with signs of some growth. In other words, natural fibre consumption shows a somewhat positive trend, without the substitution threat from synthetic fibres that existed in the past.

With respect to consumption patterns, cotton has remained the single most important fibre, in spite of the significant growth of synthetics. In 1990, world-wide cotton consumption reached an estimated level of 19,325,000 tonnes, after an almost uninterrupted record of growth at an average rate of 2.77 per cent per year between 1976 and 1990. Expressing world cotton consumption as a percentage of all fibres, cotton shared an estimated 45.7 per cent of the fibre market in 1976 and 46 per cent in 1990. Between these two terminal years, the market share of cotton declined somewhat. However, cotton has been making a recovery in recent years. In addition to cotton, the non-cellulosic fibres (both filament and staple) have shown growth, while cellulosics (filament and staple) have experienced a decline.

Growth for the two major types of fibre, cotton and non-cellulosics, seems to stem from the following two sources: general economic improvement around the world; and interfibre competition, that is, the loss of a number of cellulosic and even non-cellulosic fibre markets, and their replacement by cotton and some other synthetic fibres.

World wool consumption increased consistently from 1,463,400 tonnes in 1976 to 1,902,200 tonnes in 1989, an average increase of 2.04 per cent per year. The estimated value of output for 1989 is $9.34 billion [23]. Long-term consumption growth relates to a number of basic stimulants of demand. Some of the contributing growth factors are as follows: the trend towards greater use of natural fibres; the unique and desirable characteristics of wool; the improved performance of wool; the availability of improved wool-

Table V.53. World mill use and major consumers of natural and chemical fibres, 1976 to 1989
(Thousand tonnes)

Country, region or grouping and year	Natural fibres					Chemical fibres							
						Rayon and acetate				Synthetics			
	Cotton	Wool	Jute	Linen	Silk	Production Yarn	Production Staple	Imports	Exports	Production Yarn	Production Staple	Imports	Exports
China													
1976	2 383.21	74.00	..	..	..	55.00	70.00	..	..	15.00	37.00	..	..
1980	3 195.38	123.75	..	..	..	..	95.00	..	..	43.00	205.00	..	..
1985	3 843.87	188.62	..	..	..	51.00	130.00	..	..	134.90	597.10	..	..
1988	4 414.34	298.68	..	..	8.20	53.00	120.00	110.18	..	407.60	666.70	539.10	..
1989	4 420.09	243.46	..	..	..	50.00	130.00	..		412.00	763.00	..	..
India													
1976	1 268.00	24.50	..	..	..	60.60	83.70	10.30	1.00	24.20	19.70	8.75	0.09
1980	1 345.54	32.30	..	..	..	57.70	74.70	41.82	1.81	39.70	30.80	19.50	0.32
1985	1 547.59	35.00	..	..	..	46.90	95.00	17.37	0.41	127.50	66.20	24.27	0.41
1988	1 736.69	33.70	..	..	9.10	52.60	121.50	3.13	1.45	200.10	121.50	21.86	6.85
1989	1 819.00	32.16	1 705.80	..	..	53.00	125.00	..	..	205.00	137.50	..	..
Japan													
1976	696.00	156.80	..	..	..	109.30	250.30	0.82	127.10	553.70	650.40	10.80	431.92
1980	732.59	106.70	..	..	..	119.30	278.00	1.81	177.99	625.70	731.10	47.26	357.98
1985	683.88	123.16	..	..	..	104.60	283.30	1.59	150.96	645.40	757.30	36.88	403.75
1988	753.73	126.26	82.80	..	17.00	99.80	190.80	2.04	126.33	618.90	733.00	85.68	366.28
1989	725.06	121.91	76.10	..	..	99.00	174.00	..	..	656.90	720.30	..	..
United States													
1976	1 526.00	52.90	..	..	..	160.80	220.60	31.48	39.60	1 265.90	1 479.90	64.41	197.59
1980	1 377.28	56.64	..	..	..	161.30	204.30	8.53	50.89	1 411.60	1 830.50	27.13	523.00
1985	1 269.00	51.83	..	..	..	92.80	160.20	11.88	21.95	1 286.30	1 577.90	119.75	336.71
1988	1 591.19	53.01	104.60	..	8.10	97.00	181.00	17.24	16.92	1 340.90	1 806.00	141.75	315.79
1989	1 824.68	59.01	96.40	..	..	98.70	164.60	..		1 346.40	1 773.00	..	..
USSR													
1976	1 885.10	303.50	..	..	..	286.10	325.80	23.46	..	260.00	140.00	37.09	..
1980	1 819.80	331.30	..	..	..	305.00	345.00	60.32	..	319.00	231.00	90.32	..
1985	1 951.34	308.30	..	..	..	246.00	340.00	51.41		388.80	324.00	62.21	..
1988	1 984.90	320.00	165.40		3.70	263.80	337.20	13.38	0.54	457.70	411.10	46.18	1.63
1989	2 003.05	333.90	144.30	..	..	245.10	338.90	..	..	468.20	422.00	..	..

Western Europe[a/]													
1976	1 236.37	534.98	..	..	..	292.10	530.10	284.18	480.18	1 011.00	1 229.10	1 106.41	1 382.93
1980	1 207.80	502.17	..	..	..	232.70	506.30	305.82	527.49	852.20	1 212.70	1 193.28	1 431.69
1985	1 278.04	433.74	..	..	..	192.60	362.20	376.08	441.40	937.60	1 445.00	1 406.15	1 672.22
1988	1 406.59	419.97	..	..	..	189.80	341.60	406.24	349.63	950.90	1 378.10	1 550.30	1 875.49
1989	1 365.52	411.55	..	..	..	195.60	334.90	..	..	967.40	1 349.80	..	..
Developed countries[b/]													
1976	3 591.18	793.48	..	..	..	567.90	1 022.20	363.56	654.18	2 941.80	3 406.20	1 304.05	2 022.95
1980	3 466.78	776.20	..	..	..	527.30	1 018.60	351.49	783.45	3 009.00	3 842.30	1 415.68	2 334.21
1985	3 377.13	646.97	..	..	..	398.00	832.60	416.18	638.66	3 011.80	3 866.60	1 701.90	2 651.00
1988	3 890.76	636.00	..	..	..	399.70	746.90	441.62	526.26	3 062.70	4 012.70	1 951.01	2 607.96
1989	4 050.00	629.44	..	..	..	406.40	707.00	..	..	3 114.30	3 939.80	..	..
Developing countries and areas[c/]													
1976	6 436.65	298.68	..	..	..	215.40	279.90	161.80	22.41	702.90	634.10	299.92	58.74
1980	7 618.80	368.92	..	..	..	140.90	331.70	219.04	31.03	1 115.60	1 302.50	392.63	254.24
1985	9 033.57	419.75	..	..	..	173.40	454.20	174.27	55.07	1 807.80	2 294.40	359.48	643.74
1988	10 883.24	569.36	..	..	..	180.70	507.40	229.52	54.75	2 604.50	2 940.70	958.04	828.54
1989	11 136.84	467.10	..	..	..	180.50	565.30	..	..	2 738.60	3 171.90	..	..
World													
1976	13 183.00	1 463.40	3 365.00	..	47.30	1 187.80	2 021.90	..	..	4 128.00	4 473.00	..	..
1980	14 392.00	1 555.80	3 617.00	708.70	54.90	1 161.40	2 081.00	..	..	4 732.00	5 744.00	..	..
1985	16 492.00	1 695.50	4 075.00	..	58.00	923.00	2 006.90	..	..	5 578.00	6 911.00	..	..
1988	18 577.00	1 852.10	3 358.00	..	62.90	944.00	1 939.00	..	..	6 542.00	7 821.00	..	..
1989	18 779.00	1 902.20	3 197.00	..	65.20	930.00	1 946.10	..	..	6 719.00	7 998.00	..	..

Sources: Basic statistics from the International Cotton Advisory Committee; linen statistics from the Food and Agriculture Organization of the United Nations, *World Apparel Fibre Consumption Survey* (Rome 1985); jute statistics from the report of the twenty-sixth session of the Intergovernmental Group on Jute, Kenaf and Allied Fibres, organized by the Food and Agriculture Organization of the United Nations and held at Rome from 22 to 24 October 1990; and Statistikon Corporation.

a/ Western Europe includes Austria, Belgium, Finland, France, Germany, Federal Republic of, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

b/ Total developed countries include Australia, Canada, Japan, South Africa, United States and Western Europe.

c/ Total developing countries and areas include Argentina, Bangladesh, Brazil, Chile, China, Colombia, Ecuador, Egypt, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Malaysia, Mexico, Nigeria, Pakistan, Peru, Philippines, Republic of Korea, Taiwan Province, Thailand, Turkey, Uruguay and Venezuela.

processing equipment used for the conversion of fibre into yarn and finished wool fabric; and the organized effort of the international wool community to promote the fibre and support research and development work aimed at its improvement.

In retrospect, in spite of the long-term growth there were some short-term disruptions during this period. For instance, the wool fibre industry recently has seen market disequilibrium between supply and demand. Wool demand during the early part of 1989 declined below the level of the same period a year earlier. The high price of wool during the immediately preceding period possibly contributed to the decline in the use of wool in apparel. Given the length of time required to process raw wool into finished fabrics and garments, the rising and relatively high wool prices during 1987, 1988 and 1989 eventually made this fibre less competitive in the market place. This was particularly true during the time when the price level of synthetic fibres stabilized. In addition, the development of new synthetic yarns, such as the recently introduced microfibre polyester filament, provided an increased competitive threat to wool.

One of the major factors contributing to the recent reversal in wool consumption has been its price. Although price is determined primarily by the relationship between supply and demand, it is also affected by fluctuations in international exchange rates. Since wool is essentially an export commodity, any unfavourable change in the rate will inhibit trade. The wool-growing community has developed mechanisms that attempt to regulate or "manage" the market price. These quasi-government mechanisms are independently run in each of the major producing market economies, such as Australia and New Zealand. There are also other more direct government mechanisms in China and the USSR.

3. *Fibre production*

World cotton production has generally responded to cotton prices, although this reaction has been dampened in the past few decades when the United States cotton programmes tended to support the world price structure for medium-staple cottons ([24], pp. 269-273). Cotton legislation adopted in the United States during the period 1986-1990 authorizes mechanisms to keep United States cotton prices competitive with the prices of other comparable cottons. Policies adopted in other countries include practices allowing world cotton prices to have a more direct influence on cotton acreage decisions, mainly through greater flexibility in annually fixed producer prices. The experience of China in the mid-1980s provided its policy makers with guidelines on the responsiveness of growers to such changes in incentives. Another massive increase in production similar to that of 1984 is thus less likely. It should be noted, however, that all cotton-producing countries are subject to widely fluctuating yields, and this will continue to be a major source of volatility in production, which in turn can affect cotton prices.

World-wide cotton acreage reached a peak in 1952, at 89 million acres*, declined to a level of 77.6 million in 1975, and then rose again, reaching 82.3 million acres in 1990. The allocation of land to growing cotton involves critical choices between certain factors, such as the following: the price of cotton and its relationship to the price of other crops; government policy in encouraging or discouraging the use of land for cotton planting; demand expectation for crops, including cotton; availability of productive land; and the need for food crops. Looking ahead, and over the long run, the world-wide cotton acreage is not expected to increase or at least increase significantly. Even if such an increase takes place it will be marginal. It appears that the allocation of land and resources is a function of local priorities, in spite of the fact that cotton could provide the best value among key crops.

Cotton yield in pounds per acre is one of the key variables that has shown a consistent world-wide improvement. There are many factors that have contributed to this growth, including increased fertilizer use, irrigation and improvements in cotton seeds, sowing, weather forecasting, pest and weed control and management techniques. The improvement in yield per acre was significantly higher during the period 1975-1985, with an average rate of 2.44 per cent per year, as compared with the lower average rate of 0.13 per cent per year during 1985-1991. Some of the technological changes being introduced are expected to help reverse the declining trend and to make a significant contribution to growth. It appears that the only effective way to increase cotton production is through yield improvements, since the planted area is expected to remain fairly stable.

Production is a result of the combination of two previously discussed variables, planted acres and yield per acre, as reflected in table V.54. World cotton production is expected to reach an estimated 90.6 million bales in 1991, and to continue increasing in the foreseeable future. However, the new processing technology at the spinning mills, combined with increased quality requirements by the consumer, puts pressure on cotton growers and seed farmers to improve the quality of the cotton crop. The concern with production or availability of supply relates not only to volume levels, but also to ensuring desirable processing characteristics.

Table V.54 suggests that developing countries generally have lower yields than developed countries. There are more cotton producers among developing than among developed countries. Among the latter, the United States was the leading producer in 1990, followed by USSR, Greece, Australia and Spain. In terms of yield, Australia had the highest rate at 1,158 pounds per acre, followed by Spain, Greece, USSR and United States. Among developing countries, India had the largest cotton planted area (18.4 million acres), followed by China (13.7 million acres). However, owing to a weak production rate (226 pounds per acre), India produced only 8.7 million bales in 1990, second to 20.7 million bales in China.

With regard to yields in 1990, Mexico had the highest at 842 pounds per acre, and Nigeria the lowest at 134 pounds per acre. Irrespective of development level, the combined total production of five countries (China, India, Pakistan, United States and USSR) amounted to 72.93 per cent of world output. This high level of concentration could be misleading, since the

*1 acre = 0.405 hectare.

Table V.54. Cotton acreage, production and yields in selected developed and developing countries, 1990

Country	Area (thousand acres)	Yield (pounds per acre)	Production (thousand bales)	Percentage share of production
Developed				
United States	11 650	625	15 169	17.53
USSR	7 974	693	11 519	13.31
Greece	741	818	1 263	1.46
Australia	597	1 158	1 440	1.66
Spain	218	890	404	0.47
Total	21 180	4 184	29 795	34.43
Developing				
India	18 369	226	8 650	9.99
China	13 676	726	20 686	23.90
Pakistan	6 690	510	7 108	8.21
Brazil	5 852	285	3 476	4.02
Turkey	1 881	796	3 120	3.60
Argentina	1 384	397	1 146	1.32
Paraguay	1 310	390	1 065	1.23
Egypt	1 095	668	1 525	1.76
Nigeria	983	134	275	0.32
Mexico	646	842	1 134	1.31
Total	51 886	4 974	48 185	55.67
World	84 029	9 158	86 548	100.00

Source: International Cotton Advisory Committee and Statistikon Corporation.

quality of cotton produced by these countries is varied. The Asian countries produce a relatively lower grade of cotton, while the United States and the USSR offer a higher quality.

Major wool-producing countries have increased wool supplies by 55 per cent between 1983 and 1990. This growth has come from the increase in the sheep population, in the clipper per head (more wool per sheep) and in yield (a greater amount of clean wool extracted from a given quantity of greasy wool). Between 1983-1984 and 1988-1989, the world's sheep population increased by 62 million to 1.168 million heads [23]. With this overall growth, some countries experienced an increase in sheep population, and others a decrease. The most significant increase took place in the Australian sheep population.

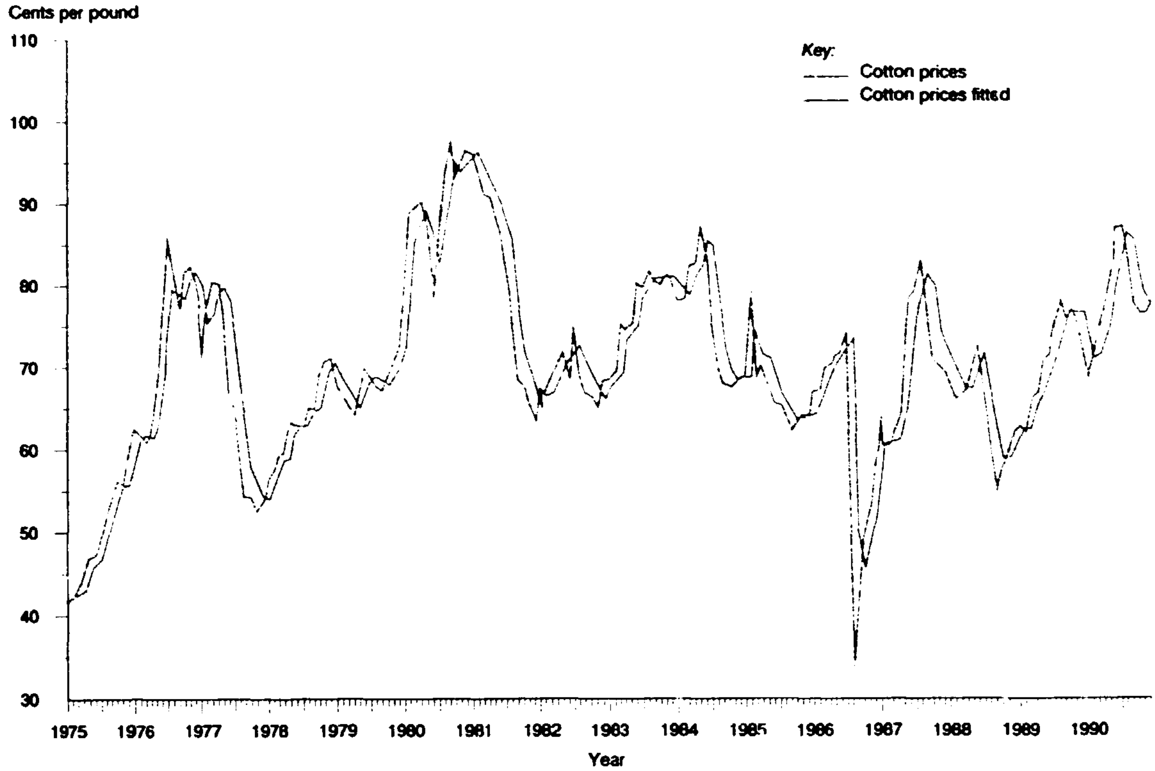
Another factor that contributes to the increase in wool supplies is productivity. Among ways to measure productivity, a straight-forward increase in volume or an improvement in the quality of output may be used. Although the quantitative measure of quality is limited, the quality level of wool fibre has improved over the years. Productivity in terms of New Zealand wool clipper per head went through a fluctuation starting with 5 kilograms (1947-1949), rising to 5.9 kilograms (1956-1966), and then falling back to 5.1 kilograms (1989-1990), basically, a negative growth trend for the period. Yields for the same country have shown a more promising trend, increasing from 71.3 per cent (1965-1966) to 74.9 per cent (1989-1990). Australia, however, has had a more consistent growth pattern in terms of clipper per head, which increased from 5.3 kilograms (1980-1981) to 6.1 kilograms (1989-1990).

Wool production for the leading countries is shown in table V.55. The single most dominant wool-producing country is Australia, with 36.86 per cent of the world's clean production, or 32.53 per cent in terms of greasy wool. Australia produces the highest volume of fine wool (24 microns and finer), with a share of 58.84 per cent of world output. This wool is consumed primarily in apparel end-uses such as suits, skirts, shirts and sweaters. New Zealand, on the other hand, is the major producer of coarser wool, accounting for approximately 30 per cent of world output in this wool category. Coarse wool is used primarily in home furnishings, such as carpets, blankets and felts.

4. *Fibre costs and prices*

The economic aspects of cotton, in particular its price and cost, play a major role in the competitive position of the fibre in relation to its rivals, rayon and polyester staples. Figure V.13 reflects the recent history of cotton price fluctuations in the United States. However, price is not the single most important criterion of fibre choice; other factors already mentioned including the suitability of the fibre to its intended application and the commitment of management to use a particular fibre, play just as important a role. A comparison of cotton growing costs in selected developed and developing countries is shown in table V.56. In general, and with one exception, developing countries have a small cost advantage over the listed developed countries in growing cotton, reflecting lower direct farm costs (labour, power, seed, fertilizer etc.), lower off-farm direct costs (transportation to

Figure V.13. Cotton price fluctuations in Memphis territory



Source: Statistikon Corporation

Table V.55. Leading world wool producers, 1989/1990

Country	Clean wool		Greasy wool							
			24 microns and finer		25-32 microns and stronger		33 microns and stronger		Total	
	Weight (thousand tonnes)	Percentage share	Weight (thousand tonnes)	Percentage share	Weight (thousand tonnes)	Percentage share	Weight (thousand tonnes)	Percentage share	Weight (thousand tonnes)	Percentage share
Developed										
Australia	718	36.86	912	58.84	181	20.34	6	0.64	1 099	32.53
New Zealand	231	11.86	14	0.90	65	7.30	230	24.52	309	9.15
USSR	213	10.93	306	19.74	71	7.98	95	10.13	474	14.03
South Africa	57	2.93	92	5.94	5	0.56	2	0.21	99	2.93
United Kingdom	49	2.52	..	..	40	4.49	30	3.20	70	2.07
Total	1 268	65.09	1 324	85.42	362	40.67	363	38.70	2.051	60.72
Developing										
China	119	6.11	60	3.87	83	9.33	95	10.13	238	7.05
Argentina	97	4.98	48	3.10	100	11.24	13	1.39	161	4.77
Turkey	41	2.10	..	..	..	..	82	8.74	82	2.43
Pakistan	'	1.23	..	..	..	..	57	6.08	57	1.69
Romania	20	1.03	15	0.97	15	1.69	14	1.49	44	1.30
Total	301	15.45	123	7.94	198	22.25	261	27.83	582	17.23
World	1 948	100.00	1 550	100.00	890	100.00	938	100.00	3 378	100.00

Source: New Zealand Wool Board, *Statistical Handbook* (Wellington, 1990), and Statistikon Corporation.

Table V.56. Comparative cotton-growing costs in selected developing and developed countries, 1983
(Dollars per hectare)

Cost items	Developing countries							Developed countries			
	Argentina[a]	Bangladesh	Egypt	Mexico[b]	Mexico[c]	Nigeria	Pakistan	Australia	Greece[a]	Spain	United States
On-farm direct costs											
Preharvesting	-	-	-	-	-	573.28	-	-	-	-	-
Labour	22.83	72.00	227.35	78.00	93.33	-	40.22	218.90	454.50	350.00	-
Power	26.87	19.53	115.28	-	88.67	-	23.72	263.70	214.80	194.00	-
Equipment	87.95	4.07	-	56.00	-	-	-	-	293.50	-	-
Seed	9.55	2.51	6.41	2.68	3.73	28.66	4.81	21.20	37.90	86.00	-
Fertilizer	-	45.51	129.59	15.69	17.70	22.93	34.5	56.40	84.80	250.00	-
Herbicides	-	-	35.49	2.76	19.19	-	-	50.50	37.90	22.00	-
Insecticides and fungicides	79.27	52.25	-	82.21	23.35	71.66	55.88	155.10	34.80	196.00	-
Defoliants and other chemicals	-	-	-	-	-	-	-	27.30	20.10	-	-
Irrigation	-	15.07	24.16	-	15.50	-	-	66.50	45.50	39.00	-
Custom or contract work	-	-	-	-	-	-	-	59.70	-	-	-
Other (hoes, barriers, etc.)	23.34	-	31.86	4.00	4.00	-	-	-	-	-	-
Subtotal A	249.81	210.94	545.98	241.34	265.47	696.53	193.29	919.30	1 223.70	1 137.00	-
Harvesting	-		-	-	-	71.66	-	-	-	-	-
Labour	113.72	22.58	383.92	58.00	100.00	-	29.16	75.80	50.00	-	-
Power	-	-	-	-	-	-	-	198.60	149.70	-	-
Equipment	-	-	-	-	-	-	-	-	-	-	-
Custom or contract work	-	-	-	-	-	-	-	-	-	761.00	-
Other (sacks, threads, luggage, etc.)	2.86	-	-	4.67	4.67	-	-	-	11.40	26.00	-
Subtotal B	116.58	22.58	383.92	62.67	104.67	71.66	29.16	274.40	211.10	787.00	-
Interest on operating capital[c]											
Subtotal C	10.44	14.01	-	28.00	52.53	64.49	23.2	-	213.30	63.00	133.98
Off-farm direct costs											
Transport	-	6.10	-	-	20.00	7.16	7.13	21.70	84.10	26.00	-
Ginning (including bagging and ties)	-	16.27	-	11.95	-	28.66	67.46	194.10	336.40	275.00	114.01
Other	-	-	-	86.67	130.13	-	-	-	-	-	-
Subtotal D	-	22.37	-	98.62	150.13	35.82	74.59	215.80	420.50	301.00	-
Total direct costs (A to D)	376.83	269.90	929.90	430.63	572.80	1 409.50	2 068.60	2 288.00	868.50	320.24	-
Overhead costs											
Management and administration	29.47	8.14	193.63	10.00	13.33	28.66	8.55	258.10	27.90	134.00	55.28
Land (typical rental)	4.34	150.73	-	66.67	-	4.29	95.04	124.80	606.10	196.00	151.00
Other (taxes, patents, automobile insurance etc.)	3.33	-	-	7.47	11.33	-	8.67	-	-	-	-
Total overhead costs	37.14	158.87	193.63	84.14	24.66	32.95	112.26	382.90	634.00	330.00	404.6
Total costs for seed (E)	413.97	428.77	1 123.53	514.77	597.46	901.45	432.50	1 792.40	2 702.60	2 618.00	1 079.75
Value of cotton seed (F)	40.00	28.14	-	89.83	115.50	41.56	112.75	196.80	500.00	446.00	322.00
Net cost for lint (E - F)	373.97	400.63	1 123.53	424.94	481.96	859.89	319.75	1 595.60	2 202.60	2 172.00	757.75
Productivity (kilogram per hectare)											
Unginned cotton	1 200.00	1 102.60	2 703.21	-	4 109.00	300.00	1 153.00	762.00	3 150.00	-	-
Cotton lint	408.00	367.53	1 029.56	-	1 422.00	100.00	384.00	762.00	1 050.00	-	592.00
Cotton seed	792.00	735.07	1 673.65	-	2 687.00	200.00	769.00	-	2 100.00	-	-
Net cost for lint	0.92	1.09	1.09	-	1.12	8.60	0.83	-	2.07	-	1.28

Sources: International Cotton Advisory Committee, *Survey of Cost of Production of Raw Cotton* (Washington, D.C., 1983); and Statistikon Corporation.

a/ Estimated.
b/ Rain-fed.
c/ Irrigated.

gin, ginning costs etc.), and lower overhead costs (management, land costs etc.). The major indirect cost disadvantage of selected countries in the South is their yield. This low productivity adds a significant cost burden.

A major problem in assessing substitutability between various fibres is the degree to which their attributes match the end-use requirements, in addition to their price. Cotton prices are more volatile than those of synthetics. Such fluctuations make cellulose and synthetic fibres more favourable because of their relatively more stable prices. However, comparing cotton fibre prices at face value to those of potentially competing fibres can be misleading. Table V.57 presents the raw fibre list prices of cotton, rayon and polyester staple as of December 1990. The tabulation shows a parity between cotton and polyester, while the two rayon types are higher. However, adjusting prices for the variables shown may lead to different conclusions. If other pertinent factors are considered, such as waste generated in processing specific gravity and brand support, the price relationships of the three fibres change. Polyester becomes the lowest-price fibre, at an adjusted price of 77 cents per pound, cotton increases to 99.8 cents and the rayons to 137.4 and 160.6 cents per pound for the regular and high-wet modulus, respectively.

The following conclusions can be drawn from this comparison of costs and prices:

(a) Rayon staple (in both forms) is considerably more expensive than cotton and polyester staple;

(b) The loss of rayon staple could be partly attributed to its relatively high price, as well as its high pollution risk and manufacturing cost. In addition, one of the reasons for the growth of polyester staple is its relatively low price;

(c) The major reason for the recovery of cotton is not its price, but its qualities, which are preferred by the consumer.

Details of the elements that make up the cost of harvesting and marketing wool fibre are given in table V.58. The specific cost values are given in local currencies and also converted into dollars per kilogram. Although there are some differences in cost allocation between the two major wool-producing countries, estimates were made for the allocation of the New

Table V.57. Relative fibre prices, December 1990
(Cents per pound)

Cost element	Cotton	Rayon staple		Polyester staple (1.5 denier)
		Regular	High-wet modulus (1.5 denier)	
Basic price	77.79	124.00	145.00	77.00
Delivery cost to mill	2.00	-	-	-
Total A	79.79	124.00	145.00	77.00
Waste [a]	9.57	4.96	5.80	3.08
Total B	89.36	128.96	150.80	80.08
Specific gravity [b] (value)	10.36	11.21	13.11	-
Total C	99.73	140.17	163.91	80.08
Other [c]				
Advertising	-	-	-	-
Promotion	-	-	-	-
Research	-	-	-	-
Technical service	-	-	-	-
Total	-	(2.80)	(3.28)	(4.00)
Adjusted price	99.73	137.37	160.63	76.08

Source: Statistikon Corporation.

Notes: 1 inch = 25.4 millimetres.

Figures in parentheses are negative.

[a] Cotton at 12 per cent, rayon and polyester staples at 4 per cent.

[b] Cotton = 89.4 ((1.54/138)-1); rayon regular = 128.96 ((1.50/1.38)-1); rayon high-wet modulus calculated on same basis as rayon regular; polyester specific gravity = 1.38.

[c] Advertising, promotion, research and technical service provided free by the fibre producer. The following percentages of subtotal C are therefore to be subtracted: rayon staple, 2 per cent; and polyester staple, 5 per cent.

Table V.58. Harvesting, marketing and distribution costs of greasy wool, Australia and New Zealand, 1990

Activity	Australian wool		New Zealand wool[a]	
	Million Australian dollars	United States dollars per kilogram	Million New Zealand dollar.	United States dollars per kilogram
Wool-grower shearing shed				
Crutching	118.160	0.09	..	..
Shearing	354.061	0.26	20.85	0.12
Classing[b]	237.396	0.18	6.19	0.04
Pressing	59.461	0.04	2.15	0.01
Subtotal	789.060	0.57	29.19	0.17
Packaging, storage, transport				
Woolpacks	37.001	0.03	3.76	0.02
Transport to store	35.960	0.03	5.72	0.03
Insurance (sheep's back to store)	0.917	..	0.59	..
Subtotal	73.878	0.06	10.07	0.06
Warehousing, sales				
Warehousing	83.772	0.06	..	..
Broker's commission	70.427	0.05	12.5	0.07
Insurance (store fires)	1.780	..	..	..
Core test certificate, pre-sale	21.854	0.02	2.76	0.02
Staple length and strength certificate pre-sale	6.805	0.01	..	..
Interlotting	2.758	..	..	..
Rehandling	13.208	0.01	..	..
Transport to main dump	9.077	0.01	0.6	..
Subtotal	209.681	0.16	15.86	0.09
Taxes				
Wool tax	249.194	0.19	..	..
Market support levy	225.549	0.17	27.6	0.16
Subtotal	474.743	0.35	27.6	0.16
Subtotal of direct costs to wool-growers	1 527.382	1.14	82.72	0.49
Mill buying costs				
Core test certificate, post-sale	6.297	..	1.04	0.01
Staple length and strength	0.525	..	..	..
Buying costs		102.909	0.06	6.98.04
Buyers' service charge	37.695	0.03	9.22	0.05
Subtotal	147.426	0.11	17.24	0.10
Shipping costs				
Shipment preparation	49.853	0.04	7.04	0.04
Sea freight	103.007	0.06	23.46	0.14
Insurance (marine and port to mill)	2.897	..	4.99	0.03
Transport to mill	30.853	0.02	..	..
Subtotal	186.41	0.14	35.49	0.21
Scouring	..	..	32.5	0.19
Subtotal costs to mill	333.836	0.25	85.23	0.50
TOTAL	1 861.218	1.39	167.95	0.99
Sales value of greasy wool	5 934.394	4.44	1 405.374	2.68
Cost to growers as a percentage of sales value	25.74	26.74	..	18.19
Total cost as a percentage of total value of greasy wool	31.36	31.36	..	36.93

Sources: Australian Wool Corporation; New Zealand Wool Board; and International Cotton Advisory Committee, *Survey of Cost of Production of Raw Cotton* (Washington, D.C., 1990).

Note: Tabulation and conversions by Statistikon Corporation.

a/ Basic data for New Zealand were not fully compatible with Australian data. Adjustments were made to achieve conformity.

b/ Including shedhands.

Zealand costs in a manner that conforms with the cost classification of Australia. However, in making cost comparisons between the two countries, only their total costs should be considered.

It appears that Australian wool costs $4.44 per kilogram, while the cost for New Zealand is $2.68 per kilogram. The higher cost of the Australian wool could be attributed to its finer grade. Even though the tabulation is for one year, if the data are compared to those for 1989, it is evident that there was a slight cost increase in 1990.

Reviewing several particular cost factors, it can be seen that shearing constitutes the single biggest item, followed by tax payments. These payments are made primarily in support of the national and international wool research and promotion efforts by various wool organizations. When taken as a ratio of its sales value, the total cost of greasy wool is 31.36 per cent for Australia and 36.93 per cent for New Zealand. A major portion of the balance would include administrative costs and gross profit.

With the exception of some short-lived reversals, there has been a rising long-term trend in wool prices in Australia, New Zealand and South Africa. The strong wool prices could be attributed in part to the effectiveness of the price support system. Experience has shown, however, that such a system cannot forever maintain its effectiveness which could be undermined by changes in the level of demand.

The price of raw wool has a major impact on the price of the wool yarn and fabric subsequently produced from that fibre. The Australian Wool Corporation has noted that wool production in Australia is responsive to price, with a price elasticity of supply of about 0.6, and a lag of about 12 to 18 months. The relative profitability of alternative enterprises, particularly cattle-grazing or cereal-cropping, is another important factor.

5. *Manufacturing capacity in developing countries*

Developing countries have accounted for two thirds of world cotton production during the last three years and are projected to maintain that share during the 1990s ([24] pp. 269-273). China has become the world's leading producer, manufacturer and final consumer, as well as being a major exporter, of both cotton fibre and textiles. During the latter part of the projection period, increased food-crop competition for land and the growth in textile manufacturing are expected to reduce the amount of raw cotton available for export from China. India, the second-largest cotton producer among developing countries, has expanded its output as both the area devoted to cotton growing and yields have increased.

India has demonstrated its potential for producing longer-staple cotton in excess of domestic mill requirements, and this production could be developed into a regular source of export supply. Pakistan has achieved consecutive record cotton crops in recent years, meeting the increasing requirements of local mills, while remaining a major exporter of raw cotton, a role it is expected to continue to play, in addition to that of a major cotton textile exporter. Cotton production in Turkey was relatively stable during the period 1987-1990, and moderate growth is projected for the 1990s.

Cotton acreage in Brazil is responsive to cotton price changes, and yields fluctuate considerably, depending on seasonal growing conditions. A moderate rate of increase in production is anticipated during the 1990s.

Although Egypt has long been the prime supply source for extra-long staple cotton exports, the competition for cropland and water supply will make it difficult to maintain the present level of production. Individually, the countries in West Africa are small producers of cotton, but as a group, they have become an important source of supply of medium-staple cotton. They are expected to achieve a moderate production increase during the 1990s, along with further recovery of production in East Africa. In all those countries, cotton exports make an important contribution to exchange earnings, and the technological know-how used for cotton production improves the output of food crops grown in rotation.

6. *Technological trends*

(a) *Cotton*

In the absence of data on levels of spending on cotton research worldwide, a recent estimate of $165.4 million for 1987 must be viewed as an indication of the amounts involved. This figure includes government, but not private, spending, and is the result of a review of reported research expenditures by 10 cotton-producing countries (Argentina, Australia, Colombia, Greece, Guatemala, India, Israel, Thailand, Turkey and United States).

With regard to the impact of technology on productivity levels, the cotton yield in terms of pounds per acre increased by 2.24 per cent annually between 1950 and 1991. During the same period, cotton quality has also improved. The major factors involved in the changing levels of cotton productivity were fourfold. Firstly, the development and use of insecticides contributed to higher cotton yields owing to the control of pests, which opened up new regions previously classified as unsuitable. The recent introduction of biological pest controls has complemented the use of chemical pesticides. Other important factors contributing to improved productivity are the use of advanced equipment and chemicals for controlling weeds, and the development of automated high-volume-instrument classing, a technique for measuring length, fineness, strength, elongation and short-fibre content. Eventually this technique will also be used to measure nappiness, stickiness and dust particles, which are very important parameters in yarn spinning. Secondly, the recent introduction and use of computer software for the simulation of growing cotton is helping to improve management efficiency. For instance, the COSYYM-COMAX software is a cotton growth simulation model and expert system that is being used to optimize production. Thirdly, new equipment such as five-row pickers and eight-row strippers will help improve productivity further. Finally, cotton developments will come to the forefront through the application of gene-splicing techniques. The new varieties produced will offer improved yield and quality as well as the performance characteristics required by the new fibre-processing technologies.

(b) Wool

Wool-growing organizations, such as the Australian Wool Corporation and the New Zealand Wool Board, have extensive research and development programmes ranging from raw wool to the finished fabric. For instance, the Australian Wool Corporation provides research and development funding both within Australia and abroad through the International Wool Secretariat. During the 1988-1989 season, Australian wool growers contributed 14 million Australian dollars (an estimated $10.85 million) and the Government provided 16.1 million Australian dollars (or $12.39 million) for such programmes. Normally, there is a 0.25 per cent levy on the receipts of wool-growers to fund research and development, and a 3.5 per cent levy to fund promotion programmes, which include the technical development carried out by the International Wool Secretariat. New Zealand has a similar programme. In 1989-1990, New Zealand spent 11.3 million New Zealand dollars (approximately $6.63 million) on research.

Some of the research work and objectives of the international wool community are as follows: research on the physical and chemical structure of wool; improving the wool marketing system through technical development; improving the processing of wool into useful products; discovering better ways of controlling wool growth and eliminating defects; keeping wool competitive in the world textile market; increasing the demand for wool through the introduction of new products and processes; increasing the efficiency of raw wool marketing procedures; increasing the efficiency of sustainable raw wool production; and determining the environmental impact of the wool industry.

Some of the achievements of recent research programmes are as follows:

(a) Installation of the first commercial Siroscour system, which is reported to produce clean wool that is lower in residual ash and of superior colour;

(b) A major advance in wool carding, resulting in a 100 per cent productivity increase;

(c) A new low-temperature dyeing technique that considerably reduces fibre damage;

(d) New spinning spindles;

(e) A new applicator for "sizing" fine warp yarns used in light-weight worsted fabrics;

(f) The development of methods of measuring clothing comfort;

(g) The development of laboratory procedures for the measurement of pilling, prickle, abrasion and surface texture;

(h) A new chemical treatment that protects wool from sunlight damage;

(i) Improvement in the productivity of sheep pastures and the efficiency of conversion of pastures into wool;

(j) Selection and breeding of pasture species;

(k) The application of genetic engineering to the breeding of pest- and disease-resistant sheep and to devising new methods of improving wool production.

(c) New wool end-use products

New technology and products that have recently been, or are about to be, introduced include the following:

(a) Soft knop technology. The small balls of rolled wool or knops are used for fillings in duvets, pillows, and increasingly in futons, especially in Japan;

(b) New and lighter wool fabrics made from a combination of fine and strong (coarse) wools, used mainly for men's suits;

(c) Wooltwist handknitting. This yarn has exceptional stitch clarity and is resistant to pilling and more elastic than other knitting yarns;

(d) A new wool fur fabric to be used as a real fur. It creates an extremely supple wool fabric. Styles range from close-cropped to longer pile or shaggier types to simulate specific species of fur.

7. *Short- and medium-term outlook*

The demand for fibre to use in apparel, in particular cotton, wool, cellulosics and non-cellulosics, is driven by the growth of population and per capita income. Consumption patterns for such fibres and growth prospects for world income and population suggest that world demand for these fibres could reach approximately 46.7 million tonnes by the year 2000 ([24], pp. 269-273). This projection represents an average annual increase of 2 per cent, during the period beginning in 1987.

Among the above-mentioned fibres, cotton has benefited in recent years from a recovery in the demand for natural fibres. Cotton prices have strengthened and yields improved, and as a result the farmer now seems to be better off than before. The World Bank ([24], pp. 269-273) thus estimates that the level of demand for cotton could increase to approximately 19.8 million tonnes by the year 2000, a projected average growth rate of 1.1 per cent per annum when measured from the 1987 cyclical peak in consumption. The most rapid decline in the share of cotton in the fibre market has come in recent years, as rising consumer income has stimulated demand for man-made fibre products, which compete only marginally with cotton, in such applications as carpeting and industrial fabrics. The market share of cotton is expected to decline to about 42 per cent in the year 2000 from its 47 per cent share in 1987.

Projected growth rates in cotton consumption vary from region to region because of different levels and rates of increase in income and population, the proportion of total fibre demand accounted for by synthetic fibres, and climate differences [24]. In developed countries, demand for cotton is strongly affected by cyclical economic conditions. In Eastern Europe and the USSR cotton demand is expected to increase at an average rate of 0.9 per cent per annum up to the year 2000, with the expected growth rate in the USSR being roughly double the expected rate of increase in

Eastern Europe, where synthetic fibres account for a larger share of the fibres market.

Developing countries account for over one half of world cotton consumption. Although difficult economic and financial circumstances have slowed the growth of cotton consumption in many countries in recent years, strong growth in demand in Asia and southern Europe has sustained consumption growth in developing countries at nearly 2 per cent per annum. This rate of growth in demand for cotton in developing countries is expected to be maintained though the 1990s, as improved income growth stimulates total fibre demand. Increasing investment in synthetic fibre capacity will result, however, in further attrition in the market share of cotton.

During the 1990s the cotton trade is projected to grow in parallel with demand at an average rate of 1.2 per cent per annum ([24], pp. 269-273). The growth of cotton imports is expected to be centred in the textile-exporting developing countries. As industrial expansion in the countries of North-East Asia should be concentrated more heavily in non-textile manufacturing, the countries of South and South-East Asia are expected to emerge as more important textile suppliers. Bangladesh, Indonesia and Thailand have made substantial progress in this direction during recent years, and textile manufacturing in these countries now depends primarily on imported cotton. China is well positioned to continue supplying large quantities of cotton textiles for export, most of it made from indigenous cotton. It is conceivable that in the late 1990s the profitability of alternative crops will restrict growth in cotton production, and imports will be required to supply the large Chinese textile manufacturing industry.

With regard to demand prospects for wool, the resurgence of consumer interest in natural fibres is expected to continue. Wool, with its unique properties, along with the possible technological improvements discussed earlier, will be able to maintain its pace of growth. In the long run, however, its growth might be impeded by such interconnected factors as its relatively high price and the problem of availability. World wool demand is projected to increase from 1.95 million tonnes in 1991 to 2.08 million tonnes in 1995. The anticipated growth between 1989 and 1995 is an average of 1.5 per cent per year, slightly less than the 2.04 per cent per year between 1976 and 1989.

In spite of this favourable scenario, there are many problems that need resolution, particularly in the cotton industry. For instance, there is unpredictability and great variation in cotton yield both within and among countries, partly as a result of climate changes, but also to a large extent because of poor management of resources, inadequate soil maintenance, faulty application of various types of chemicals, lack of equipment etc. Other problems include the impact of pests and weeds, the inability to maintain pure seeds, and, in some parts of the world, water contamination, soil deficiencies in phosphorus and potassium, and rising water tables. In addition to these "natural" problems, the cotton-growing industry is facing pressures from new consumer expectations. The consumer is becoming both a better judge of quality and more discriminating. The textile-processing industry must therefore offer improved textile goods. Despite all the difficulties of the new business environment, however, the cotton-growing industry will probably be able to survive and prosper, thanks largely to the technological innovations described in this study.

G. Wine-making (ISIC 3132)*

1. Recent trends and current conditions

World wine production has fluctuated widely in recent years, from a relatively high level in 1986, declining in 1988, gaining slightly in 1989 and 1990, with a possible downtrend in 1991. Despite modern technology, climatic conditions still dominate supply changes. The decline in the 1988 harvest could be found in most of the major wine-producing countries. For example, exceptionally cold weather in Spain beginning early in 1988, followed by excessive rainfall and hailstorms together with an outbreak of mildew, resulted in large crop losses. Similar cold and wet conditions prevailed in Italy and France, leading to a production decline from 7.9 million to 6.1 million hectolitres in the former, and from 6.9 million to 5.7 million hectolitres in the latter. French production in 1989 was 6.1 million hectolitres and Italian production was 6 million hectolitres.

In recent years wine exports have not fluctuated as much as wine production. Since the peak reached in 1985, world exports have stagnated, if not stabilized, at approximately 4.9 million hectolitres. While shipments to a few major Western European importers are estimated to have risen to supplement domestic production or to meet rising market requirements, little import growth has been perceived elsewhere. Wine imports at the global level have remained surprisingly constant since 1980. Large stocks in importing countries, reflecting ample domestic supplies relative to declining consumption, have also dampened import demand.

The pattern of international trade in table wine has remained relatively stable in recent years. The main exporters continue to be Italy, France, Spain and Germany. The main importers are Germany, France, United Kingdom, Belgium and United States. Germany re-exports considerable amounts of imported wine after blending. Exports from Spain show a decline owing to a substantial reduction in its sales to Hungary and the USSR. Where export patterns can be traced within total country exports, increases can be found for what are termed quality wines of controlled denomination of origin, particularly in Australia, France, Italy and United States.

While new technology and favourable market conditions have caused production to expand in most countries, consumption has not kept pace. Factors responsible for this decline include the recent emphasis on reduced alcohol consumption, fears of wine tampering and lower real incomes. Regarding the first of these, efforts have been made not only to reduce consumption of alcoholic drinks to cope generally with alcoholism, but also to reduce specific problems

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*UNIDO acknowledges the contribution of Walter C. Labys, West Virginia University.

such as drunken driving, alcohol-induced diseases and alcoholism among teenagers.

The decline in wine consumption is best reflected in changing patterns of per capita consumption. For example, per capita consumption in litres declined in France from 109.3 in 1970 to 91 in 1980 and to 74 in 1989. In Italy the decline was from 111 litres per capita in 1970 to 80 in 1980 and to 72.1 in 1989. Consumption in the United States, however, increased from 5 litres per capita in 1970 and 8 in 1980, and then stagnated after 1985; it reached 8.5 in 1989. In the United Kingdom, the increase was from 2.9 litres per capita in 1970 and 7.5 in 1980 to 12 in 1989.

The major international wine problem which must be dealt with is the substantial increase in existing world wine production relative to declining consumption. The most serious world surplus, which occurred between 1981 and 1982, appears to have been temporarily checked. The estimated surplus in 1989-1990 is relatively high at 4.2 million hectolitres, most of which lie in stock. The greatest impact of the disequilibrium between production and consumption appears to be in the EEC. In 1988-1989, total production exceeded 1.8 million hectolitres, while consumption stagnated at roughly 1.4 million hectolitres. While wine management programmes have resulted in severe reduction in the surfaces planted, restructuring and replanting activities have resulted in increases in productivity. The general trend is in the direction of expanding the production of wine of better quality, although table-wine production remains relatively large. Another uncertainty facing EEC producers is the possible impact of 1992, when the fiscal harmonization of alcoholic beverage taxes occurs between community members.

Because the disparities between wine production and consumption vary appreciably from country to country, it is difficult to determine how representative wine prices move in the face of wine market disequilibria. Wine prices have fluctuated considerably since 1975, reflecting the impact of unstable wine production relative to a fairly constant, but steadily declining, demand.

In general, wine prices have risen moderately in Europe. Relative wine surpluses in the United States have been responsible for the relative levelling of United States domestic wine prices. Only in the case of rare wines, sold at auctions, can a price increase be detected ([25], pp. 35-49). The lower-quantity vintages in 1988-1989 in many major producing countries, the strengthening of market interventions to remove surpluses from the market, and increases in EEC allocations to structural programmes to reduce wine acreage have caused wine prices to recover, particularly in France.

The recent increase in California wine exports to Europe has focused attention on that area [26]. Exports jumped by 30.6 per cent between 1988 and 1989, reaching 7.9 million hectolitres. California remains the major wine-producing region in the United States, accounting for 90.2 per cent of total production and 82 per cent of total consumption in 1989. Wine production in 1989 was 3 per cent down from that of 1988. Although per capita wine consumption has been on the increase, California production has been relatively constant since 1980. California wine consumption in the United States appears to be sensitive to exchange rates, declining relative to foreign imports when the purchasing power of the dollar rises, and increasing when the dollar falls.

2. *Wine processing, consumption and prices*

(a) Major wine products

Wine processed from grapes is a heterogeneous product classified into a number of types and categories [27]. The most basic distinction is between still wines and sparkling wines. Still wines are typically further classified into table wines, quality wines, dessert and other fortified wines, and vermouths and other flavoured wines. In Europe, wines are classified as table wines (soumis à une organisation de marché) or VQPRD (vins de qualité produits dans des régions déterminées). Quality French wines are designated AOC (vins d'appellations d'origine contrôlée) or VDQS (vins délimités de qualité supérieure), corresponding to VQPRD. Lesser-quality wines in France are designated vins de pays (vins de table avec indication de provenance) and vins de table (vins sans indication de provenance), corresponding to European table wines Similarly, Italian wines are either denominazione d'origine controllata (DOC) or non-DOC. German wines have a somewhat different system, with several designations of wine qualities. The first distinction is between table wines, Tafelwein, and quality wines. The quality wines are denoted Qualitätswein for regular quality wines and Qualitätswein mit Prädikat for superior quality wines. The superior wines are further divided by quality characteristics into one of five categories. In the United States, quality is usually designated by whether a wine is a varietal (containing 75 per cent or more of the named grape), a generic (white, red or rosé), or a semi-generic wine, such as chablis, burgundy and rhine. It is important to note that the term "table wine" in Europe always denotes a still wine, which contains below 14 per cent alcohol, has no flavour additives, and meets minimum standards regarding quality.

Sparkling wines produced in Europe are first classified by type, for example, spumanti, sekt or mousseux. Those wines that have a quality designation of origin (AOC or DOC) will use that designation, for example, champagne or Asti Spumanti. The higher-quality sparkling wines are generally produced using the "méthode champenoise", and the lower-quality wines are produced by the Charmat bulk process, although the label may not designate which process was used. In the United States, most white or pink sparkling wines are labeled "champagne", and are distinguished by the method of production.

(b) Production and capacity

The highest production of wine has traditionally been found in Mediterranean countries. More recently, production has spread not only across continental Europe, but also to Asia, Australia, Japan, New Zealand, North and South America and South Africa. As shown in table V.59, France and Italy are the largest producers, each averaging from 60 million to 70 million hectolitres per year. When this production is

Table V.59. World production of wine, 1985 and 1989

Rank in 1989	Country, region or economic grouping	Production 1985 (thousand hectolitres)	Production 1989 (thousand hectolitres)	Percentage change 1985-1989	Percentage share 1985	Percentage share 1989
1	France	69 249	60 818	-12.17	23.0	21.0
2	Italy	63 340	59 800	-5.59	21.0	20.6
3	Spain	33 103	28 955	-12.53	11.0	10.0
4	USSR	34 025	21 177	-37.76	11.3	7.3
5	Argentina	15 741	20 310	29.08	5.2	7.0
6	United States	17 204	15 572	-9.48	5.7	5.4
7	Germany, Federal Republic of	5 402	13 226	144.84	1.8	4.5
8	Romania	8 700	10 000	14.94	2.9	3.4
9	South Africa	8 314	9 670	16.31	2.8	3.3
10	Portugal	9 744	7 664	-21.35	3.2	2.6
11	Australia	4 026	4 999	24.17	1.3	1.7
12	Greece	4 559	4 970	9.02	1.5	1.7
13	Yugoslavia	3 660	4 855	32.65	1.2	1.7
14	Chile	3 500	3 900	11.42	1.2	1.3
15	Hungary	2 890	3 711	28.41	0.1	1.3
16	Brazil	4 005	2 981	-25.57	1.3	1.0
17	Bulgaria	3 400	2 889	-15.03	1.1	1.0
18	Austria	1 126	2 581	129.22	0.4	0.8
19	Algeria	1 010	1 000	-0.99	0.2	0.2
20	Tunisia	567	233	-58.91	0.0	0.0
	Europe	240 901	224 052	-6.99	80.0	77.2
	Western Europe	192 649	179 999	-6.57	63.9	62.0
	EEC	185 729	175 457	-5.53	61.6	60.5
	Latin America	24 911	30 336	21.78	8.3	10.4
	North America	17 674	16 143	-8.66	5.9	5.6
	Africa	10 312	11 041	7.07	3.4	3.8
	Oceania	4 622	5 402	6.87	1.5	1.9
	Western Asia	1 759	1 354	-23.02	0.6	0.5
	East Asia	514	610	18.68	--	--
	North[a]	263 711	248 771	-5.66	87.5	85.7
	South	37 526	41 377	11.06	12.4	14.3
	TOTAL	301 237	290 148	-3.68	100.0	100.0

Source: Office international de la vigne et du vin, *Situations de la viticulture dans le monde* (Paris, various issues).

[a] North America, Europe, East Asia and Oceania.

added to that of Germany, Portugal and Spain, approximately 62 per cent of the world total is accounted for. The United States, with 15.6 million hectolitres produced in 1989, represents about 5.2 per cent.

While the total production area has stabilized, yields over time have increased, generally as a result of improvements in cultivation methods. Using France and Italy as examples, production in the former rose from an average of 49.4 million hectolitres for the period 1955-1957 to 62 million hectolitres in 1967, a high of 74.4 million in 1970 and 60.8 million in 1989. Italy increased its production from an average of 54.7 million hectolitres in 1955-1957 to 74.7 hectolitres in 1967, 68.9 million hectolitres in 1970 and 59.8 million in 1989. One of the most quickly growing producers is the United States, where production has increased from an average of 9.7 million hectolitres in 1955-1957 to 14 million in 1971 and 15.6 million in 1989. World production of wine during the same period increased from 214.7 million hectolitres between 1955 and 1957 to 287.1 million in 1971 and 290.1 million in 1989.

The concept of capacity in wine production is difficult to measure; crushing capacity is used in Europe while storage capacity is used in the United States. Table V.60 provides an approximate global measure of production capacity, in the form of the existing stock of grape vines used to produce wine. The table shows major producing countries to have the greatest surface areas planted with vines. As explained later, significant reductions in vine acreage has occurred in some countries in an attempt to reduce surplus producing capacity. World wine-producing surface areas decreased from 9.8 million hectares in 1985 to 8.8 million hectares in 1989.

(c) Consumption

Most of the world's consumption of wine is concentrated in the European region. Of the major producers, France and Italy are also the major consumers, with 41.6 million hectolitres and 41.4 million hectolitres consumed, respectively, in 1989. Both countries together accounted for 33 per cent of total consumption in that year. Table V.61 shows a levelling-off, if not reduction, in wine consumption since 1985 in a number of countries. Decreases among the high-consumption countries can be attributed to decreases in the relative proportion of the lower-income workforce (typically consumers of relatively large quantities of low-quality wines in some European countries); increases in per capita income encouraging trading in a lower volume of much higher-priced, higher-quality wines; and a change in preferences toward other beverages [28]. The net result is a decreased consumption of ordinary wines and an increased demand for quality wines. In contrast to the above, increases in income and in the proportion of the labour force engaged in white collar occupations are associated with increased wine consumption.

Changes in wine consumption trends are normally analysed using per capita consumption. Table V.62 shows that these figures have declined steadily since 1980. Average world per capita consumption of 36.4 litres in 1989 was less than the 1980 average of 40 litres. In some of the major wine-producing countries, per capita consumption continued to decline as a result of changing consumption habits. In France and Italy, per capita consumption declined by 18.68 per cent and 9.88 per cent, respectively. In Spain it declined by 21.33 per cent, or 47.2 litres, and in Portugal by 24.29 per cent, or 53 litres. Among other major markets, consumption per capita rose considerably in Denmark and the United Kingdom, while it increased only slightly in the Federal Republic of Germany and the United States. Some decreases occurred in Eastern Europe with Hungary going from 35 to 20 litres, and Bulgaria from 22 to 15 litres.

In developing countries, consumption continued its long-term declining trend in almost all countries. Among major markets, consumption declined again between 1980 and 1989, in Argentina by 28.70 per cent, and in Chile by 30.42 per cent.

(d) Wine surpluses and prices

The relative growth of wine production *vis-à-vis* consumption in the early 1980s led to a structural change in world wine surpluses. Table V.63 reflects the differences between production and consumption in major producing countries and the world as a whole since 1971. It is important to realize that these surpluses largely reflect the production of table wines. The growing relative increase in higher-quality wine consumption has been noted in the previous section and has absorbed any increases in quality wine production. Table wine surpluses grew quickly among the major EEC producers (France, Italy and Spain) until 1985, but now appear to have levelled off. In other parts of the world, production and consumption appear to be closer to what could be considered long-run market equilibrium.

As will be explained later, the rather large surpluses have created particular problems for the EEC, where the Common Agricultural Policy has been continuously modified to deal with that situation. There is no doubt about the downward pressure that these surpluses

Table V.60. World surface areas planted within wine-producing vines, 1985 and 1989

Rank in 1989	Country	Surface area 1985 (thousand hectares)	Surface area 1989 (thousand hectares)	Percentage change 1985-1989	Percentage share 1985	Percentage share 1989
1	Spain[a]	1 593	1 473	-7.53	16.2	16.7
2	USSR	1 337	1 081	-19.14	13.6	12.3
3	Italy	997	1 074	7.72	10.1	12.2
4	France	994	948	-4.63	10.1	10.8
5	Turkey[a]	794	625	-21.28	8.1	7.1
6	Portugal	372	385	3.49	3.8	4.4
7	United States	130	331	154.62	1.3	3.8
8	Romania[a]	301	268	-10.90	3.1	3.0
9	Argentina	287	260	-9.41	2.9	3.0
10	Yugoslavia	249	227	-8.84	2.5	2.6
11	Iran, (Islamic Republic of)[a]	186	170	-8.60	1.9	1.9
12	Greece[a]	168	170	1.19	1.7	1.9
13	Hungary[a]	154	140	-9.09	1.6	1.6
14	Algeria	257	134	-47.86	2.6	1.5
15	Chile[a]	106	118	11.32	1.1	1.3
16	Syrian Arab Republic[a]	106	110	3.77	1.1	1.2
17	South Africa	96	106	10.42	1.0	1.2
18	Germany, Federal Republic of	93	102	9.68	0.9	1.2
19	Brazil	58	62	6.90	0.6	0.7
20	Australia[a]	64	58	-9.38	0.6	0.6
	World[a]	9 823	8 812	-10.29	100.0	100.0

Source: Office international de la vigne et du vin, *Situations de la viticulture dans le monde* (Paris, various issues).

[a] Vines used for all types of grape production.

Table V.61. World consumption of wine, 1985 and 1989

Rank in 1989	Country, region or economic grouping	Consumption 1985 (thousand hectolitres)	Consumption 1989 (thousand hectolitres)	Percentage change 1985-1989	Percentage share 1985	Percentage share 1989
1	France	43 550	41 600	-4.48	15.8	16.7
2	Italy	46 301	41 387	-10.61	16.8	16.6
3	United States	21 849	20 900	-4.34	8.0	8.4
4	USSR	36 033	20 846	-42.15	13.1	8.4
5	Spain	16 908	18 498	9.40	6.2	7.4
6	Argentina	18 552	17 396	-6.23	6.8	7.0
7	Germany, Federal Republic of	15 538	15 880	2.20	5.7	6.4
8	Romania	6 833	9 540	39.62	2.5	3.8
9	United Kingdom	5 734	6 826	19.04	2.1	2.7
10	Portugal	8 900	5 285	-40.62	3.2	2.2
11	Yugoslavia	3 660	4 770	30.33	1.3	1.2
12	Chile	4 800	3 383	-29.52	1.7	1.4
13	South Africa	3 152	3 321	5.36	1.1	1.3
14	Australia	3 327	3 179	-4.45	1.2	1.3
15	Switzerland	3 113	3 160	1.51	1.1	1.3
16	Austria	2 588	2 681	3.59	0.9	1.1
17	Greece	3 635	2 494	-31.38	1.3	1.0
18	Hungary	2 642	2 172	-17.79	1.0	0.9
19	Netherlands	2 143	1 996	-6.86	0.8	0.8
20	Poland	3 167	900	-71.58	1.2	0.4
	Europe	210 593	188 333	-10.57	76.7	75.8
	Western Europe	149 889	147 122	-1.85	54.6	59.2
	EEC	137 645	137 646	0.0	50.1	55.4
	Latin America	31 369	25 422	-18.96	11.4	10.2
	North America	21 849	23 296	6.62	7.9	9.4
	Africa	6 028	6 142	1.89	2.2	2.5
	Oceania	3 765	3 604	-4.28	1.4	1.4
	East Asia	799	1 143	43.06	0.3	0.5
	Western Asia	1 158	508	56.10	0.4	0.2
	North	37 006	216 376	-8.70	86.3	87.1
	South	37 655	32 072	-14.83	13.7	12.9
	TOTAL	274 661	248 448	-9.54	100.0	100.0

Source: Office international de la vigne et du vin, *Situations de la viticulture dans le monde* (Paris, various issues).

have had on table wine prices. Table V.64 reflects the declining price trend, particularly for French and EEC prices, between 1982 and 1988. Some of the recovery after 1988 is due to the relatively smaller harvests and vintages for that year and 1989.

3. *Wine trade*

(a) *Trade patterns*

Exports of wine are even more strongly dominated by Europe than is wine production [27]. Italy and France together account for over one half of world exports, Europe for 93.9 per cent, and the EEC for 73.6 per cent, as shown in table V.65. Wine imports are somewhat less concentrated than are exports, although Europe still accounts for more than 80 per cent of the market. The share of the EEC is somewhat lower for imports than for exports, and the distribution among member countries is uneven. Both the United Kingdom and the United States are important to the wine import market, but neither is a major exporter.

The greatest part of trade involves wine in bulk containers. Trade in bottled wines is far less significant, except for trade with the United States, which consists almost entirely of bottled wines. This difference is partly due to United States tariffs, which are higher for bulk wines than for bottled wines. Bulk wines may be bottled in the importing country without further finishing, as is the case in Sweden, or used to blend with domestic wines, as in Japan. Much of the wine trade takes place among EEC member countries, a pattern that has persisted since 1980. In 1985, 83 per cent of wine imports of EEC member countries (excluding vermouth) came from other EEC countries, while 70 per cent of their exports were destined to remain within the EEC.

(b) *Exports*

World exports of wine increased in 1988 and 1989. While consignments to a few major importing countries of western Europe appear to have risen to supplement domestic production or to meet rising market requirements, little growth can be found elsewhere [29]. Thus, following many years of expansion in world wine trade, the stagnation after 1985 is due to large availabilities in many major importing countries, reflecting ample supplies of domestically produced wines and declining consumption.

In 1989, world exports were 5.91 per cent below the 1984-1985 level. The value of trade expressed in dollar terms rose considerably, but this reflected mainly the weakening of the currency; in terms of national currencies, earnings increased by less than 5 per cent. Shipments from Italy declined to 26.61 per cent below the 1985 average. Reduced import requirements of major trading partners and the continued adverse effects on table wine consignments of the 1986 methanol incident were responsible for the relatively low level of exports of table wines. By contrast, shipments from Italy of wines of controlled denominations of origin increased more substantially.

Exports from France registered growth of 11.66 per cent as a result of larger shipments of wines of controlled denominations of origin and a rise in table wine exports. While a 17.20 per cent increase took place in exports from Portugal between 1985 and 1989, those from Spain further declined by 23.48 per cent owing to the substantial contraction in sales to the major outlets of Hungary and the USSR. In Eastern Europe, consignments from both Bulgaria and Hungary were lower because of smaller availabilities and weak export demand. Exports from the United States and Australia, though relatively small, advanced sharply to peak between 1985 and 1989. The weak dollar and intensified promotion campaigns helped stimulate exports from the United States.

(c) Imports

Table V.66 shows that global import requirements have stabilized at relatively low levels as a result of a change in the structure of the market [29]. The USSR, formerly the world's second largest importer of wine, accounting for between 6 million and 7 million hectolitres annually, sharply reduced import levels in pursuance of recent anti-alcohol campaigns. In 1989, its imports were 66.27 per cent below the 1985 average. This development resulted in a sharp downward shift in world demand for bulk table wines, of which the USSR was the major outlet, and thus aggravated European wine surplus problems.

Another development, which may also lead to a permanent reduction in trade, was the growing self-sufficiency in production of many countries where domestic demand was traditionally met through substantial imports. In particular in the United States, ample wine availabilities, slower growth of wine demand, and the weakness of the dollar led to a contraction of imports in 1989 for the fourth consecutive year. As a result, imports fell to the lowest figure since 1977, and was around 47.27 per cent below the 1985 average. Imports rose slightly in Canada over the same period, while in several European countries, including Belgium, Switzerland and the Netherlands, import increases appear to have been checked. By contrast, imports into the Federal Republic of Germany rose, without regaining 1985 levels, while continued growth occurred in the United Kingdom market. Imports into France remained stable at relatively low

Table V.62. Per capita consumption of wine by major consuming countries, 1980 to 1989

Rank in 1989	Country	Per capita consumption 1980 (litres)	Per capita consumption 1989 (litres)	Percentage change 1980-1989
1	France	91.0	74.0	-18.68
2	Italy	80.0	72.1	-9.88
3	Luxembourg	48.2	61.4	27.39
4	Argentina	76.3	54.4	-28.70
5	Portugal	70.0	53.0	-24.29
6	Switzerland	47.1	47.7	1.27
7	Spain	60.0	47.2	-21.33
8	Romania	28.9	42.8	48.10
9	Austria	35.5	35.2	-0.84
10	Chile	50.3	35.0	-30.42
11	Greece	44.9	29.9	-33.41
12	Uruguay	25.0	28.0	12.00
13	Germany, Federal Republic of	25.5	26.1	2.32
14	Denmark	12.8	24.8	93.75
15	Belgium	14.3	21.1	47.55
16	Hungary	35.0	20.0	-42.86
17	Australia	17.4	19.1	9.77
18	Bulgaria	22.0	15.0	-31.82
19	United Kingdom	7.5	12.0	60.00
20	United States	8.0	8.5	6.25
Average		40.0	36.4	-9.00

Source: Office international de la vigne et du vin, *Situations de la viticulture dans le monde* (Paris, various issues).

Table V.63. World wine production and consumption imbalance, 1971 to 1989
(Thousands of hectolitres)

Country or economic grouping	Year or period			
	1971-1975	1981-1985	1985	1989
Italy				
Production	69 557	72 146	63 340	59 800
Consumption	60 515	46 301	46 301	41 387
Difference	9 042	25 845	17 039	18 413
France				
Production	68 742	67 462	69 241	60 818
Consumption	54 886	46 161	43 550	41 600
Difference	13 856	21 301	25 691	19 218
Spain				
Production	32 189	33 964	33 103	28 955
Consumption	25 887	19 681	16 908	18 498
Difference	6 302	14 283	16 195	10 457
USSR				
Production	28 128	34 439	34 025	21 177
Consumption	30 500	36 033	36 303	20 846
Difference	-2 372	-1 594	-2 278	331
United States				
Production	13 223	17 710	17 282	15 572
Consumption	13 259	20 305	21 849	20 900
Difference	-36	-2 595	-4 567	-5 328
Argentina				
Production	22 778	20 463	19 500	20 318
Consumption	19 472	20 188	18 552	17 396
Difference	3 306	275	948	5 328
EEC				
Production	152 328	162 470	192 649	175 457
Consumption	133 199	123 686	137 645	137 646
Difference	19 129	38 784	60 004	37 511
World				
Production	313 115	330 575	301 237	290 148
Consumption	281 356	281 876	274 661	248 448
Difference	31 759	48 700	26 576	41 700

Source: Office international de la vigne et du vin, *Situations de la viticulture dans le monde* (Paris, various issues).

Table V.64. Representative wine prices, 1975 to 1990

Year	France (1983=100)	United States (1983=100)	EEC[a]
1975	56.5	56.1	1.60
1980	77.3	80.0	2.19
1981	91.6	91.5	2.10
1982	97.3	98.1	2.49
1983	100.0	100.0	2.56
1984	101.5	98.4	2.44
1985	109.1	98.5	2.61
1986	104.2	99.3	2.67
1987	101.9	101.8	2.48
1988	119.8	104.1	2.52
1989	145.9	107.0	2.96
1990[b]	146.9	109.4	3.20

Source: Institut national de statistiques et des études économiques, *Bulletin mensuel de statistiques* (Paris, various issues); J. Dubos, *La situation du marché vinicole* (Toulouse, Institut national de la recherche agronomique, various issues); and Department of Labor, *Producer Prices Statistics* (Washington, D.C., Government Printing Office, various issues).

[a] Average red table wine price index, 10-12 degrees, ECU per hectolitre.

[b] Preliminary.

Table V.65. World exports of wine, 1985 and 1989

Rank in 1989	Country, region or economic grouping	Exports 1985 (thousand hectolitres)	Exports 1989 (thousand hectolitres)	Percentage change 1985-1989	Percentage share 1985	Percentage share 1989
1	Italy	17 988	13 202	-26.61	33.3	25.9
2	France	11 617	12 972	11.66	21.5	25.5
3	Spain	6 481	4 959	-23.48	12.0	9.7
4	USSR	546	4 774	774.36	1.0	9.4
5	Germany, Federal Republic of	2 919	2 944	0.86	5.4	5.8
6	Hungary	3 221	2 273	-29.43	6.0	4.5
7	Portugal	1 389	1 628	17.20	2.6	3.2
8	Bulgaria	2 974	1 618	-45.60	5.5	3.2
9	Greece	1 308	1 380	5.50	2.4	2.7
10	Yugoslavia	1 252	933	-25.48	2.3	1.8
11	Algeria	1 300	871	-33.00	2.4	1.7
12	United States	242	788	225.62	0.4	1.6
13	Australia	88	415	371.59	0.2	0.8
14	Cyprus	342	277	-19.00	0.6	0.5
15	Tunisia	394	64	-83.76	0.7	0.1
16	Austria	269	45	-83.30	0.5	0.1
Europe		51 023	47 772	-6.37	94.3	93.9
EEC		36 123	37 456	3.69	66.8	73.6
Africa		1 947	1 037	-46.74	3.6	2.0
North America		242	794	228.10	0.4	1.6
Latin America		342	500	46.19	0.6	1.0
Oceania		91	441	384.61	0.2	0.9
Western Asia		435	340	-21.81	0.8	0.7
North		51 357	49 009	-4.57	95.0	96.3
South		2 723	1 877	-31.07	5.0	3.7
	TOTAL	54 080	50 886	-5.91	100.0	100.0

Source: Office international de la vigne et du vin, *Situations de la viticulture dans le monde* (Paris, various issues).

levels owing to ample domestic availabilities. Shipments to Japan more than doubled in 1989 to 902,000 litres from an average value of 421,000 litres in 1985.

4. *Industry structure and intervention*

Both vertical and horizontal integration characterize the market structure of the wine industry. From the bottom level there are wine producers who sell to negociants, distributors, wholesalers and bottlers, who in turn sell to retailers, etc. At the same time, there are large vertically integrated conglomerates that deal in spirits (and sometimes in beer and other drinks), as well as wine supermarkets with immense distribution and sales potential and their own wine purchasing, bottling and labelling systems. Specialized wine markets also exist where high-quality wines capable of being stored for 20 years or more are traded or auctioned. All of these industry structures are regulated to a lesser or greater degree by government policy, the most well-known regulatory framework being the common wine policy of the EEC. Examples of concentration in industry structure are provided for Spain and the United States.

(a) *Structure based on the largest companies*

Concentration in wineries is highly unequal, varying from the thousands of production units in France and Italy, to the quasi-monopolistic structure in South Africa [30]. Although grape cultivation has remained highly fragmented, as with many raw materials such as cotton, cocoa and rice, there are great variations among countries. Corporate market structures in the wine industry tend to differ from the much more concentrated beer and spirits industries. Wine is one of the few commodities that are geographically branded, for example, Champagne, Bordeaux or Porto. In beer, spirits, cigarettes and many other products, specific brands are instead promoted for individual market segments by age, sex, income group and ethnic origin. Another feature of the regional character of wine is that it does not lend itself to global marketing through licensing agreements or the setting-up of subsidiaries. For example, although Möet-Hennessy has established wineries in other countries, it cannot produce its native French brands there. Consequently, exports are and will remain the major medium for the globalization of the wine industry. This industry also differentiates itself from the beer industry, because of the existence of the wine importer and distributor. This intermediary often exists as an integrated stage of large wine conglomerates.

The vertical integration of the industry can on the other hand be compared to that of the beer industry, with a few corporations overlapping the three basic stages: grape cultivation; wine making; and distribution, exports and imports. Linkages between the three major stages are mainly embodied in contracts between

Table V.66 World imports of wine, 1985 and 1989

Rank in 1989	Country, region or economic grouping	Imports (thousand hectolitres) 1985	1989	Percentage change 1985-1989	Percentage share 1985	1989
1	Germany, Federal Republic of	9 568	8 821	-7.81	17.8	19.0
2	United Kingdom	5 881	6 826	16.07	11.0	14.7
3	France	6 842	5 702	-16.66	12.9	12.3
4	United States	5 185	2 734	-47.27	9.7	5.9
5	USSR	6 780	2 287	-66.27	12.6	4.9
6	Netherlands	2 282	2 165	-5.13	4.2	4.7
7	Switzerland	2 051	1 982	-3.36	3.8	4.3
8	Belgium	2 317	1 845	-20.37	4.3	4.0
9	Canada	1 421	1 473	3.66	2.6	3.2
10	Sweden	938	1 076	14.71	1.7	2.3
11	Denmark	1 058	1 064	0.57	1.9	2.3
12	Poland	486	908	85.18	0.9	1.9
13	Italy	697	655	-6.02	1.3	1.4
14	Hungary	757	132	-82.56	1.4	0.3
Europe		40 745 a/	38 696	-5.03	75.9	83.5
EEC		28 915	29 316	1.38	53.9	63.3
North America		6 566	4 207	-35.83	12.2	9.1
Africa		1 838 a/	1 373	-25.30	3.4	3.0
Asia		601 a/	1 090	81.36	1.1	2.4
Latin America		188 a/	713	279.26	0.4	1.5
Oceania		263 a/	260	-1.14	0.5	0.6
North a/		47 894	44 065	-7.99	89.2	95.1
South a/		2 307	2 274	-1.43	4.3	4.9
	TOTAL	53 663	46 339	-13.65	100.0	100.0

Source: Office international de la vigne et du vin, *Situations de la viticulture dans le monde* (Paris, various issues).

a/ Estimate based on 1981-1985 average. World total incomplete.

growers and wineries, and between the latter and importers or exporters. Often a few large wineries are in a strong market position compared to the large numbers of competitive small-scale growers with limited sales outlets.

Substantial competition that could increase shares of the world export market already exists between Italy, France and the United States. Compared to beer, where the growth potential of peripheral areas and Eastern European economies is immense, wine exports face barriers in the periphery owing to foreign exchange restraints and low incomes which in certain regions have not kept pace in real terms over the last decade. Consequently, global competition for markets is being waged between major producers in major countries, and only marginally for smaller well-placed producers in a handful of peripheral countries.

(b) Spain

The major wine and spirit companies operating in the Spanish market are listed in table V.67. Because of the nature of their operations, it is not possible to rank wineries specifically. The three major wine industries of Spain—Sherry, Rioja and Penedes—are witnessing the beginnings of concentration and foreign penetration, albeit on a lesser scale than that of Portugal [31]. Although sherry is still largely dominated by big family-owned firms, foreign corporations have made various attempts to enter the market, and, in the case of Seagram, they triumphed. Predominantly domestic conglomerates, such as Domecq, still produce over one half of the sherry output of the country.

Over the past two decades, the house of José Maria Ruiz-Mateos has become one of the largest companies, as well as the biggest holding company, in Spain. By far the largest beverage group, Rumasa owns eight of the top beverage corporations in the country. In the case of wine, their ownership encompasses about one third of domestic sherry output; almost one third of Rioja wine, sparkling wines and Catalan table wines; four fifths of Montilla of Cordoba; and a third of La Mancha regional wines. Its overseas marketing extensions include wine merchandising in the United Kingdom and Denmark, and wine warehousing in Argentina and Chile.

The Pedro Domecq group exhibits a more diverse, but no less dominant ownership structure led by Banesto Bank, Hiram Walker España, Pedro Domecq of Mexico, and the Banco Internacional de Comercio. The extensive internationalization of Domecq is exemplified in its wholly owned Luxembourg subsidiary, which owns more than two thirds of Pedro Domecq Médico, the country's largest tequila and brandy producer. Rioja and Penedes, the other two major wine categories, have undergone some concentration, but still have not been penetrated by foreign investment. The latter is dominated by Torres, the single largest exporter of Spanish wines to the United States.

Table V.67. Major wine and spirit companies in Spain and the United States, 1987 and 1989

Rank	Spanish wine and spirit companies, 1987	Balance sheet (million pesetas)	Rank	United States wine companies, 1989	Total storage capacity (thousand gallons)
1	Osbourne Y Cia. S.A. (Grupo)	31 887 00	1	E & J Gallo[a/]	335 000
2	Pedro Domecq S.A.	26 164 00	2	Grand Metropolitan plc (United Kingdom)	90 945
3	Larios S.A.	22 686 00			
4	Codorniu S.A.	20 000 00	3	Vintners International[b/]	84 531
5	Freixenet S.A. (Grupo)	19 700 00	4	The Wine Group[c/]	50 800
6	Gonzalez Byass S.A.	19 419 00	5	The Beverage Source[d/]	50 500
7	Savin S.A. (Grupo)	15 669 00	6	Canadaigua Wine Co.[e/]	50 00
8	Codorniu S.A.	14 028 00	7	Vie-Del Company	47 525
9	Martini & Rossi S.A.	13 200 00	8	JFJ Bronco Winery	46 800
10	Bacardi Y Cia. S.A. Espana	11 598 00	9	Guild Wineries & Distilleries	39 000
11	Savin S.A.	11 378 00	10	Delicato Vineyards	38 301
12	Fernando A.De Terry S.A.	9 467 53	11	Master Cellars	35 700
13	Grupo Pracsa	8 419 00	12	Golden State Vintners	28 500
14	Destilerias y Crianza del Whiskey S.A.	7 965 00	13	Giumarra Vineyards	16 500
			14	Sebastiani Winery	12 574
15	Compania Internacional Vinicola Agricola S.A.	7 864 50	15	Wine World[f/]	11 700

Source: Private correspondence.

a/ Includes Heublein (84,100,000 gallons); Beaulieu (3,350,000 gallons); Inglenook Napa Valley (3,450,000 gallons); Christian Brothers (39,245,000 gallons); and Quail Ridge (45,000 gallons).

b/ Includes Taylor Wine Co. (23,657,481 gallons); Great Western Winery (5,196,601 gallons); and Vintners International (55,677,000 gallons).

c/ Includes Corbett Canyon, (1,100,000 gallons).

d/ Includes Bisceglia Cros. Wine Co. (20,000,000 gallons); Canadaigua Wine Co. (18,000,000 gallons); Tenner Bros. (6,000,000 gallons); Bactavia Wine Cellars (6,000,000 gallons); and Widmer's Wine Cellar (500,000 gallons). California Products is parts of Bisce, ia with 1,400,000 gallons.

e/ Includes Sierra Winery (37,000,000 gallons).

f/ Includes Beringer Vineyards (5,919,000 gallons); Chateau Souverain (2,616,000 gallons); Asti Winery (3,439,000 gallons); and Meridian Winery (522,000 gallons).

(c) *United States*

Vineyard holdings in the United States are highly concentrated by region, with four fifths of the grape and wine output centred in California. While New York State ranks a far distant second, Oregon, Texas, Virginia and Washington have also entered the market. Wine sales in the United States topped some 507 million gallons in 1989.

This regional concentration is matched at the corporate level [31]. By the end of 1979, there were 724 bonded wineries, with California alone having 450, of which 100 accounted for four fifths of output. Table V.67 provides a list of the top 15 wineries. A relatively high degree of concentration can be found with wine subsidiaries of five of the largest spirits corporations which already possessed almost one half of the total wine sales by the end of the 1970s: Heublein (18 per cent), Seagram (9 per cent), National Distillers and Chemical Corporation (8 per cent), Rapid American (7 per cent) and Brown-Forman (5 per cent).

Heublein entered the market in 1969 with the acquisition of United Vintners and subsequently invested $100 million into upgrading and expanding their wine facilities. In addition, it also imports a large number of wine brands from Western Europe, Hungary and Japan. Seagram owns several wineries (New York and California) through its major subsidiary Paul Masson, which boosted its wine sales during the 1970s at three times the rate of the United States wine market. National Distillers and Chemical Corporation was also one of the first to penetrate the wine sector with its 1967 acquisition of Almaden vineyards. Through its Schenley subsidiary, Rapid American has also become important in wine markets, primarily through imports. Less than one third of its sales are from wine and spirits, with merchandising dominated by retailing and apparel. Finally, Brown-Forman bears comparison with Rapid American in its emphasis on wine imports. As with most of the above corporations, wine remains the company's fastest-growing segment.

While penetration of the distilled spirits giants has provided the major impetus to the expansion of the wine sector, two other corporations have also been central. Gallo, a family enterprise established in 1933, is a single-product firm operating a self-contained wine complex in California. This includes large-scale research facilities, a complete wine-making complex, a glass plant, bottling lines and its own trucking firm.

Coca-Cola, the world's largest soft-drink manufacturer and distributor, entered the wine industry in 1977 for several reasons: the likelihood of wine being the fastest-growing beverage segment in the 1980s; its desire to expand profits from its all-embracing soft-drink distribution networks in 135 countries; and the need to enter a production area that would offset the price fluctuations of sugar, by far the major soft-drink ingredient. Between 1977 and 1979, Coca-Cola invested $111 million into wine facilities, and in 1980, Wine Spectrum, its fastest-growing division, recouped its investment with sales of more than $100 million. Six years after its dramatic entry into the wine market, Coca-Cola sold its wine holdings to Seagram for $200 million, which in turn relegated most of its operations to International Distillers and Vintners. The latter has now become the world's largest wine producer.

A recent change in United States industry structure is exemplified by increased foreign investment. The house of Baron Philippe de Rothschild (including Château Mouton-Rothschild), Moët-Hennessy and Piper-Heidsieck, three of the leading French and world wineries, have entered the United States market through joint ventures in wineries and purchases of vineyards. In 1983, the American operations of Moët-Hennessy topped $200 million, about one third of its total sales.

(d) Interventions and stabilization in the EEC

Growing surplus stocks in table quality wines in the EEC market have led to considerable instability and renewed intervention attempts to curb this instability ([32] and [33], pp. 167-172). Although the EEC wine regime has attempted to reduce production by banning new plantings and limiting replacement options, increased yields and improved processing technology have meant that wine production is still rising. Distillation measures, which in some instances are generous and which to a certain extent are storage aids, have supported returns to producers by raising the prices of wine for distillation. There seems little possibility that EEC wine consumption will increase in the future, given the permanence of its downward trend. Moreover, the enlargement of the common wine reform to the new entrants, Portugal and Spain, could increase supply and raise wine stock levels further.

The EEC support regime for wine came into operation in 1970. The wine regime based on the Common Agricultural Policy exists to ensure a minimum price in order to reduce wine surpluses (by taking excess wine off the market) for the producer and to improve the quality of wine produced in the EEC. The principal elements of the regime involve a series of prices for each type of wine which are set at the beginning of each marketing year. The commission then calculates and publishes weekly average producer prices and representative prices. Reference prices are also fixed annually on the basis of the guide price plus transport costs incurred in taking EEC wines to the same place of marketing as imported wines. Effectively, reference prices are the minimum prices for imports from non-EEC countries. Activating prices, which may not exceed 95 per cent of the guide prices, are also set by the Commission. The role of the activating prices is to trigger the various market support systems when average market prices fall below them. Values of the actual average producer prices needed for the EEC countries in recent years were given in table V.64.

Internal market support in the wine sector consists mainly of private storage aid for table wines or distillation of wines that are usually of poor quality or have a low alcohol level. Private storage aid is available when the supply of a particular type of wine exceeds demand by the equivalent of four months' consumption. Storage contracts are subject to quality conditions and may contain provisions for the termination of aid, if market prices rise above guide prices for two or more consecutive weeks. If, at the start of the wine marketing year, the quality of wine in storage is low, or wine stocks are high and private storage aid alone is not sufficient to correct the market imbalance, the Commission can initiate policies centring on percentage distillation, compulsory distillation, support distillation, and excess distillation for wine coming out of long-term (nine months) storage.

The budgetary cost of the EEC wine regime to the Community has been rising. In the period 1976-1980, the EEC wine regime accounted for an average 1.5 per cent of total guarantee expenditure from the European Agricultural Guidance and Guarantee Fund ([33], pp. 167-172). But since 1980, expenditure on wine has risen dramatically and, in the period 1981-1984, averaged almost 5 per cent of the EEC agricultural guarantee budgetary expenditure, the latter itself increasing. Since the mid-1970s, the cost of the various distillation measures has increased considerably. In 1976, for example, expenditures on distillation measures totalled some 91 million ECU, or just over two thirds of the total guaranteed expenditure on the wine regime in that year ([33], pp. 167-172). By 1984, the cost of distillation measures had risen to 820 million ECU and accounted for about three quarters of EEC expenditures on the wine regime.

While the budgetary cost of these measures has been rising rapidly, there are also other costs to the Community. The distillation of excess supplies reflects inefficiency in the allocation of resources in wine grape and wine production, with accompanying economic costs to the Community. Earlier in connection with table V.63, the substantial wine inventory surpluses of the Community have been demonstrated. As a consequence, the Council of the EEC decided in February 1988 to maintain a freeze on nominal wine guide prices for as long as supply exceeds demand requirements. Meanwhile, surplus wines will be sent for compulsory distillation where prices have been recently increasing, and for this only a fraction of the guide price will be paid. Premiums were also raised substantially in an effort to induce farmers to take vineyards out of production. These measures are commonly referred to as "wine budget stabilizers". They are expected to drain the "wine lake" and to stabilize expenditures well before 1996, when the wine regime becomes fully applicable to Portugal and Spain. However, there is some question among experts as to whether the new budget stabilizers will bring the market into balance by 1996 ([33], pp. 167-172).

5. Markets and capacity in developing countries

Another problem facing world wine markets is the frustrations experienced by developing countries that have attempted to increase investment in the wine sector. According to an FAO report, areas under vineyards for wine production in these countries decreased by 21 per cent from an estimated 1.15 million hectares to 0.91 million hectares between 1975-1977 and 1985-1987. The biggest declines were experienced by major African developing countries, especially Algeria, where areas continued to decline sharply. In Latin America, the other major production region among developing countries, vineyard areas dropped by an overall 13 per cent. The largest single reduction in area occurred in Chile, where the decline was 24 per cent. In Argentina, the area under wine grapes remained stable. During the reference period developing countries adjusted their vineyard areas downwards in relation to market outlet possibilities. However, other countries such as China, India and Thailand increased their grape and wine production.

Developing-country production decreased by 23.9 per cent, from 38.9 million hectolitres in 1975-1977 to 29.6 million hectolitres in 1985-1987, continuing the declining trend set since the beginning of the 1970s. These figures represent 12.1 per cent of world production in 1975-1977 and 9.8 per cent in 1985-1987. The largest percentage decline was recorded in north-west Africa, where crops in Algeria, Morocco and Tunisia fell by 74, 56 and 36 per cent, respectively. However, the largest decline was recorded in Latin American countries, with a drop in production of 6.7 million hectolitres. Production in Argentina declined by 5.1 million hectolitres, in Chile by 1.6 million hectolitres, and in Uruguay by 0.3 million hectolitres. These declines were primarily caused by export marketing difficulties, especially diminishing shares of EEC imports and recent declines in import demand by the USSR.

Total consumption in developing countries fell by an average of 3.4 million hectolitres, mostly in Latin America, which accounts for nearly 90 per cent of this total. This decline reflected diminishing personal incomes related to high inflation rates and foreign debt-servicing problems. Consumption in North African countries has been steadily falling in the last two decades.

Exports of developing countries also have decreased considerably, especially in Algeria (the largest wine exporter in the 1960s, but with declining exports since 1970), with a drop of 80 per cent (3.4 million hectolitres), and in Morocco, by 85 per cent (0.1 million hectolitres). These decreases were mainly due to the loss of assured markets in France and, more recently, the USSR and to the establishment of the EEC common wine organization, which favours trade among member countries [34]. Although the common organization of the EEC wine market was established in 1970, its full impact was not felt until the latter half of the decade. Export statistics for other developing countries showed either stagnation or marginal declines.

FAO projections, however, suggest that production growth rates are anticipated to be higher in developing than in developed countries in the next decade (1.5 per cent compared to almost zero growth until the year 2000); but as the former contribute only 10 per cent to world production, their overall impact on global volumes will not be of great significance [34]. In North Africa, production in Morocco is forecast to increase by 2.3 per cent (140,000 hectolitres) by the year 2000, and in Tunisia by 0.8 per cent (60,000 hectolitres). Production in Algeria is expected to continue its declining trend with a decrease of 220,000 hectolitres to be reached by the year 2000. Latin American countries, on the other hand, should experience more significant increases, mainly to meet projected increases in domestic market demand. Argentina is expected to record an increase of 4.3 million hectolitres (annual growth 1.5 per cent), Brazil, just over a million hectolitres (annual growth 2.4 per cent), and Chile, 940,000 hectolitres (annual growth 1.7 per cent).

Projections for wine consumption in developing countries suggest an overall increase from 30.5 million hectolitres in 1985-1987 to 36 million hectolitres in 1995 and 39.6 million hectolitres in 2000. The expansion in consumption is expected to take place mainly in Latin America. In Africa, a slight expansion in total consumption of wine reflects a slackening in the declining trend of per capita levels in a number of countries of West Africa. However, consumption of wine in North Africa (apart from that consumed by tourists) is expected to continue its declining trend. Import requirements of developing countries are projected to rise to 4.2 million hectolitres by 2000.

It is difficult at this point to speak of a future for wine production and consumption in these countries, and particularly for exports from them. Among countries such as Algeria, Morocco and Tunisia, policies geared to the uprooting and the reconversion on vineyards for the production of quality wines and diversion to other non-wine products were implemented from the early 1970s. In Latin America, especially in Chile, the production of non-wine products such as table grapes has increased to offset declining wine exports. This has occurred despite the fact that Chile made great strides in improving the quality of its wine products. Likewise, Brazil is poised to have the potential to export 500,000 hectolitres of wine by 2000.

6. *Technological and environmental considerations*

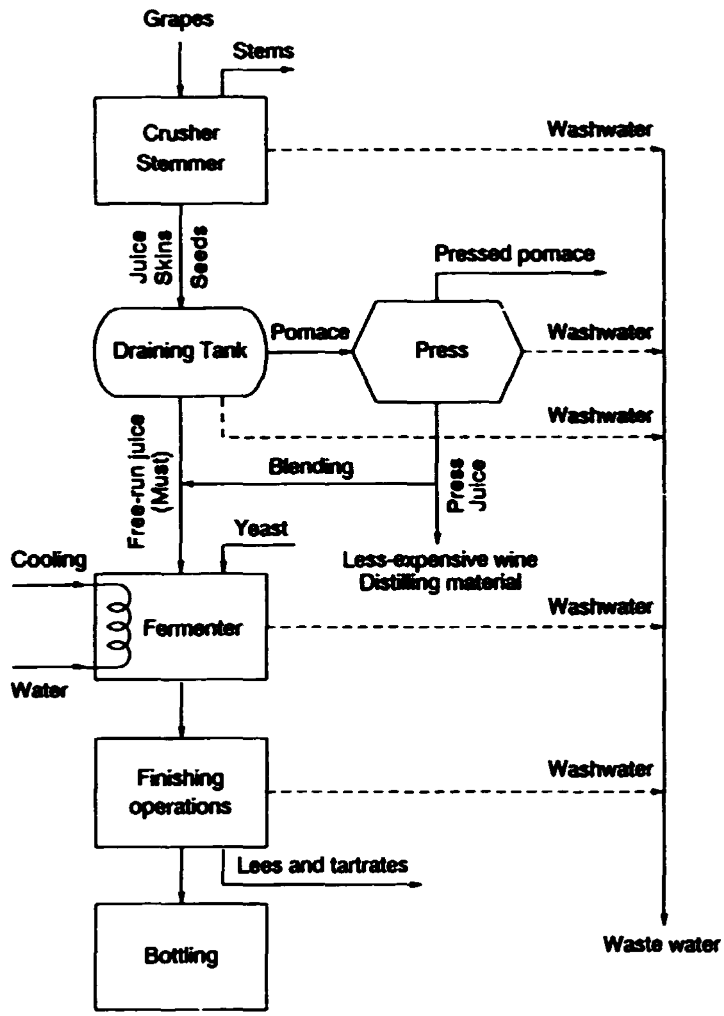
(a) The winery as processor

Methods used to produce table wines vary with the winery, but the basic procedures are as shown in figures V.14 and V.15 [35]. Fresh grapes are usually delivered to the winery in trucks or gondolas and discharged into a hopper from which they are transported by conveyor to a stemmer-crusher. Stems and debris are discharged at this point and constitute a solid waste disposal problem. It is necessary to wash down the crusher, conveyor and hopper periodically or at the end of the day. This produces a considerable volume of waste water.

Grapes used to make white wine are stored in a tank to allow juice to separate from the skins, seeds and stems. The separated juice is transferred to a fermenter. The remaining solids are pressed to remove the juice, which is used for blending or making less expensive wines. The solids are referred to as pomace and constitute a major waste disposal problem.

Crushed grapes used to make red wines are introduced to the fermenter immediately following the crusher. Wine fermentation is a batch process that requires very careful control. Undesirable microbial growth in the crushed grapes is controlled by the addition of sulphur dioxide prior to starting fermentation. Special yeast cultures are used in the fermentation process, and a considerable amount of heat is generated. In the preparation of red wine, the skins are used to provide colour and tannin; once the wines have reached the proper colour, they are removed from the skins and the fermentation is completed without the skins. As in the white wine operation, the skins are pressed to extract juices, and these are used as blending or distilling material. The only difference in the fermentation of white wines is that the skins are

Figure V.14. White-wine production process and discharges



Source: E. J. Middlebrooks, *Industrial Pollution Control* (New York, John Wiley & Sons, 1979), vol. I.

excluded from the fermentation tanks. After the fermentation process is complete and the wine has been removed, it is necessary to clean the tanks thoroughly. Presses are also washed to remove solids and juices. Both these cleaning operations result in vast amounts of wastes.

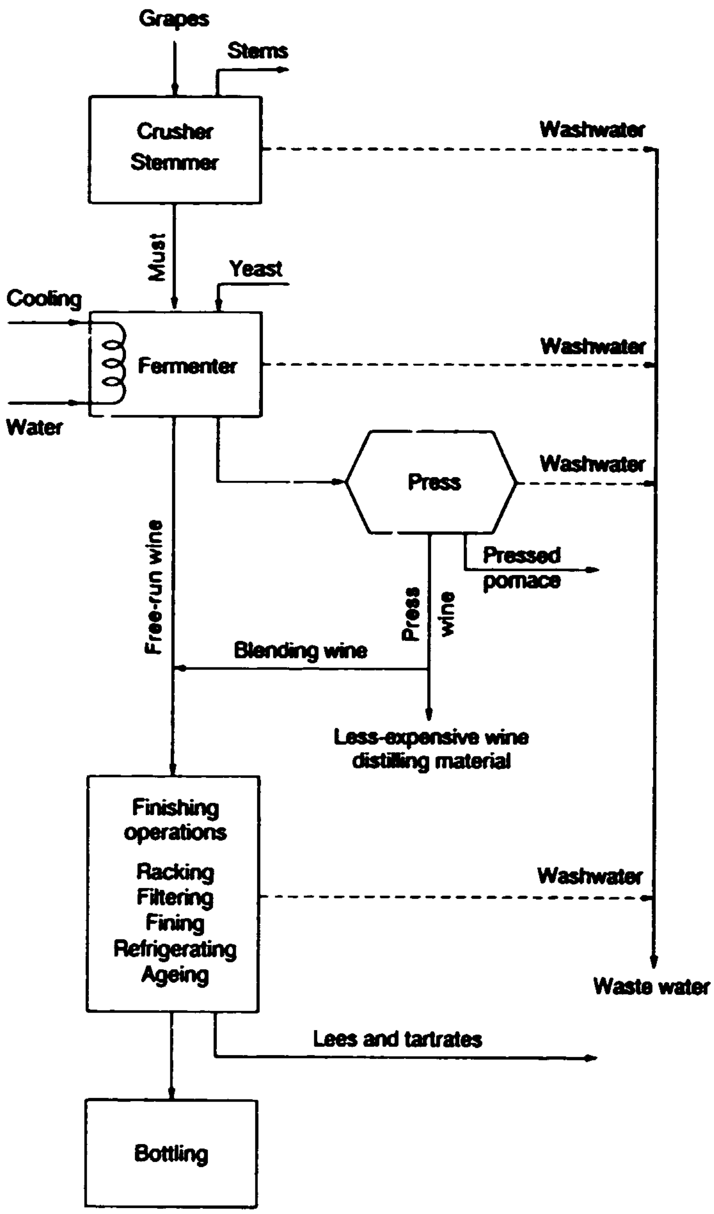
Following fermentation, new wines are pumped to storage tanks for clarification and ageing. Solids in the wines settle out, and it is necessary to transfer the clarified wine to other tanks. When the wine is transferred, a residue of lees (yeast cells and grape residue) remains behind, and it is necessary to dispose of this residue or use it as distilling material. Again, after transferring the wine, it is necessary to clean the tanks thoroughly and to prepare them for the next batch of wine.

Both white and red wines are aged, with the red receiving a longer storage period. Before bottling most aged wines are filtered through a diatomaceous earth filter to remove any remaining residue. The solids from the filters are relatively dry and are usually landfilled. Fining (addition of bentonite) is also used to clarify the wine before bottling. The bentonite absorbs suspended material and clarifies the wine as it settles to the bottom of the tank. The solids that settle are normally handled in the same manner as lees.

Bottling of wine is usually done automatically and little waste water is generated during this operation. It is customary to use new bottles, and no washing and little rinsing are required. However, there is some indication that the industry may return to reusable bottles. If it becomes necessary to wash bottles, the volume of waste water will increase significantly. Waste water produced in the bottling operation now results from the rinse operation and clean-up.

Dessert wines are produced in essentially the same manner as table wines. The major difference is that fortifying spirits are added to increase the alcohol content and to halt the fermentation process at a desired sugar level. The production of sparkling wines is basically the same with the exception of the addition of carbon dioxide to the wine. The major variation in the process of preparing sparkling wines is the method of adding the carbon dioxide. Methods of carbon

Figure V.15. Red-wine production process and discharges



Source: E. J. Middlebrooks, *Industrial Pollution Control* (New York, John Wiley & Sons, 1979), vol. I.

dioxide addition vary from the fermentation of added sugar after the fermentation has been completed to the direct adding of carbon dioxide.

(b) *Environmental discharges and treatment technology*

It is worth recalling that prior to the wine-making process, vineyards typically receive several chemical treatments. Some of these are pesticides; others protect against vine diseases; and still others are directed against moulds. These treatments can be said to have two different environmental consequences. The first of these involves waste diffusion into the soils of chemicals such as copper sulphates and phosphates. These wastes can eventually leech into water supplies. The second pertains to the accumulation of certain toxic chemicals in the soil which under certain circumstances can be transmitted to the grapes themselves. A related problem is the possible spraying of vines and grapes with chemicals too close to the date of the grape harvest. To counter such problems, "biological" or "organic" wines have begun to appear on the market.

In the case of the wine-making process, waste water from a winery can be characterized by its biochemical oxygen demand, suspended solids and pH value [36]. Winery waste waters are high-strength, relatively low-volume wastes. Waste waters from wineries are generated in only a few months each year (approximately three months) and the waste water flows are erratic. By-product recovery in the wine industry has received a considerable amount of attention because of the economic advantages and the large reductions in pollution loads by by-product recovery. It is possible that the cost of waste treatment and the price of tartrate may be high enough to entice some wineries to return to tartrate production.

Tartrate removal can reduce the biochemical oxygen demand of winery wastes by 50 to 75 per cent. Tartrate is removed by hot water extraction or cold acid extraction by passing these liquids through the pomace. Tartrate recovery from stillage is difficult, and one technique that has been suggested is to precipitate tartrates by chemical addition. Ion exchange resins have also been tried. Recovery of tartrates from lees is accomplished by allowing the material to settle and then to stand several days, while the cream of tartar crystallizes. The liquid is removed and the crystals are washed and dried. The precipitation on the walls and floors of wine tanks is almost pure cream of tartar and is normally washed from the tanks with a strong solution of sodium hydroxide. The material could be removed by hand in the dry form, but this is expensive.

Pomace has been used for hundreds of years as a soil conditioner and fertilizer. This is a convenient disposal technique and also provides a useful product. Pomace can also be used as livestock feed supplement. Grape-seed oil is another by-product that has good potential. Oil recovery from grape seed has been practised in Europe and in the United States, but the market so far has not grown. With current stringent water pollution control regulations, it appears that grape-seed oil recovery has promise. Waste stems are usually spread on the fields.

Waste water from wineries that do not practise distilling is amenable to conventional biological treatment. Depending on the location of the winery, the waste water may be discharged to a public treatment plant, or the winery may have its own biological treatment system. Activated sludge, extended aeration, rotating biological contactors, and aerated lagoons produce an effluent of excellent quality when treating winery waste water without stillage.

Conventional biological treatment systems do not perform well when treating waste water containing stillage. Most biological systems are upset by the introduction of the high-strength stillage. Land application of stillage is the most successful method of treating the waste. Some wineries in the United States have planted wheat and barley on their disposal fields without additional fertilization and have produced an excellent crop. The crop has paid for a major portion of the operating cost of the waste treatment system.

As with most waste water-treatment systems, there are drawbacks to the land application of stillage. The major disadvantage is the large land area required, ranging from 0.75 to 1.5 hectares per 100,000 litres of stillage produced per day [36]. The other serious problem is the pollution of groundwater. Most attempts to treat winery stillage with conventional biological treatment processes have failed to produce even marginal results because of the high-strength waste and the high solids content. Some type of pretreatment is necessary before conventional processes work. The large volume of solids produced by pretreatment operations is a significant disadvantage to biological treatment schemes. If some by-product could be produced from the solids separated from the stillage, then conventional processes might be more attractive.

Apart from waste water, the major environmental problem in the winery industry is the disposal of solid materials. Fortunately, most of these materials are recoverable as by-products with the exception of stillage solids, and in most instances land application of these materials is possible. Air pollution problems are of little consequence in the winery industry, and the only possible concern would be odours from land application of waste or the biological treatment processes, if improperly designed or operated. Energy requirements for treatment and disposal of wastes from the winery industry are small and would add little to present requirements.

7. *Short- and medium-term outlook*

The world wine-processing industry appears to be undergoing structural adjustment in which a levelling of activities is taking place, following years of slow but steady growth. Except for the high levels of world production in 1982 and 1987, production has tended to remain at approximately 300 million litres per year. Because demand and prices are not giving signals to increase investment, wine production is not expected to increase over the next several years, excepting the sudden jumps that result from occasionally ideal weather conditions.

Stagnation in the growth of the consumption of wine seems to be the major deterrent to further immediate growth in the industry. The factors that have been mentioned as reducing demand are likely to continue. In particular, an effort is being made to reduce the numbers of road accident caused by excess drinking of alcohol. Similarly, an attempt is being made in many countries to reduce alcoholism. Even if wine may have only a minor role in both cases, there is no doubt that wine consumption has been adversely affected. In the case of the United States and several other countries, increased import tariffs and domestic taxes on wine will ultimately affect consumption.

The imbalance between wine production and consumption is likely to continue. The effects of the change in the Common Agricultural Policy of the EEC towards restricting wine production are not likely to lead to a reduction in this imbalance. At the same time, any increases in consumption likely to occur will be concerned with quality wines, and such effects will not reduce the imbalance.

World trade in wine will continue to be influenced by changes in exchange rates, corresponding relative price levels, tariff and non-tariff barriers, and commercial trading arrangements. Not only are wines from, for example, Romania, Yugoslavia or Chile likely to have an export advantage because of lower production costs and prices, but changes in exchange rates make these wines more favourable in certain countries, as reflected in imports induced by the weakening of the dollar versus the major currencies. Exports of some countries will undergo growth because of marketing initiatives and of improved trading policies. Countries whose exports have increased in this respect include Australia, Chile and the United

States. Concerning the future of imports, countries with relatively higher personal incomes such as Denmark, Japan, Sweden and Switzerland are likely to increase their imports. Eastern Europe as a region is likely to be a source of exports and a destination for imports.

There is also concern that over the next several years reduced economic activity if not recession will have a weakening affect on wine consumption. The table-wine market seems to be destined for production excess, given the difficulties of enacting the kinds of stabilization policies that will effectively reduce production. But in the case of quality wine consumption, which has been growing relative to production, continued increases in personal income and improvements in taste habits will stimulate further expansion. While the former depends on economic expansion in the major economies, the latter depends on reshaping consumer markets, most probably through further broad sales promotion and market segmentation. Once such adjustments take place, the wine-making industry may again see steady growth, albeit at slower rates than previously.

H. Waste paper for paper and board*

1. Recent trends and current conditions

Describing waste paper as an industry is unusual because the producers of waste paper are all the millions of consumers of paper and paper-board products. This industry must thus be covered from the perspective of the user, and measurements should be based on the recovery of waste paper from industrial and domestic waste for recycling to make more paper and board. Outside the paper industry there is little recognition of the size of the international waste paper business, of the millions of tonnes of waste paper shipped around the world, of the complexities of gathering and reusing it, and in particular of the fact that the paper and board industries of many countries are vitally dependent on their supply of waste paper.

The recent surge in environmental concerns among developed as well as developing countries has made the recycling of products such as waste paper important for the industry. Traditional supply and trade patterns for the waste paper market are thus likely to change considerably over the next few years from an already established base. The paper industry has been dependent on recycled fibre for many years and has been the main driving force for the collection of waste paper. Since at least the early 1980s, over 30 per cent of the paper and board used by the world annually has been recovered, and most of it has been recycled to make more paper and board. This percentage increased steadily through the decade, reaching 35 per cent of paper and board consumption in 1989.

The importance of waste paper as a raw material for the paper and board industry is shown by the amount of recycled fibre used by the industry as a proportion of total paper and board output. The steady increase from 30 per cent to 35 per cent between 1981 and 1989 occurred during a seven-year sequence of record annual output of paper and board. As a result, the use of recycled fibre has more than kept pace with increasing production. In short, recycling waste materials has a number of advantages ranging from reduced needs for landfill sites to increased gains in fuel substitution from firing generators with waste paper.

The waste paper market has traditionally been cyclical: increased collection drives down the price, thus reducing collection, and this in turn increases the price, which leads to a new cycle of collection. Recent expanded efforts to collect waste have, however, created a massive oversupply in Europe and North America, depressing prices for some grades down to zero, with waste paper merchants having to be paid to take the waste away. The amount of legislation imposing recycling is also increasing to such an extent that the oversupply problem is unlikely to disappear. One short-term effect is that more waste paper is being burnt or dumped. However, it is likely that the installation of new equipment to use recycled fibre at mills could eventually allow the capacity to use waste paper to catch up with the increased supply.

(a) Main types of waste paper

While a wide range of waste paper types can be found, the following five broad sub-divisions are normally employed: mixed paper, usually from domestic and office waste of varying quality, including boxboard; old newspapers collected from households or unsold from shops, as well as leftover waste from the printer; old corrugated containers collected from industrial and domestic waste, as well as waste cuttings from plants used to make corrugated boxes; pulp substitutes including high-quality unprinted white, coloured and brown paper, as well as waste offcuts from stationery producers and printers; and de-inking grades of waste just below pulp substitutes in quality, suitable for having the ink removed in an industrial process, before being reused to make paper. These grades include coated books, magazines and computer print-outs.

It is important to know these subdivisions to appreciate how dependent several of the world's major papermaking countries are on the supply of waste paper from the United States, and how any change in that supply could have far-reaching consequences.

(b) World consumption and production

Increases in waste paper consumption for paper and board have occurred in the same major regions that are important for recovery, as reflected in table V.68. North America and Western Europe displayed gains of 29 per cent and 30.7 per cent between 1985 and 1989. Market shares for these and other regions are shown in figure V.16. More significant gains were achieved in the South, with centrally planned Asia at 141.4 per cent, market economies of Asia at 82.2 per cent, and Western Asia at 81.3 per cent. Similarly, as shown in table V.69, the leading consuming countries in the North in 1989 were the United States with 18.7 million tonnes, Japan with 13.5 million tonnes, and the Federal Republic of Germany with 5.1 million

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*UNIDO acknowledges the contribution of P. Sutton, editor, *Pulp and Paper International*

Table V.68. World waste-paper consumption and recovery, 1985 and 1989

Country, region or economic grouping	Consumption 1985 (thousand tonnes)	Consumption 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989	Recovery 1985 (thousand tonnes)	Recovery 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989
North								
North America	15 977	20 613	25.47	29.0	18 968	26 607	33.01	40.3
Western Europe	16 359	21 377	26.41	30.7	15 507	20 105	24.94	29.7
Eastern Europe	4 616	5 518	6.82	19.5	4 718	5 493	6.82	16.4
Japan	10 442	13 487	16.66	29.2	10 152	13 091	16.24	28.9
Other developed countries	1 076	1 312	1.62	21.9	1 115	1 403	1.74	25.8
South								
Africa	333	226	0.28	-32.1	202	188	0.23	-6.9
Asia								
Western Asia	252	457	0.56	81.3	269	479	0.59	78.1
Centrally planned economies	1 740	4 201	5.19	141.4	1 740	3 756	4.66	115.9
Market economies	4 839	8 819	10.90	82.2	3 142	5 754	7.15	83.5
Latin America	3 834	4 921	6.08	28.4	3 109	3 712	4.61	19.4
North	48 470	62 307	76.99	28.5	50 460	66 699	82.76	32.2
South	10 998	18 624	23.01	69.3	8 462	13 899	17.24	64.3
TOTAL	59 468	80 931	100.00	36.1	58 922	80 598	100.00	36.8

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

Table V.69. World's largest waste-paper consumer and recovery countries and areas, 1989

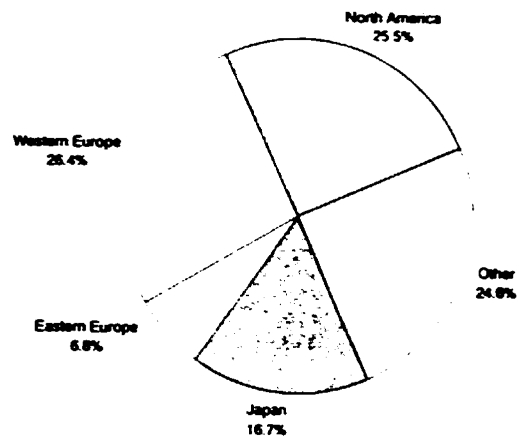
Rank	Country or area	Consumption (thousand tonnes)	Percentage share	Rank	Country or area	Recovery (thousand tonnes)	Percentage share
	North						
1	United States	18 747	38.62	1	United States	24 953	45.97
2	Japan	13 487	27.78	2	Japan	13 091	24.11
3	Germany, Federal Republic of	5 081	10.47	3	Germany, Federal Republic of	5 623	10.36
4	France	3 086	6.36	4	USSR	3 000	5.53
5	USSR	2 885	5.94	5	United Kingdom	2 977	5.48
6	Italy	2 682	5.52	6	France	2 878	5.30
7	United Kingdom	2 578	5.31	7	Italy	1 764	3.25
	TOTAL	48 546	100.00		TOTAL	54 286	100.00
	South						
1	China	4 176	29.53	1	China	3 730	37.89
2	Republic of Korea	3 319	23.47	2	Republic of Korea	1 903	19.33
3	Taiwan Province	3 083	21.80	3	Taiwan Province	1 724	17.51
4	Mexico	1 966	13.90	4	Brazil	1 553	15.77
5	Brazil	1 597	11.29	5	Mexico	935	9.50
	TOTAL	14 141	100.00		TOTAL	9 845	100.00

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

tonnes. In the South, China consumed 4.2 million tonnes, the Republic of Korea 3.3 million tonnes, and Taiwan Province 3.1 million tonnes.

The production of waste paper is measured here by its recovery from industrial and domestic waste to make paper and board. Table V.68 shows that total world recovery increased some 36.8 per cent from 58.9 million tonnes in 1985 to 80.6 million tonnes in 1989. Among the regions or groupings showing the greatest production increases are the centrally planned economies with 115.9 per cent over the same period, market economies of Asia with 83.5 per cent, and Western Asia with 78.1 per cent. The relative importance of regional market shares is reflected in figure V.17. Individual countries with the largest recovery volumes as reported in table V.69 include the United States with 25 million tonnes in 1989, Japan with 13.1 million tonnes and the Federal Republic of Germany with 5.6 million tonnes. Among countries and areas of the South, China led in recovery with

Figure V.16. World waste paper consumption, 1989



Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991)

3.7 million tonnes, followed by the Republic of Korea with 1.9 million tonnes and Taiwan Province with 1.7 million tonnes.

Recovery systems tend to be the same in the North and South. Collection of domestic and office waste paper is undertaken usually by city authorities, charitable organizations or private companies. In the South, in many countries, the first collection of separated domestic and office waste is made in small amounts by individuals, often from the poorer sections of the community, who sell it to merchants. These collectors sell or give the waste paper, often sorted, to merchants, dealers or brokers, who sell it to the end-user, in many cases a paper or board mill. They may also deal directly with a subsidiary of a paper company itself. Increasingly, merchant companies are being acquired by paper-making companies and, in the United States particularly, producers of recycled paper and paper-board are setting up their own complete integrated recycled fibre procurement lines including collection. They may also deal directly with the municipal authorities. Dealers may be in the export business, selling waste paper on to shipper or merchant in another country.

Some city and state authorities have imposed legal requirements on consumers to recycle their waste paper, usually sorted by household or office. It is expected that more countries will adopt laws to ensure more separated waste collection. There are also many cases of city authorities offering incentives and payments directly to consumers to collect and deliver separated household waste paper to a central point.

The second, and currently more important, source of supply is pre-consumer manufacturers' waste. This includes high-quality waste paper, such as offcuts of white paper by a forms printer or stationery producer, and high-quality waste board, as from the shipment of packaged goods from one industry to another. Sources such as these provide a large supply of waste, often of a single type, which is sold or given to merchants or paper producers for procurement operations, or sold and returned directly to the paper-mill which supplied it in the first place.

Costs of labour and collection may vary widely within this system, from free labour for charities which then sell the waste, to what is effectively State-financed recycling of waste by municipal employees who collect domestic waste. Meanwhile, waste-paper merchants and private collection companies, which operate at a profit, have full-time employees.

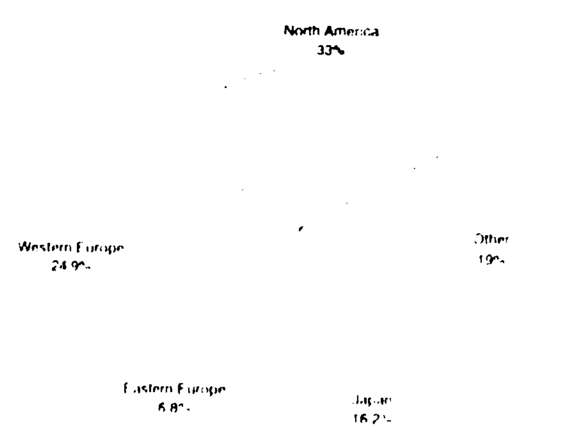
(c) International trade

Two of the three countries that recover the most waste paper also generate the largest exports. As shown in table V.70, the United States increased its exports by 91.9 per cent from 3 million tonnes in 1985 to 5.7 million tonnes in 1989. The export increases for the Federal Republic of Germany were approximately 39.7 per cent, up from 911,000 tonnes to 1.2 million tonnes over the same period. After France, Netherlands, Belgium and United Kingdom, another small but significant supplier of waste paper was Hong Kong. This area until recently did not have a domestic paper-board industry employing its own waste. It bought much of its needed packaging board from Taiwan Province and the Republic of Korea, which then bought back waste packaging for recycling. The United States remained the major exporter. There was, however, a considerable level of international trade in Europe, totalling about 4.5 million tonnes in 1989, most of which stayed within Europe. Another key element in the trade within Europe was the amount of United States waste paper entering Italy and Spain, which in 1989 totalled 420,000 tonnes.

Table V.71 lists the remaining major importing countries. Among the largest importers were the Republic of Korea with 1.37 million tonnes and Mexico with 1.03 million tonnes. Other significant European importers in 1989 were Federal Republic of Germany, France, Netherlands and Austria. Imports by Japan in 1989 amounted to 438,000 tonnes.

It is worth looking in more detail at individual trade flows in waste paper from the United States to the major buyers, Republic of Korea, Taiwan Province and Mexico. Table V.72 shows that in 1989, United

Figure V.17. World waste paper recovery, 1989



Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991)

Table V.70. Waste-paper exports of major trading countries and areas, 1985 and 1989

Rank	Country or area	Exports 1985 (thousand tonnes)	Exports 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989
1	United States	2 981	5 722	42.41	91.9
2	Germany, Federal Republic of	911	1 273	9.43	39.7
3	Netherlands	443	588	4.36	32.7
4	Belgium	390	541	4.01	38.7
5	France	255	510	3.78	100.0
6	United Kingdom	196	479	3.55	144.4
7	Hong Kong	350	400	2.96	14.3
8	Canada	190	314	2.33	65.3
9	Austria	53	89	0.66	67.9
10	Japan	18	51	0.38	183.3
11	Spain	17	18	0.13	5.9
12	Italy	..	..	..	..
13	Mexico	..	..	..	..
14	Taiwan Province	..	..	..	..
15	Republic of Korea	..	..	..	..
	TOTAL	5 804	9 985	74.00	72.0
World			13 493	100.00	

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

Table V.71. Waste-paper imports of major trading countries and areas, 1985 and 1989

Rank	Country or area	Imports 1985 (thousand tonnes)	Imports 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989
1	Republic of Korea	701	1 373	10.85	95.9
2	Taiwan Province	959	1 359	10.74	41.7
3	Mexico	589	1 031	8.15	75.0
4	Italy	702	922	7.29	31.3
5	Netherlands	463	788	6.23	70.2
6	Germany, Federal Republic of	565	727	5.74	28.7
7	France	284	718	5.67	152.8
8	Austria	491	588	4.65	19.8
9	Canada	520	544	4.30	4.6
10	Spain	395	533	4.21	34.9
11	Japan	300	438	3.46	46.0
12	United States	79	162	1.28	105.1
13	Belgium	85	102	0.81	20.0
14	United Kingdom	92	80	0.63	-13.0
15	Hong Kong	..	..	..	..
	TOTAL	6 225	9 365	74.00	50.4
World			12 655	100.00	

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

Table V.72. United States waste-paper exports compared to paper and board output by major consuming country or area, 1989
(Thousand tonnes)

Importing country or area	Old News-print	Pulp substitutes and de-inking grades	Total paper output	Old corrugated containers	Mixed grades	Total board output	Total United States waste imports	Total paper and board output
Republic of Korea	282	325	1 965	226	282	2 054	1 116	4 018
Taiwan Province	202	168	684	483	206	2 275	1 060	3 042
Mexico	93	193	1 544	556	220	1 192	1 062	2 737

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

States waste paper alone provided 28 per cent, 35 per cent and 39 per cent of the fibre needed by, respectively Republic of Korea, Taiwan Province and Mexico to make paper and board. After these three came Japan, which imported nearly 500,000 tonnes of United States waste (United States exports to these countries plus significant amounts to Canada, Italy, Philippines, Spain and other countries together comprise the major international trade flows by volume in waste paper). These amounts were not exceptional to 1989. United States waste paper exports exceeded 3 million tonnes in 1984 and climbed steadily to total 5.5 million tonnes in 1989. Total international trade in waste paper in 1989 was about 11.5 million tonnes. Even allowing for the greater use of recycled fibre within the United States, the American Paper Institute projected in 1990 that global demand for United States waste paper will continue to grow, reaching 11 million tonnes or more by 1995.

United States waste exports to Europe were affected by a shortage of containers caused by the Gulf war. The diversion of shipments from the Suez Canal to round the Cape of Good Hope was another consequence of that war. The resulting rise in costs hit European waste exports to Asia. The end of the conflict led to a gradual re-establishment of trade, though the glut of German waste paper available in Europe, plus the rise in the value of the dollar at the end of the first quarter of 1991, made European waste paper more attractive to buyers.

(d) *Major companies in the global industry*

Because of the nature of the waste paper business, it is not possible to list the biggest producers of waste paper, or the thousands of municipal, charitable and other organizations, merchants and agents that collect it. A tentative list of the biggest paper and paperboard producers that use large amounts of waste paper is given in table V.73. Financial results are listed by sales from all paper, board and converting operations, including those products made partly or completely from waste paper. The margin is the ratio of profit to total consolidated sales, including any non-paper products. The first five companies in the North—International Paper, James River, Stone Container, Georgia-Pacific and Weyerhaeuser—are located in the United States.

An equivalent list of company rankings has also been provided for the South in table V.73. The five largest are Yuen Foong Yu and Cheng Loong located in Taiwan Province, Chonju Paper in the Republic of Korea, SEKA in Turkey and Pipsa in Mexico.

Table V.73. World's largest waste-paper consuming companies in the North and the South, 1988 and 1989a/

Rank in 1989	Company and country or area	Paper and board sales (million dollars)	Percentage change 1988-1989	Net profits after tax (million dollars)	Percentage margin (ratio of profit to total sales)	Percentage change 1988-1989 total sales
North						
1	International Paper (United States)	9 224	13	864	8	15
2	James River (United States)	5 950	1	516	9	5
3	Stone Container (United States)	5 265	41	523	10	7
4	Georgia-Pacific (United States)	4 042	18	661	7	42
5	Weyerhaeuser (United States)	3 723	9	341	3	-40
6	Oji Paper (Japan)	3 666	6	433	9	19
7	Jujo Paper (Japan)	3 532	9	112	3	-3
8	SCA (Sweden)	3 211	24	496	13	8
9	Honshu Paper (Japan)	2 737	1	123	4	-20
10	Daishowa Paper (Japan)	2 500	3	222	8	-18
11	Jefferson Smurfit (Ireland)	2 356	21	281	12	11
12	PWA (Germany, Federal Republic of)	1 979	10	150	7	-4
13	Daio Paper (Japan)	1 832	10	210	11	11
14	Sonocco (United States)	1 293	-3	167	9	2
15	Federal Paperboard (United States)	1 287	20	274	21	36
South						
1	Yuen Foong Yu (Taiwan Province)	434	21	41	9	14
2	Chonju Paper (Republic of Korea)	340	28	75	22	84
3	SEKAa/ (Turkey)	337	122	78	23	111
4	Cheng Loong (Taiwan Province)	320	7	21	7	192
5	Pipsab/ (Mexico)	257	33	6	2	
6	Moorim Paper (Republic of Korea)	215	4	4	2	-47
7	Kye Sung Paper (Republic of Korea)	175	7	2	1	-35
8	Ban Yu Paper (Taiwan Province)	121	-4	5	4	24
9	Venepal (Venezuela)	107	72	12	11	32
10	Picopa/ (Philippines)	93	2	20	22	5

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

a/ Financial results are listed by sales from all paper, board and converting operations, including products made partly or completely from waste paper.

b/ State-owned.

2. *Waste paper recovery in developing countries*

Because of the unusual nature of this raw material, the measurement of capacity must be different from that of a normal manufactured product. The possibility (the equivalent of "manufacturing capacity") and the success of recovery and use of waste paper ("production") are useful measures. Comparing paper and board production to waste paper consumption is a good measure of the importance of waste paper as a raw material for paper-making. Table V.74 indicates the extent to which developing countries have the capacity to employ waste paper by percentage of waste paper use for paper and board production, on the basis of 1989 data. Countries with percentages of 65 per cent or above include Mexico, Republic of Korea, Thailand and Venezuela.

3. *Capacity utilization and expansion plans*

Because of the fluid nature of capacity and capacity utilization, it is difficult to evaluate not only utilization rates but also the prospects of expansion plans. An accurate measure of capacity utilization is to compare paper and board consumption to the amount of waste paper recovered. This a good measure of the efficiency of reusing a waste material. In table V.75, therefore, capacity becomes apparent paper-and-board consumption; production becomes recovery or collection; and utilization rate becomes recovery rate. Utilization rates are shown to be only slightly higher in the North at 35.5 per cent in 1989, than in the South, at 31.4 per cent. Countries and areas with utilization rates above 45 per cent in 1989 include Czechoslovakia, German Democratic Republic, Japan, Netherlands, Republic of Korea, Switzerland and Taiwan Province.

In Europe, supplies of waste paper have regularly varied from undercapacity to overcapacity. In simple terms, overcapacity leads to lower prices, no price at all, or a negative price, that is, payment to take the waste away. With low prices, collectors such as charities will lose all incentive to collect, and municipal authorities will use landfill or burn the waste. As a result, supply will diminish and prices will rise, leading to the collection of more waste paper and then to over capacity, etc. Attempts have been made to ease the problem by maintaining large stocks to even out the

Table V.74. Importance of waste-paper to the paper and board industry in the South, 1989

Rank	Country, region or area	Paper and board production	Waste-paper recovered (thousand tonnes)	Waste-paper consumption	Ratio of waste- paper consumption to paper and board production
	Latin America				
1	Brazil	4 831	1 553	1 597	33
2	Mexico	2 736	935	1 966	72
3	Argentina	916	354	342	37
4	Chile	591	167	122	21
5	Venezuela	525	240	350	67
6	Colombia	503	253	280	56
	Western Asia				
1	Turkey	830	280	330	40
2	Iran (Islamic Republic of)	177	50	50	28
3	Kuwait	23	15	14	61
4	Iraq	102	50	41	40
	Africa				
1	Egypt[a/]	164	40	50	30
2	Algeria	85	40	40	47
3	Morocco	120	50	71	59
4	Zimbabwe	85	25	32	38
	Asia Market economies				
1	Taiwan Province[b/]	3 042	1 724	3 083	101
2	Republic of Korea	4 019	1 903	3 319	83
3	India[a/]	2 185	900	1 100	50
4	Indonesia	1 106	135	360	33
5	Thailand	690	350	450	65
6	Philippines	374	26	229	61
7	Malaysia	209	130	107	51
	Asia Centrally planned economies				
1	China	13 338	3 730	4 176	31

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

a/ Estimated.

b/ Stock-building partly accounts for the 101 per cent utilization rate.

flow. Currently, in both Western Europe and North America, new legislation and consumer concern for the environment have led to an exceptional glut of waste paper, particularly of the lower grades that usually come from households.

Another key factor is the health of the industry that uses the waste, the paper and board industry, particularly the packaging board producers. The demand for and output of these products have risen steadily for the last few years, but neither has had a major effect on waste paper supply. In 1990 and 1991 there has been some slow-down in demand growth, with a consequent effect on the need for waste paper as a raw material. This has not helped a market already suffering from oversupply.

In conclusion, the major constraints for greater recycling of waste paper may be summed up as follows: physical capacity to handle it has to be increased; technology has to be improved to reuse more types of waste in more types of paper; and a widespread system allowing separation of household waste paper not only from other waste but also into different categories has to be established. Capital and skilled labour are not major bottlenecks. Any significant fall in the demand for paper and board could result in such low capacity utilization rates as to constitute a bottleneck itself.

4. *Environmental considerations*

A main reason today for the rapid increase in collection of waste paper for recycling is the growing concern for the environment worldwide. By reducing the solid waste problem and recycling a raw material, the waste paper business contributes to an improved

Table V.75. World-waste paper capacity and capacity utilization rates, 1985 and 1989

Rank in 1989[a/]	Country, region or area	Paper and board consumption (thousand tonnes) 1985	1989	Percentage change 1985-1989	Waste-paper recovery (thousand tonnes) 1985	1989	Percentage change 1985-1989	Recovery rates 1985	1989
	North America								
1	Canada	67 693	75 953	12.2	17 868	24 953	39.7	26.4	32.9
2	United States	5 069	5 857	15.5	1 100	1 654	50.4	21.7	28.2
	Total	72 762	81 810	12.4	18 968	26 607	40.3	26.1	32.5
	Western Europe								
1	Germany, Federal Republic of	10 625	13 085	23.2	4 371	5 623	28.6	41.1	43.0
2	United Kingdom	7 795	9 584	23.0	2 171	2 977	37.1	27.9	31.1
3	France	6 557	8 356	27.4	1 936	2 878	48.7	29.5	34.4
4	Italy	6 718	5 198	-22.6	1 313	1 764	34.3	19.5	33.9
5	Spain	2 942	4 110	39.7	1 291	1 591	23.2	43.9	38.7
6	Netherlands	2 477	3 018	21.8	1 148	1 491	29.9	46.3	49.4
7	Switzerland	1 162	1 437	23.7	503	674	34.0	43.3	46.9
	Total	45 621	56 394	23.6	15 507	20 105	29.7	34.0	35.7
	Eastern Europe								
1	USSR[b/]	9 260	10 255	10.7	2 500	3 000	20.0	27.0	29.3
2	German Democratic Republic	1 375	1 413	2.8	647	666	2.9	47.1	47.1
3	Poland	1 336	1 334	-0.1	327	495	51.4	24.5	37.1
4	Czechoslovakia	1 209	1 232	1.9	537	570	6.1	44.4	46.3
5	Yugoslavia	1 200	1 095	-8.8	425	420	-1.2	35.4	38.4
6	Hungary	663	653	-1.5	282	221	-21.6	42.5	33.8
	Total	16 249	16 980	4.5	4 718	5 493	16.4	29.0	32.3
	Other developed countries								
1	Japan	20 300	27 442	35.2	10 152	13 091	28.9	50.0	47.7
2	Australia[b/]	2 349	2 761	17.5	557	690	23.9	23.7	25.0
3	South Africa[b/]	1 295	1 547	19 5	375	500	33.3	29.0	32.3
4	New Zealand	592	530	-10.5	111	103	-7.2	18.8	19.4
5	Israel[b/]	356	472	32.6	72	110	52.8	20.2	23.3
	Total	24 892	32 752	31.6	11 267	14 494	28.7	45.3	44.3
	Latin America								
1	Brazil	3 597	4 156	15.5	1 155	1 553	34.5	32.1	37.4
2	Mexico	2 515	2 709	7.7	978	935	-4.4	38.9	34.5
3	Argentina	839	850	1.3	284	354	24.6	33.8	41.6
4	Colombia	538	574	6.7	194	253	30.4	36.1	44.1
5	Chile	276	521	88.8	90	167	85.6	32.6	32.1
	Total	9 783	10 965	12.1	3 109	3 712	19.4	31.8	33.9

Table V.75. (continued)

Rank in 1989[a]	Country, region or area	Paper and board consumption 1985 (thousand tonnes)	1989	Percentage change 1985-1989	Waste-paper recovery 1985 (thousand tonnes)	1989	Percentage change 1985-1989	Recovery rates 1985	1989
	Africa								
1	Egypt	478	564	18.0	31	40	29.0	6.5	7.1
2	Morocco	180	267	48.3	48	50	4.2	26.7	18.7
3	Algeria	189	260	37.6	35	40	14.3	18.5	15.4
4	Zimbabwe	78	95	21.8	23	25	8.7	29.5	26.3
	Total	1 878	2 168	15.4	202	188	-6.9	10.8	8.7
	Western Asia								
1	Turkey	691	996	44.1	150	280	86.7	21.7	28.1
2	Iran (Islamic Republic of)	379	516	36.1	50	50	0.0	13.2	9.7
3	Kuwait	73	91	24.7	40	15	-62.5	54.8	16.5
4	Jordan	60	61	1.7	10	6	-40.0	16.7	9.8
	Asia								
	Market economies								
1	Republic of Korea	2 290	3 867	68.9	817	1 903	132.9	35.7	49.2
2	Taiwan Province	2 063	3 176	54.0	901	1 724	91.3	43.7	54.3
3	India[b]	1 770	2 440	37.9	500	900	80.0	28.2	36.9
4	Thailand	632	1 005	59.0	120	350	191.7	19.0	34.8
5	Indonesia	702	896	27.6	80	135	68.8	11.4	15.1
6	Philippines	369	588	59.3	45	26	-42.2	12.2	4.4
7	Malaysia	416	543	30.5	90	130	44.4	21.6	23.9
	Asia								
	Centrally planned economies								
1	China[b]	9 889	13 980	41.4	1 724	3 730	116.4	17.4	26.7
	Total	22 836	30 804	34.9	5 125	9 909	93.3	22.4	32.2
North		159 164	187 936	18.1	50 460	66 699	32.2	31.7	35.5
South		34 497	43 937	27.4	8 436	13 809	63.7	24.5	31.4
	TOTAL	193 661	231 873	19.7	58 896	80 508	36.7	30.4	34.7

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

a/ According to paper and board consumption.

b/ Estimated.

environment. However, the recent tendency to oversupply ironically has led to the increased burning of waste paper. Not only is this a waste of good fibre in exchange for a fairly small energy value, it adds to atmospheric carbon dioxide, leaving a mound of ash which still has to be disposed of.

There can also be problems with disposal of the sludge resulting from the process of de-inking waste paper before using the recycled fibre. Indeed, the amount of water that is required in some de-inking processes and the subsequent treatment that it requires are a cause for concern.

There have also been some worries by consumers (in turn reflected in some governmental organizations) about the cleanliness of recycled paper-board and its close proximity to food and drink in packaging. Concern has also been expressed about tissue products made partially from recycled fibre, although such worries seem to have diminished. Various bodies, however, including the Commission of the European Communities, want a ban on direct contact between a board made from recycled fibre and food or drink products. There does not seem to be a good reason why recycled fibre cannot be sterilized.

Finally, there is little general appreciation of the fact that there will always be a need to use wood pulp, not only to meet the continuing rise in demand for paper, but also because wood fibres cannot be endlessly recycled. It is currently estimated that after three to five circuits of the recycling system, the fibre is unusable.

Paper and board producers are carrying out research and development to allow greater proportions of recycled fibre in the production of paper and to solve some remaining problems of contamination. However, the basic techniques for using waste paper to make lower-quality grades of paper and board are now well established. Estimates of research and development expenditure in major countries are not possible with any accuracy.

The basic processes of pulping waste paper, however, are not thought to be complicated. Pulping waste paper is easier than pulping wood, and the technology is relatively simple and well established. Any gap in technology between North and South is thus unlikely to be wide. If waste printing paper is to be de-inked, then washing, or more commonly, flotation systems, or a mixture of both methods, are used, followed by some chemical bleaching (perhaps using sodium hydrosulphite followed by hydrogen peroxide). These are established technologies which are being further refined.

At present, there are at least two areas where research and development are concentrated. One involves contaminant removal, which can still be a problem with adhesives and glues. With the likelihood that more compound packaging will be collected in future, there will be a need to separate the paper fibre from the plastic and metal parts. The technology is not yet sufficiently advanced to cope on an industrial scale with metallized drink cartons.

The other area involves the further adding of recycled fibre. Some recycled fibre content can be introduced into grades of paper that have not traditionally contained any. There are problems of strength, brightness and consistent quality to be overcome. It seem likely, however, that consumer demand will push forward the development of more printing and office papers with an increased proportion of recycled fibre.

5. *Short- and medium-term outlook*

Probably the single most important factor in the outlook for the waste paper industry is the growth in both the recovery and use of recycled fibres in the United States. Consumers not only want to collect more paper, but are seeking products made from recycled materials. This provides a market reason for papermakers to use more recycled fibre. Another key reason is the increased number of laws to promote recycling. This is a reaction by the United States to the increasing shortage of disposal sites for waste. It is estimated that about half of all solid waste in that country is waste paper. There are regulations imposing recycling programmes, but when it became clear that there was not sufficient growth in the use of waste paper to handle increasing amounts of it, regulations were introduced to impose a minimum recycled fibre content in newspapers, and then in other grades for printing and writing, and finally in some packaging. State purchasing agents have also been required to buy paper with a certain amount of recycled fibre.

Since June 1989, the Government of the United States has had to buy paper with a specified recycled-fibre content. The guidelines for this were established by the Environmental Protection Agency and cover 24 paper and board grades. For example, newsprint must contain at least 40 per cent post-consumer waste-paper fibre and corrugated boxes 35 per cent. All of this is having a major impact on the paper industry in North America, which is now restructuring production lines to handle recycled fibre.

This new trend should be compared with the rise in the use of waste paper in proportion to total paper and board output over the last 20 years. Virtually unchanged at about 23 per cent until 1978, it reached 25 per cent by 1988 and jumped to 27 per cent by 1989. This is still less than the 50 per cent in the EEC and the 34 per cent for all of Western Europe. Early in 1990, the American Paper Institute announced that the industry has set a goal of a 40 per cent recovery rate of all paper used in the United States by the end of 1995. This compares with a 33 per cent rate in 1989. The survey conducted by the Institute found that plans by United States mills would already increase waste paper consumption to 28.5 million tonnes by 1995, compared with nearly 19 million in 1989 and 20.3 million in 1990.

Such a forecast suggests that supplies of recycled fibre are likely to expand internationally. Waste-paper collection for recycling is being stimulated by legislation in North America and Europe, where landfill capacity is becoming exhausted, adding to the need to extract and recycle this major ingredient of waste. It is difficult to predict what widespread effects this may have. One immediate short-term effect is oversupply, with more waste produced than papermakers in North America and Europe can handle. This has led to give-away prices, and increased the burning of waste paper rather than its recycling. But the capacity to collect and use waste paper profitably is already expanding rapidly in North America. It may grow to such an extent that the free availability of waste paper today could be much more difficult to maintain in the future.

A more serious consequence is that the surplus could seriously undermine the profit incentive needed by waste-paper enterprises to ship waste paper to Asia, particularly to the Republic of Korea and Taiwan Province, but also to Japan and Thailand. Today, large sections of the board industry in the first two countries depend on such supplies. They are likely to have problems finding new sources of supply, and could increase their own recycling efforts.

The economics of making newsprint in North America could possibly become more like those of Europe, where the building of newsprint mills located closer to both the buyer of the end-product (newspaper purchasers) and the main source of raw material (waste-paper collectors) makes economic sense. This puts the big Canadian newsprint industry in a quandary. Based as it is on virgin fibre, this industry will have to use more waste paper in its mills in order to make paper that complies with legislation on minimum recycled fibre content. It may mean that Canada will seek to sell even more of its virgin-fibre newsprint overseas.

Future developments will depend largely on whether companies and printers make their contribution to the protection of the environment by increasing their demand for paper containing recycled fibre. Many problems must be overcome, but it is likely that more grades of paper will contain some recycled fibre in the future, helping to absorb the increasing supply of waste paper.

I. Market pulp (ISIC 341101-34116)*

1. *Recent trends and current situation*

Market pulp is defined as pulp sold by one company to another at a price profitable to the seller. It therefore excludes pulp sold between companies

*UNIDO acknowledges the contribution of P. Sutton, editor, *Pulp and Paper International*.

having a legal connection, based, for example, on membership of the same group, as such transactions could cause price distortions. Although the empirical definition of market pulp may be subject to various limitations and interpretations, the data presented relate mostly to pulp used to make paper or paper-board.

Completely separating such pulp from specialty pulps intended for other uses, such as textile manufacturing, is difficult. It is thus estimated that the 1989 figures include about 1.5 million tonnes of specialty pulps. In some cases it is also difficult to differentiate between pulp sold on the open market and pulp used in the producer's own paper-mills or in an affiliated company. In most cases, however, the production figures should be for open-market pulp only. It is also assumed that where specific trade figures are not available, all pulp traded across frontiers is market pulp.

Of the total pulp used by the world paper and board industry in 1989, approximately 20 per cent was market pulp, about the same proportion as in 1985. Though a relatively small contributor, market pulp is a vital raw material worldwide for many paper-mills without their own pulp supply. Paper-mills are often partially integrated with their own pulp or recycled fibre supply, but still need some market pulp to secure a paper quality acceptable to customers.

Most market pulp is wood pulp made by a chemical separation process. In 1989, about 2 per cent of the total wood pulp was non-wood market pulp, including some pulp made from recycled fibres. About 6 per cent was wood pulp made by mechanical processes, or combined mechanical and chemical processes. The remaining 92 per cent was chemically produced wood pulp. The nearly 85 per cent of the chemically produced, market wood pulp made by the kraft chemical process is generally recognized as the highest-quality market pulp for paper-making, and therefore dominates the market. For many paper makers, this pulp provides an essential extra strength component, and while they continuously aim at reducing their dependence on it as far as possible, it is still a necessary ingredient for many types of paper and some paper-board.

Bleached kraft pulp is the most common market pulp, accounting for about 75 per cent of all chemical market pulps in 1989. It is classified by the type of wood used, as follows: softwood, commonly pine and spruce, usually from the big producers in the North, such as Canada, United States and the Nordic countries; and hardwood, commonly birch and aspen from the North, and eucalyptus from Latin America, Portugal and Spain and other countries of the South. About 24 million tonnes of bleached kraft market pulp were produced in 1989, of which about 60 per cent were softwood and 40 per cent hardwood. The most popular type of market pulp, one considered to be the benchmark grade, is northern bleached softwood kraft (NBSK) pulp.

The pulp market is international. Available data show the major trade flows to be as follows: market pulp (mostly NBSK) goes from Canada to the United States; pulp, again mostly NBSK but also significant quantities of both soft and hardwood pulps from the South of the United States, flows from North America and the Nordic countries into the fibre-deficient countries of the EEC, from Brazil (mostly eucalyptus) to North America, Europe and Asia, and from North America, especially Canada, into the fibre-deficient countries and areas of Asia, especially Japan, Republic of Korea and Taiwan Province.

(a) Cyclical market conditions

The state of the pulp market is often seen as a barometer of the entire pulp and paper industry. It is known for its traditional boom and bust business cycles, with high prices and low stocks followed closely by the reverse situation. From 1985 to mid-1991, the market has gone through an almost complete cycle. An example of this can be seen in the price of the main grade, NBSK. From the end of 1985 to the third quarter of 1989, its c.i.f. dollar price rose 110 per cent in Europe from $400 to $840 per tonne. Much the same happened in Asia and North America, with the latter experiencing a rise of 105 per cent. This was a time of strong growth in demand for paper in most major markets, while there was little increase in the production capacity of market pulp, making supply tight. As prices rose, so did the number of announcements of plans by market pulp producers to build new mills.

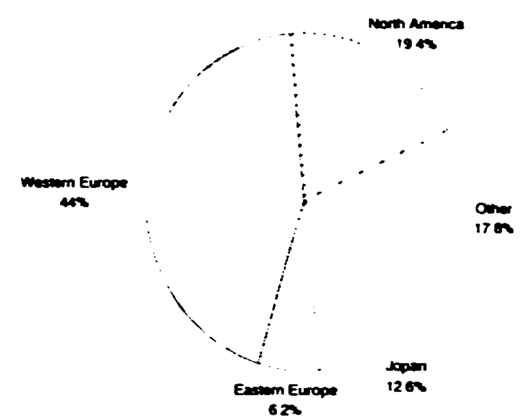
Then the market took a new direction. From the end of 1989 to the end of the first quarter of 1991, the NBSK dollar price fell by 23 per cent to $650 per tonne. As 1990 progressed, market pulp supply eased while the growth in demand for paper and board slowed. The rapid fall in prices resulted in much weaker profits in 1990 and in the postponement of several large projects to increase market pulp capacity, notably in Europe. An example of the effect of such a market turnaround is the cost of the pulp for a non-integrated wood-free paper maker in Europe. In 1986, the cost of pulp took about 60 per cent of the sales price of the paper; by early 1990, it was 80 per cent; by the first quarter of 1991, it was back to about 65 per cent.

A further important factor is that pulp produced in Europe, mostly by Portugal, Spain and the Nordic countries, is usually sold in Europe in the currency of the buyer or, increasingly, in ECU. But competitive United States pulp is sold in Europe and in most of Asia in dollars. The recent decline of the dollar has allowed increases in the price of pulp sold in dollars, whereas it was not possible for pulp priced in European currencies to follow that trend. In each of 13 quarters between the beginning of 1986 and the end of 1989, North American pulp suppliers successfully pushed through a price increase in Europe and Asia. In contrast, European pulp sold in the German market using deutsche mark experienced an increase in price by about 50 per cent during the same period. And in the 12 months since then, it has fallen in price by the same amount of 50 per cent. For the rest of 1991 it is likely that the depressed mood of the pulp market will continue. While still steady, the demand for paper in Europe and North America is down from previous record growth rates, and prices for many grades have fallen. Asia continues to have the most rapid growth in paper and board demand compared with other continents, but even this demand has declined. Partly because of the slow-down in growth, and partly because of heavy capital investment by paper makers (following high profits in the late 1980s), key branches of the paper industry in all three regions are suffering from overcapacity, with no shortage of market pulp.

(b) World consumption and production

Table V.76 provides estimates of apparent consumption of paper pulp based on pulp shipments, while figure V.18 illustrates the shares of the largest consuming regions. It is often difficult to differentiate between true market pulp and pulp sold or shipped between mills belonging to the same group. It is also difficult to separate paper-grade market pulp from other speciality pulps, such as dissolving and special alpha pulps, which have non-paper uses. In the case of the United States, the significant volume of dissolving market pulp, about 1.3 million tonnes in 1989, has been excluded, but for other countries, dissolving pulp may still be part of the total. With regard to centrally planned economies, defining market pulp is particularly difficult. Data on market pulp shipments are available for China. But for the USSR, it has been assumed that domestic pulp shipments are not true market pulp; only pulp made for export and imported pulp are categorized here as market pulp. Market mechanical pulp production and shipments have been included for Canada, although data for 1985 are estimates. Apparent consumption is shown to have increased worldwide by 19.8 per cent between 1985 and 1989. The most important regional increases occurred in North America, with 45 per cent, Western Asia, with 26 per cent, and the market economies of Asia, with 28.9 per cent. The three largest consumer countries in this respect were Germany, Japan and United States. Table V.76 also gives data on regional

Figure V.18. World market pulp consumption, 1989



Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991)

changes in world market pulp production between 1985 and 1989, and figure V.19 shows the major producing regions. The 14.2 per cent increase in total world production was slightly less than the increase in consumption. The biggest production changes occurred in North America, with 26.6 per cent, and in the centrally planned economies of Asia, with 22.9 per cent. As reflected in table V.77, the three largest producer countries in the world are Canada, Sweden and United States. When market pulp consumption and production patterns in the South are examined, the largest consumers are found to be Brazil, China, Mexico, Republic of Korea and Taiwan Province.

The main factor in the expansion or contraction of production is the balance between market demand

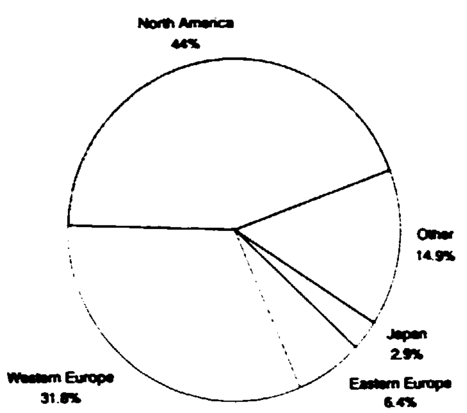
Table V.76. World market pulp consumption and production, 1985 and 1989

Country, region or economic grouping	Apparent consumption a/ 1985 (thousand tonnes)	Apparent consumption a/ 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989	Production 1985 (thousand tonnes)	Production 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989
North								
North America	4 592	6 662	19.44	45.1	11 555	14 632	44.00	26.6
Western Europe	12 669	15 077	44.00	19.0	9 560	10 582	31.82	10.7
Eastern Europe and USSR	2 295	2 120	6.19	-7.6	2 281	2 120	6.37	-7.1
Japan	3 281	4 309	12.58	31.3	1 033	956	2.87	-7.5
Other	503	253	0.74	-49.7	885	1 039	3.12	17.4
South								
Africa	291	336	0.98	15.5	304	316	0.95	3.9
Asia								
Centrally planned economies	736	687	2.00	-6.7	179	220	0.66	22.9
Market economies	2 100	2 707	7.90	28.9	606	659	1.98	8.7
Western Asia	165	208	0.61	26.1	0	0	0.00	0.0
Latin America	1 979	1 907	5.57	-3.6	2 724	2 732	8.22	0.3
North	23 340	28 421	82.94	21.8	25 314	29 329	88.19	15.9
South	5 271	5 845	17.06	10.9	3 813	3 927	11.81	3.0
TOTAL	28 611	34 266	100.00	19.8	29 127	33 256	100.00	14.2

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

a/ Figures may be distorted by the inclusion of small amounts of market pulp stocks.

Figure V.19. World market pulp production, 1989



Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

from paper and board producers and market pulp production capacity. Until recently, demand for paper was growing strongly, thereby increasing demand for market pulp in Europe, North America and especially Asia. Market pulp capacity utilization was fairly high, leading to plans to expand market pulp production. By 1990, however, the growth of paper demand in the major markets had slowed down, with a consequent effect on market pulp demand leading to lower mill operating rates and the subsequent build-up of pulp stock levels.

Although a detailed breakdown of the structure of production costs in major producing countries is not often available to the public, table V.78 provides recently published data on the cost structure in the first quarter of 1990. This is the latest confirmation of the well-known fact that low-cost producers in the South can compete successfully in the markets of the North. The general cost relationship is unlikely to have changed significantly since early 1990.

(c) International trade

Market pulp is always a traded commodity and the majority of that trade is international. Current major trade flows are from Canada into the United States, from the Nordic countries into the rest of Europe and to Asia, from North America to Europe and Asia, and from South America to Europe and Asia. Despite fears that the Gulf crisis would affect transatlantic shipments of market pulp, there is little evidence that this or any other pulp trade was severely affected by those events.

Tables V.79 and V.80 suggest that major exporting and importing countries reflect their status as the major producing and consuming nations. Canada, Sweden and the United States are again the major exporters. However, while Canada and the United States showed export increases of, respectively, 19.9 per cent and 41.8 per cent between 1985 and 1989, Sweden reported an export decrease of 2.8 per cent. Another surprising change was the 57.8 per cent increase recorded by the Federal Republic of Germany. The major importing countries were Germany, Federal Republic of, Japan and United States, with sizeable

Table V.77. Largest market pulp producer and consumer countries in the world and in the South, 1988 and 1989

Rank	Country, area or grouping	Apparent consumption[a] (thousand tonnes)	Percentage share	Rank	Country, area or grouping	Production (thousand tonnes)	Percentage share
			A. North, 1989				
1	United States	5 516	23.30	1	Canada	8 064	31.85
2	Japan	4 309	20.54	2	United States	6 568	25.94
3	Germany, Federal Republic of	3 625	17.28	3	Sweden	3 669	14.49
				4	Finland	2 073	8.19
4	Italy	2 373	11.31	5	USSR[b]	1 240	4.90
5	United Kingdom	2 131	10.16	6	Portugal	1 235	4.88
6	France	2 126	10.14	7	Japan	956	3.78
7	Sweden	895	4.27	8	Spain	774	3.06
				9	Norway	741	2.93
	Total	20 975	100.00		Total	25 320	100.00
			B. South, 1988				
1	Republic of Korea	1 116	29.84	1	Brazil	1 618	53.12
2	Brazil	690	18.45	2	Chile[b]	550	18.06
3	China	687	18.37	3	Taiwan Province	350	11.49
4	Taiwan Province	643	17.19	4	Mexico[b]	308	10.11
5	Mexico[b]	604	16.15	5	China	220	7.22
	Total	3 740	100.00		Total	3 046	100.00

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

a/ Figures may be distorted by the inclusion of small amounts of market pulp stocks.

b/ Estimated.

Table V.78. Cost structure of market pulp production in the major producing countries, first quarter 1990
(Cost of delivery to Northern Europe in thousand dollars per tonne)

Product and country or grouping	Production cost	Transport, finance and sales	Total cost
Bleached softwood kraft			
Chile	313	170	483
Canada (British Columbia coast)	411	222	633
Nordic countries	525	180	705
Bleached hardwood kraft			
Brazil	260	140	400
United States (South)	335	220	555
Portugal	362	200	562
Finland	410	195	605
Spain	450	168	618

Source: Roger Wright and Hawkins Wright, speech at the Siva Market Pulp Conference held at Rome in October 1990.

increases of, respectively, 15 per cent and 225.7 per cent and 43.7 per cent.

For many years there has been trade in woodchips from some countries of the South, and until recently smaller amounts of such trade from Portugal and Spain, to companies in the North, usually in the Nordic countries or the southern part of the United States. The Congo has also been a significant exporter. Larger shipments of woodchips have been sent from Australia, New Zealand, Asia and South America to Japan for pulping, and from the USSR to Europe and Japan. Virtually all the tonnes of traded woodchips have been used to make pulp that is directly integrated with paper production lines and not sold on the open market. This is undoubtedly a case of extraction of a raw material from countries that have no developed pulp and paper industries for use in developed countries, which may well sell back the paper product to the same developing countries.

(d) *Major companies in the global industry*

It is difficult to separate the revenues from selling market pulp from those earned from paper and paperboard, which most market pulp producers also make. Thus the companies listed in tables V.81 and V.82 are ranked by market pulp production capacity in 1989, but the financial results are for the entire company. Sales and profits of market pulp production are tied closely to the market itself. In 1989, therefore, most of the world's producers had good sales and profits from this business, with record highs in some cases, in contrast to 1990, when market prices declined, particularly in the last quarter, demand eased, and the revenue and profits of most suppliers fell sharply.

The five major companies in the North are located in either the United States (Georgia-Pacific, Weyerhaeuser and International Paper) or in Sweden (Soedra Skogsaegarna and Stora). Canadian Pacific in Canada is ranked sixth. In the South, the first four major companies are located in Brazil (Aracruz and Klabin) or in Chile (Arauco y Constitución and CMPC). The last two reported are located in Indonesia and Venezuela.

2. *Manufacturing capacity of developing countries*

Table V.83 shows the market-pulp manufacturing capacity, production and domestic consumption together with total pulp production and exports of developing countries and areas in 1989. As was to be expected, Brazil and Chile have the biggest market pulp capacity, followed by Argentina, China and Taiwan Province.

Table V.79. Market pulp exports of major trading countries, 1985 and 1989

Rank in 1989	Country	Exports 1985 (thousand tonnes)	Exports 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989
1	Canada	5 920	7 097	26.18	19.9
2	United States	2 871	4 072	15.02	41.8
3	Sweden	2 997	2 913	10.75	-2.8
4	Finland	1 534	1 652	6.09	7.7
5	USSR[a]	1 000	1 100	4.06	10.0
6	Portugal	942	1 033	3.81	9.7
7	Brazil	937	1 003	3.70	7.0
8	Norway	597	551	2.03	-7.7
9	France	313	358	1.32	14.4
10	Germany, Federal Republic of	116	183	0.68	57.8
11	Italy	63	68	0.25	7.9
12	Japan	20	11	0.04	-45.0
13	United Kingdom	2	10	0.04	400.0
14	Netherlands	21	7	0.03	-66.7
	TOTAL	17 333	20 058	74.00	15.7
	World	..	27 105	100.00	..

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

[a] Estimated.

Table V.80. Market pulp imports of major trading countries, 1985 and 1989

Rank in 1989	Country	Imports 1985 (thousand tonnes)	Imports 1989 (thousand tonnes)	Percentage share 1989	Percentage change 1985-1989
1	Germany, Federal Republic of	3 076	3 536	13.45	15.0
2	Japan	1 033	3 364	12.30	225.7
3	United States	2 102	3 020	11.49	43.7
4	Italy	1 770	2 181	8.30	23.2
5	United Kingdom	1 559	2 141	8.14	37.3
6	France	1 623	1 753	6.57	8.0
7	Republic of Korea	680	959	3.55	41.0
8	Netherlands	555	626	2.38	12.8
9	USSR[a]	350	230	0.87	-34.3
10	Canada	220	179	0.68	-18.6
11	Sweden	146	139	0.53	-4.8
12	Finland	62	82	0.31	32.3
13	Norway	112	80	0.30	-28.6
14	Brazil	39	75	0.29	92.3
15	Portugal	30	37	0.14	0.0
	TOTAL	13 357	18 402	70.00	37.8
World		..	26 289	100.00	..

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

[a] Estimated.

Table V.81. The largest market pulp companies in the North, 1989

Rank in 1989	Company and country	Approximate market pulp capacity (thousand tonnes per year)	Pulp, paper and board sales (million dollars)	Percentage change 1988-1989	Net profits after tax (million dollars)	Profit as a percentage of total sales[a]	Percentage change 1988-1989
1	Georgia-Pacific (United States)	1 675	4 042	18.0	661	7.0	42.0
2	Weyerhaeuser (United States)	1 560	3 723	9.0	341	3.0	-40.0
3	Stora (Sweden)	1 160	3 002	10.0	552	8.0	30.0
4	Soedra Skogsaegarna (Sweden)	960	644	-4.0	118	12.0	23.0
5	International Paper (United States)	850	9 224	13.0	864	8.0	15.0
6	Canadian Pacific (Canada)	800	1 997	-5.0	314	13.0	-22.0
7	Fletcher Challenge (New Zealand)	780	2 033	5.0	687	9.0	14.0
8	Champion International (United States)	695	4 037	1.0	432	8.0	-5.0
9	MoDo (Sweden)	675	2 723	-5.0	362	12.0	10.0
10	Parsons & Whittemore (United States)[b]	660	..	..	..	..	..
11	Portucel (Portugal)	650	496	10.0	119	24.0	13.0
12	Noranda (Canada)	568	2 434	-1.0	160	4.0	-28.0
13	Canfor (Canada)	555	424	1.0	116	10.0	-1.0
14	MacMillan Bloedel (Canada)	500	1 532	..	319	13.0	-17.0

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

[a] Total sales are total consolidated sales, including revenue from other business sectors not directly connected to making and converting pulp, paper and board.

[b] Financial data not made public.

3. *Capacity utilization and expansion plans*

World-wide capacity utilization rates in 1989 are higher than those of 1985, reflecting the overall increase in market pulp production and consumption during the intervening period. Table V.84 shows that utilization rates in the major producing countries, Canada, Sweden and United States, jumped from about 86 per cent in 1985 to approximately 94.5 per cent in 1989.

In 1988 and 1989, strong demand led to a substantial rise in both prices and profits and consequently to further plans for new capital investment in market pulp production. However, when the market faltered and prices began to drop fast in 1990, the result was either a delay in or cancellation of a number of these projects. The number and status of the major chemical market-pulp projects as of the end of 1990 are given in table V.85.

Overcapacity and undercapacity in major producing countries depend on a few key factors. For example, paper and board demand is closely related to economic conditions in a country and drives market pulp demand, thus determining overcapacity or undercapacity. Within

Table V.82. The largest market pulp companies in the South, 1989

Rank in 1989	Company and country	Approximate market pulp capacity (thousand tonnes per year)	Pulp, paper and board sales (million dollars)	Percentage change 1988-1989	Net profits after tax (million dollars)	Profit as a percentage of total sales[a]	Percentage change 1988-1989
1	Aracruz (Brazil)[b]	525	97	1.1	136	140.0	1.5
2	Arauco y Constitución (Chile)	370	218	-11.0	129	42.0	-13.0
3	Klabin (Brazil)	350	938	-98.0	157	17.0	-97.0
4	CMPC (Chile)	150	425	29.0	173	33.0	40.0
5	Indah Kiat (Indonesia)	120	119	34.0	43	36.0	17.0
6	Venepal (Venezuela)	70	107	73.0	12	11.0	32.0

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

[a] Total sales are total consolidated sales, including revenue from other business sectors not directly connected to making and converting pulp, paper and board.

[b] Several of these companies are planning expansions, but that of Aracruz is the most dramatic. Its capacity should rise to 1,050,000 tonnes per year in 1991. Its net earnings are larger than sales, thanks to other revenues (such as export premiums and financial income) which accrued during fiscal year 1989. Also, as of 31 December 1989, the new cruzeiro rate has been used for conversions into dollars, in accordance with accounting requirements in Brazil following the replacement of the cruzado by the new cruzeiro in 1989.

Table V.83. Market-pulp manufacturing capacity, production, consumption and exports of developing countries and areas, 1989
(Thousand tonnes)

Rank	Country, area region or economic grouping	Market pulp			Total pulp production	Pulp exports
		Capacity	Production	Consumption		
	Africa					
1	Swaziland	180	147	-	147	147
2	Morocco	115	107	55	107	80
	Asia					
	Market economies					
1	Taiwan Province	370	350	643	437	93
2	Republic of Korea	160	157	1 116	302	-
3	Indonesia	150	120	320	510	10
	Centrally planned economies					
1	China[a]	275	220	687	11 866	9
	Latin America					
1	Brazil	1 745	1 618	690	4 501	1 003
2	Chile	575	550	68	841	482
3	Argentina[a]	275	257	218	721	56
4	Mexico[a]	140	140	439	799	31

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

[a] Figures may be estimates.

the available production capacity of the industry, the start-up of new market-pulp production lines or the drop in supply when a market pulp line is integrated with a paper machine has direct effects on this fairly small market. Variations in currency exchange rates, import controls, freight rates and other more common market factors also help to generate overcapacity or undercapacity.

Major foreign direct investment is fairly common, although actual amounts of investment are often not available to the public. It is clear, however, that Northern companies undertake major capital investment projects in countries with a low wood cost, as exemplified by the Japanese in New Zealand, Brazil and Chile; by the Swedish in Portugal, Chile and Brazil; by New Zealanders in Chile (as well as in Canada).

Establishing a market pulp mill is often the first move into this industry by developing countries with substantial forest resources. Big foreign pulp and paper producers will make such investments even if it is only to secure a source of pulp for themselves, or to tie in potential competitors. This has been true of the rise of the Southern hardwood market-pulp producers

Table V.84. World market-pulp capacity utilization rates, 1985 and 1989

Rank[a]	Country, area, region or economic grouping	Capacity 1985 (thousand tonnes)	Capacity 1989 (thousand tonnes)	Percentage change 1985-1989	Production 1985 (thousand tonnes)	Production 1989 (thousand tonnes)	Percentage change 1985-1989	Utilization rates 1985	Utilization rates 1989
	North America								
1	Canada	7 503	8 536	13.8	6 462	8 064	24.8	86.1	94.5
2	United States	5 935	6 891	16.1	5 093	6 568	29.0	85.8	95.3
	Western Europe								
1	Sweden	4 000	3 890	-2.8	3 475	3 669	5.6	86.9	94.3
2	Finland	1 920	2 170	13.0	1 746	2 073	18.7	90.9	95.5
3	Portugal	1 270	1 235	-2.8	1 091	1 235	13.2	85.9	100.0
4	Norway[b]	750	835	11.3	706	741	5.0	94.1	88.7
5	Spain[b]	755	775	2.6	663	774	16.7	87.8	99.9
	Eastern Europe								
1	USSR[c]	1 450	1 450	0.0	1 240	1 240	0.0	85.5	85.5
2	Czechoslovakia[c]	520	500	-3.8	518	450	-13.1	99.6	90.0
	Japan	1 400	1 166	-16.7	1 033	956	-7.5	73.8	82.0
	Other developed economies								
1	New Zealand	535	647	20.9	455	569	25.1	85.0	87.9
2	South Africa[c/d]	500	600	20.0	430	550	27.9	86.0	91.7
	Africa								
1	Swaziland	180	180	0.0	180	147	-18.3	100.0	81.7
2	Morocco[c]	100	115	15.0	81	107	32.1	81.0	93.0
	Asia								
	Market economies								
1	Taiwan Province	370	370	0.0	350	350	0.0	94.6	94.6
2	Republic of Korea	140	160	14.3	129	157	21.7	92.1	98.1
3	Indonesia (1985)[c]	50	150	200.0	50	120	140.0	100.0	80.0
	Centrally planned economies								
1	China[b]	224	275	22.8	179	220	22.9	79.9	80.0
	Latin America								
1	Brazil	1 765	1 745	-1.1	1 619	1 618	-0.1	91.7	92.7
2	Chile[b]	555	575	3.6	522	550	5.4	94.1	95.7
3	Argentina[c]	260	275	5.8	223	257	15.2	85.8	93.5
4	Mexico[c]	296	140	-52.7	234	140	-40.2	79.1	100.0

Source: Pulp and Paper International, *Fact and Price Book* (San Francisco, Miller Freeman Inc., 1991).

[a] In terms of capacity in 1989.

[b] Capacity estimated.

[c] Estimated.

[d] In the estimates for South Africa an attempt is made to exclude its dissolving market-pulp output.

over the last 15 years. In general, attempts by big foreign producers to move in, or indeed dominate, these emerging market-pulp-producing countries have not been very successful—or have enjoyed only short-term success.

The short-term response to overcapacity in market pulp mills has been to shut them down for a while to reduce mill stocks further down the supply chain, with possible employment consequences. The importance of down time to the regulation of the market is shown by the close attention paid to Norscan pulp stocks, which are monthly figures giving the tonnes of chemical market pulp held in stock at the major market pulp mills in North America and the Scandinavian countries. A relatively high figure can lead to some softening of the market, while comparatively low Norscan stocks have the opposite effect, leading to reduced employment. However, with the rise of market pulp producers in Portugal, Spain, South America and the southern United States, the importance of the Norscan stock has declined somewhat in recent years.

4. *Restructuring*

The role of government in industrial restructuring is limited, certainly in countries of the North, where there are few if any State-owned mills, and where State aid, although provided from time to time in the past, has been substantially reduced. There are few State-owned mills in the South where State support, tax incentives for exports, occasional market-pulp import duties, or other benefits have been offered. The pace of adjustment is unsettling and can change rapidly. The major bottlenecks likely to curb the

Table V.85. World's major expansions of chemical paper-grade market-pulp production capacity

Country, region and company	Location	Capacity (thousand tonnes per year)	Start-up date
Canada			
Champion (Weldwood)	Hinton (Alberta)	10 BSK	1990
James Maclaren	Thurso (Quebec)	70 BHK	1990
Canadian Pacific FP	Dryden (Ontario)	(110 BSK)	1990
Daishowa Forest Products	Peace River (Alberta)	340 BHK/BSK[a]	1990
Howe Sound Pulp (Canfor/Oji)	Port Mellon (British Columbia)	100 BSK	1990
Fletcher	Three mills in British Columbia	105 BSK	1991
James River	Marathon (Ontario)	70 BSK/BHK	1992
Malette Kraft Pulp & Paper	Smooth Rock (Ontario)	70 BSK/BHK	1992
Repap Enterprises[a]	Tha Pas (Manitoba)	170 BHK	..
Alberta-Pacific[b]	Athabasca (Alberta)	500 BHK/BSK[a]	1993
Procter & Gamble[b]	Grand Prairie (Alberta)	250 BHK/BSK	..
Repap Enterprises[b]	Tha Pas (Manitoba)	450 BSK/BHK	..
Celgar Pulp[b]	Castlegar (British Columbia)	200 BSK	..
Canfor[b]	Prince George (British Columbia)	525 BSK	..
United States			
Bowater	Calhoun (Tennessee)	80 BHK	1990
ITT Rayonier	Jesup (Georgia)	85 BSK	1990
Weyerhaeuser	Columbus (Mississippi)	425 BSK/BHK[a]	1990
Champion International	Quinnesec (Michigan)	(100 BHK)	1990
Union Camp	Eastover (South Carolina)	100 BSK/BHK	1991
Stone Savannah River	Port Wentworth (Georgia)	240 BHK	1991
Simpson	Passadena (Texas)	50 BSK	1991
Alabama River	Calibome (Alabama)	450 BSK/BHK[a]	1992
Gulf States[b]	Demopolis (Alabama)	240 BSK[a]	1993
Pope & Talbot[b]	Halsey (Oregon)	240 BSK	..
WTD Industries[b]	Port Westwood (Oregon)	300 BSK	..
Potlatch[b]	Cloquet (Minnesota)	200[a]	1995
Europe			
Alicel	Alizay (France)	120 BHK	1990
ENCE	Two mills in Spain	120 BHK	1990
Stora	Skuetskar (Sweden)	140 BHK	1990
Veitsiluoto	Oulu (Finland)	(150 BSK)	1991
Soporcel	Lavos (Portugal)	(150 BHK)	1991
Enocell (Enso/USSR)	Uimaharju (Finland)	515 BHK/BSK[a]	1992
Celbi (Stora)[b]	Figueira (Portugal)	360 BHK	..
Rauma	Rauma (Finland)	90 BSK	1992
Cel. du Rhone (CRDA)	St. Gaudens (France)	120 BSK/BHK	1994
	Tarascon (France)	40 BSK	1994
Pohjan Sellu[b]	Kajaani (Finland)	135 BSK/BHK	..
Metsae-Botnia[b]	Kaskinen (Finland)	485 BSK/BHK[a]	..
Soedra[b]	Moensteras (Sweden)	400 BSK	..
Asia			
Indah Kiat	Riau (Indonesia)	100 BHK[a]	..
Dong Hae[b]	Kyungnam (Republic of Korea)	200 BHK	..
Phoenix	Bangkok (Thailand)	100 BHK	1992
Hyundai/USSR[b]	Olga (USSR)	300 BSK	..
Latin America			
Cel. Bahia (Klabin)	Camacari (Brazil)	90 BHK[a]	1990
Aracruz	Espirito Santo (Brazil)	525 BHK	1991
Cel. Santa Fe (Scott/Shell)	Nacimiento (Chile)	240 BHK	1991

Table V.85. (continued)

Country, region and company	Location	Capacity	Start-up date
Cel. Pacifica (CMPC/Simpson)	Renaico (Chile)	315 BSK	1992
Bahia Sul	Mucuri (Brazil)	240 BHK	1992
Ripasa	Limeira (Brazil)	(180 BHK)	1992
Simao	Jaceri (Brazil)	160 BHK	1992
Puerto Piray	Misiones (Argentina)	230 BHK/BSK	1992
Cel. Arauco	Arauco (Chile)	350 BSK	1992
Cel. Attisholz	Lincanten (Chile)	100 BSK	1993
Cenibra	Belo Oriente (Brazil)	350 BHK	1994
Norcel (Riocell/Compone)	Bahia (Brazil)	420 BHK	1995
Riocell	Guiaba (Brazil)	310 BHK	1995
Ripasa/Simao[b/]	Maranhao (Brazil)	420 BHK	1997
Arauco/Stora[b/]	Southern Chile	500 BSK	1997
Champion[b/]	Mato Grosso (Brazil)	350 BHK[a/]	..

Source: Pulp and Paper International, *Fact and Price Book* and *Capinvest* (San Francisco, Miller Freeman Inc., 1990).

[a/] Not all pulp will be for sale on the open market.

[b/] Possible projects only. All other projects are considered definite or highly probable.

Notes: BSK = bleached softwood kraft pulp.
BHK = bleached hardwood kraft pulp.
Parentheses indicate capacity withdrawal as a result of new paper machine.

expansion of production capacity are not usually related to technology, which is now well established, or skilled labour, which can be brought in initially to train local inhabitants. A limited domestic market—that is, few local paper makers wanting to buy market pulp—can be a problem, but most such mills are built with the central aim of earning export revenue. Lack of capital and infrastructure, rapidly changing market conditions, and increasing environmental restrictions are more common bottlenecks. Chemical market-pulp mills today must be large, and are therefore initially a very costly capital investment. This requirement, in a market where the price of a product may change rapidly, perhaps plunging a greenfield mill deep into debt, may deter potential investors.

It has been stated* that market pulp supply will be particularly influenced by the extent of tied or captive tonnage. In 1983, only about 13 per cent of market bleached kraft pulp, approximatley 860,000 tonnes, was shipped by suppliers to their affiliated companies in Europe. Significant restructuring in recent years has left just 4 out of 85 NBSK pulp producers in the Norscan countries without any paper production interests. And just 2 of 37 market suppliers of hardwood bleached kraft market suppliers in Norscan have no paper-making connections.

5. *Environmental considerations*

Most market pulp mills have long had sophisticated chemical recovery and waste-water treatment systems. The industry has a fairly good record for spending on equipment to reduce the amount of airborne or water-borne waste that leaves the mill. Most mills are therefore fairly clean. This is the result of economic considerations, which make it more profitable to recover costly chemicals and wood fibre than to discharge them in waste water, of a recognition of the need to minimize their effect on the environment, and of the increasingly stringent environmental regulations imposed by many countries. However, the very strict environmental guidelines, applied particularly in countries of the North, have added to the cost of greenfield mills, and raised production costs in some existing mills. A major new environmental problem has arisen in recent years. It is necessary to bleach the chemical pulp produced by most market pulp mills to raise the brightness of the resulting paper to a level acceptable to customers, that is, the general consumer, as well as printers, publishers etc. The bleaching chemical sequence has commonly included free chlorine and chlorine dioxide. The discovery of minute traces of dioxin in water downstream from pulp mills a few years ago gave rise to fears that products made from pulp bleached in this way might also contain traces of dioxin.

Subsequent investigations and statements issued by government departments in various countries (for example, Germany, Sweden and United Kingdom) showed that dioxin in such products, if present at all, was at an extremely low and harmless level. Nevertheless, there has been a vigorous campaign by environmentalists against chemically bleached pulp, paper, diapers and other products made from it. One result of this has been the launching of chemical "chlorine-free" pulp that has been bleached without the use of free chlorine, and sometimes also without the use of chlorine dioxide. Other results have been the increasing use of oxygen as a bleaching agent, and renewed interest in a chemical pulping method that had been on the decline for years precisely because of the pollution it caused. The sulphite pulp process, now much cleaner than older versions for a variety of reasons, is thus undergoing a small-scale revival partly because it can be bleached without chlorine.

More mills are switching to processes that do not use free chlorine, and the use of chlorine dioxide—which is not the source of the traced dioxins—also appears to be receding, partly as a result of the claim by Greenpeace, one of the best-informed environ-

*In a paper presented by Roger Wright and Hawkins Wright at the Siva Market Pulp Conference, held at Rome in October 1990.

mental groups, that all organochlorines in the pulp-mill discharge, not just the molecules of dioxin, should be eliminated as potentially harmful because they are not naturally occurring substances.

6. *Technological trends*

New arrivals in rapidly increasing quantities on the market pulp scene are the so-called mechanical pulps, made, as the name suggests, primarily by grinding wood to separate the fibres, often with the help of heating and the use of some chemicals. Being high energy users is their environmental disadvantage, but the use of fewer chemicals and the need for less bleaching make them attractive. They are also priced considerably lower than prime NBSK. New mechanical market pulp mills, particularly in North America, will alter the shape of the market, but probably not radically. This is because of potential energy savings and the fact that chemical pulps still have considerable technical advantages. The current production capacity of mechanical market pulps is only about 8 to 10 per cent for the total of all market pulps. This could rise to about 10 per cent by the mid-1990s.

There continues to be a search for small-scale chemical pulp mills using "environmentally friendly" processes to complement existing paper mills, thus replacing at least a portion of bought-in market pulp. These efforts have so far not met with widespread success, but new techniques may prove more successful.

The rise of the eucalyptus tree over the last 10 to 15 years as a source of good bleached kraft hardwood pulp has been well charted. It reflects the arrival of Portugal, Spain and some countries of the South as substantial market pulp producers. In this connection, the work on the genetic selection of eucalyptus to increase its quality and speed of growth, carried out in Brazil, notably by Aracruz, is being continued in other countries, such as Indonesia and Thailand.

Overall, the North enjoys no significant advantage in applying new technology to offset the lower cost of labour and raw materials in the South. The technology of making wood pulp is sufficiently well-known to render it improbable, but not impossible, that a major competitive advantage could suddenly be achieved as a result of a technical innovation.

7. *Short- and medium-term outlook*

The short-term outlook for market pulp producers is not good. In a traditionally cyclical market, which in early 1991 was at or near the bottom of a cycle, more new production capacity is coming on stream. Pulp stocks at producers' mills have risen from their low point of 1989, and there is too much pulp available.

On the demand side, many of the paper mills which need market pulp are seeing a slow-down in the growth of demand and, in some cases, a drop in demand below the levels of 1989. Though still good overall, demand is not growing at the same strong rate as in the late 1980s. In Europe, and to a lesser extent in Asia, the continuous shift in local currency exchange rates relative to the dollar means that the market prices may change quickly. In mid-April 1991, European suppliers were trying to raise NBSK prices by about 5 per cent and those of bleached kraft eucalyptus by about 3 per cent, solely because of a rise in the value of the dollar against most European currencies. This should at least halt the fall in prices, but whether it will be a long-term halt or merely a short-term adjustment is hard to tell.

When the current cycle will bottom out is a matter of conjecture, althought the low point is generally expected to come by the end of 1991. There is little reason to doubt that the cycle will continue, and there may be a slow recovery in the pulp market during 1992, with stronger demand, tighter supply and rising or at least stable prices, followed by a stronger market in 1993. This will be helped by the delay in or cancellation of several big expansion projects, which should help tighten supply.

There are many underlying longer-term trends in the market pulp industry, two of which are worth mentioning. First, there is likely to be a significant increase in the supply of recycled fibre. Legislation in North America and Europe is spurring a growing desire among consumers to collect waste for recycling. It is difficult to judge what effect this may have on the market pulp business. But a greater supply of paper-making fibre from another source, plus a desire to develop methods to use more of it, particularly in grades of paper that today contain no recycled fibre, would seem to have an inevitable effect on the market pulp business. The much higher quality of virgin bleached fibre is a major advantage for market pulp. But it is possible, for example, that much more efficient collection of separated office waste would lead to a greater supply of white waste paper of high quality, the nearest equivalent of pulp. Another element may be the increasing demand for paper containing recycled fibre by companies and printers that can in turn claim to be environment friendly. Changes such as these could impinge on market pulp demand.

The second trend is much older. Producing market pulp is often seen as a preliminary step toward the making of higher-value paper. While some companies continue to produce pulp, others aim at eventual integration of their pulp mill with paper production lines, a fairly common objective in developing countries. Emerging forest products industries move from selling logs or woodchips to making pulp and paper. It is natural to want to add value to the raw material, and to want to end the unprofitable trade of exporting market pulp and importing paper. However, the making and, particularly, the marketing of paper is a much more complex and expensive business, and there have been occasions when integration plans have not worked out well.

Other developments include long-distance integration, where a pulp mill in one country will supply part of its output to a paper mill, often part of the same group, in another. The pulp and paper industry has been going through its biggest-ever period of acquisition and mergers. As a result, the size of companies has increased, and the number of small and medium-sized independent companies decreased. One result of this process is more market pulp tonnage being traded among newly merged companies.

J. Crude steel (ISIC 371016 and 371019)*

1. *Recent trends and current situation*

Many political and economic developments of 1990, including the changes in Eastern Europe and the USSR, the beginning of a recession in developed countries, the attention to environmental concerns, and an increasing globalization of commerce and manufacturing, will have a long-lasting and profound effect on the world steel industry. Forecasters at the end of 1990 together agreed that never was it so hard to construct market predictions on which major steelmakers of the world could rely to plan future capacity, products and strategy.

(a) *World consumption*

Forecasts for world steel demand are a mixture of declining demand in the North and only slight increases by the newly emerging economies in the South, with a downturn of from 2.5 to 8 per cent in major steel-producing regions for 1991 and 1992. However, the prediction of such a huge downturn might be premature. Table V.86 provides estimates of apparent world steel consumption for 1990 and forecasts for 1991 and 1995. The EEC is shown to dominate world consumption, with 120 million to 122 million tonnes of crude steel forecast for 1990 and 1991. Taken together, consumption in developing countries in 1991 is expected to increase from 128 million to 135 million tonnes. World consumption is likely to be maintained in spite of the Gulf war, with only a slight downturn predicted from 779 million tonnes in 1990 to 773 million tonnes in 1991. When those forecasts are extended to 1995, the consumption trend shows only slight change, with a possible world consumption level of 782 million tonnes forecast. However, the probability does exist that a peak of about 828 million tonnes might occur by 1995.

(b) *World production*

World crude steel production in 1990 was 769.7 million tonnes, that is, 2 per cent below the all-time high of 785.1 metric tonnes recorded in 1989, with the drop in output becoming more significant in the second half of 1989. An evolutionary view of the global performance of the crude steel industry together with recent annual changes in world production are reflected in table V.87.

Production in developed market economies stood at 490.8 million tonnes in 1990, a decrease of only 1.3 per cent, with United States production down by just 0.2 per cent to 88.7 million tonnes. The output of Japan continued to rise, reaching 110.3 million tonnes in 1990, 2.2 per cent above the 107.9 million tonnes recorded in 1989, while EEC production declined by 2.6 per cent to 136.5 million tonnes. Overall, output in developed countries and regions such as Australia, Canada, Japan, New Zealand, South Africa, United States and Western Europe was down by 1.5 per cent at 389.6 million tonnes in 1990, compared to 395 million tonnes in 1989.

Table V.86. World apparent crude steel consumption, 1990 and forecasts for 1991 and 1995
(Million tonnes)

Country, region or economic grouping	1990	Forecasts 1991	1995 trend	1995 peak
North				
North America	113	111	113	119
EEC	122	120	120	125
Japan	99	96	85	90
Other developed countries	35	35	37	39
South				
Africa	13	13	13	14
Western Asia	10	10	8	10
Asia	75	80	90	95
Latin America	30	32	37	41
Centrally planned economies	282	276	279	295
North	369	362	55	373
South	128	135	148	160
TOTAL	779	773	782	828

Source: International Iron and Steel Institute, *Annual Report of Secretary General* (Brussels, October 1990).

In developing countries, production fell by just 0.7 per cent to 101.2 million tonnes from an all-time high of 101.9 million tonnes in 1989. Crude steel production in China and other Asian centrally planned economies rose by 8.8 per cent to 74.2 million tonnes. However, output in the USSR and other Eastern European countries dropped to 204.6 million tonnes, 6.8 per cent below the figure a year earlier, bringing the total output of centrally planned economies down 3.1 per cent from the 1989 level to 278.9 million tonnes.

2. *Manufacturing capacity*

Projections of the International Iron and Steel Institute for crude steel capacity show a strong growth in developing countries up to 1995, a small decline in developed market economies capacity, and a rising global trend as shown in table V.88. The percentage shares for the major regions in 1990 are shown in figure V.20. The growing economies of Indonesia, Malaysia, Philippines and Thailand are having their steel industry development supported by overseas finance and technical assistance from the Republic of Korea, Japan and Taiwan Province, with China also playing a role. The region of the Pacific Rim is predicted to be the home of one third of the world population by the end of the century, and its current per capita consumption is relatively low when compared with that of the developed market economies.

This transnational involvement in steel projects has become increasingly apparent in other regions as well. The relative success of many European steelmakers during 1989 and early 1990 tempted them to make

*UNIDO acknowledges the contribution of B. Cooper, editor, *Steel Times International*.

Table V.87. World production of crude steel, 1983,1989 and 1990

Rank in 1990	Country, area or economic grouping	Production (million tonnes) 1983	1989	1990	Percentage share 1983	1990	Percentage change 1983-1990	1989-1990
1	USSR	152.5	160.1	153.9	22.98	19.99	0.9	-3.9
2	Japan	97.2	107.9	110.3	14.65	14.33	13.5	2.2
3	United States	76.8	88.9	88.7	11.57	11.52	15.5	-0.2
4	China	40.0	61.3	67.2	6.03	8.73	68.0	9.6
5	Germany, Federal Republic of	35.7	41.1	38.4	5.38	4.99	7.6	-6.6
6	Italy	21.8	25.2	25.4	3.29	3.30	16.5	0.8
7	Republic of Korea	11.9	21.9	23.1	1.79	3.00	94.1	5.5
8	Brazil	14.7	25.0	20.6	2.22	2.68	40.1	-17.6
9	France	17.6	19.3	19.0	2.65	2.47	8.0	-1.6
10	United Kingdom	15.0	18.7	17.9	2.26	2.33	19.3	-4.3
11	India	10.2	14.4	14.9	1.54	1.94	46.1	3.5
12	Czechoslovakia	15.0	15.5	14.8	2.26	1.92	-1.3	-4.5
13	Poland	16.2	15.1	13.6	2.44	1.77	-16.0	-9.9
14	Spain	13.0	12.8	12.7	1.96	1.65	-2.3	-0.8
15	Canada	12.8	15.5	12.1	1.93	1.57	-5.5	-21.9
16	Belgium	10.2	10.9	11.4	1.54	1.48	11.8	4.6
17	Romania	12.6	14.4	11.0	1.90	1.43	-12.7	-23.6
18	Taiwan Province	5.0	9.0	9.6	0.75	1.25	92.0	6.7
19	Turkey	3.8	7.9	9.3	0.57	1.21	144.7	17.7
20	Mexico	7.0	7.9	8.8	1.06	1.14	25.7	11.4
21	South Africa	7.2	9.6	8.7	1.09	1.13	20.8	-9.4
22	Democratic People's Republic of Korea	6.1	6.9	7.0	0.92	0.91	14.8	1.4
23	Australia	5.7	6.7	6.6	0.86	0.86	15.8	-1.5
24	German Democratic Republic	7.2	7.8	5.6	1.09	0.73	-22.2	-28.2
25	Netherlands	4.5	5.7	5.4	0.68	0.70	20.0	-5.3
	Other	43.7	55.7	53.6	6.59	6.96	22.7	-3.8
	Centrally planned economies	256.6	287.8	278.9	38.67	36.23	8.7	-3.1
	North	343.8	395.4	389.6	51.82	50.62	13.3	-1.5
	South	63.1	101.9	101.2	9.51	13.15	60.4	-0.7
	TOTAL	663.5	785.1	769.7	100.00	100.00	16.0	-2.0

Source: International Iron and Steel Institute press release, Brussels, 21 January 1991.

overseas investments to increase their market share in different regions and to protect their production capacity against retrenchment which became increasingly apparent on their domestic markets. Usinor-Sacilor (France) has thus acquired steelworks and service centre outlets in Germany, United Kingdom, United States and East Asia; and privatized British Steel (United Kingdom) had spectacular success in its first two years following denationalization, and has been active in Europe and North America.

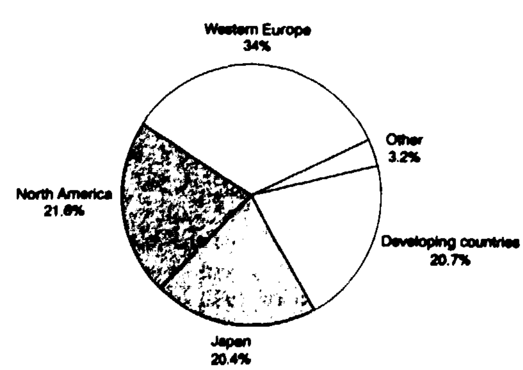
Japan and the Republic of Korea have not confined their interest to East Asia. While steelmakers in Japan have become more involved in the United States with joint ventures and equity shares, the Republic of

Table V.88. World crude steel capacity, 1974 -1990 and forecasts for 1995

Country, region or grouping	1974	1980	1985	1990	1995
Western Europe	203	223	195	192	190
North America	156	152	139	122	121
Japan	126	142	125	115	113
Developing countries	33	60	86	117	139
Other	15	18	16	18	19
TOTAL	533	595	561	564	582

Source: International Iron and Steel Institute, *Annual Report of Secretary-General* (Brussels, October 1990).

Figure V.20. World crude steel capacity, 1990



Source: International Iron and Steel Institute, *Annual Report of Secretary-General* (Brussels, October 1990)

Korea has also begun to make an impression in that country with wholly owned production units. In Europe, Germany has led the way in creating joint ventures and associations with steelmakers of the former German Democratic Republic, and Japan has shown early interest in gaining a foothold in Eastern Europe by offering technical and financial assistance, particularly in the field of pollution control and energy conservation.

Pollution control during the steelmaking process is now an integral part of plant and equipment design. Eastern Europe has its own problems in this respect, since much of its plant is outdated and heavily polluting and represents a major challenge to modernizing the industry in those countries. This attention to the environment can also be used to the benefit of steelmakers, since their product is eminently recyclable. Steel products such as automobiles, tin cans and consumer durables provide useful steel scrap. Unlike plastics, steel scrap is a valuable resource which can be charged in an electric-arc furnace and remelted into crude steel for transformation into new products.

3. *Output and capacity expansion plans in the North*

In this and the next section, the current state of crude steel output and sometimes demand are considered on a regional, but more specifically at a country, level. The state of the industry is then assessed and plans for capacity expansion related to technological progress and economic development needs are considered.

(a) United States

The flat-products suppliers have continued to add value to their products in a pattern repeated in Western Europe, with the installation and planning of metallic coating and painting lines. USX began construction of a 600,000-tonnes-per-year galvanizing line in a joint venture with Kobe Steel of Japan, planned for start-up in 1992. Inland Steel has tied in with Nippon Steel of Japan, and with the success of the I/N Tek integrated cold mill project, the adjacent I/N Kote hot-dip galvanizing line neared completion. With a second galvanizing line in hand under an Armco-Kawasaki joint venture, the same partners announced a third such line to be completed by 1996. Meanwhile NKK Corporation of Japan rather reluctantly protected its holding in National Steel by increasing its share from 50 to 70 per cent, after National Steel's parent company failed to find any domestic takers.

The French giant, Usinor-Sacilor, was active in acquiring a United States steel interest by purchasing Jones and Laughlin Stainless, Alloy and Stainless (J&L), TechAlloy, and 50 per cent of Georgetown Steel (rod and wire makers). At the end of the year it was still pursuing LTV Steel with a view to acquiring a stake, and by the end of 1990 it had improved its marketing opportunities in the United States by increasing its service centre outlets to three.

Republic of Korea interests built a 180,000-tonnes-per-year stainless-steel, flat-products plant based on melting and casting equipment bought second-hand from Sweden. This is the second plant owned by firms from the Republic of Korea in North America, following the purchase of Atlas Steels (Canada) by Sammi Steel, the major stainless producer of the Republic of Korea. But the most surprising overseas investment was the involvement by China in the Monessen plant of Sharon Steel (Pennsylvania). They are converting the 800,000-tonnes bloom semis plant into a 2.5-million-tonnes slab plant for export to China and other East Asian markets. Suggestions that the blast furnaces will be replaced with cokeless ironmaking technology have yet to be confirmed, but a third basic-oxygen-steelmaking vessel is planned for the refurbished steelmaking plant.

Technologically, the United States has been the scene of the next major breakthrough in flat steelmaking efficiency. The thin slab technique pioneered by Nucor at its Crawfordsville (Indiana) plant has reached its planned capacity of 800,000 tonnes per year, finally demonstrating to an eager steel world that the technology works. This success means that minimills can now enter the flat products market and offer a commercial product at a lower cost than the integrated mills.

Nucor then went on to announce that it would build a second thin slab plant, to be located at Blythesville (Arkansas), with a capacity of 1 million tonnes per year. Its location on the Mississippi will enable the plant to take hot briquetted iron from Venezuela by ship. Venezuela is the world's best source for hot briquetted iron and is currently expanding capacity fast. The use of hot briquetted iron rather than scrap in electric-arc furnaces will ensure that the metallurgical quality of steel is kept high and free from the deleterious elements which are always a problem with purchased scrap. This will further enhance the impact of the minimill on the flats market.

The success and confidence of Nucor reflected on the management at Geneva Steel in Utah, where they need to replace the open hearths with basic-oxygen-steelmaking converters, and to introduce continuous casting to replace the ingots. The company has now decided to press ahead with a combined caster, supplied by the contractor who built Nucor machines, SMS of Germany. The new caster will produce conventional thickness slabs and thin slabs so as to continue to satisfy its plate and strip markets. The commissioning date is set for late 1992. Meanwhile Birmingham Steel has opted out of a joint venture with Italian plant suppliers, Danieli, and United States strip processors, Proler Industries, to build a thin slab plant at an old United States steel plant at Baytown.

(b) Japan

Japan surprised other countries by increasing its steel output in 1990, surpassing previous forecasts. Planned retrenchments were delayed as domestic consumption remained buoyant, although exports to established Chinese customers had not fully recovered from the currency problems of the previous year. In addition, the USSR also had foreign exchange problems which reduced its ability to meet import commitments. This resulted in an export squeeze that was, however, adequately compensated for on the home front. Later in 1990, moves were made back into the Chinese market both for steel as a product and for steelmaking projects.

The major flat products manufacturers have looked carefully at strategy during the current levelling-off in world steel demand. In addition to retrenchment of steelmaking plants, they have been looking at alternative products, both within their existing market spheres and outside. The automotive industry is the largest customer for flat rolled products in Japan, consuming around 11.6 million tonnes per year. Understandably, they know this market well and it is no surprise that competitive materials are being considered by the industry. To counter new suppliers to the automobile market, at least two of the major manufacturers, NKK and Kawasaki, have been examining the aluminium sector, and Nippon Steel has started manufacturing reinforced plastics. However, the eminent recyclability of metals remains a clear advantage over non-recyclable materials, as the emphasis on pollution abatement and on environmentally friendly products continues to grow.

Although the automotive market is the biggest customer for flat steel products, the largest Japanese market sector for steel is construction, with an estimated demand of some 17 million tonnes. The construction market consumes chiefly long steel products which are made by both the integrated manufacturers and the minimills. The minimills have enjoyed an excellent market situation and look set for a highly productive decade. Their output in 1990 was over 35 million tonnes, against 33.04 million tonnes in 1989. This sector has recently seen increased activity in the form of mergers and acquisitions. Lower scrap prices and electricity costs have helped boost results in the buoyant market-place, and the market share for the minimills has exceeded 30 per cent for the first time.

The biggest of the Japanese minimills, Tokyo Steel, which has a capacity of 3.3 million tonnes, putting it well above some integrated plants in other countries, is currently building a 1-million-tonnes hot-strip mill, the first by a Japanese electric-arc-furnace operator. This will enable it to move into the flat products sector. The company is also installing a direct-current arc furnace to feed the mill with steel. At least one other electric-arc-furnace operator is installing a direct-current furnace, which offers reduced running costs and environmental advantages.

(c) Western Europe

The Commission of the European Communities has called for further reductions in certain sectors, as the region continues to face excess steelmaking capacity, as shown in table V.89 [37]. Reversing plate mills and heavy and light section mills have been specifically mentioned. Among major closures announced has been that of the hot strip mill of British Steel at Ravenscraig, considered to be a step towards the inevitable end of steelmaking in Scotland. The company's seamless tube plant in the region was also closed as demand for oil country tubular goods declined. British Steel has enjoyed good profits since privatization, and has been regarded as one of the most efficient steelmakers in the world. It also has been active overseas, and acquiring all the stock of Tuscaloosa Steel in the United States. It had partial ownership before and has been supplying slab to Tuscaloosa for many years. This move has protected its valuable inroad into the United States market. In Europe, British Steel has increased its distribution and marketing outlets with strategic acquisitions, and plans to acquire 45 per cent of the Spanish section producer, Aristrain.

Overseas activity by Usinor-Sacilor of France has been intense. In the United States it has bought three companies in the special steels sector, a 50 per cent share in a wire and wire rod producer, and three service centre outlets. It was negotiating with LTV

Table V.89. EEC steel capacity and production, 1992-1995

Item	Capacity 1992-1995	Production 1992 (million tonnes)	Utilization rate	Production 1995a/ (million tonnes)	Utilization rate a/	Production 1995b/ (million tonnes)	Utilization rate b/
Raw steel	186.0	138.9	74.7	143.3	77.0	138.3	74.4
Hot-rolled steel							
Wide and narrow strip	79.0	59.6	75.4	62.3	78.9	61.2	77.5
Reversing-mill plate	13.9	9.0	64.7	9.1	65.5	9.0	64.7
Total	92.9	68.6	73.8	71.4	76.9	70.2	75.6
Heavy sections	14.5	8.9	61.4	9.0	62.1	9.0	62.1
Light sections	35.2	22.4	63.6	22.7	64.5	21.5	61.1
Wire rod	19.8	13.2	66.7	13.8	69.7	13.3	67.2
Total	69.5	44.5	64.0	45.5	65.5	43.8	63.0
Total hot-rolled products	162.4	113.1	69.6	116.9	72.0	114.0	70.2
Other finished products							
Cold-rolled sheet	47.3	32.3	68.3	34.0	71.9	33.4	70.6
Coated sheet	21.5	16.1	74.9	17.3	80.5	17.5	81.4

Source: Commission of the European Communities, *General Objectives for Steel* (Brussels, 1990).

a/ Top of forecast range.

b/ Bottom of forecast range.

Steel for a stake in that major United States producer towards the end of 1990. Back in Europe, Usinor-Sacilor, which had earlier acquired a share of the steel industry in the Federal Republic of Germany with the purchase of service centres in that country and Italy, was reported to be seeking processing facilities in the territory of the former German Democratic Republic.

Privatization of the steel industry in Norway has proceeded, but not smoothly. The Norwegian ferroalloy supplier, Elkem, which had previously withdrawn from steel, wanted to purchase the ferroalloy interests of the company, but was only allowed to take the whole package. It agreed to do so on condition that it could find a partner in the steel industry, most probably a Swedish rebar maker. Privatization moves have also been reported from the Portuguese national steel company.

All of the major German steelmakers have formed joint ventures or associations with steel companies in the former German Democratic Republic (see next section on Eastern Europe). They viewed this both as protecting their own market and as ensuring that they are in a position to capitalize on the potential for growth in the newly enlarged Germany. Meanwhile, the first move by a Japanese company into a major European steelmaker has come with a 5 per cent share in Klockner Werke being taken by C. Itoh, the Japanese trading company. In Belgium, the stainless steelmaker ALZ has commissioned its 2-metre-wide stainless-steel mill, becoming only the second European supplier of this width of stainless steel strip. The Italian tubemaker, Arvedi, has continued to build the first commercial thin slab mill in Europe, scheduled for start-up in autumn 1991, using technology from Mannesmann of Germany.

For the last few years European steelmakers have been building coating lines to meet the demand, mainly from the automotive industry, for sheet that does not corrode, both for structural and cosmetic (exterior) panels. As shown in table V.90, the capacity of the region for hot-dip galvanized strip has increased rapidly and continues to do so, despite warnings that there will soon be overcapacity in this area. New lines have been built or are being planned by British Steel (United Kingdom), Krupp (Germany), Thyssen (Germany), Hoogovens (Netherlands), Usinor-Sacilor (France); and a joint venture between Klockner (Germany) and Rautaruukki (Finland) is to build a 40,000-tonnes line at Bremen in Germany. The market situation worsened, as predicted in Europe, in mid-1990, although in the United Kingdom the recession materialized earlier with a slump in construction.

The future of Irish Steel remained undecided during 1990 as the Government looked for the best offer from a buyer. After many years of losses the company had started to look more promising in 1989, and so the need to sell it off became less necessary. Three potential buyers were on a short list—Korf of Germany, Ispat of India and North Star of the United States. Ispat has been very successful in ventures in Indonesia and Trinidad and Tobago in addition to its activities in India, but the Korf Group was badly shaken by the death of its founder. At the end of 1989 North Star was favoured as a likely purchaser.

(d) *Eastern Europe*

The steel industries of Eastern Europe face certain common problems. These include out-of-date and undersized plants, lack of management and commercial experience, raw material supply shortages, currency problems, product quality, energy wastage, pollution, overmanning, overcapacity, poor productivity and lack of investment capital. If that were not enough, they also lack established domestic markets and face a stagnant export market as developed market economies adjust to recession.

One observer has estimated that an investment of $25 billion is needed to put the Eastern European steel industry on a competitive footing with that of developed market economies; other estimates are higher. In the current economic climate, it has been suggested that management advice and technical support are the main ways in which developed market economies could help Eastern Europe, and there have been many signs that this is indeed happening. There were already output reductions of 5 to 10 per cent in 1990 compared with 1989, marking the beginning of a necessary retrenchment. It has been suggested that the steel production in the territory of the former German Democratic Republic will need to fall from 7 million to around 3 million tonnes within the next decade.

The East Slovak Iron and Steel Works in Czechoslovakia set up a joint stock company in the first stage of its move to privatization. In Romania, it has been warned that production could fall by as much as 50 per cent in 1991. The most obvious changes have occurred in the newly united Germany, where most of the former Federal Republic of Germany steelmakers have involved themselves in some form of cooperation with firms of the former German Democratic Republic. Overmanning in the latter will have to be addressed, and the 90,000-strong workforce in the steel industry will probably need to be reduced by two thirds.

Table V.90. Galvanizing capacity in developed market economies, 1985, 1990 and forecasts for 1995

Item	1985		1990		1990	
	Volume	Index	Volume	Index	Volume	Index
Hot dip	29	100	33	114	42	145
Electro-galvanizing	7	100	11	157	15	214
TOTAL	36	100	44	122	57	158

Source: International Iron and Steel Institute, *Annual Report of Secretary-General* (Brussels, October 1990).

The Japanese have been quick to become involved in Eastern Europe, and the recently enlarged Kyoei Steel Group, one of Japan's large electric-arc furnace operators, has established technical cooperation agreements with Poland. Sumitomo Metal Industries has sent technical delegations to Czechoslovakia, Poland and Hungary, looking specifically at energy and pollution problems. In these sectors the Government of Japan can help to alleviate the most pressing problem for the steel industry of Eastern Europe, the lack of finance.

Italy has also been active, and the plant supplier, Pittini, is involved in a joint venture project in Poland to build a 75,000-tonnes-per-year bar mill. The "State" group, Ilva of Italy, is also involved in a joint venture in Hungary to revamp the rolling mill at Salgotarjan. Privatization of Hungarian mills has proceeded quickly, with many joint ventures being formed to provide essential funds.

In Bulgaria, the Italian plant supplier, Danieli, is planning a 250,000-tonnes-per-year minimill plant, and even Albania is the scene for new developments as Pittini of Italy has agreed to cooperate in a "gradual technical revolution". The Elbasan steelworks in Albania produced a reported 112,000 tonnes of steel in 1989.

The USSR has installed 8 million tonnes of oxygen steelmaking capacity over the last two years, replacing open hearths in all cases. A total of 67.4 million tonnes of steel was made through the converter route in 1989, compared with 49.9 million tonnes in 1985. One of the world's biggest steelworks, the 14-million-tonnes Magnitogorsk Combine, has announced that it will build a 320,000-tonnes-per-year hot-dip galvanizing line, with construction due to start in August 1991, while Danieli of Italy has obtained an order for a 1-million-tonnes-per-year continuous caster for round billets for tubemaking.

(e) Australia and New Zealand

Domestic demand for steel in Australia has declined in the second half of 1990, as reflected in reductions in industry output. However, exports chiefly to South-East Asia doubled over 1989 levels, and a record 30 per cent of output was sold on the overseas market. BHP Steel, which had previously been the most profitable of the BHP operating divisions, fell behind minerals and oil and gas.

BHP Steel has had particular success in the coated products sector. Some years ago it acquired the licensing rights for the Galvalume process from Bethlehem Steel of the United States, and this process is now licensed to some 40 operators throughout the world. It is a superior zinc-aluminium coating process that greatly reduces corrosion of steel sheets, and the material is much used by the construction and building industries. Steel is widely accepted as a building material for homes and commercial buildings in Australia, and the Coated Products Division of BHP Steel has been a marked success for the company.

When the new slab caster is completed at Whyalla Works in South Australia, BHP Steel will be able to claim that it is a 100 per cent continuous casting company. Another technical achievement, completed in 1990, was the commissioning of an integrated cold mill at the Coated Products Division at Port Kembla Works in New South Wales. This line, the most modern of its kind anywhere in the world, links a turbulent pickling line directly to a cold mill and annealing line.

A joint venture between CRA of Australia and Midrex of the United States to build a plant for the direct reduction of iron ore using coal as the reductant, known as the Hismelt project, was given the go-ahead at a site at Kwinana. This is one of many such projects currently under development around the world which could form the basis for the next generation of ironmaking, and ultimately replace the blast-furnace and its demand for coke.

New Zealand Steel was acquired by a consortium in which BHP holds the largest share; since the takeover, BHP Steel claims that turnover has increased by 50 per cent and costs decreased by 30 per cent. The 700,000-tonnes plant uses coal-based direct reduction technology to produce iron feedstock from the local ironsand, which is charged into electric-arc furnaces for melting. The steel is slab cast and hot-rolled in a new mill. Towards the end of the year New Zealand Steel announced that it was offering its electric resistance welding tubemaking mill for sale.

4. Output and capacity expansion plans in the South

(a) East Asia and Indian Subcontinent

China

China remains the country with the biggest potential for growth in the steel industry, but the rate of growth is unpredictable. Phase three in the expansion of the mighty Baoshan works near Shanghai has been delayed owing to financial problems. However, the possibilities of further mega projects have not been ignored by the Japanese, and pre-feasibility studies for an integrated plant, either in Shandong or Hebei provinces, have been submitted.

Another project under investigation could be China's first gas-based direct-reduction plant using either Midrex (United States) or Hyl (Mexico) technology. The plan involves for a slab mill in Canton with a capacity of 500,000 to 700,000 tonnes per year. The possibility of thin slab casting is being investigated, now that this technology is becoming accepted. The steelplant is likely to be built before the ironmaking plant, and will rely initially on scrap or imported hot-briquetted, direct-reduced iron, for which Malaysia would be one of the closest sources.

China has been a good market in which to sell existing steelmaking plants from developed countries, and is now the home of a former United States rod mill, a second-hand hot-strip mill and a used-plate mill. In 1990, the Meishan Iron and Steel Plant bought a mothballed 1.2-million-tonnes hot-strip mill from the Sakai Works of Nippong Steel in Japan. A survey carried out on behalf of Voest-Alpine of Austria, the inventors of oxygen steelmaking back in the 1950s, showed that China was one of the few countries in the world to have shown growth in its oxygen steelmaking capacity since the previous survey in 1988, adding 5 million tonnes of capacity.

India

The Steel Authority of India Ltd. is a government-owned organization that suffers from major inefficiencies. Its recent plan to increase steelmaking capacity to 15 million tonnes by 2000 has been abandoned. Actual production in 1990 was 8.27 million tonnes, as against a planned output of 11.23 million tonnes; the revised 1995 output is now scheduled to be 11 million tonnes. Among other schemes, the Steel Authority of India Ltd. has promoted two new integrated steelworks. One of these, at Visakhapatnam, is now in a position to produce iron but not steel, following the commissioning of its main blast-furnace in 1990. Coke ovens had been completed earlier. However, until the steelworks have been finished, iron will be sold as pigs to foundries and other steelworks.

Another of the major planned integrated works was at Vijaynagar, in a proposal first put forward some 20 years ago. The largest electric-arc furnace operator in India, Mukand, has proposed taking up the construction of this plant in Karnataka State. Meanwhile USSR finance has been offered for an equity share.

Tata Iron and Steel Company successfully operates an integrated flat-products steelworks and has confirmed its expansion plans with orders for a new hot strip mill and slab caster, both from European suppliers, scheduled for commissioning in 1992.

India has been one of the few countries to add oxygen steelmaking capacity in recent years, according to a survey commissioned by Voest-Alpine of Austria, the originators of the LD process. Approximately 8 million tonnes of new capacity have come on stream since the 1988 survey. The move by Mukand to involve itself in the Vijaynagar project has been made possible by an important change in government strategy. Restrictions on development of private steelworks of more than 1 million tonnes capacity were lifted, possibly to increase pressure on Steel Authority of India Ltd. to improve efficiency. The private sector plants that the Government hopes to encourage will be units based on electric-arc furnaces, using scrap or direct reduced iron as feedstock. Alternatively, small blast-furnaces or new cokeless ironmaking technology could be applied. A delegation from India visited China in 1990 to examine the use of small blast-furnaces.

Direct reduction has met with some success in India, and the new electric-arc-furnace direct-reduction steelplant of Sunflag Group has been sufficiently successful for plans to have been made for a doubling of output.

Republic of Korea

Some estimates of steel capacity plans for the Republic of Korea are given in table V.91. Posco, which produces by far the biggest share of steel in the Republic of Korea at its works at Pohang and Kwangyang, has hinted at delays in stage four of its Kwangyang development in the south of the peninsula, but remained very active in overseas projects in the United States and South-East Asia. It was the value-added sector of the market that took most of the attention in 1990. Inchon has commissioned a 50,000-tonnes-per-year stainless-steel cold-rolling mill, which takes hot coil from Posco, and two new stainless-steel pipe plants designed with the export market firmly in mind have been announced. Posco has taken a 51 per cent share in a 120,000-tonnes-per-year electrolytic tinning line, while Dongbu has commissioned a 360,000-tonnes six-stand reversing cold-rolling mill to add to its existing two cold mills. The total capacity of 660,000 tonnes per year is to supply feedstock to the galvanizing and colour coating lines of the company.

The minimill sector is predicted to continue to grow strongly in the Republic of Korea, with another 1.2 million tonnes of capacity coming on stream by 1992, bringing total potential output up to 7.3 million tonnes. Existing rerollers may also increasingly build melt-shops so as to ensure their billet supply. Kia Steel has announced plans to build a 280,000-tonnes-per-year stainless steel works for automotive blooms, and will probably add a heavy bar mill for special steel grades in a next development. The melt-shop and caster are due to come on stream in 1992.

Taiwan Province

Plans for expansion of the government-owned China Steel Corporation were shelved as increased pressure from imports reduced its market share on the domestic front. It thus turned to considering several large overseas investments in greenfield integrated plants, with Malaysia, Canada and Australia all a possibility. On the home front China Steel Corporation will commission a second cold-rolling mill in mid-1992, and a 200,000-tonnes electro-galvanizing line. Providing hot coil for the cold mill will reduce the ability of China Steel Corporation to supply hot-rod coil to other domestic cold rollers. However, those cold rollers are unlikely to be short of raw material as An Feng brought its 1.2-million-tonnes hot-strip mill on stream during 1990. Buying in slabs from China Steel Corporation, from CST in Brazil and Sicartsa in

Table V.91. Changes in the structure of the iron foundry industry in the Republic of Korea, 1981, 1985 and 1990

Iron foundry size	Capacity (tonnes per month)	1981 Number of foundries	1981 Percentage share	1985 Number of foundries	1985 Percentage share	1990 Number of foundries	1990 Percentage share	Percentage change 1985-1990
Small	<200	209	77.41	89	32.60	100	30.58	12.4
Medium	200-990	54	20.00	121	44.32	147	44.95	21.5
Large	>1 000	7	2.59	63	23.08	80	24.46	27.0
TOTAL		270	100.00	273	100.00	327	100.00	19.8

Source: UNIDO database.

Mexico, this mill should reduce imports of rolled steel. Cold-coil producer and tubemaker Kao Hsing Chang has installed a Kawasaki 250,000-tonnes-per-year, six-high, single-stand cold mill to meet the expanding market for black plate in Taiwan Province. An Mau has started up a 240,000-tonnes-per-year, dual-purpose, hot-dip galvanizing line to become the fourth licensee of the Galvalume process in East Asia.

Two very similar joint venture projects in the stainless steel sector reached very different outcomes. The South-East Asian market for stainless sheet has much growth potential, and overseas stainless producers have been trying to establish a share. Krupp of Germany cooperated with Tung Mung to build a 150,000-tonnes-per-year, stainless-steel, cold-rolling mill, which will be supplied with stainless hot coil from Krupp. A similar project involved Samancor of South Africa and Yieh Loong, with technical assistance from Thyssen of Germany. Samancor was to build a stainless hot mill in South Africa and supply to the cold mill in Taiwan Province. Meanwhile, Yieh United, another branch of the Yieh Group, is building a thin slab caster to feed its tube mills with hot strip.

In the long products sector, five new arc-furnace-based plants are planned to reduce imports of billets by 2 million tonnes per year. Orders have been confirmed for a 500,000-tonnes-per-year facility based on a 100-tonnes electric-arc furnace and for the first Universal beam mill in Taiwan Province with an annual capacity of some 400,000 tonnes.

(b) South-East Asia

Indonesia

PT Krakatau, the largest steelmaker in South-East Asia, is to embark on an expansion project to increase steel output from 1.5 million to 2.5 million tonnes. There are also outline plans for expansion of melt-shop capacity to 5 million tonnes. The company recognizes the huge growth potential in Indonesia, which has one of the lowest per-capita steel consumption figures in the region, and the expansion is aimed at flat-products markets, as Indonesian manufacturing industries become more sophisticated. Voest-Alpine of Austria has been selected as the main contractor for the expansion that will involve two Hyl 3 shaft furnaces adding 1.3 million tonnes of direct-reduction capacity to the existing 1.5 million tonnes, and two 130-tonnes electric-arc furnaces.

An existing minimill operator, PT Ispat Indo, has also recognized the flat market potential in the area and plans a direct-reduced-iron, electric-arc-furnace flat-products plant in a joint venture with Surabaya. The 1-million-tonnes direct-reduction module will provide direct-reduced iron for the furnaces. These will supply steel to the hot-rolling mill, which will be rated at 950,000 tonnes per year. The $600 million project will be built at Gresik and is scheduled for start-up by the end of 1992. A second stage, doubling capacity, is on the drawing-board. The existing Ispat Indo mill is a 420,000-tonnes-per-year, long-products plant, which is itself the subject of expansion plans to raise its annual output to 650,000 tonnes. In addition, a second 500,000-tonnes, long-products mill at the Surabaya site is planned.

PT Budidharma of Jakarta is the first of many Indonesian rerollers to move upstream and supply their own billets. It commissioned a 35-tonnes electric-arc furnace during 1990 and continuous-billet casting facilities for 150,000 tonnes per year. Six other rolling mills are said to be moving in a similar direction. This will further reduce scrap availability in the region and generate a market for direct-reduced iron.

Malaysia

Malaysia moved into the flat-products sector in 1990, and was the location for many proposed major steelworks developments with foreign investment and overseas joint-venture partners. This country offers many advantages as a site for such investment. It is centrally located for the dynamic South-East Asian market-place, and has a stable political climate, an educated workforce, low labour costs and generous government investment policies. The Chinese Anshan Iron and Steel Works has carried out a feasibility study into the reopening of a 20-year-old iron ore mine in the country. China has been active in securing overseas iron ore supplies, and had previously closed a deal in Australia with Hammersley, involving the use of Chinese investment to open up new resources. Anshan has also announced a 200,000-tonnes cold mill, which will be commissioned in the first quarter of 1992, with Anshan owning 49 per cent of the equity. Hot coil would be supplied from the Chinese partner.

Other cold mill activity in Malaysia includes the commissioning in 1990 of a 144,000-tonnes-per-year plant in a joint venture with the Japanese Mariuchi and Malaya Steel Tubes. Hot coil will be taken from China Steel Corporation in Taiwan Province, from Posco in the Republic of Korea and from Japan. Posco have themselves announced a cold-rolling mill of from 300,000 to 400,000 tonnes in partnership with Malayan Flour Mills to be built at Johore, although a government licence was yet to be issued at the end of 1990. The size of the proposed plant may double before construction commences. Other investment from the Republic of Korea has been a 50,000-tonnes-per-year wire and wire rope plant built by Korean Iron and Steel Limited, which went on stream in July 1990.

Southern Iron and Steel of Penang, 23 per cent of which is owned by National Iron and Steel of Singapore, is a reroller which has decided to move upstream by building a billet plant based on a 70-tonnes electric-arc furnace and a 250,000-tonnes per-year billet caster, scheduled for completion in 1992. Malayata, currently the third largest Malayan steel producer at 158,000 tonnes per year, is 24 per cent Japanese-owned. Expansion plans were announced in 1990, but no details were made available. Other Japanese involvement was seen in Penang, where Nissho Iwai opened a service centre for sheet products. Silicon steel coated and cold-rolled sheet is to be sourced from Nippon in Japan. More flat-product and value-added development was seen with the commissioning of the second tin-plate line in Malaya by Pershima Industries, doubling tin plate output to 180,000 tonnes per year.

Malaya has had mixed results with direct reduction. Perwaja Steel commissioned a direct reduction plant from Nippon Steel of Japan in the early 1980s, but the plan never worked satisfactorily. It has had to rely on up to 600,000 tonnes of imported scrap to feed its three 70-tonnes electric-arc furnaces. A balance of domestic scrap and purchased direct-reduced iron has enabled an annual output of 720,000 tonnes of billet, mostly for domestic rerolling. In addition, they have contracted Ferrostaal of Germany not only to revive the Japanese-designed direct-reduction plant, but also to build new direct-reduction capacity to take total production of direct-reduced iron to 1.2 million tonnes by late 1992. By 1996 it is proposed that capacity will rise to 2.5 million tonnes. Meanwhile, Perwaja has announced a 400,000-tonnes-per-year wire rod mill, scheduled for start-up in 1992.

One of the factors that have doubtless influenced Perwaja in committing itself to direct-reduced iron has been the success of the Sabah direct-reduction plant. This is a 800,000-tonnes Midrex-type plant making merchant direct-reduced iron for the international market. This plant, on Sabah island, has now undertaken a feasibility study for a 100,000-tonnes billet plant to be fed with its own direct-reduced iron. The billet would be for domestic rerolling and for export primarily to Indonesia and the Philippines.

Direct-reduced iron makes a lot of sense in South-East Asia. Abundant natural gas supplies and low scrap availability point the way for electric-arc furnace operators. Malaysia and Indonesia have planned a total capacity of 4 million tonnes of direct-reduced iron, but a planned electric-arc furnace expansion to 8.3 million tonnes is set to keep the scrap supply tight.

Philippines

Two companies in the Philippines are both actively involved in plans to expand the flat-products capacity of the country. National Steel Corporation is the government-owned steelmaker that was originally founded by the privately owned Jacinto Group. Both National Steel Corporation and the Jacinto Group have flat-products expansion plans. National Steel Corporation already imports 500,000 tonnes of slab for hot-rolling to strip and plate on a reversing hot mill. Its plan is to install an additional 1.1-million-tonnes hot-strip mill, and to concentrate on plates in the first mill. The new mill will supply hot coil to the two existing cold mills of the National Steel Corporation in an attempt to reduce imports. The Philippines will then be in an excellent position to supply plate and hot coil to Thailand and Malaysia, until such time as their flat-products capacity comes on stream.

National Steel Corporation has also built a third tinning line in the flat-product sector to supply tin plate to the large fruit canning industry in the Philippines. An ambitious project by National Steel Corporation to roll back slab imports by building a 2.5-million-tonnes integrated plant, with a possible expansion to 5 million tonnes, is under study, and foreign partners are welcome. It is understood that approaches have been made from both Taiwan Province and the Republic of Korea. Ore could either be local or imported.

National Steel Corporation, in addition to rolling imported slab, currently runs a 300,000-tonnes-per-year billet plant based on two 50-tonnes electric-arc furnaces, supplying about one third of the domestic mills. The Sy and Lim family groups have announced new billet mill projects which have received government approval, and which should start up within the next couple of years.

The flat-products plan of the Jacinto Group is more modest at 1 million tonnes, and is considered by some to be more realistic at $500 million (one quarter of the price of the National Steel Corporation project). A possible second phase up to 2 million tonnes would be available at an additional $300 million. The Jacinto Group is exploring a joint venture with the Chinese Shougang Special Steel Company, and has the option to construct a 280,000-tonnes section mill as an adjunct to the flat-mill project.

The Japanese have been active in increasing their share of the Philippines market with the setting-up of service centres. Marubeni is involved with the Sy family in two stockholding facilities, and Nissho Iwai has built a service centre for Nippon sheet products.

Singapore

National Iron and Steel Mills of Singapore, the rebar and wire rod producer, plans to install a new electric-arc furnace of 100 tonnes to replace two of its present three furnaces of 50 tonnes and upgrade its rolling mills from 500,000 to 600,000 tonnes per year. The mill modernization will also allow the rolling of higher grades of steel. National Iron and Steel Mills owns 23 per cent of Southern Iron and Steel of Malaysia, and is a joint venture partner with Bangkok Steel in a minimill project in Thailand.

Thailand

Forecasts for rapid growth in the Thai economy have stimulated demand in the construction industry, which is projected to grow from a current demand for 1.2 million tonnes of long products to 2.7 million tonnes in five years. The economy as a whole is predicted to grow at 10 per cent per year during the 1990s. This has led to government approval for six electric-arc-furnace minimills for the private sector. In addition, a major integrated plant for flat products has been proposed and a handful of cold-rolling projects are in the pipeline. Bangkok Steel, in a joint venture with National Iron and Steel Company of Singapore, is building a 500,000-tonnes-per-year, rod-and-bar plant for start-up in late 1992. NTS (which rerolls billet) has started construction of a 400,000-tonnes minimill which is scheduled to come on stream in late 1991 at a cost of $180 million.

At the end of 1990 the integrated flat-products mill proposed by the Sahavirija Group was downgraded to a strip mill complex consisting of a 1.8-million-tonnes, hot-strip mill, a 670,000-tonnes cold mill and a 13,500-tonnes electro-galvanizing line. Approval has been received and grants made available. Meanwhile, Nippon Denro Ispat, the Indian-Japanese consortium, plans to build a slab plant using imported ores. If the strip mill complex goes ahead, then this would be a complementary project.

The special steels subsidiary of the French Usinor-Sacilor group, Usine Acier, has obtained approval for the construction of a 70,000-tonnes-per-year cold mill for rolling stainless steel. Some 51 per cent of the project will be Thai-owned. The capacity of the plant will be around double the consumption of the country, so the regional export market is obviously firmly in mind.

In the value added sector, Thai-Tinplate commissioned a new electrolytic dual tinning line to help meet the 300,000-tonnes-per-year demand for tin plate and tin-free steel. Meanwhile, progress is reported to be slow on the 120,000-tonnes, dual-coating line for Siam Tinplate. As in Indonesia, Malaysia and the Philippines, Japanese interests have been active in the service centre area, improving the availability of Japanese steel.

(c) *Latin America and Caribbean*

Brazil

Rampant inflation has again proved a problem for the Brazilian steel industry. Energy prices and raw material costs rose sharply and steelmakers were forced to cut back production so that overall steel output for 1990 was about 20 per cent less than in 1989. Exports fell by a smaller percentage, but for a country that relies on overseas earnings to produce hard currency, this had an even more important effect than the reduced home market. The proposed liquidation of the State holding company, Siderbras, and the associated privatization of the operating companies suffered as a consequence of the economic uncertainty, and were officially delayed for a further six months. By the end of the year, bids had been submitted for a privatization agent to be appointed, and the choice of a Brazilian consortium with international interests had been made.

The first works to be put up for sale are likely to be CST (Cia Siderurgia Tubarao) and Usiminas. The former is a slab plant without continuous casting facilities, and the latter an integrated flats producer with Japanese shareholders. There was a reported problem with this shareholding as the company was being valued. The engineering subsidiary of Siderbras was sold off to its employees at the end of 1990. The sale of these works will not be easy. Siderbras is very heavily in debt, and the poor financial showing of the production companies during 1990 will be a strong disincentive for investors. They operated at around 70 per cent capacity during the year.

In the private sector the weak market position resulted in heavy corporate losses in the first half of 1990, which then continued as the construction industry and other consumers of long products were affected by the recession. A plan has been announced by a group of eight distributing companies to form a joint venture in building a 250,000-tonne cold-rolling mill, but so far progress has been halted. Meanwhile, Usiminas will build the first electro-galvanizing line in Brazil.

Mexico

Production in Mexico increased in 1990 with the coming on stream of phase two of the Sicartsa project. This slab mill is currently exporting its total production and was the main reason why exports jumped by 40 per cent to 1.1 million tonnes. Prospects for growth in domestic consumption of around 5 per cent for the next five years have boosted the privatization plans for the State-owned Sidermex Group, which owns the two main plants, Altos Hornos de Mexico (Ahmsa) and Sicartsa.

The private steelmaker and technology supplier, Hylsa (developer of the Hyl gas-based direct-reduction process), has expressed considerable interest in Sidermex and confirmed that it would be happy to take a controlling stake. This would put Hylsa in control of 75 per cent of the Mexican steel industry. However, steelmakers in Japan, Republic of Korea and Taiwan Province have shown interest in Sicartsa, which has a more modern plant, and a United States steelmaker is considering a project in Ahmsa.

Foreign investment in the Mexican steel industry would not be novel. In 1990, two European stainless-steel makers, Thyssen of Germany and Acerinox of Spain, each took a one third share in the Mexican stainless producer, Mexinox.

Caribbean

Since the dynamic Indian Ispat organization took over Trinidad Steel, the company has prospered, although in 1990 a damaging strike severely disrupted production. The company makes long products using the direct-reduction electric-arc-furnace route, buying ore from nearby Venezuela. Caribbean Ispat, as the company is now known, has a proposal for thin-slab caster on the stocks, following the confirmation of this technology in the United States. This would allow the company to enter the flat-products market, probably in the construction sector. Meanwhile, a joint venture proposal, in which Usinor-Sacilor of France would hold a 20 per cent stake, to build a 50,000-tonnes-per-year colour-coating line in Trinidad and Tobago is also under consideration. This would tie in fairly sensibly with the diversification plans of Caribbean Ispat. The only steel plant in Cuba has commissioned two billet casters, raising capacity from 400,000 tonnes to 600,000 tonnes per year of rod and bar. In Puerto Rico, a plan to build a galvanizing line in 1991 has been announced. This would rely solely on imported strip.

(d) *North Africa and Western Asia*

Egypt

A tentative plan for an Arab engineering steel plant with international Arab cooperation and involving an Italian plant supplier has created some interest with foreign investors, but so far no action has been taken. Egypt has remained firm on the idea, however, since it would provide jobs for a workforce enlarged by refugees from Kuwait and Iraq. The Gulf crisis had a more direct influence at the Hadisolb plant, where a hot-strip-mill renovation project, which was to be financed through investment by Kuwait, ran into problems when finance was withdrawn. However, a new caster came on stream in October 1990.

Iran (Islamic Republic of)

The Islamic Republic of Iran has once again become a likely market for steel, with imports in 1990 three times the level of 1989, representing a return to that of 1985. The refurbishment of two blast-furnaces at the long-products plant at Isfahan has been completed, bringing ironmaking capacity up to 1.8 million tonnes. A new billet caster with an annual capacity of 1.3 million tonnes has been brought on stream, and financial support from the USSR has been agreed upon for plans to double plant output. Meanwhile, it is understood that the 2.4-million-tonnes, flat-products project at Mobarakeh is still two years away.

Ore reserves and natural gas supplies in the Islamic Republic of Iran make it a candidate for a direct-reduction plant. This product has a ready market in developing Arab countries such as Egypt and Saudi Arabia, where scrap supplies are restricted. Given this potential, the Japanese company, Kobe Steel, is seriously considering the construction of a direct-reduction plant in the Queshm island free trade zone. Partners are sought for the project, but initial proposals are for a plant that would expand in five stages to 5 million tonnes of direct-reduced iron. Kobe owns the United States-based Midrex Corporation, which is the leading gas-based direct-reduction-technology company.

Saudi Arabia

The Saudi Basic Industries Corporation has commissioned a study from W.S. Atkins of the United Kingdom to look at the feasibility of a 1- to 2-million-tonnes-per-year flat-products mill. This would be the fourth flat-rolling mill in the Arab world following Algeria, Egypt and Libyan Arab Jamahiriya. The plant would probably be based on direct reduction technology, similar to that used at the Hadeed plant in Egypt, since natural gas is available in copious quantities.

Turkey

Plans by major automotive manufacturers to build assembly plants in Turkey has stimulated the major steelmakers to consider widening their product ranges to meet this potential demand. Iskenderun looked at the possibility of installing a thin slab caster to enable it to move into the flat-products sector. The technology supplier sought for the project is Austrian-based. This would be a low-cost entry route into a potentially profitable market-place. The plant has a theoretical overcapacity in raw steel of 1.5 million to 2 million tonnes which the long-products market cannot absorb. The other TDCI plant at Karabuk has undergone modernization, with the installation of a new coke oven battery, upgraded power plant and revamping of blast-furnace stoves and sinter plant.

Eregli, which has a minority government shareholding, is the only flat products plant in Turkey. It has entered into a joint venture agreement with Usinor of France and Ilva of Italy to build a 300,000-tonnes cold-rolling mill in Turkey, with the option of adding a galvanizing line and a colour-coating line. Both these products represent value-added steel for the automobile industry and other important industries such as construction and consumer durables.

In the minimill sector, Metas of Izmir has been affected by the economic downturn and by labour problems. The minimill sector expanded rapidly during the 1980s, and the Sivas minimill is one of the most recent, coming on stream at the beginning of 1991 with a rod and bar capacity of 400,000 tonnes per year. An established minimill, Cukurova, has also announced plans to build a thin-slab caster and flat mill of 1.5 million tonnes projected to come on stream in 1993, thereby giving it the opportunity to expand its market sector from its traditional construction base-product line.

(e) Africa

Nigeria

The construction of the Ajaokuta steelmill still causes financial problems; as a consequence, the 1.3-million-tonnes-per-year long-products mill is said to be proceeding at a slow pace. Towards the end of 1990 the Government demonstrated its commitment to the project by adopting it as a State company and installing new management. However, the infrastructure needed to support the project is not in place, and the foreseen production capacity of the mill will be less than expected. Delta Steel, the other Nigerian steelmaker, continues to experience cash-flow problems which restrict its ability to buy essential raw materials and spares. Delta was said to have operated at less than 20 per cent capacity in 1990, and new management was installed on the insistence of the World Bank.

South Africa

The South African national steel company, Iscor, has been applying new ironmaking technology supplied from Austria. The Corex process reached maturity in 1990 as the first of a new generation of cokeless, ironmaking systems. Further applications are now expected in areas where coking coal is not readily available or where small-scale ironmaking plants are required, for example, in India. But while there has been success with ironmaking, a joint venture project with Taiwan Province in the stainless sector has been less fortunate. Samancor of South Africa held discussions with Yieh Loong of Taiwan Province, with technical cooperation from Thyssen of Germany, to build a 300,000-tonnes-per-year stainless-steel hot mill in South Africa which would supply hot coil to Taiwan Province. Taiwan Province would cold-roll the product for domestic and export markets.

South Africa has the chrome ores needed to make stainless steel and East Asia is seen as the best growth market area for the cold-rolled sheet. However, the so-called Columbus project failed to find the necessary financial backing, and Samancor is now looking for other partners, either in Taiwan Province or Europe. European steelmakers may view the idea with more interest as sanctions against South Africa are being removed.

Zimbabwe

Zimbabwe Iron and Steel Company (Zisco) operates blast-furnaces on an integrated steelworks pattern to produce billet and sections, mostly for domestic consumption. Although demand was adequate in 1990, the capacity utilization of the 500,000-tonnes-per-year plant was less than 80 per cent. A period marked by management changes appears to be at an end, and the company should now be able to plan its next phase following the commissioning and submission of a feasibility study (financed by the Government of Canada) for the building of a flat-products mill to boost the product range. The project would include a hot-strip mill and cold-mill complex including a galvanizing line, with a capacity of 250,000 tonnes per year. However, financial restrictions have delayed the purchase of the second-hand hot-strip mill from Sweden, where it remains unshipped, pending suitable guarantees from the Government of Zimbabwe. The year 1994 is now seen as the earliest date by which the project may be commissioned.

5. *Restructuring and redeployment*

As a country reaches advanced stages of industrial development, its steel industry responds with more advanced products. Countries enter the steel industry in the long-products sector, producing rebar for construction. Rerollers using imported billet are often a first step, followed by electric-arc-furnace melting facilities to feed the bar mill. The next products to be made are sections, with slightly more sophisticated mills. The breakthrough to flat products production often comes about initially through the rolling end. Imported hot coil is cold-rolled to finished sheet. Steelmakers then involve themselves in hot-coil production and slabmaking, working backwards along the production route. But the impediment to flat-products integrated production is one of cost.

Until very recently the entry into flat products production has been restricted by massive investment. But in 1990 the technology of thin slab casting was proven after many years of development and false starts. In the United States, the first commercial flat-products minimill based on a thin slab caster reached its full production capacity and started a wave of orders for similar plants in many countries of the world. A low-cost entry into flat-products steelmaking will enable developing countries to be more confident of their investment plans and will accelerate the move to higher value-added products.

The next product leaps are into special steels, such as stainless steel and engineering steels, and coated flat products either metallic or paint-coated. These products are able to meet the needs of the most sophisticated industrial end-users. Even higher-technology products involve the introduction of such steels as vibration damped sheet, enhanced electrical steels, supertough steels for extreme oil country-tubular-goods applications and even composite products.

6. *Short- and medium-term industry outlook*

The outlook for the crude steel industry over the next several years can be described on the basis of the forecasts discussed in this survey. To begin with, forecasts for apparent crude steel production for 1991 and 1995 were given in table V.86. Here a levelling of the consumption trend with only slow growth was predicted. Crude steel capacity forecasts were given for 1995 in table V.88. Only a small increase from 564 million to 582 million tonnes was indicated. In table V.89 these forecasts were extended to the major product level, but just for the EEC. Capacity utilization rates were roughly predicted to be between 60 and 80 per cent. Finally the forecasts of galvanizing capacity reported in table V.90 suggest a marked increase from 44 million tonnes in 1990 to 57 million tonnes in 1995.

Concerning the regional aspects of this outlook, steel industry development on a large scale for the next few years is expected to be firmly concentrated in South-East Asia. Further retrenchments in the EEC are likely in the short term as the recession expands, and prospects for growth in Eastern Europe will be hindered by a lack of risk capital. It is significant that Europe, Japan and the United States for many years the sources of industrial development know-how, heavy plant and equipment, technology and finance, are now being supplanted by countries of the Pacific rim which not long ago were recipients of that same technology.

K. Cast metals (part of ISIC 3710 and 3720)*

1. *Recent trend and current situation*

Castings form the basis for the manufacture of almost everything used or relied upon in modern life: automobiles, trains, prime movers, power generation, aircraft engines, chemical plant, paper manufacture, printing machinery and much more. Casting, one of the oldest and most traditional of metal-forming methods, is the shortest route to a finished component. Metal is melted and poured into a mould cavity where it solidifies to provide a casting which, in many instances, can be of a very complex form. It is difficult, for example, to imagine a more economic way of producing an automobile cylinder block or head.

In analysing recent trends in the foundry industry, it must also be realized that casting covers an enormous range of products and process technologies which, on close inspection, reveal a number of diverse sectors linked only by the common denominator of molten metal solidifying in a mould or die cavity. For example, a production plant manufacturing single-crystal gas-turbine blades for advanced jet engines is very different from a pressure-diecasting shop producing parts for zip fasteners, while a foundry making steel valves for the nuclear industry has little in common with an aluminium foundry producing gravity-diecasting cylinder heads. Yet the products are all castings.

It is important to realize that it is not always competition or economic pressures that influence the ability of the foundry industry to survive. Markets are often finite and change with shifts in technology and societal needs. For example, one of the most important tonnage outlets of iron castings for a major part of the 1980s was ingot moulds. However, this business has suffered a dramatic reduction as a result of the introduction of continuous casting technology for steel. Evidence of this is seen in the fact that United Kingdom foundries produced 200,700 tonnes of ingot moulds in 1981 and only 54,000 tonnes in 1989. In the

*UNIDO acknowledges the contribution of C. McCombe, editor, *Foundry Trade Journal International*.

United States, ingot mould production was 3.5 million tonnes in 1972, but fell to 516,000 tonnes in 1989.

The automobile industry represents the most important market for castings in many developed countries. It is also the sector involving the greatest import and export of cast components. For example, 57 per cent of all castings made in the Federal Republic of Germany in 1987 found their way into the motor industry. In Japan, 2.8 million tonnes of castings were used by the automobile industry in 1989, representing 53.7 per cent of total casting production. More specifically, in that year, Japanese motor manufacturers absorbed 86.5 per cent of all light-alloy castings, 77.4 per cent of diecastings, 62.2 per cent of castings in ductile iron, 50.9 per cent of grey iron components, 37.9 per cent of malleable-iron castings, and 26.3 per cent of parts produced by the precision casting route [38]. In the United States, around one third of all castings produced are for the automobile industry. Even in a country like the Republic of Korea, automobile casting production is soaring. For example, 14.3 per cent of the output of grey iron castings of the Republic of Korea in 1985 went to the automobile industry, rising to 22 per cent in 1990. Ductile-iron automobile casting production, which represented 15.8 per cent in 1985, now stands at 30 per cent.*

There is no doubt that when automobile sales decline, the foundries are the first to suffer a decline in demand. This is especially true in the United States, where foundries are currently experiencing the lowest demand levels in many years. In 1990, United States automobile production fell by 11 per cent to 6.075 million units, its lowest level since 1983. This was directly responsible for the 8.8 per cent fall in casting production in 1990, including components cast from iron, aluminium, zinc and magnesium [39]. The three largest United States vehicle manufacturers, General Motors, Ford and Chrysler, are also facing stiff competition from Japanese manufacturers. Output of the Japanese transplants and Japanese factories in the United States, including joint ventures with United States manufacturers, rose by 16.4 per cent in 1990 to 1.32 million units, representing 22 per cent of all passenger-cars sold, compared with less than 17 per cent in 1989 ([40], pp. 23-25; [41], pp. 23-29).

This competition does not necessarily mean that overall casting production in the United States suffers accordingly. Japanese manufacturers in the United States are increasing the percentage of castings of local manufacture used in both automobiles and engines. In a number of cases, these castings are supplied by new or acquired Japanese ventures in North America. A recent phenomena is the move by major European casting producers to set up automobile casting plants in the United States and Canada. For example, the Atsugi Unisia Corporation, a Japanese manufacturer of automobile components, recently set up a joint venture in the United States with Kolbenschmidt AG of the Federal Republic of Germany, intending to produce pistons. The new firm, Karl Schmidt Unisia Inc., subsequently took over Bohn Piston, a well-known independent United States piston manufacturer.

*Information supplied in private correspondence from Dong-A University, Pusan, Republic of Korea.

Recently, Toyota Motor Manufacturing USA, Inc. decided to build a new engine foundry near St. Louis to supply castings to the organization's Camry plant in Georgetown, Kentucky. The $30-million project is to produce aluminium cylinder-heads and intake manifolds which are currently being supplied from Japan. A second Japanese automobile manufacturer, Honda of America Manufacturing Inc., based in Marysville, Ohio, already operates an aluminium foundry in the United States, and the local content of the Ohio-manufactured Accord is expect to rise to 75 per cent in the current model.

The increase in the number of such overseas ventures is already adding to the problems of excess capacity within automobile foundries in the United States, Canada and Mexico. Currently, this surplus capacity is between 15 and 25 per cent. General Motors has attempted to counter Japanese competition with its $4-billion Saturn project designed to develop, produce and sell small passenger-cars in North America at cost and quality levels that will outstrip those of the transplants. One aspect of this involves the introduction of lost-foam casting technology, an approach also being adopted by many automobile casting manufacturers around the world. This technique will be referred to under the section dealing with new advances in casting processes.

Automobile manufacturers worldwide are being called upon to produce lighter, more fuel-efficient vehicles with cleaner emissions. One direct result has been the widespread movement towards the adoption of light-alloy castings for both the cylinder block and head. While the use of aluminium engines has long been commonplace in Europe, cast-iron blocks and heads have been basic to many Japanese and North American automobile engines. This is an area of technology undergoing rapid change. For example, in Japan, Nissan Motor Company has announced its intention to raise its output of aluminium engines from 20 to 40 per cent of all engines by 1993. Evidence of this is seen in the reconstruction of Nissan's Yokohama plant to raise aluminium engine production to 10,000 units per month. Honda has already converted all its engines to aluminium. Most the blocks are produced using the pressure-diecasting process, although one version is manufactured by a low-pressure technique involving the use of sand cores to form the internal cavities; the 1991 Prelude engine incorporates metal-matrix preformed cylinder liners. The new Japanese luxury passenger-cars, Lexus, Acura and Infiniti, all incorporate aluminium engines and suspension components.

The adoption of aluminium engine blocks in North America has not been as fast in spite of cast-iron offering superior strength, rigidity and lower noise levels. As in the past, when faced with competition, the iron founder has provided the designer with thinner-walled, more accurate castings. Nevertheless, there are moves by a number of manufacturers to produce light alloy blocks in the United States and Canada. For example, the Ford Motor Company announced in 1990 that it will build a new $59-million plant in Windsor, Ontario, to produce aluminium components, particularly cylinder blocks. The facility will employ the advanced Cosworth Process developed in the United Kingdom, and the casting of engine blocks incorporating the very latest design of valve-train ports will commence in mid-1993. With the exception of cylinder blocks and heads, the automobile industry consumes 45 per cent of all aluminium diecastings manufactured in North America.

One metal which is now attracting increased interest is magnesium. It is suggested that production of pressure-diecast magnesium components for automobiles will rise as the design, manufacturing and performance advantages of magnesium alloys become more widely recognized. Another growing area is in the adoption of the low-pressure diecasting process for the manufacture of light-alloy automobile wheels. It is estimated that from 25 to 30 per cent of all passenger-cars are fitted with aluminium-alloy wheels produced by this technique. This is widely regarded as a growth market worldwide, one source suggesting that world output ranges from 30 million to 40 million aluminium wheels per year.

The precision-investment-casting industry has failed to make significant inroads into the automobile industry. One exception is Japan, where around 26 per cent of all investment castings are used by motor manufacturers [38]. Elsewhere the industry has yet to persuade vehicle-engine builders that the higher price of investment castings justifies their adoption. Even so, one area of investigation is hollow investment-cast camshafts, which is supposed to offer reduced weight and higher contact-stress capability.

2. *Producing and consuming countries*

The latest accumulated statistics for the world casting industry, based on the output of 30 countries or areas, relate to 1989. The figures, if corrected to take account of USSR production could exceed the actual figure by over 20 million tonnes, to be just short of 73 million tonnes, as shown in table V.92 ([42], pp. 26-27). Of the 26 countries that reported output figures for 1989, 16 showed increases over 1988, while the remaining countries either decreased or stayed about the same.

While there is much debate concerning the accuracy of statistics on casting production in the USSR, the overall level is such that the country ranks first at the world level. One source* suggests that 24,232,000 tonnes of castings were produced in 1988. The breakdown is as follows: 16,915,000 tonnes of iron casting, subdivided into 557,800 tonnes of ductile iron; 727,600 tonnes of malleable iron, and 950,800 tonnes of alloyed iron; 5,881,200 tonnes of steel castings; and 1,435,200 tonnes of non-ferrous castings, of which 985,600 tonnes were aluminium alloy, and 13,400 tonnes were magnesium alloy castings. The USSR has a very active foundry-equipment construction industry, and has been an important market for many years for the foundry-plant equipment manufacturers of developed market economies. The country has continued to make important purchases of very large "package" foundries from developed market economies, typified by plants designed to produce automobile, tractor and heavy vehicle castings.

*Information supplied in private correspondence from Moscow Steel and Alloys Institute.

The above data confirm that the United States increased casting output slightly in 1989 to over 11 million tonnes, making it the second-largest producer in the world. Casting output appears to have remained fairly stable from 1985 to 1989. In third place in 1989 was China with 9.6 million tonnes. The first available figures quoted for 1985 were 6.5 million tonnes. The breakdown of the total at that time, by major metal cast, included 80 per cent for cast iron, 15 per cent for steel and 5 per cent for non-ferrous alloys ([43], pp. 34-35). Not much accurate information is available on the structure of the foundry industry of China. In 1989, the country had 7,910 iron foundries, 550 steel foundries, 2,040 non-ferrous foundries and 500 investment casting foundries, which together produced 9.6 million tonnes of castings. In fourth place was Japan with 7.8 million tonnes, followed by the Federal Republic of Germany with 4.2 million tonnes, France with 2.4 million, and Poland with 1.8 million. Two countries reported output at around 1.5 million tonnes—Romania and the United Kingdom. They were followed by Czechoslovakia with 1.4 million tonnes and the Republic of Korea with 1.3 million tonnes.

It appears that the metal casting industry in the United Kingdom is currently experiencing a particularly difficult period. The effect of the ever-deepening recession is one of the primary factors, given the expectation of another round of foundry closures, a phenomenon associated with the previous recession in the manufacturing industry in the late 1970s and early 1980s. Total production of ferrous castings in 1989 was 1,145,000 tonnes, of which 723,000 tonnes were categorized as grey iron and 398,000 tonnes as ductile iron. Ductile iron has consistently improved its annual market share. At the same time, malleable iron production fell during the 1980s from 138,000 tonnes in 1980 to 24,000 tonnes in 1989, reflecting the competitive stance of ductile iron.

It is interesting to see the relative importance of ductile-iron casting in the product mix of developed market economies, compared with output in China, and the formerly centrally planned economies of Eastern Europe and the USSR. For example, Czechoslovakia produced only 38,960 tonnes of ductile iron in 1989, compared with 977,297 tonnes of grey iron. China produced 741,000 tonnes of ductile iron in 1989, compared with 6,972,000 tonnes of grey iron. France, on the other hand, during the same period produced 883,215 tonnes of ductile iron and 1,043,968 tonnes of grey iron.

(a) United States

The metal casting industry in the United States has seen a decline from 1988 to 1990, a trend expected to continue in 1991. Estimated figures for casting shipments in 1990, shown in table V.93, suggest that overall production fell to 8.7 million tonnes in 1990, and a further decline to 8.6 million tonnes is anticipated for 1991 [44]. The hardest-hit industries may be the producers of iron pipe fittings and copper-base plumbing castings, because of severe cutbacks in the housing market, amounting to a drop of 6.5 per cent from the 1990 level. In addition, the demand for iron castings, the largest category of cast components, is expected to fall by at least 3 per cent. This is likely to be especially

Table V.92. World casting production, 1989
(Tonnes)

Country or area	Grey iron	Ductile iron	Malleable iron	Steel	Copper base	Aluminium	Magnesium	Zinc	Other	Total
Austria	90 141	70 434	10 050	20 804	8 691 1/	43 122 3/	..	..	..	243 242
Canada a/	475 766 2/	229 175	..	84 783	..	..	..	..	..	789 724
China	6 972 000	741 000	255 000	1 152 000	106 080	336 000	..	23 520	14 400	9 600 000
Czechoslovakia	977 297	38 960	31 325	304 855	10 466	64 238	254	4 815	612	1 432 822
Denmark	85 187	20 000	..	1 135	..	3 827	..	..	..	110 149
Finland	72 026	30 146	1 737	15 614	4 345	3 302	..	848	523	128 541
France	1 043 968	883 215	16 955	139 139	24 428	240 090 4/	..	40 143	3 514	2 391 452
Germany, Federal Republic of	2 304 200	887 100	122 000	221 000	85 414	475 529	6 788	71 229	9 794 5/	4 183 054
Hungary	161 221	13 810	4 793	27 706	6 627	15 745	..	2 868	136 6/	232 906
Israel b/	12 100	1 050	1 450	2 900	3 700	2 200	..	700	140	24 240
Italy	..	..	..	..	92 400	413 000	1 700	67 000	1 800 7/	575 900
Japan	3 946 436	1 952 392	271 815	451 229	112 752	980 352	110	56 300	10 370 8/	7 781 756
Republic of Korea c/	802 000	298 000 9/	42 000	125 000	18 000	28 500	..	..	3 500 10/	1 317 000
Mexico	14 936 b/	1 960 b/	26 782 b/	54 981 11/	..	29 070	..	..	..	127 729
Netherlands b/	116 200	51 000	5 000	..	2 250	13 107	..	..	157	187 714
Norway b/	32 301	17 526	2 829	2 977	1 591	2 088	..	2 596	..	61 908
Peru	22 050	1 400	550	44 000 12/	2 000	1 200	..	13 000 13/	2 500 14/	86 700
Poland	1 307 482	52 667	54 051	264 147	30 988	55 154	232	11 005	360 15/	1 776 086
Portugal	50 740	15 878	16 399	14 587	1 900	4 600	..	2 300	..	106 404
Romania	1 030 769	38 059	18 594	356 110	..	45 436	..	..	..	1 488 968
South Africa	99 500	45 200	4 800	93 300	..	..	5 300	..	..	248 100
Spain	454 000	196 000 16/	25 500	99 500	16 000	90 000 17/	..	26 000	1 500	908 500
Sweden	219 400	61 400	4 300	13 400	10 500	30 000	1 200	3 300	..	343 500
Switzerland	118 000	69 000	..	..	2 750	14 300	..	1 800	..	205 850
Taiwan Province	830 000	136 000	11 500	83 300	30 650	91 800	..	..	..	1 183 250
Turkey	428 000	48 500	13 200	61 500	11 500	17 800	..	4 200	..	584 700
United Kingdom	723 000	398 000	24 000	115 200	44 500	121 000 18/	..	43 000	..	1 468 700
USSR	990 692	38 894	31 817	320 523	10 937	64 487	252	5 576	595 19/	1 463 773
United States	5 179 505 20/	3 039 120 21/	277 603 22/	1 076 846 23/	217 423 24/	997 940 25/	10 706 26/	213 666 27/	20 977 28/	11 033 786
Zambia	549	..	..	15 618	..	..	..	..	..	16 167
TOTAL	28 559 466	9 375 886	1 274 050	5 162 154	855 892	4 183 887	26 542	593 866	70 878	50 102 621

Source: "24th census of world casting production - 1989", *Modern Casting*, vol. 80, No. 12 (December 1990), pp. 26-27.

a/ Figures estimated to be 75 per cent of actual amount by the Canadian Foundrymen's Association.
b/ 1988 tonnages.
c/ Estimated tonnages.

1/ Includes zinc, lead and tin castings.
2/ Includes magnesium castings.
3/ Includes 17,450 tonnes of alloy iron.
4/ Includes aluminium and magnesium castings.
5/ Includes 8,933 tonnes of lead, 714 tonnes of tin and 147 tonnes of nickel.
6/ Lead castings.
7/ Lead and tin castings.
8/ Includes investment castings.
9/ Includes 145,000 tonnes of spun pipe.
10/ Includes magnesium and zinc castings.
11/ Includes 24,038 tonnes of steel forging pieces.
12/ Includes fabrication of grinding balls for mining.
13/ Includes die castings.
14/ Lead castings.
15/ Includes lead, tin and other non-ferrous castings.
16/ Includes cast pipe.
17/ Includes 63,000 tonnes of die castings and 27,000 tonnes of sand, gravity and other castings.
18/ Includes magnesium castings.
19/ Lead castings.
20/ Includes 670,000 tonnes of moulds and stools for steel ingots, 60,000 tonnes of pressure pipe and fittings, 330,000 tonnes of soil pipe and fittings, 1,529,000 tonnes of automotive castings and 332,000 tonnes of construction and utility castings.
21/ Includes 1,643,000 tonnes of pressure pipe and fittings, 663,000 tonnes of automotive components, 9,000 tonnes of construction elements and 128,000 tonnes for machinery uses.
22/ Includes 174,000 tonnes of standard malleable and 103,000 tonnes of pearlitic malleable.
23/ Includes 4,400,000 tonnes of railroad specialities, 421,000 tonnes of alloy steel, 105,000 tonnes of high-alloy steel and 44,246 tonnes of investment castings.
24/ Includes 4,244 tonnes of die castings, 20,580 tonnes of permanent and semi-permanent mould castings and 12,763 tonnes of centrifugal castings.
25/ Includes 661,839 tonnes of die castings and 195,614 tonnes of permanent and semi-permanent mould castings.
26/ Includes 5,268 tonnes of die castings.
27/ Includes 210,810 tonnes of die castings.
28/ Includes 13,175 tonnes of mill balls.

Table V.93. The United States production of castings, 1987 - 1990

Item	1987	1988	1989	1990[a]	Percentage change 1989-1990	Percentage share	
	(thousand tonnes)					1989	1990
Ductile iron	2 684	2 884	2 554	2 357	-7.7	26.76	27.09
Grey iron	5 159	4 838	4 241	3 770	-11.1	44.44	43.32
Malleable iron	288	330	257	227	-11.7	2.69	2.61
Steel	753	919	1 031	980	-4.9	10.80	11.26
Copper	218	227	218	204	-6.4	2.28	2.34
Aluminium	1 007	1 051	998	945	-5.3	10.46	10.86
Zinc	223	221	214	192	-10.3	2.24	2.21
Magnesium	10	11	10	9	-10.0	0.10	0.10
Lead	22	24	21	18	-14.3	0.22	0.21
TOTAL	10 364	10 505	9 544	8 702	-8.8	100.00	100.00

Source: Department of Commerce, *United States Industrial Outlook 1991 - Metals* (Washington, D.C., Government Printing Office, 1991), and industry sources.

[a] Estimated.

true of construction industry castings, such as centrifugally cast pipes and street furniture.

A source of particular concern is the impact of falling automotive sales on the producers of vehicle castings. Total sales of passenger-cars and light trucks had already fallen to 13.8 million units in 1990, down 5.1 per cent from 1989, the lowest level since 1983. It is already forecast that new vehicle sales may fall by another 2 to 6 per cent, to as low as 13 million passenger-cars and trucks in 1991. A resultant drop of 3.5 per cent in automobile castings is expected.

Steel casting production in the United States has been rising steadily from a low of 662,291 tonnes in 1983, reaching 1,076,846 in 1989 ([45], pp. 19-20). However, it is expected that this growth will be checked in 1991, with overall demand falling by about 1 per cent. The loss may be due to a cutback in railway- and construction-equipment castings, which will drop by 1 per cent and 4 per cent, respectively. Other sectors of the steel castings industry producing high-alloy and corrosion-resistant components are expected to escape the worst of the downturn.

Aluminium casting production reached 997,940 tonnes in 1989, a level likely to be sustained in 1991, aided by the increasing utilization of light-alloy components in automobile engines. Indirect imports of zinc pressure diecastings have increased dramatically in recent years and caused a severe decline in the domestic zinc alloy and pressure-diecasting industry. United States consumption of domestically produced, zinc diecastings fell from a record high of 543,150 tonnes to the current level of 241,000 tonnes. At the same time, the number of companies producing zinc diecastings was reduced to 385 in 1990, after reaching a high of 460 in 1987.

It is thought that foundries serving a so-called niche market, such as speciality stainless-steel castings and precision investment castings for the aircraft and aerospace industries, are doing significantly better than plants primarily geared to serving the automobile industry.

(b) Japan

Table V.94 indicates that total Japanese foundry production in 1989 reached 7.81 million tonnes, a continuous increase from 1988, registering a gain of 420,000 tonnes (up 5.7 per cent) [38]. This exceeded even the 1973 record output of 7.78 million tonnes, a high for the 16 preceding years. Although there were gains across every category of casting, the most impressive was that of light-metal alloy castings which soared to 366,000 tonnes, up 10 per cent, followed by pressure diecastings, up 8.9 per cent at 705,000 tonnes. Precision casting production also increased to 9,624 tonnes, up 5 per cent.

The total production of grey iron and ductile iron castings in 1989 amounted to 5.22 million tonnes, representing 66.8 per cent of total casting production. The largest market for such components is the automobile industry, which took delivery of 2.80 million tonnes (53.7 per cent). Much of Japan's output of light-alloy castings is also destined for the automobile industry. Total light-alloy castings amounted to 366,000 tonnes, of which 86.5 per cent was for vehicles. Diecastings, also in aluminium, are listed separately at 705,000 tonnes. Of this, 498,000 tonnes (70.7 per cent) go into automobiles and 47,000 tonnes (6.7 per cent) into motorcycles. Unlike other industrial countries, Japan's investment casting industry manages to sell 26.3 per cent of its output to the automobile manufacturers. As in many other countries, casting producers in Japan often fail to obtain a reasonable price for their components. Information on changes in the number of foundries in Japan in recent years appears in table V.95.

(c) Republic of Korea

Perhaps one of the greatest increases in casting production can be found in the Republic of Korea. Cast metal production for 1990 was 1,395,200 tonnes, more than double the 667,940 tonnes produced in 1978 as shown in table V.96. This expansion is the result of the effort of 34,500 people employed in 709 foundries. As in other major developed countries, automobile castings are of particular importance in the product mix. Of the castings manufactured in 1990, table V.97 indicates that 22 per cent of iron castings and 30 per cent of ductile iron castings found their way into vehicles. The demand for castings is likely to grow still further with the targeting of the home market by

Table V.94. Production of various classes of castings in Japan, 1985 and 1989

Material group and casting process	Production 1985 (tonnes)	Production 1989 (tonnes)	Percentage change 1985-1989	Percentage share 1985	Percentage share 1989
Cast iron	4 406 415	5 218 477	18.4	63.06	66.80
Grey-iron castings	3 467 597	3 932 310	13.4	49.63	50.34
Ductile-iron castings	938 818	1 286 167	37.0	13.44	16.46
Cast-iron pipes and fittings	794 946	680 351	-14.4	11.38	8.71
Grey-iron castings	16 335	14 126	-13.5	0.23	0.18
Ductile-iron castings	778 661	666 225	-14.4	11.14	8.53
Melleable-iron castings	296 279	271 814	-8.3	4.24	3.48
Steel castings	537 567	451 229	-16.1	7.69	5.78
Copper-alloy castings	103 097	108 421	5.2	1.48	1.39
Light-metal alloy castings (sand gravity and low-pressure diecastings)	..	366 965	..	0.00	4.70
Pressure-diecastings	550 983	704 875	27.9	7.89	9.02
Aluminium-alloy castings	..	643 498	..	0.00	8.24
Zinc-alloy castings	..	56 300	..	0.00	0.72
Precision castings	8 740	9 624	10.1	0.13	0.12
TOTAL	6 987 257	7 811 756	11.8	100.00	100.00

Source: Ministry of International Trade and Industry, *Annual Report of Machinery Industry Statistics and Iron and Steel Statistics* (Tokyo, 1989).

Table V.95. Changes in the number of foundries in Japan based on type of castings manufactured, 1980-1989

Year	Cast iron	Cast-iron pipes and fittings	Malleable-iron castings	Steel castings	Non-ferrous metal castings	Pressure-diecastings	Precision castings	Total
1980	1 003	24	46	152	415	154	19	1 813
1981	971	25	41	152	405	152	29	1 775
1982	935	25	47	150	388	154	29	1 728
1983	866	30	39	141	363	149	29	1 617
1984	873	30	39	134	382	179	34	1 671
1985	843	30	39	136	398	175	35	1 656
1986	806	29	37	129	356	175	35	1 567
1987	787	29	38	119	360	172	35	1 540
1988	773	30	39	114	398	178	34	1 566
1989	751	30	37	113	390	176	34	1 531

Source: Ministry of International Trade and Industry, annual and monthly reports of machinery industry statistics and iron and steel statistics.

Notes: 1. 1979-1982: as of March every year; 1983-1988: as of December every year.

2. The grey-iron and non-ferrous-metal castings, forgings from billet and bar and metal-stamping products represent factories with over 20 employees and the malleable-iron castings, pressure-diecastings, precision castings and powder-metallurgy products represent factories with 30 employees. The steel castings, cast-iron pipe and fittings and steel forgings from ingot cover all existing factories.

passenger-car manufacturers. Even in 1987, there were only half as many passenger-cars in the Republic of Korea per 1,000 people as there were in Taiwan Province (and a quarter compared with Japan) despite the fact that each country and area had comparable per capita GNPs. Furthermore, almost all passenger-cars sold in the Republic of Korea are produced domestically.

A move peculiar to the Republic of Korea is a recent decision to group foundries together on specialist foundry estates. Encouraged by generous government grants, many foundries are quitting their premises in

Table V.96. Growth in output from foundries in the Republic of Korea, 1978 - 1990
(Tonnes)

Year	Ferrous metals			Non-ferrous metals		Total
	Grey iron	Ductile iron	Malleable iron	Cast steel	Copper, aluminium, other	
1978	473 372	72 752	33 694	77 722	10 400	667 940
1979	493 391	79 853	31 295	88 956	11 000	704 495
1980	478 000	92 000	27 000	88 000	23 300	708 300
1981	410 000	94 000	28 000	88 000	22 700	642 700
1982	450 000	110 000	29 000	92 000	24 500	705 500
1983	490 000	140 000	31 000	101 000	28 000	790 000
1984	510 000	160 000	32 000	103 000	30 500	835 500
1985	540 000	170 000	33 000	105 000	32 000	880 000
1986	590 000	200 000	35 000	109 000	36 000	970 000
1987	650 000	226 000	37 000	115 000	40 000	1 068 000
1988	730 000	262 000	40 000	121 000	45 000	1 198 000
1989	802 000	298 000	42 000	125 000	50 000	1 317 000
1990	842 700	332 500	42 500	126 500	51 000	1 395 200

Source: Dong-A University, Pusan, Republic of Korea (private correspondence).

Table V.97. Markets for castings of the Republic of Korea, 1985 and 1990.

Markets	Grey iron (tonnes)		Percentage change 1985-1990	Percentage share		Ductile iron (tonnes)		Percentage change 1985-1990	Percentage share	
	1985	1990		1985	1990	1985	1990		1985	1990
General engineering	99 900	151 686	51.8	18.5	18.0	5 440	9 975	83.4	3.2	3.0
Steel-mill components	80 460	50 562	-37.2	14.9	6.0	..	..	..	..	..
Automotive components	77 220	185 394	140.1	14.3	22.0	26 860	99 750	271.4	15.8	30.0
Household articles	39 420	67 416	71.0	7.3	8.0	..	..	..	..	..
Machine tools	37 800	101 124	167.5	7.0	12.0	..	..	..	..	..
Mining and construction	29 160	42 135	44.5	5.4	5.0	..	..	..	..	..
Pipe fittings	28 080	33 708	20.0	5.2	4.0	..	..	..	..	..
Pipes	..	..	..	..	..	99 960	152 950	53.0	58.8	46.0
Shipbuilding	23 220	33 708	45.2	4.3	4.0	..	..	..	..	..
Others	124 740	160 113	28.4	23.1	19.0	37 740	69 825	85.0	22.2	21.0
TOTAL	540 000	842 700	56.1	100.0	100.0	170 000	332 500	95.6	100.0	100.0

Source: Dong-A University, Pusan, Republic of Korea (private correspondence).

urban areas or in run-down industrial complexes and moving to purpose-built estates in country districts. Typical of these are the Kyoung-In Foundry Industry Estate at Incheon, which currently houses 61 foundries, soon to be increased to 180, and new estates at Chin Hae Macheon near Pusan, with 74 foundries in the final phase, and another at Taegu.

(d) Germany

The latest figures available for the performance of the ferrous foundry sector in the former Federal Republic of Germany, comprising grey, ductile and malleable iron and steel, show that the total production of castings reached 3.59 million tonnes ([46], p. 34). This was an increase of 1.6 per cent over 1989, the third year of growth for the industry. To this rise in volume must be added a further growth factor based on quality or user value, which can be taken to be around 2.5 per cent. This figure represents the higher performance value of the castings, many of which exhibit the trend towards progressively thinner wall thicknesses. In 1990, 73 per cent of production was destined for the general engineering and road vehicle industries. In previous years, these customer sectors only received two thirds of the total production of the foundry industry. This rise highlights the trend towards the specification of high-quality cast components, and it is also a reflection of the successful restructuring of the foundry industry in the Federal Republic of Germany.

As shown in table V.98, casting orders placed in 1990 amounted to 3.35 million tonnes, 2.2 per cent below those of 1989. However, the order books showed a further fall, particularly during the last few months of 1990. This was especially true of orders from the general engineering industry. Additionally, fewer orders were received in 1990 from the road vehicle manufacturers, compared with 1989. The continuing reduction in weight of passenger-car components and increased sourcing abroad may have contributed to this development. Furthermore, there is an apparent trend for individual foundries to search for alternative markets, because of the difficulty of

Table V.98. Foundry statistics of the Federal Republic of Germany, January to November 1989 and 1990

Item	Deliveries 1989 (tonnes)	Deliveries 1990 (tonnes)	Percentage change 1989-1990	Orders received 1989 (tonnes)	Orders received 1990 (tonnes)	Percentage change 1989-1990
Steel castings						
Rolls	25 003	25 918	3.7	30 342	24 062	-20.7
Railroads	4 369	4 541	3.9	4 941	5 259	6.4
General engineering industry	59 844	59 209	-1.1	64 318	57 470	-10.6
Vehicle construction industry	19 321	16 542	-14.4	21 668	15 244	-29.6
Miscellaneous	67 682	73 408	8.5	74 666	73 353	-1.8
Total	176 219	179 618	1.9	195 935	175 388	-10.5
Ductile and malleable iron castings						
Building industry	220 791	258 650	17.1	221 754	279 044	25.8
Steel industry	8 912	8 371	-6.1	9 578	8 319	-13.1
General engineering industry	213 629	230 893	8.1	239 334	230 353	-3.8
Vehicle construction industry	373 360	396 983	6.3	397 576	444 841	11.9
Miscellaneous	86 394	90 181	4.4	90 669	84 741	-6.5
Total	903 086	985 078	9.1	958 911	1 047 298	9.2
Flake-graphite iron castings						
Building industry	103 403	108 496	4.9	104 644	106 032	1.3
Steel industry	61 723	57 585	-6.7	62 613	52 358	-16.4
General engineering industry	742 840	773 011	4.1	808 780	762 158	-5.8
Vehicle construction industry	960 071	928 149	-3.3	974 014	902 224	-7.4
Miscellaneous	250 089	259 390	3.7	259 561	259 818	0.1
Total	2 118 126	2 126 631	0.4	2 209 612	2 082 590	-5.7

Source: *Deutscher Giesserverband* (private correspondence).

achieving a satisfactory profit from the manufacture of automobile castings.

However, the stock of orders held by the foundry industry at large is still relatively high, guaranteeing that there will be good utilization of capacity in the short term. Steel castings also showed a 1.9 per cent growth, 179,618 tonnes from January to November 1990, compared with 176,219 tonnes for the same period in 1989. The status of foundries in the Federal Republic of Germany remains good, with only 7 per cent of firms in January 1991 reporting unsatisfactory trading conditions. This has encouraged the casting producers in the region to expect that 1991 will be another good year.

The situation of the foundry industries in the formerly centrally planned economies of Eastern Europe and the USSR gives cause for concern. For example, it is widely believed that ferrous output has slumped to a very low level. It has been estimated that casting output in 1990 attained only 60 per cent of the 1989 figure. Production in 1990 amounted to about 550,000 tonnes. This strong decline was particularly evident in the second part of 1990. However, capacity utilization varies from foundry to foundry. The situation is especially difficult for foundries supplying the road vehicle industry and those producers who sold most of their products to customers in Eastern Europe, and particularly to the USSR.

The foundry industry in the formerly centrally planned economies is facing a far-reaching period of restructuring which will inevitably lead to a number of closures. Concern has been expressed that this reduction in capacity will be brought about in a haphazard manner, resulting in the elimination of foundries that may be essential to the industry in the territory of the former German Democratic Republic when rehabilitation commences. The effect of the current recession has yet to have an appreciable impact on foundry output in Germany. A certain slow-down is being observed, but most foundries are still working at full production capacity.

In the territory of the former German Democratic Republic, the situation is not so good. The last few months of 1990 reflected a sharp decline in orders. This has largely to do with the general state of the engineering industry, which previously mainly supplied countries in Eastern Europe and the USSR. With the move to a market economy in the territory of the former German Democratic Republic, Czechoslovakia and in other countries of the region, many foundry closures can be expected as a result of excess capacity and uneconomic operations sustained by the previous regimes.

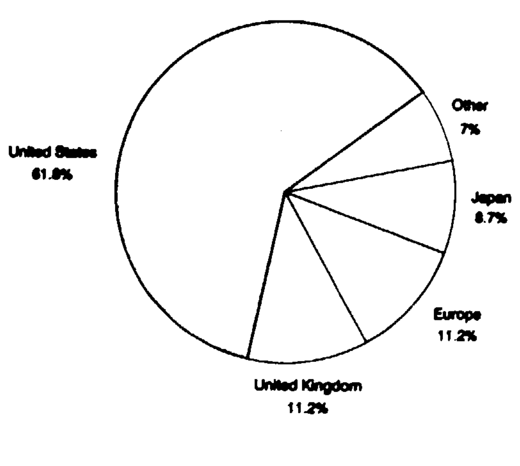
3. *Special case of investment casting*

The precision investment casting industry is dependent on the use of expendable patterns formed from wax, around which a multi-layer ceramic shell is built. The one-piece mould is subsequently dewaxed and fired to a high temperature before filling with molten metal, either in air or under vacuum, hence the term "lost-wax process". This is a sector of the foundry industry where tonnage produced is not a tenable measure by which to judge performance, and turnover or sales value must be employed. Traditionally, the major proportion of castings produced is for the aerospace industry. On the one hand, this consists of gas turbine blades and increasingly large engine components for the aircraft industry, and on the other, of a wide range of thin-walled aluminium castings for housing on-board computers and guidance systems. The castings can be not only exceedingly complex in nature, of a form unobtainable by any other process, but also cast in a wide range of advanced alloys. Investment casters have also achieved close control over the solidification of components, as in the case of single-crystal turbine blades.

Excluding the formerly centrally planned economies of Eastern Europe and the USSR, world sales of investment castings reached $3,560 million in 1989. As shown in figure V.21, sales of $2,200 million were recorded in the United States, $400 million in the United Kingdom, $400 million in the rest of Europe, $310 million in Japan, and $250 million in the rest of the world, including Australia, Israel, Republic of Korea, Taiwan Province and South Africa. In the United States, turbine castings account for $1,400 million of the market. Other castings, such as those for airframes, missiles, nuclear-power components, medical implants and others, make up $450 million, and commercial castings account for the remaining $420 million.

Despite the impressive growth of the turbine market, casting sales are now likely to level off as this sector achieves maturity. The industry is now looking to other areas for increased sales [47]. One area with an anticipated 15 to 20 per cent growth is that of land-based gas-turbine blading. Yet another is the possible production of high-integrity steel castings which are subsequently hot-isostatically pressed (hipped) for fatigue-related applications. Whereas Japanese investment casters have been successful in selling large quantities of components to the automobile industry, there is a general disbelief that this can ever represent a growth market. Nevertheless, there is a consensus of opinion that the growth of the investment casting sector will continue.

Figure V.21. Investment casting world market*, 1989



Source: T. M. Thys, "Investment casting in the United States 1989", conference paper presented to the British Investment Casting Association at Birmingham in October 1989.

*Excluding the formerly centrally planned economies of Eastern Europe and the USSR.

4. *Environmental considerations*

One of the problems with the foundry industry is that many of the processes involve the handling of particulate materials, such as sand and carbonaceous additives, and this causes substantial dust emissions. This difficulty is compounded when the fine particles are entrained in strong convection currents, which arise when molten metal is poured into moulds or when the hot castings are subsequently recovered. The moulding process also gives rise to large quantities of used sand, often coated with a chemical bonding agent. This, and the residues such as slag from the melting operation are becoming increasingly difficult and expensive to eliminate. The melting and treatment of metal can also be the source of fume, smoke and grit.

As a result, the castings industry has been increasingly targeted by local and national authorities anxious to improve the environment. In almost every developed country, legislation is being directed at the foundry sector to improve its environmental conditions. In a number of countries this has placed a heavy financial burden on the foundries, many of which were only marginally profitable. As a result, a number have had to close, especially in urban areas. Among attempts to reduce pollution emissions, the following abatement techniques have been introduced: sand reclamation; close capture of fume from electric furnaces; improved emission control systems on cupolas; total enclosure of operations such as casting knockout stations; and extensive use of dust-collection equipment. The high cost of such controls is likely to lead, indirectly, to higher casting prices, a situation which may be responsible for work being lost to foundries in countries where environmental restraints do not exist, or are poorly enforced.

5. *Technological trends*

(a) *New materials*

The invention of spheroidal-graphite (ductile) iron 43 years ago changed the fortunes of the iron-founding industry worldwide, opening new horizons at a time when the properties of grey cast iron were inferior. The ability to transform the flakes of graphite, which made cast-iron a non-ductile material, into discreet spheroids provided an iron with more than twice the strength, and with the added properties of toughness and ductility.

It is hardly surprising that the foundry industry would welcome another alloy with the same potential to expand the market for castings. It is widely believed that this metal exists in the form of austempered ductile iron. In this case, the microstructure is further altered by alloying and heat treatment to give remarkable strength, ductility and wear-resistance properties which almost doubles the strengths of conventional ductile iron. The possible range of applications includes the replacement of forged-steel gears and the production of automobile crankshafts. As yet production is low, about 20,000 tonnes per year in the United States and 5,000 tonnes in Europe. However, many casting producers hope that the potential for austempered ductile iron will become more widely recognized, thus making a significant impact on production figures in the years to come.

Another developing technology within the foundry industry is the production of cast metal matrix composites (MMCs) in which an alloy is reinforced with silicon-carbide particles and ceramic or other refractory fibres. It is claimed that MMC light-alloy castings can possess characteristics such as strength and stiffness similar to their equivalent produced from titanium. Several methods are adopted for producing MMC castings. One is the use of a proprietary aluminium ingot that already contains dispersed particles of silicon carbide. It can be melted and cast in a manner similar to conventional practice. The material is subject to widespread trials for a variety of potential applications including automobile brake discs. Another approach is to place fibre preforms into a die into which a measured amount of liquid metal is poured. This is then "squeezed" or forged to produce a squeeze-cast component.

Some founders are employing a combined vacuum impregnation and pressure consolidation technique to produce castings incorporating silicon carbide preforms. Liquid aluminium is introduced by a low-pressure technique. Mechanical properties are said to be spectacular, 10 times higher than that of unreinforced alloy.

(b) Extending the processing chain

There is now a growing realization that one way to increase profitability is to add value to the raw casting. As a result, a rapidly growing number of foundries are offering partly or completely machined castings, a trend originally set by the pressure-diecasting sector. Machine shops linked to foundries are becoming better equipped and are no longer repositories for antique, out-dated machine tools. Numerical-control machine tools and machining-centres of the very latest design enable foundries to provide components ready for the customer's assembly lines. Indeed, there is a growing trend towards the supply of complete casting-based assemblies incorporating such elements.

(c) New process technologies

Over the last three or four decades, there has been no shortage of technical innovation within the foundry industry ([48], p. 210). Much of this has been centred on new process technologies concerned with the bonding of sand grains basic to the production of permeable moulds and cores. These bonding agents, which may be inorganic, as in the case of sodium silicate, or based on organic resins, are hardened chemically, either by a "catalyst" or by a reactive gas. There has recently been growing interest, especially on the part of the manufacturers of automobile castings, in the use of expendable patterns formed from expanded polystyrene. These patterns are volatilized *in situ* by the ingress of molten metal which replicates the original form of the pattern upon solidification. Many automated plants based on the lost-foam process are now operating worldwide. The foundry industry has also widely adopted the technique of filtering molten metal as it enters the mould. First applied to light alloys, the use of filtration media has now spread to irons and steels. Mention has already been made of Ford's adoption of the Cosworth process. This approach to the manufacture of high-integrity, light-alloy castings is based on the use of precision-assembled resin-bonded zircon-sand moulds, filled from below by an electromagnetic pump. However, the low-pressure bottom-fill procedure has meant that the speed of production is dictated by the time needed for the metal in the entry channel to solidify, prior to the mould being advanced to the cooling line. However, the latest development has seen the rotation of the mould through 180° in the final stage of the pouring cycle, allowing immediate transfer to the next station in the system. As a result, production rates approaching 100 moulds per hour are now being achieved.

Another novel process developed by CWC Textron in the United States involves a vacuum-casting technique whereby the bottom-gated mould is partially immersed in molten steel contained within an induction furnace. The creation of a vacuum in the mould void causes the metal to be drawn up into the interior where it solidifies. Among its advantages are the ability to cast a group of alloy steels, previously difficult or impossible to cast, and to produce sections as thin as 1.75 millimetres.

With regard to cast MMCs, one route has been the use of squeeze casting where molten aluminium is "forged" in a closed die. The process allows the preplacement of a ceramic fibre preform in the die cavity. Recently, Duralcan has introduced an aluminium-alloy ingot containing a ceramic particulate reinforcement. This can be melted and poured directly into a mould which provides an MMC casting with enhanced strength, stiffness, wear-resistance and thermal stability.

Another foundry process which has aroused interest is the diecasting of alloys in their semi-solid state, a technique known as rheocasting. One version is the thixomoulding process which has a close affinity to plastic injection moulding. Alloy, in pellet form, is heated to the stage where it is soft and semi-molten. It is then fed into a rotary screw where it is consolidated and pressurized, resulting in the expelling of any entrapped air. The mass is then injected into the die. It is said that the porosity level in the resultant casting is much lower than that obtained by the conventional high-pressure diecasting route. Furthermore, because of the low temperatures involved, tool life is greatly enhanced. It is suggested that the process may be particularly suitable for the manufacture of magnesium castings.

Finally, the "near net-shape" manufacture of castings and forgings has emerged as a very strong market force and one of the most important trends in the industry. The investment casting process is one example of such a technology with a world growth rate of about 10 per cent per year.

L. Bulk chemicals (ISIC 3511-3513)*

1. *Recent trends and current situation*

The bulk chemical industry, which is related to the petrochemical industry, provides basic feedstocks and building blocks, such as ethylene, propylene, methanol, benzene xylene and toluene, to a large number of processing industries that produce plastics, synthetic fibres and many other products. Plastics include commodity plastics such as high-density polyethylene, low-density polyethylene, polyvinyl chloride, polypropylene, polystyrene and engineering plastics, which are basically composed of hard polymers reinforced with glass fibres, aramid fibres, carbon fibres etc. Synthetic fibres include such fibres as polyesters, polyamides and acrylics.

The economic recession of the early 1980s led to a severe, world-wide drop in the demand for petrochemicals. The countries most affected were those of OECD, which faced huge overcapacities for most petrochemicals. The petrochemical industry responded to those developments by adopting rationalization and restructuring schemes in order to reduce production costs and to diversify into new fields of business.

The petrochemical industry in developing countries, although struggling with the same problems, performed relatively better. As demand has not yet been saturated in those countries, cut-backs and shutdowns of production units could generally be avoided. On the contrary, the availability of low-priced feedstock in many of them induced Governments to continue planning for future expansions.

World chemicals output increased by nearly 2 per cent in 1990, representing considerably less growth than the 3.6 per cent seen in 1989 [49]. In the last six months of 1989, world chemicals output slowed sharply, mainly owing to downward stock adjustments rather than weak demand.

Inventory adjustment continued in the first half of 1990 and demand growth slowed as a result of the general economic downturn and the Gulf crisis. Performance was mixed around the world, with Japan maintaining a 3.5 per cent growth in chemical output for 1990, while the United States recorded 1.4 per cent, the EEC as a whole 1.7 per cent, France 0.5 per cent, Federal Republic of Germany 2 per cent, Spain 3.5 per cent, and United Kingdom −1.3 per cent, showing negative growth for the first time. Profits declined during 1990 and fell off rapidly after the 2 August invasion of Kuwait by Iraq, when feedstock costs rose sharply.

Petrochemical producers were generally successful, however, in passing on higher feedstock costs, and by December had regained profit margins enjoyed before August. But the end of the Gulf war signalled a drop in petrochemical prices, and by April 1991 buyers were taking their revenge and petrochemical producers were again facing a serious decline in profit margins.

(a) *Sales and trade*

Total sales by the global chemicals industry according to the most recent data [50] were estimated at over $1,100 billion in 1989, after a steady climb from $700 billion in 1984, although the growth curve slowed dramatically after 1987. The share of Western Europe in 1989 is put at 31 per cent, with the United States holding 22.6 per cent, Japan 14.2 per cent and the rest of the world 32.2 per cent. Of this, petrochemicals is the largest single sector, accounting for the bulk of sales—approximately $440 billion.

Petrochemical sales in value terms peaked in 1989 and have since declined, particularly in the United States and Western Europe. But these two regions remain central areas of influence in terms of production, technology and world-wide investment. Growth now centres on markets in East Asia where demand growth is strong and fundamental costs, such as labour and land, are still cheaper.

In terms of the chemicals trade, Western Europe showed an improved positive balance over the 10-year period 1979-1989, rising from about $17.5 billion to $27.5 billion; the United States also had an increase from $10 billion to over $16 billion, but Japan's surplus of $1 billion fell to a deficit of $1 billion.

While per capita output rose by nearly 3 per cent, employment in the industry declined by 7 per cent during the decade 1979-1989 and, certainly in developed countries, is set to fall further, particularly in the short term. Contributor effects include the economic downturn and ongoing rationalization. The most marked cut-backs are in the chemicals industry in Eastern Europe and the USSR.

(b) *Leading companies*

In 1989 there were 10 chemical companies with sales of $10 billion or more [51], 8 were European and 2 United-States-owned (see table V.99). The world's three biggest chemical companies are German: BASF, Hoechst and Bayer. Five chemical companies had sales of over $20 billion. The two most profitable companies, however, are both United States-owned: Dow Chemical and Du Pont.

2. *Manufacturing capacity of developing countries*

(a) *Western Asia*

The Gulf war served to illustrate the dependence of the global industry on Western Asia because of the export of key naphtha feedstock from Kuwait and Saudi Arabia to Japan and Western Europe. Japan, now taking steps to lessen this dependence, obtained 71 per cent of its imported naphtha from Western Asia. Saudi Arabia controls 4 per cent of world ethylene production and 8 per cent of monoethylene glycol output. Saudi Arabia and Bahrain control 11 per cent of world methanol output, most of which is exported. The region as a whole can be seen as more secure than before the invasion of Kuwait by Iraq, and confidence in future investment there is steadily growing.

The region is set to increase in importance: the six States belonging to the Gulf Cooperation Council, namely Saudi Arabia, Kuwait, Qatar, Bahrain, United Arab Emirates and Oman, together with Iraq and the Islamic Republic of Iran, foresee chemical investments totalling nearly $15 billion over the period 1990-1995.

*UNIDO acknowledges the contribution of I. Lattum, editor-in-chief, *Chemical Week*

Table V.99. World's biggest chemical companies in 1989

Company	Sales (million dollars)	Percentage change over the previous year
BASF	28 180	8.6
Hoechst	27 162	12.0
Bayer	26 624	7.0
Du Pont a/, b/	22 014	12.3
ICI	21 258	12.6
Dow Chemical	17 600	5.5
Ciba-Geigy	13 364	16.8
Rhone-Poulenc	12 648	11.8
Enimont	12 120	4.7
Shell a/, b/	11 075	4.8
	Net profit	Percentage change
Dow Chemical	2 487	3.7
Du Pont a/	2 120 c/	15.4
ICI	1 706	26.3
Shell a/	1 567 c/	-4.6
Merck and Company	1 495	23.9
Hoechst	1 261	5.7
Bayer	1 233	12.3
BASF	1 192	42.9
Exxon a/	1 082 c/	-17.2
Occidental	1 056	20.3

Source: *Chemical Insight* (London, October 1990).

a/ Chemicals only.

b/ Excluding transfers between business segments.

c/ After-tax operating profit.

Plans by Kuwait and Iraq may remain in abeyance for some time, however. The key player in the region, the Saudi Basic Industries Corporation, is also seeking to diversify production centred on the base petrochemicals ethylene and methanol when its naphtha cracker comes on stream at Al Jubail in 1993. Downstream units are also planned, including polypropylene units.

(b) East and South-East Asia and Indian Subcontinent

The petrochemical industry of the ASEAN region is underdeveloped. Despite holding 8 per cent of the population of the world, the region consumes only 2 per cent of its chemical output [52]. Production is even lower and there are large products shortages. During the 1990s consumption is expected to grow three to four times as fast as the world average. Many projects are planned, and if all proceed well, shortages will disappear by the year 2000. Many of the projects might run into serious problems, however, particularly in obtaining finance, as they are all competing for scarce resources.

As yet there is neither an ASEAN strategy for promoting the chemical industry nor any joint projects. Major financing problems arise concerning chemical projects in the ASEAN region because banks require limited debt financing. Sometimes even equity financing is difficult, since many local companies seeking involvement in projects are financially weak and have limited experience in the sector. Local banks are sometimes barred from lending to the projects on the grounds that transnational corporations are involved, or that the financial markets are just too small.

The availability and cost of feedstocks is also a problem. With the exception of Singapore, refining capacity supplies insufficient naphtha feedstock for ethylene plants. Ethane gas is only available so far in Thailand, where an ethylene unit is being built; and in Malaysia, a plant is proposed jointly by the State company Petronas and BP Chemicals of the United Kingdom. Much of the liquefied petroleum gas produced in the region is committed under long-term contracts to Japan.

Indonesia. This is a gas-rich country and many projects have been put forward and approved, but construction is uncertain. Plans include an aromatic complex, four naphtha-based olefin complexes (Chandra Asri, Shell, Pertamina/Mitsui and Salim) and at least five plants to produce pure terephthalic acid, a raw material for synthetic fibres. Licences are readily granted by the Indonesian Government, but majority ownership of projects by local companies is required. Tariff concessions are generous.

Malaysia. Other ASEAN countries generally do not have a coordinated petrochemicals plan, although Malaysia did make efforts in the early 1980s, and Petronas is investing in several projects. There are two polypropylene projects in Malaysia, and plans for ethylene plants based on gas and liquid feedstock. Methanol and ammonia will also be produced in the gas-rich states.

Singapore. This country is the hub of chemical activity in the ASEAN region, with planned spending on products currently close to $5 billion. The value of production is already $3 billion (see table V.100). A number of companies are investing in Singapore on the existing island petrochemicals site at Pulau Ayer Merbau. Shell Eastern Chemicals annually produces 320,000 tonnes of styrene, 140,000 tonnes of propylene oxide and polyether polyols; Petrochemical Corporation of Singapore is to double its existing ethylene cracker to 800,000 tonnes per year; Phillips Petroleum is to double its high-density polyethylene capacity of 340,000 tonnes per year; the Polyolefin Co. is to increase low-density polyethylene and polypropylene capacity and many other products are planned for the island. Du Pont is planning a major investment in nylon materials; GE Plastics is to invest in an engineering resins unit and Glaxo in a drug manufacturing plant; and oil companies such as Mobil, Exxon and Amoco are investing in petrochemicals intermediates.

Thailand. One petrochemical complex is being built in Thailand, based on 315,000-tonnes-per-year ethane cracker of the National Petrochemical Corporation, and another is planned on the basis of a 350,000-tonnes-per-year naphtha cracker. Polypropylene and polyvinyl chloride plants are already under construction in connection with the new unit and an aromatic complex is planned. The world's first propane dehydrogenation unit to provide propylene raw material has been built in Thailand. It is, however, experiencing operational difficulties.

Regarding supply and demand for specific petrochemicals, ASEAN polyethylene demand is projected

Table V.100. Olefins projects in ASEAN countries and in China

Country	Project	Location	Licenser	Start-up
Malaysia	Petronas/BP/ Idemitsu	Kerteh	..	1995
	CGPC/Titan	Pasir Gudang	Stone & Webster	1993
Indonesia	Shell/C Itoh/ Mitsubishi	Cilacap	Kellog	..
	Chandra Asri	Serang	Lummus	1993
Thailand	Thai olefins	Mab Ta Put	..	1993
Singapore	PCS/Shell	Pulau Ayer	..	..
Philippines	Luzon	Bataan	Lummus	..
China	Fushun	Fushun	Lummus	1992
	Henan	Puyang	Lummus	..
	Doshanji	Xinjiang	..	..
	Eastern Chemicals	Beijing	..	..
	Guangzhou	Guangzhou	..	..
	Tianjing	Tianjing	..	..

Source: Chemical Week (London, March 1991).

to grow from 754,000 tonnes per year in 1990 to 1.6 million tonnes per year in 2000. But total capacity could be 2 million tonnes per year by 2000, against 605,000 tonnes per year today. Only projects by BP Chemicals in Indonesia and Malaysia are considered firm. Polypropylene demand should grow by 7 per cent per year from 517,000 tonnes per year in 1990 to 1.03 million tonnes per year by 2000. But supply could reach 1.2 million tonnes per year from 415,000 tonnes per year currently. Only two plants in Malaysia and one in Indonesia are considered firm, however.

China. Developments in China will be crucial for supply and demand balances in Asia. The country has a well-developed chemical industry in terms of quantity, with over 6,000 chemical plants and nearly 4 million employees. Chemical output in 1989 was valued at 114.6 billion yuan renminbi, or approximately $22 billion, an increase of 6 per cent over the previous year [53]. After a slump in late 1989 and early 1990, the value of chemicals output jumped by 13.8 per cent to $4.17 billion in the first two months of 1991, according to government statistics. But it was also noted that demand for fertilizers and pesticides, one of the largest sectors, has fallen, and increasing stockpiles are hampering further production. The ministry responsible for the chemical industry said plants throughout the country had stockpiled roughly 6.27 million tonnes of agrochemicals since the beginning of 1991, a 70 per cent increase over the same period in 1990. Many plants were forced to cut production, and increasing numbers were halting output altogether. Quality of production is often unsatisfactory, and generally the chemical industry is inadequate to meet the needs of the population of the country, especially in agricultural chemicals and synthetic materials. The value of imports has risen from $2.5 billion in 1980 to $6 billion in 1989. Approximately 36 per cent of total foreign exchange used for chemicals was spent on fertilizer imports in 1989.

The problems of the chemical industry included scattered production and small factories that do not benefit from economies of scale. The country's 12 ethylene plants together produce 2.2 million tonnes per year, but each produces only 200,000 tonnes per year or less, which is far below optimal levels in developed market economies. Poor transport facilities encourage local, decentralized production.

The Government is now giving priority to the chemical industry. Chemicals and petroleum are the country's second largest foreign exchange earner, valued at $3.8 billion in 1989. There are ambitious government proposals to build or expand 14 major complexes under the current five-year plan; one such project would double current ethylene capacity to 4 million tonnes per year by 1995. The country is seeking foreign investment, and the United States and Japan have already shown interest. The Government has amended legislation to make joint-venture participation by overseas companies both simpler and more attractive, including majority ownership by the foreign partner for example.

Republic of Korea. This country plans to triple ethylene capacity to around 3 million tonnes by 1995. If all six planned projects go ahead there will be a major surplus arising in the country, and this will also affect export markets. But there are considerable uncertainties about naphtha feedstock supply to the proposed plants, as the Republic of Korea has no oil resources.

Taiwan Province. There are several ambitious chemical expansion plans by local companies, but investments by foreign firms have been discouraged by violent protests over growing environmental problems in the area.

India. Major shortages in important industries such as fertilizers, fibres and plastics have appeared. One of the main problems is the shortage of basic raw material supplies, with producers relying on imports and irregular domestic supplies. In addition, plants suffer from the interruption of energy supplies. New projects can take a long time to be cleared because of red-tape, and the country suffers from a lack of foreign exchange for imports.

Government statistics compiled in 1990 point to a fertilizer shortfall in India reaching 3 million tonnes in 1991, and possibly tripling by the turn of the century. In 1990, nearly 25 per cent of demand was met by imports at a cost of $987 million, a figure expected to reach $1.2 billion for the 1990/91 fertilizer year.

Domestic output in 1990 is put at 8.5 million tonnes, while consumption of both nitrogenous and phosphorous fertilizers was in the region of 11.6 million tonnes. Production of nitrogenous fertilizers in India is predicted to reach 7.1 million tonnes and phosphorous fertilizers 2.2 million tonnes by 1992.

Consumption of polyolefins is 7 million tonnes per year with 50 per cent imported, requiring a foreign exchange outlay of $430 million. Efforts were under way in early 1991 to bring the largest gas cracker in Asia, Maharashtra Gas Cracker Complex, back on stream after a fire forced its closure. With a slated output of 2.75 million tonnes per year of polyolefins, the complex could meet all domestic demand for polypropylene, linear low-density polyethylene and low-density polyethylene. In the case of high-density polyethylene, imports could be greatly reduced. Overall, the complex could save about $300 million per year in foreign exchange.

(c) Eastern Europe and USSR

It could be years before the potential of the region is realized both in demand and production terms. The chemical manufacturing capacity of the two biggest producers, the former German Democratic Republic and the USSR, is being steadily eroded.

The chemical industry is under pressure on several fronts throughout the region, forcing minimum operating rates and in many cases permanent closure of plants. Reasons for closure are primarily related to environmental pressures, particularly in the former German Democratic Republic, where strict environmental standards are being applied. But in the longer term, there appears to be a growing commitment to develop major petrochemical complexes such as at Buna and Leuna, rather than to opt for complete closure, as had been feared. Recent developments include 500 million deutsche mark in government aid for the two complexes mentioned, and Deutsche Shell is leading a consortium of companies building a 450-kilometres ethylene pipeline from western to eastern Germany for completion by 1995.

In the USSR, despite huge hydrocarbon resources, most proposed chemical projects have been halted because of difficulties in financing. One major venture, Asetco, involving John Brown of the United Kingdom, is going ahead in Siberia. The infrastructure of the country seems to be decaying. Oil output in 1990, at 570 million tonnes, was the lowest for over a decade. Further declines were seen in the first quarter of 1991, according to government statistics. Environmental pressure has also forced many chemical plant closures and a huge proportion of plant and equipment is outdated. Hopes that there would be a decentralization of control of chemical factories and enterprises were dashed recently when a new minister for chemicals was appointed in Moscow. Local managers wanted the ministry abolished.

Hungary, Poland and Czechoslovakia are experiencing a more stable economic environment, but are also suffering from environmental pressures and feedstock shortages, especially since the USSR started demanding dollars and world prices for its oil at the beginning of 1991. Outside the former German Democratic Republic, privatization programmes have been slow to attract substantial involvement by companies from developed market economies. But a notable deal in Hungary, which has a well-developed pharmaceuticals sector, was the purchase of Chinoin drugs company by Sanofi of France.

(d) Latin America

Project financing is a major problem for Latin America, which has been investing heavily in its petrochemicals industry for the past five years. In Brazil the chemical industry is still labouring under severe pressure because of the restrictions forced on it by stringent government economic plans. Many foreign chemical companies with investments there, such as Rhône-Poulenc, Solvay, Akzo and BASF, have cut back their workforce and stalled or abandoned earlier plans for expansion or for new plants. And the outlook for 1991 is not good, since petrochemical prices were frozen indefinitely at the end of January 1991. More generally, Brazil also suffers from an inability to develop technologically because of government policies.

Venezuela. This country has ambitious expansion plans for its chemical industry on the basis of local oil and gas, and is less hindered than its neighbours by political and economic constraints. Petroleos de Venezuela, the State oil and chemicals company, represents 24 per cent of the country's GDP and over 70 per cent of foreign-sourced income. The company is pursuing petrochemical projects that will expand capacity from 3.6 million tonnes per year to 12 million tonnes per year in 1996.

3. Capacity utilization and expansion plans

Capacity utilization has increased in recent years but is forecast to tail off in 1991-1992 under reduced demand. A Japan Development Bank forecast issued in March 1991 notes that world ethylene capacity will rise from around 61 million tonnes per year at the end of 1989 to approximately 79 million tonnes per year by 1995, on the basis of planned expansions worldwide. With demand expected to grow by between 2.8 per cent and 4.1 per cent, the Bank says that capacity utilization would range between 88 per cent at the top end and 85 per cent at the lower end, even if capital investment plans continue to be cut back.

An increasing trend is for international chemical companies to direct investment at rapidly growing markets, notably in Asia, or countries with low feedstock costs, as in Western Asia (see above). For example, Shell and BP Chemicals of London are making huge investments in the markets of East and South-East Asia. Trichem consultants estimates that the petrochemical industry as a whole requires an investment of $10 billion to $14 billion per year over the period 1989-2010 (on the basis of 1989 values).

Developed countries are now cautious about further domestic expansion, although spending has not stopped and companies are replacing old plants. But cancellation and delays are in evidence in Western Europe and in the United States as overcapacity threatens. Expansion has also slowed in Japan because local export markets are under threat from new domestic capacity.

Nevertheless, Japan still has five new ethylene complexes planned, with the first set for completion in mid-1992. Government-imposed restrictions, however, may slow down Japanese expansion plans.

At the Chemical Industries Association Investment Intentions conference held in London in April 1991, BP Chemicals said it believes 50 per cent of new ethylene projects announced in Europe over the period 1987 to mid-1988 have been cancelled, with 10 per cent delayed and the rest going ahead as scheduled. An optimistic growth scenario for European chemicals of around 3 per cent per year, set against the scheduled expansion programme, would cause plant utilization rates to fall to roughly 90 per cent from over 100 per cent recently. A "no-growth" scenario would force operating rates down to the levels of the mid-1970s. BP also notes that this forecast does not take into account the possible increase in imports and decrease in exports resulting from the 7.5 million tonnes of new ethylene capacity due on stream in Western, East and South-East Asia between 1991 and 1995.

4. *Restructuring and deployment*

Restructuring is very evident in the large European and United States companies, where job cuts, investment trimming and plant closures have been particularly noticeable. In the fibres sector, for example, where competition from East Asian markets is strong, Du Pont has pulled out of acrylics, and Courtaulds made big cut-backs in capacity during 1990.

The fertilizer industry is still undergoing rationalization because of poor market conditions, despite a boost to prices stemming from the Gulf war. A classic example is ICI, which plans to close production in the United Kingdom if it cannot divest its facilities. Efforts to sell to Kemira of Finland were blocked by the Government of the United Kingdom. In southern Europe, talks are in progress between State-owned fertilizer companies in Italy, Spain and possibly France and Portugal. As mentioned above, huge privatization programmes are under way in Eastern Europe and the USSR, as well as in Portugal and Turkey, which will contribute to restructuring. It is anticipated that a couple of difficult years, after the large profits earned in the late 1980s, will encourage more business swaps and portfolio rationalization schemes among chemical companies. In Europe, however, negotiations are sometimes hampered because of disapproval by the EEC.

5. *Environmental considerations*

The environment is becoming one of the most important issues facing the chemical industry in the 1990s. Legislation concerning emissions from chemical plants is most stringent in the United States, and public reporting of emission levels is being called for in Europe, where the industry faces varying degrees of control, the strictest being in Germany and the Netherlands. With the arrival of the single European market in January of 1993, all EEC members are supposed to comply with minimum standards.

In fast-growing chemical markets such as the Republic of Korea, Taiwan Province and Thailand, there has been a backlash against the pace of chemical plant construction because of growing environmental problems. As well as reductions to chemical leakage into air, water and land, efforts are being made to restrict the use of chemicals because of disposal problems. Polyvinyl chloride is gradually being forced out as a plastic used in food packaging because of worries over the migration of carcinogenic substances into food. In 1990, McDonald's food chain stopped using polystyrene as a packaging material because of concerns over waste disposal. There is still worry over landfill of plastics and chemical waste, and incineration is still not a palatable option, although technology is improving constantly and scientists claim that incineration is a safe disposal method. Interest in plastics recycling is growing, and the chemical industry is convinced that this is an area in which it can become usefully involved in order to preserve plastics as environmentally acceptable commodities. On the whole, transnational corporations are making efforts to achieve world-wide standards for the environment, health and safety.

6. *Technological trends*

Novel technological developments are occurring mainly in high-technology industries such as biotechnology and pharmaceuticals. Advances are being made in materials technology, for example in the field of ceramics, but no new family of polymers is expected to be discovered in this century. Developments in basic and engineering polymers will focus on new blends and growing applications in areas such as automotive and consumer durables, more sophisticated synthetic fibres and other such goods. Much research spending is going into environmental improvement, that is, chemical processes with lower emissions and energy loss, incinerators with higher burning temperatures or destructive capability etc. There is also product research inspired by environmental considerations, focusing on such products as water-based or powder paints that avoid use of solvents, or new types of agricultural products or biodegradable polymers. Du Pont, ICI and others are spending heavily on developing alternatives to chlorofluorocarbons, with some success. Large companies are still spending heavily on research in the applications of chemical derivatives, Bayer being the biggest spender at $1.6 billion in 1989.

7. *Short- and medium-term outlook*

For developed countries, the short-term outlook for petrochemical and bulk chemical producers is relatively bleak compared with recent years. Profit margins are under pressure, domestic demand growth has slowed considerably, and export markets are under threat as developing countries build up their own production base. But the downturn is not expected to last beyond mid-1992, with more optimistic reports predicting an upturn in the second half of 1991. In the slightly longer term, the balance of production and demand will continue to shift with Western Europe and the United States seeing increasing inroads by Western and East Asian manufacturers into their market dominance of the industry.

Petrochemicals demand is closely linked to economic activity. Prior to the invasion of Kuwait in August 1990, the outlook for OECD countries was still 2.5 per cent GDP growth per annum. More recently, the German economy is showing the pressures of unification while the French and Italian economies showed declines of around 2 per cent in 1991. Overall growth in Western Europe could be as low as 1 per cent.

The Japanese economy is forecast to grow at 3.5 per cent in 1991, and that of the Republic of Korea by 8.0 per cent. Historically, the effects of economic activity on chemical production have lagged by up to 12 months. The United Kingdom now predicts a 3 per cent fall in output during 1991.

M. Advanced materials (parts of ISIC 3513, 3610, 3620, 3710 and 3720)*

1. Recent trends and current situation

A fundamental reversal in the relationship between materials and the economy is currently taking place, and the consequences are likely to be wide-ranging. Developed countries are experiencing a period of rapid change, both technologically and competitively. The emergence of advanced materials and associated modern technologies offer new opportunities for those countries possessing a potential for investment ([54], pp. 10-14; [55], pp. 7-18).

(a) Definition of advanced materials

Advanced materials are defined as new materials with advanced functions, or conventional materials with significantly improved properties. Scientists can now adjust the atomic and molecular structure in matter, and manipulate and control its form and uses for specific applications. These changes have had an impact on all major technologies and biotechnologies. The materials industry is now a science-intensive, high-technology industry of primary importance to innovation, competitiveness and growth of national economies. Materials engineering and production has thus become an integral part of product design throughout the manufacturing industry, employing advanced, computer-based, integrated design and manufacture, and moving towards world-class manufacturing.

Current and potential markets for advanced materials, the factors affecting them and the implications of the use of new materials in the engineering industries will be examined in the present survey. This not only includes developments in plastics and ceramics and the new generation of composite materials such as fibre-reinforced plastics, metal matrix composites and cermets (substances that combine ceramics and metals), but also innovations and improvements in metals and alloys. The quest for new materials is motivated by the need for improved performance and reduced production costs. It also affects suppliers of materials, manufacturers, assemblers, component makers and subcontractors.

Developments also affect suppliers of plant and equipment and personnel who work with the materials in the sense that they may need to learn new skills. The choice of materials is a multisectoral and cross-sectoral issue. It involves collaboration, cooperation and changing relationships up and down the production and supply chains. There is little doubt that new materials pose a threat and challenge as well as an opportunity to traditional, metals-based industries within both developed and developing countries [56]. Many industrial regions that have been heavily dependent on metal-based manufacturing face the inevitable decline of their traditional metal-based industries.

A common assumption is that non-metals are replacing conventional metals in a wide range of established engineering applications. A more current view is that the new materials are capturing the new engineering product markets. Many leading international companies are involved in developing and using both conventional and new materials, both metal and non-metal [57]. The dynamics governing the development and usage of new materials are complex. In attempting to understand the issues involved, the following key questions must be addressed for both developed and developing countries:

(a) What criteria are used in selecting materials and what factors encourage or impede the use of new material developments?

(b) Will metals and alloys continue to be the main materials used while newer materials find applications in higher value-added markets?

(c) Is the impetus for new materials development coming from suppliers or customers? If the latter, what role does materials selection play in competition?

(d) What are the implications for the organization and methods of production, for skills and employment?

(e) Will the development and application of new materials lead to an inevitable decline in traditional metal-forming and fabrication industries or to a revitalization of industrialization?

(b) The range of materials

New engineering materials comprise four distinct categories: metals and alloys; plastics; advanced ceramics; and composites. They are competing for engineering applications on the basis of the particular properties that they offer. These properties can be described as inherent, for example, strength, conductivity and corrosion resistance, and as attributive, for example, cost, availability and processability. All materials offer a discrete set of properties, and it is their particular strengths and weaknesses that determine their usefulness to different industries. Their choice requires that they offer tangible, additional benefits in terms of lower cost, enhanced product performance or the creation of entirely new products. For this reason, the metals, especially steels, that

*UNIDO acknowledges the contribution of K. Stanford, editor, *Metallurgia*.

Table V.101. World advanced materials markets, 1988

Country or area	1988 (billion dollars)	Annual growth rate in real terms 1988-1995
United States	62.3	6.5
Japan	38.6	8.0
Western Europe	44.2	5.8
Germany, Federal Republic of	14.0	6.0
United Kingdom	6.5	5.9
Italy	7.4	5.0
France	8.0	5.8
Other	23.3	..
TOTAL	168.4	6.5

Source: Bureau interprofessionnel de prévisions économiques, *Observatoire des matériaux* (Paris, 1988).

Table V.102. European advanced materials markets, 1988

Market or industry	Percentage share 1988
Automobile	24
Electricity/electronics	18
Mechanical engineering	18
Construction	16
Packaging	8
Sport	3
Aeronautics	2
Miscellaneous	11
TOTAL	100

Source: Bureau Interprofessionnel de prévisions économiques, *Observatoire des matériaux* (Paris, 1988).

dominate the materials market will continue to do so for the foreseeable future. Some evidence can be seen in tables V.101, V.102 and V.103. Cost-effectiveness and all-round performance, for example, will help them sustain their pre-eminence in the important vehicle market.

New metals will, however, only show a growth in market value of around 2 to 4 per cent per annum. Plastics, starting from a lower base, will exhibit an estimated 8.7 per cent annual market growth rate, mainly owing to their light weight, corrosion resistance and malleability, and will make increasing inroads into vehicles markets. Ceramics will grow at an estimated 12 per cent annually up to 1991, tailing off to around 10 per cent thereafter, on the basis of their high temperature and, corrosion-, wear- and abrasion-resistance. Applications such as in engine components, cladding, cutting tools and electronic components represent the main opportunities. Composites are highly diverse. They have been forecast in aggregate to grow by 8.7 per cent per annum. Polymer and metal matrix composites in particular are finding applications in the structural parts of aircraft and motor vehicles.

The success with which these market forecasts will be realized depends very much on the research and development activities of companies within the materials industry. This industry not only incorporates traditional materials suppliers (for example, in the United Kingdom, BSC and Alcan) petrochemicals suppliers, (for example, ICI, Shell and BP), and traditional ceramic suppliers diversified into advanced products, but also large engineering conglomerates that are seeking to broaden and protect their materials base (for example, GKN, GEC., T & N and Cookson). The end-user firms (for example, Rolls Royce, British Aerospace and Ford) have a particular role in that not only do they engage in materials research and development themselves, but they also determine the future shape of the materials industry by their decisions on materials usage and their collaborative activities with different material suppliers.

Further constraints on materials use are presented by the production infrastructure, the network of materials processors, equipment suppliers and training providers. While well-established technologies and skills exist to process metals, the techniques and capacity to process plastics and especially ceramics and composites are much less developed. These non-metals behave differently from metals and hence require a completely different approach to their processing and the design of applications. A lack of awareness of the performance, behaviour and proper-

Table V.103. World market for advanced materials, 1988 and forecasts for 1995

Material	1988 (billion dollars)	Average annual growth rate in real terms 1988-1995
New steel products	61.3	2.8
Engineering thermoplastics	15.1	8.7
Engineering thermosets	20.7	4.9
Non-ferrous metals	18.0	2.8
Composites	16.6	8.7
Structural ceramics	10.0	11.9
New glass-based products	6.5	9.6
Functional materials for electronics	20.0	12.0
TOTAL	168.2	6.5

Source: Bureau interprofessionnel de prévisions économiques, *Observatoire des matériaux* (Paris, 1988).

ties of these materials limits the speed and extent of their incorporation, factors which are accompanied by a tendency towards caution among their users.

In conclusion, new materials will become increasingly important, both within new applications and as substitutes for traditional substances. However, this will be an evolutionary, incremental (rather than rapid and radical) process. In terms of the future of developing countries, metals will continue to be dominant for many years to come, owing to their integral and extensive role in engineering at present. Non-metals however, will assume increasing importance once process and information deficiencies have been overcome. The slow progress made in new materials technology within various NICs, as a result of under-investment in research and development and skill development, is also an important factor.

(c) Major categories

The selection of engineering materials is an essential step in component and structural design in industry. Various properties and characteristics affect the choice of particular materials for particular applications. Materials have both inherent properties (such as strength, conductivity and corrosion resistance) and attributive properties (such as cost and availability). Other properties, notably processability, are also taken into account in the selection of a material for a particular application. Various factors used in the selection process inhibit the introduction of new engineering materials. Engineering materials are normally grouped into four main "families" based on common chemical elements, which in turn affect the properties of different types of materials, as summarized in table V.104. Composites differ from the other three categories in that they consist of a combination of two of the other three types of material, and are specifically designed to offer a superior combination of properties for particular applications.

Metals and alloys. These metals, particularly the ferrous metals and alloys, are the best-known and longest-established engineering materials. Different ways of processing iron and steel have made it adaptable to a variety of end-uses. Steel may, for example, be case-hardened, forged or pressed, depending on the shape and strength required in the finished product or component. Its adaptability has been further increased by alloying steel with other metals such as nickel or titanium. Several non-ferrous metals are used in the pure form. The lightness and thermal conductivity of aluminium, for example, makes it suitable for situations where weight and heat conduction are critical factors. Copper, on the other hand, is used where electrical conductivity is important.

The possibility that metals and alloys will eventually be superseded by what are perceived to be the newer families of materials is unlikely to occur within the foreseeable future, for four reasons. First, some of the newer materials coming into use are in fact metals. Examples include coated and high-strength, low-allow steels, and steels with enhanced machinability. Secondly, metals play an important role in composite materials. Thirdly, certain "rarer" metals have only been available in voluminous quantities since 1945, and hence the commercial demand for them has only recently been developed. This includes zirconium (used in atomic reactor components) and titanium (supersonic aircraft and rockets). The fourth reason why metals and alloys will continue to be the dominant engineering material is the enormous investment in research and development work on metalworking and forming processes that affect the molecular structure of metals and improve their inherent properties.

Polymers. These materials, better known as plastics, are synthetic organic materials which are in general tough, light and strong, with good electrical insulation properties. Some examples are as follows: phenolic, for example "bakelite", which is hard, rigid and has a good electrical resistance; fluorocarbons, which are able to withstand higher temperatures and have low friction coefficients; easily moulded polyurethanes and polyamide, and epoxy resins, which have good bonding properties; and acetal resins, which offer mechanical properties similar to those of metals.

Ceramics. These include a wide range of materials which are predominantly used outside the engineering industry. Glass, bricks, tiles, porcelain and cement among others are classified as ceramics. Technical or advanced ceramics are those inorganic non-metallic solids (for example, silicon carbide, alumina and silicon nitride) whose attributes are derived from their enhanced structural properties over traditional ceramics. The main advantages are heat-, corrosion- and abrasion-resistance, hardness and both good electrical insulation and conductivity. The major drawback with ceramics is their brittleness, owing to a susceptibility to micro-imperfections. Consequently, the major research effort is focused on improving processing techniques to reduce the likelihood of defects in the material's basic structure.

Composites. Any substance comprised of two or more materials falls into this category. Metal alloys, polymer laminates and combinations of ceramic materials, for example sialons, are usually excluded from the definition and included within the single material families described above. The two main methods of combining materials involve, first, laminates (or layers

Table V.104. Major properties of non-composite materials

Metals	Polymers	Ceramics
Strong	Weak	Strong
Stiff	Compliant	Brittle
Tough	Durable	Durable
High thermal conductivity	Temperature sensitive	Refractory/low thermal conductivity
Electrical conductivity	Electrically insulating	Electrically insulating

Sources: *Metallurgia* and *Metals Industry News* databases, Redhill, Surrey, United Kingdom.

of different materials), and secondly, matrix composites, where the molecular structure of one material is reinforced by the fibres of another material. The metal or polymer of ceramic may be used to form either the matrix or the reinforcement. By far the most commonly used composites are polymer matrix composites (PMCs), also called fibre-reinforced plastics (FRPs).

Although PMCs or FRPs are the most common composite materials offering improved strength-to-weight ratios and fatigue- and temperature-resistance, considerable potential exists for the use of the three other main types of composites: MMCs, fibre reinforced ceramics and cermets (combinations of ceramics and metals). Each of these seeks to provide a combination of properties which surpasses those of non-composite materials.

(d) Selection properties

It is estimated that there are over 50,000 varieties of engineering materials, each of which has a particular combination of properties. New materials are constantly being developed, and it is therefore impossible to maintain an up-to-date taxonomy of all materials, their properties and potential uses. It is, however, possible to delineate the range of factors that underpin the complex and imperfect but rational selection process. These factors fall roughly into three types of properties, inherent, attributive, and those which combine both inherent and attributive characteristics.

Inherent properties are mechanical (strength and elasticity), physical (thermal and electrical conductivity) and chemical (resistance to corrosion and abrasion). These properties determine the suitability of a material for manufacture and subsequent use.

The main attributive properties are cost and availability. Cost is a proxy for a variety of costs including the extraction, refinement and transport of the new material plus the complexity and value added at every stage of processing. The relative costs of different materials are affected by fluctuations in commodity markets and energy costs as well as more general economic considerations such as exchange rates. Availability depends on the size of the resource base of the original raw material. This clearly influences cost, but availability sometimes depends on geographical, ownership and political factors.

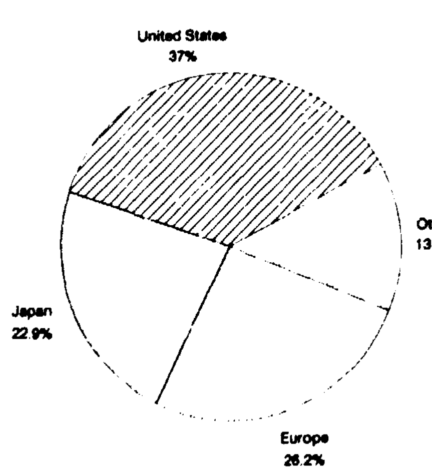
Several of the most valuable mineral reserves are, for example, controlled by cartels or Governments that have restrictive trading arrangements with the rest of the world. Cost and availability exert considerable restrictions on which materials are used in which application, but they do not necessarily operate in the same direction. Plastics and ceramics, for example, tend to be more plentiful than metals in terms of natural resources, but ceramics tend to be more expensive when used as engineering materials. The question of the divergence between cost and availability is largely explained by the processability and to a lesser extent the aesthetics and disposability of different engineering materials. The existence of an established process infrastructure is the main cause of inertia impeding the introduction of new engineering materials in both developed and developing countries. In the end, new materials must exhibit real tangible benefits such as improved quality, enhanced performance or reduced cost either in respect of the material itself or in respect of the manufacturing process. Their adoption is, therefore, in general incremental and evolutionary, but is nevertheless of immense importance to the future development of the engineering industry worldwide.

2. *Market trends*

The selection of materials has been shown to depend on their inherent and attributive properties, but the final choice often stems from the ability of suppliers of new materials to prove their superiority over established substances in existing applications. In the case where a substance is being used for a new product or new application, the competition between new and established materials is more flexible. In practice, the distinction between new and established products and materials is far from clear, and this makes estimates of sales and usage of new materials problematic. Nevertheless, tables V.102 and V.103 provide a breakdown of world sales of new materials in 1988 and a breakdown of European sales by industrial market segment. The few data available demonstrate the strength of the market for advanced materials. While improved materials predictably generated the greatest volume of sales, future growth in the market will probably remain modest. The opposite is true for high-technology materials, where the markets are smaller but the growth potential is higher.

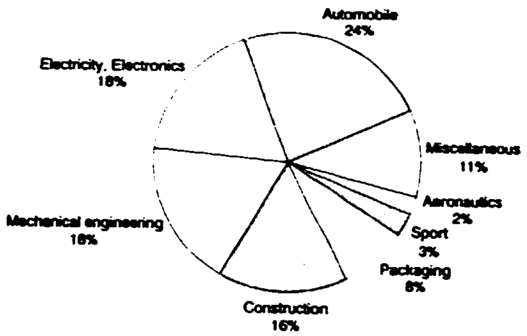
The breakdown of the combined production of the United States, Japan and the EEC given in table V.101 and illustrated in figure V.22 suggests that the United States accounted for 42.5 per cent of the aggregate materials total, the EEC 30 per cent and Japan 27.5 per cent. This ranking is more or less respected for composites, speciality alloys and superalloys, areas in which the United States possesses a lead. On the other hand, Japan has established a dominant position with regard to ceramics, carbon fibres and materials for electronics and optoelectronics, such as liquid crystals. In Europe, greater attention has been focused on conventional materials, and consistent technological breakthroughs have not occurred

Figure V.22. World advanced materials markets, 1988



Source: Bureau interprofessionnel de prévisions économiques *Observatoire des matériaux* (Paris, 1988).

Figure V.23. European advanced materials markets, 1988



Source: Bureau interprofessionnel de prévisions économiques, *Observatoire des matériaux* (Paris, 1988).

except in the fields of engineering polymers, new glasses and metals. Figure V.23 provides an indication of the sectors where materials utilization is the greatest.

It is not surprising to find that the largest market shares are held by those new substances which have evolved out of well-established families of materials with proven capabilities. Plastics (thermoplastics and thermosets), for example, have a sizeable and growing process industry established primarily to serve consumer product markets. It therefore ranks second behind new steels in new material markets. The leading position occupied by steels is partly explained by table V.102, which shows the significance of the automotive market followed by mechanical and electrical engineering. Aerospace would appear to be of considerably less significance, but this requires qualification for two reasons: first, the total aerospace market is small in relative terms; and secondly, the aerospace market is notable in that it exerts particular demands for materials at the leading edge of technology. The major market trends for each of the categories used in these industries are decribed below.

(a) Metals materials

Within metals markets, steel continues to be the dominant material and is continually being further refined and developed. Current uses in the United Kingdom by industrial branch are shown in table V.105. Development is currently focused on lighter-weight, high-strength, low-alloy steel, on micro-alloyed steels, on coated steels with enhanced durability and corrosion resistance, and on machinability and formability. This pattern of development means that while world sales of all steels are forecast to grow by only 0.4 per cent per annum up to 1995, sales of newer alloys are forecast to grow by 2.8 per cent in value terms as shown in table V.103. Given that sales of ordinary steels are growing faster in NICs, overall sales by weight in developed countries are expected to decline by 0.5 per cent per annum.

New non-ferrous products were valued at $18 billion in 1988, with an anticipated annual average

Table V.105. Steel usage by industrial branch

Industrial branch	Percentage share
Metal goods	18.8
Mechanical engineering	21.2
Electrical engineering	5.0
Cars	10.0
Commercial vehicles	7.2
Other manufacturing	20.9
Construction	16.9
TOTAL	100.0

Source: British Steel Corporation.

growth rate of 2.8 per cent as shown in table V.103. Of this extremely wide-ranging family of materials, most interest has been focused on aluminium, which is produced in greater quantities than any other non-ferrous metals (total world production is around 16.5 million tonnes), and has applications in such diverse industries as aerospace, construction, motor vehicles, computing and electrical engineering. Predictions of aluminium consumption growth rates vary between 4 per cent and 8 per cent per annum. Within aerospace, for example, a market for aluminium alloys worth 400 million pounds sterling is predicted to grow by 5 to 8 per cent, according to British Alcan. Part of the explanation for this growth is the development of new aluminium-lithium alloys, which compete with composites, and are expected by British Alcan to provide a market of at least 250 million pounds sterling by the late 1990s.

(b) Polymer and plastic materials

Engineering components account for 20 per cent of the market for plastic products. The components subsector is expected to grow at 5 per cent per annum compared with a figure of 3 per cent for the market for plastic products as a whole. While consumer electronics provides the major market for plastic components, the engineering industries, including the automotive industry, are increasing their use of technical and reinforced plastics and composites. The world market in these newer plastic materials is forecast to grow at between 5 and 9 per cent per annum.

(c) Ceramics materials

The world ceramics market was estimated to be worth $10 billion in 1988 and to be increasing at around 12 per cent per annum. By 1991 the market is forecast to reach $12 billion, and thereafter the rate of growth is expected to slow to 10 per cent as some applications approach maturity. Even so, the world market is expected to reach $17 billion by 1995. The main customer for ceramic products will continue to be the electrical and electronic engineering industries (see tables V.106 and V.107). However, a wide range of industries are showing increased interest in the heat- and corrosion-resistance properties of some ceramic materials. Introduction of ceramics within the automotive and mechanical engineering industries will continue to be slow, since reliability over time is a

Table V.106. World consumption of advanced ceramics, 1987

Country or region	Consumption 1987 (billion dollars)	Percentage share
United States	4.2	43.3
Japan	3.0	30.9
Europe	2.1	21.6
Rest of world	0.4	4.1
TOTAL	9.7	100.0

Source: B & MR Reports Ltd., *The World Market for Advanced Ceramics* (Stockport, United Kingdom, 1987).

Table V.107. World market size of advanced ceramics, 1987

Application	Market size 1987 (million dollars)	Percentage share
Low-voltage electrical	2 522	26.0
Capacitors and packages	2 134	22.0
Engineering ceramics	1 552	16.0
Other electrical/electronics	1 164	12.0
Ferrites	970	10.0
Optical fibres	873	9.0
High-voltage electrical porcelain	485	5.0
TOTAL	9 700	100.0

Source: B & MR Reports Ltd., *The World Market for Advanced Ceramics* (Stockport, United Kingdom, 1987).

prime requisite, and this almost by definition requires lengthy testing and proving periods.

(d) *Composite materials*

The world market for composites is growing at an average rate of 8.7 per cent per annum. Composites include a wide range of materials used in a large number of industries. An outline of the United States and European markets is given in table V.108 and a breakdown of major customer sectors is given in table V.109. The reliability of the estimates varies with the maturity of the market, and it is extremely difficult to obtain estimates, but the world market for composites was estimated at $16.6 billion in 1988 and to be growing at 8.7 per cent up to 1995.

There are, however, considerable differences in growth rates for different types of composites. Fibre-reinforced thermoplastics, for example, are growing at 11 per cent per annum, whereas more expensive and brittle and less easily recycled thermoset is only expanding at 3.5 per cent per annum. Advanced composites based on ceramics matrices are still in the early stages of development but offer the potential for perhaps the fastest sales growth. Rolls Royce, for example, forecast a market of £300 million in the year 2000, rising to £2 billion by 2010 as aerospace applications become more widely diffused in engineering industries.

The motivation for the development of these materials has often in the past been the requirements of the aerospace and defence industries. Very large sums

Table V.108. Present and anticipated markets for ceramic matrix, metal matrix, and carbon-carbon composites in the United States and Western Europe, 1989 and forecasts for 1995 and 2000
(Million dollars)

Item	1989		1995		2000		Average annual growth rate 1989-2000	
	United States	Western Europe	United States	Western Europe	United States	Western Europe	United States	Western Europe
Carbon-carbon								
Aircraft brakes	85	30	170	150	190	190	8.0	18.0
Other uses	102	32	121	50	140	75	3.0	8.0
Total	187	62	291	200	330	265	5.0	14.0
Metal-matrix								
Aluminium	16	5	45	40	65	75	14.0	28.0
Other metal matrix composites	5	0	17	3.5	40	10.5	21.0	23.0
Total	21	5	62	43.5	105	85.5	16.0	30.0
Ceramic matrix								
Cutting tools	10	2.5	30	6	50	12	16.0	15.0
Other ceramic matrix composites	15	1.0	28	8	40	15	9.0	28.0
Total	25	3.5	58	14	90	27	12.0	20.0
TOTAL	233	70.5	411	257.5	525	377.5	8.0	16.0

Source: J. Briggs, *Advanced Composites - Current and Potential Markets* (Watford, United Kingdom, Materials Technology Publications, 1990).

Table V.109. World markets for polymer composites, 1988

Market sector	Percentage share 1988
Aerospace	38
Leisure/recreation	31
Industrial products	23
Automotive	3
Other	5
TOTAL	100

Source: J. Briggs, *Advanced Composites - Current and Potential Markets* (Watford, United Kingdom, Materials Technology Publications, 1990).

of money have been spent, especially in the United States, to achieve performance levels which would be impossible with the more traditional materials. Most of the successful applications depend upon the exceptionally high stiffness, hardness, temperature resistance, or chemical inertness of the ceramic or carbon reinforcement phase. These properties, combined with low density, explain why so many of the applications discussed in the report relate to transport systems. Energy and cost savings result from the use of higher-performance, lower-mass components.

The United States was in 1989 the largest market for each of the categories shown. This reflects the large aerospace industry in that country. By the end of the century it is probable that Western Europe will have slightly larger markets in carbon-based and aluminium metal matrix composites. These latter predictions are a reflection of the rapid growth in large civil aircraft usage in Western Europe, and also in the relative importance of diesel engine production and cars with low fuel consumption in Western Europe.

Sales of advanced fibres and pre-impregnated composites during the first half of 1990 were up 7 per cent and 16 per cent, respectively, compared with the first half of 1989 [58]. These figures suggest that 4,881 tonnes of advanced fibres, valued at $231 million, were shipped during the first six months of 1990. The corresponding figures for pre-impregnated composites were 6,734 tonnes and $336 million. The aerospace industry continued to account for the majority of industry shipments, followed by the sports, marine and industrial sectors. The figures of the European Association for Composite Materials (based in Zurich) and the Society for Advanced Composite Manufacturing Activities (based in Arlington, Virginia) are drawn from data supplied by member companies that account for more than 90 per cent of the shipments of advanced composite fibres and pre-impregnated composites within North America, Western Europe and East Asia.

3. End-uses and derived demands

The above review of the size, growth and composition of markets for families of new engineering materials show that there are considerable variations between different types of material and within each family of materials. These variations are largely explained by the structure and trends in the following major end-use sectors, which provide the derived demand for the materials themselves.

(a) Automotive markets

The introduction of new engineering materials in the vehicle and component industries is largely influenced by intense competition in the final end-uses. This means that the industry is constantly seeking both to reduce costs and to make better quality products. Reductions in cost include selecting materials that have a longer life and involve less waste in manufacture. Product improvements also include reduced weight, improved fuel efficiency, better and more flexible design and a wide range of additional components and systems designed to increase safety and comfort. The effect of these numerous pressures is that vehicle weight and material usage have only changed slowly, since improvements in the basic shape and structure are counterbalanced by the inclusion of more parts as standard.

Steel is still by far the dominant material in vehicle manufacture. This is mainly due to its all-round technical performance, its cost-competitiveness, its well-integrated material and component supply structure and the massive investment by the major assemblers in steelworking plants. Different steels in different forms have found a wide range of uses. Cold-rolled sheet is ductile, highly spot-weldable and is used almost exclusively for body panels. Heavier-gauge flat-rolled steel is used in mountings. Steel bar has many applications, including axles and shafts. For high-stress components, such as crankshafts, connecting rods and suspension wishbones, bar or billet stock is forged. Tubing also finds varied applications, such as exhaust systems, steering columns, shock absorbers, sear frames etc. New steels with improved properties, notably formability, are continually being developed, and it will therefore continue to be the dominant material throughout the 1990s.

Cast iron is largely used for its strength and thermal resilience. It provides a relatively cheap option for manufacturing large and often complex shapes such as engine blocks, cylinder heads and gearboxes.

Aluminium is also used to make these components, although cost (it is approximately three times as expensive as steel) has so far restricted its use for body panels to a small number of parts on the more expensive vehicles. Its main advantages over steel are its lighter weight and greater corrosion resistance.

Plastics are light weight, corrosion-resistant and have mouldability properties, which explains the increasing use of plastics in the automotive industry. Their initial use was confined to interior trim, seating, dashboards, roof and door liners etc. They are however commonly used for bumpers, petrol tanks and the spare-wheel housing. The next stages in plastics research and development are to look at ways in which they might be used for under-the-bonnet components and structural load-bearing applications. Their main drawbacks, however, are their inability to withstand high temperatures in production in the paint shops, in the vehicle near the engine, poorer colour and surface finish than steel, and slow production cycle times. Research and development is consequently focused on developing engines that run at lower temperatures, on reduced-temperature, automated painting processes and on fibre reinforcement of plastics to enhance their mechanical properties.

Polymer matrix composites are already in use as leaf springs and drive shafts. Glass fibre-reinforced plastics are thought to offer potential as inlet manifolds, battery support trays, spare-wheel wells and covers, with other thermoset composites under development as suspension arms, connecting-rods, steering-wheels and road wheels. In addition, many of the above-mentioned plastic applications such as bumpers, roofs, wing panels and bonnets are fibre-reinforced.

Metal-matrix composites are also the subject of development programmes, mainly to incorporate them into engine components, such as pistons (Toyota in Japan already have these in production), piston pins, cylinder liners, connecting-rods, rocker arms and turbo-charged impellers, and, outside the engine, drive shafts, brake callipers and ball joints. Metal-matrix composites offer greater potential within the engine than fibre-reinforced polymers, owing to their greater fatigue-resistance and durability at higher temperatures, combined with high strength-to-weight ratio and stiffness.

Ceramics also seem appropriate to these thermal conditions, and have been under consideration for use in the manufacture of engine components for some time. Their lightness, higher melting-points and hardness could potentially remove the need for engine cooling systems and lubrication. However, ceramics have proved difficult to manufacture to a sufficiently consistent quality and to join to metals, and hence it is widely believed that the evolution of an engine composed principally of ceramic components is unlikely to occur, and that the use of ceramics will be restricted to small though important components such as valves, cams, rotors and exhaust port liners (Porsche already have these in production).

In aggregate terms, the automotive industry will undoubtedly continue to increase the range of new materials deployed. Vehicle manufacturers, however, tend to be understandably conservative. Despite investing in research and development work on new materials and process technologies, many are still extremely cautious about putting the products of its research on the road. Given that the development costs of new models exceed $1 billion, any miscalculations in the estimated performance of a new component or material within its working context could be very expensive. Hence manufacturers often show a bias towards known materials.

(b) *Electrical and electronics markets*

The electrical and electronic engineering industry worldwide is very different from the automotive industry in that it is a relatively young industry, subject to rapid product innovation and turnover, and is not tied to a long-established process infrastructure. In mechanical and vehicle engineering the range of products (and markets) are well-established, and hence firms tend to look to changes in technology, such as engine management systems, to secure a competitive advantage. In the same way, with product parameters predetermined, materials are chosen or manipulated to meet the product requirements. It is more difficult to make generalizations about trends in the electronics industry as it is more complex than the automotive industry, incorporating the manufacture of electronic components, consumer goods, computers, and communications, defence-related capital goods and industrial electronics. However, as a rule, opportunities for the deployment of new materials are generally presented in the development of new products and markets.

The potential for the application of new materials in electronics is vast, and hence it is impossible to estimate their degree of usage in any quantifiable sense. The main criteria for materials selection are, for obvious reasons, the physical attributes, electrical and thermal conductivity and insulation, and magnetic properties. This represents a complete contrast to other engineering sectors where the primary considerations are structural. Plastics, for example, have successfully exploited different segments of the electronics market as connectors (phenolic, nylons and polycarbonate) and wiring devices (urea, polycarbonate, phenolic and epoxy).

In addition to identifying ways of exploiting the potential of more familiar materials, the industry is also quick to seize on and develop newer, advanced materials. At present, ceramics are enjoying worldwide interest for their strengths as, paradoxically, conducting, semi-conducting and insulating materials, as well as for their optical and magnetic characteristics. Applications include printed circuit boards, integrated circuits, transducers, sensors and condensers. Specific examples of current key developments include the following: use of gallium arsenide as an alternative to silicon in niche markets such as supercomputing, signals processing and sophisticated radar systems; fibre optics that use light rather than electrical pulses in two-way communication; and the development of superconductors that, although some way from major practical applications, offer potential in a number of different areas.

Semi-conductors

For the last 20 years, silicon has dominated the market for semi-conductors, being available in large quantities and consequently cheap to produce. In the last few years, the discovery of III-V chemical compounds has both opened up this market and extended the electronics industry into new markets. III-V compounds are based on elements from the third column of the periodic table, such as gallium and indium, and from the fifth column, such as phosphorus and arsenic. The most widely known and developed is the ceramic, gallium arsenide, which is seen as being directly in competition with silicon. The main strengths offered by gallium arsenide are as follows: a more rapid flow of electrons, hence a faster rate of performing electrical functions; performance under more testing conditions, for example, radiation; and electro-optical properties.

It is the second and third strengths that give III-V compounds the edge over silicon and provide a niche for more specialist applications. With doping, gallium phosphide can produce yellow, green and red light, and has found uses in visual displays. With the growth in fibre-optics communications, the compounds can be used as light sources, detectors or sensors. Their ability to handle higher frequencies than silicon has enabled them to be incorporated into microwave communication systems and satellite broadcasting. The main focus of interest in gallium arsenide is on potentially faster processing speeds, which is particularly valuable in high-powered supercomputers.

However, ongoing difficulties in overcoming production problems (fragility in handling, problems in obtaining the right degree of purity and reducing manufacturing costs) together with advances in silicon technology, mean than gallium arsenide will probably continue for some time to be exploited primarily in specialist niche applications. These include supercomputing and signal processing within sophisticated radar systems.

Signal transmission systems

The traditional material for signal transmissions between and within electrical equipment has been copper cabling, chosen for its high electrical conductivity. However, copper is susceptible to electromagnetic interference, particularly over long distances, and as each signal must be carried through a separate cable, it is highly bulky and costly to lay. The response to these drawbacks has been optoelectronics, one element of which is fibre optics. This relies on transmitting digital, rather than analogue, signals in pulses of light that are flashed by laser down a ceramic glass fibre. Fibre optics are not subject to interference, take up less space in cable ducts, and are extremely versatile and reliable. The use of digital, rather than analogue, signals means data transfer is extremely fast and of a consistent high quality.

Telecommunications represent a potentially expanding market for fibre optics. However, although the cost of installing fibre optics has been falling, installation of a national network for the telephone system would still require a high initial capital outlay. Unfortunately, while the construction of a long-distance telephone network has been elaborated in Europe, Japan and the United States since the 1960s, so far applications have been restricted in the United Kingdom mainly to local, usually firm-level networks.

A more immediate prospect is the industrial data systems market, with applications in, for example, process control. At present, signal corruption through interference can result in errors in equipment sequencing or possibly in machine operations, which ultimately may be extremely expensive. Hence a high value can be attached to signal quality and reliability.

In addition to glass fibres, fibre optics utilize plastic or composite castings in order to protect the fragile ceramic core. The strands of glass fibre are contained with a plastic coating, which is then bundled together in cables. Glass-reinforced plastic may be employed for enhanced strength and hardness to allow the cables to be clamped to pylons and telegraph poles. These also provide the advantage over copper of negligible creep and a nullified risk of being struck by lightning.

Superconductors

Such substances offer the following two major and related attributes: a zero resistance to the flow of electrical current and the ability to expel a magnetic field. Until recently, a number of metals, usually based on copper, were known to exhibit these properties, but only at very low temperatures close to absolute zero. Recent major advances, however, based on ceramics—for example, oxides based on bismuth and on thallium—have allowed the operating temperatures to be raised to as "high" as 148° celsius, and hence much closer to the temperatures where commercial applications can be exploited cost-effectively. These potential applications of high-temperature superconductors shown in table V.110 include the following:

(a) Power transmission. Considerable savings in energy loss could be realized, and much greater energy levels sustained, enabling piping to be extended much farther than currently possible, so that cheap electricity could be piped from remote sources;

(b) Transport. Magnetically levitated vehicles that could run at up to 500 miles (805 kilometres) per hour would require only electrical and cryogenic maintenance on the tracks. There would be no mechanical wear;

(c) Computation. Superconductors could be incorporated into switches of extremely high speed, whereby changes in current could be sensitively controlled by laser or magnetic field, facilitating very high speed computers;

Table V.110. Superconductor market, 1986 and forecast for 2005

Downstream industry	1986 (million dollars)	Percentage share 1986	2005 (million dollars)	Percentage share 2005	Level of activity worldwide
Electronics	40	13.6	400	22.2	Very high
Instrumentation and medicine	200	67.8	780	43.3	High
Aerospace and defence	25	8.5	350	19.4	Quite high
Production	20	6.8	200	11.1	High
Energy generation	5	1.7	50	2.8	Very low
Transport	5	1.7	20	1.1	Low
TOTAL	295	100.0	1 800	100.0	

Source: Organization for Economic Co-operation and Development, *Advanced Materials - Policies and Technological Challenges* (Paris, 1990).

(d) Medicine. Superconductors could be built into sensors to measure very small magnetic fields, which could for example be used in the diagnosis of brain disorders. At present, medical applications provide the main market for superconducting materials, with 80 per cent of all superconductors used in body scanners.

As with many newly developed materials, superconductors in their current state suffer from several deficiencies, notably brittleness (that is mechanical weakness), chemical structural instability, and the associated difficulties of manufacture. The perceived potential benefits of superconductors are obviously significant, however. This is illustrated by current trends in research and development expenditure: £90 million in the United States (over three years, for military purposes); £100 million in Japan (over the next five years); and £27 million in the United Kingdom (over three years).

(c) Aerospace markets

Material developments in electronics often have applications within the aerospace industry. The main foci of materials research in the aerospace industry, however, are the reduction of weight and the improvement of safety levels. Aircraft manufacturers are constantly seeking to improve the thrust-to-weight ratio by designing aero-engines capable of withstanding higher thrust and hence higher temperatures, and aircraft that are lighter and consequently more economical in fuel consumption. In terms of identifying materials that can meet these criteria, the capacity to produce in volume is not a major factor, and hence many of the concerns surrounding the "process infrastructure" are less of an issue in the aerospace industry. Safety and reliability, however, are primary considerations, hence materials must be strong, tough not brittle, and must be able to retain these properties under service conditions.

The main candidate materials for structural aerospace applications are aluminium alloys, steels, titanium alloys, composites (polymer matrix composites, metal matrix composites, cermets, fibre-reinforced ceramics) and others, including nickel superalloys. The general trends in materials substitution show composites gaining at the expense of metals, with the exception of the increased use of titanium alloys in civil aircraft.

Aluminium alloys have been the dominant material used in the construction of airframes for around 75 years, offering higher strength-to-weight ratios than steels and superior stiffness over competing metals. Titanium alloys provide a higher strength-density ratio, plus an ability to withstand higher temperatures, but are expensive, particularly in terms of the production of forgings or of sheet in bulk. These materials tend, however, to be deficient in terms of fatigue-resistance, toughness and resistance to various forms of corrosion, particularly under stress.

The use of fibre-reinforced plastics is becoming more common, mainly because of their strength, lightness, high stiffness, corrosion-resistance and toughness. Over time, they have been progressively introduced in place of aluminium alloys in individual applications, such as cabin floors, wing-fuselage fairings and engine doors. Now these composites have found their way into major structural applications, such as body panels, wings, tailpiece, entire fuselages, helicopter blades, drive shafts and hubs, and shells of early-warning radar equipment.

Boeing in the United States has suggested that composites will comprise 25 per cent of the total weight of its aircraft by 1995. Other estimates have placed the percentage at 30 to 40 per cent by the year 2000 for military aircraft alone. The aluminium industry is, however, fighting back. An alloy of aluminium and lithium (Al-Li) has been developed which is 10 per cent lighter than conventional aerospace alloys, of the same strength, with greater stiffness and overall weight savings of 15 per cent. Variations that are stronger or more damage-tolerant are also being developed, with the advantage that manufacturers are able to continue with existing production techniques. Aluminium may in the future also be used to form the matrix for a composite that is fibre-reinforced and used as struts, stiffeners and airframes.

With aero-engines, which obviously form a key part of the total aircraft weight equation, materials usage is said to be entering its third phase of development. The predominance of steels in the 1960s, which despite their high weight accounted for around 60 per cent of the aero-engine, have given way to the advent of titanium alloys and nickel superalloys. These non-ferrous metals are chosen for their lightness and strength-to-weight ratios, but mostly for their ability to perform at the elevated temperatures of higher-thrust engines. Nickel superalloys operate at a higher proportion of their melting temperatures than almost any other material and are employed at the hottest part of the engine, under temperatures of over 1,000° celsius. Unlike other high-service temperature metals such as tungsten, nickel can be protected against oxidation and corrosion by chromium and aluminium.

Aero-engine designers are continually striving to increase power-to-weight ratios and hence to achieve still higher engine working temperatures, and demand improved materials in order to accomplish this. The brittleness and unreliability of basic ceramics militates against their being used unreinforced, as safety is a critical factor and fibre-reinforced thermoplastics are clearly not a viable option with their top temperature limit of around 200° celsius. Materials engineers are therefore currently considering two alternatives: metals with ceramic reinforcements and ceramic matrix composites. Regarding the former, aero-engine manufacturers, such as Rolls Royce in the United Kingdom, see major prospects for the use of titanium metal matrix materials in the core of the engine, for example, as compressors, with aluminium metal matrix substances playing a very minor role. British Petroleum envisages titanium metal-matrix composites reinforced with silicon carbide monofilaments being used for blades, discs and shrouds in gas turbines.

In competition are the ceramic matrix composites, where silicon carbide and silicon nitride are believed to offer the greatest potential. The more immediate prospects for the use of these materials are in bearings, shroud rings and combustor components. Their use for turbine blades is believed to be a longer-term objective (at least up to the mid-1990s). Above

1,000° celsius these are stronger than nickel superalloys, less easily corroded, less than half as dense and potentially cheaper. Unfortunately, while silicon carbide and silicon nitride offer melting-points of between 1,400 and 1,700° celsius, and hence satisfy the higher temperature requirements of the industry, the major drawback remains their brittleness. Engine designers still do not have a clear understanding of the behaviour of ceramics, with the turbine blade facing a particularly arduous environment. Engineers are aware of the poor tolerance of ceramics to defects, but need more precise data on critical flaw sizes. Despite these drawbacks, Rolls Royce predicts that by 2010, 40 per cent of the total weight of the aero-engine will be metal or ceramic matrix composite. This should allow a new military engine to obtain a thrust-to-weight ratio of 20:1 (compared with 8:1 today), and achieve around a 25 per cent reduction in fuel and maintenance costs and initial purchase price.

Composites are also expected to make a larger impact on landing gear, where the demand is again for high strength and stiffness with low weight. Unfortunately, most composites are reinforced with long (or "continuous") fibres with all their main properties concentrated along one axis, and hence are unsuitable for the complicated multi-directional loading experienced by landing gear. The development of short-fibre ("particular") reinforced metal-matrix composites, whose properties are more evenly distributed throughout the material, has heralded new opportunities. With silicon carbide as a particulate, reinforced titanium is being regarded as a potential replacement for ultra-high-tensile steel.

A further highly promising market for composites within the aerospace industry is the less price-sensitive space subsector. Satellite launchers, for example, have a very poor payload-to-weight ratio of around 1 per cent. The target figure for Hotol, the prospective space aircraft of the United Kingdom, is 3 to 3.5 per cent, which would require the airframe to be composed of either carbon-fibre or metal-matrix composites, with nickel alloys being utilized to withstand the hottest temperatures at the vehicle's fin.

4. *Implications for individual companies*

Given the high costs of research, testing, specification, advertising, the development of new production processes etc., companies involved in developing new materials tend to be large and to restrict their efforts to a narrow range of materials technologies [59]. Competition is therefore latent rather than explicit, since the companies involved are engaged in a wide variety of product markets. The resulting materials are generally manufactured by two groups of companies: large firms that have moved into technology or found themselves involved through the development of expertise and small specialized companies that have been built around their competence in a particular field of the business. The production of these types of material is undoubtedly a high-volume global business.

The changes in competition suggest that the traditional, mutually reinforcing commercial relationship between metal component suppliers and their customers is slowly being eroded. Many large engineering companies are no longer exclusively concerned with metals. Plastic companies are now looking at more demanding applications in engineering as distinct from consumer markets and ceramic companies are less preoccupied with customers in electrical engineering. There is widespread interest in composite materials, but research and development costs prohibit all but the largest companies from becoming involved in leading-edge technologies. Competition, and particularly international competition, is therefore bringing about a change in the use of materials in the engineering industry. However, the pace of change should not be overestimated. Considerable inertia exists because of the enormous investment in the existing industrial production infrastructure.

In terms of the future for individual firms, it is clear that there is likely to be minimal immediate impact arising from these long-term material trends. However, in order to prepare themselves for future developments, metals-processing firms (machine shops, subcontractors etc.) should consider the future machining, finishing and joining requirements of non-metals and examine the possibility of diversifying their activities accordingly. And plastics and composites processing firms, many of which are trade moulders using very specific forming techniques with low value-added, should aim at developing the capacity to produce more complex specialist work that is likely to be increasingly demanded by end-user engineering sectors. For all companies, access to finance capital will be a crucial issue, as will access to appropriate technical expertise and skills.

5. *Industrial restructuring*

Industries in Europe, in common with those in Japan, North America and other developed regions, are restructuring and moving to high-value-added and technologically sophisticated products because they recognize advanced materials as a critical technology that will influence international competitiveness in the 1990s. Indeed, advanced materials constitute a mechanism for the scrapping of existing fixed capital and the introduction of new technologies, a basis for long waves in economic activity. The gradual switching to advanced materials in a long number of end-use sectors and industries would require that a "production infrastructure" of materials processors, equipment suppliers and training providers gradually be built up. Such an infrastructure already exists within the engineering industries. A vast network of major manufacturers and assemblers, small to medium-sized component suppliers and machinery manufacturers has grown up over time, predominantly to serve metals. A similar structure exists for the plastics processing industry; however, this is less integrated and on a much smaller scale, at best 5 to 10 per cent of the total size of the metal-working industry. The ceramics industry is much smaller still, and overwhelmingly concerned with traditional ceramics based on time-honoured processes.

The technologies, techniques and skills needed to process advanced materials are on the whole quite different from those currently in use in the traditional metal-producing and fabrication industries. Hence the development of equivalent production capabilities is just as important as the development of the new materials themselves. Until these techniques have evolved into widespread practical usage, the lack of a fully developed production infrastructure will present a constraint on the take-up of new materials. Moreover, it may create inertia in the materials research and development activity itself. Three major areas where new techniques are required are as follows:

Forming. The metals industries have various casting, forging, stamping and pressing processes. The plastics-processing industries have injection mounding, extrusion, blow moulding etc. The processing of newer non-metals will require the development of an equivalent range of techniques that build upon the inherent properties and process characteristics of the materials themselves;

Machining. Metals can be milled, turned, bored, drilled etc. and finished via grinding, shot-blasting, coating etc. These processes ensure that the required fine tolerances, product shapes and performances are achieved. For many non-metals, machining is either impractical or prohibitively expensive;

Fabrication. Traditionally, the sole concern of the engineer has been to join metals to metals, usually via fasteners, welding, soldering or brazing. In order for there to be increased usage of non-metals, new solutions are required. This is a particularly vital area if non-metals are to make an impact in a broad range of applications, under different working conditions.

As far as skills are concerned, the training infrastructure worldwide has traditionally been overwhelmingly biased toward metals. This applies not only to processing skills, but also to the much stronger knowledge base that exists for metals and not for other materials. The "built-in" bias within the training infrastructure is particularly pronounced at craft, technician and operative levels. Engineering craft and technician courses in the United Kingdom, for example, are almost exclusively concerned with metals. Courses run on engineering plastics, for example, cater only to a small proportion of people within the engineering industry. The problem is even more serious in ceramics, where firms are unable to recruit skilled toolmakers and have to take on metal operatives and train them in machining ceramic materials on the job.

At graduate level, skill shortages are at present less of a problem and impediment to the development of new materials. This is partly because the numbers of people involved are much smaller than for craft-workers, technicians and operatives, and partly because firms tend to recruit graduates with a science background and train them internally to meet their particular engineering requirements. There is also currently a proliferation of tertiary and higher education courses in new materials technologies in many educational establishments around the world. Their recruitment of graduates for research and development and design work from science rather than engineering courses reflects the narrow focus of engineering degrees.

6. *Implications for developing countries*

The industry developments explained above have considerable implications for industrialization and development strategies of primary commodity-producing developing countries ([56]; [60], pp. 61-80; [61]). The significance for location of industry, science and technology strategies, institutions, employment patterns and trade policies are as yet not fully understood. Further research needs to be done in the area of advanced materials towards a major contribution to the theory and policy of industrialization and development in the 1990s. This will involve basic research and development, primary and secondary manufacturing, and assembly into finished products or structures. It is widely believed that this type of technology convergence, transfer and advancement in all branches of industry will ensure the long-term future of both developed and developing manufacturing industries within the highly competitive global markets of the 1990s.

7. *Short- and medium-term industry outlook*

This review has described trends in advanced materials and presented forecasts for different markets and applications. It has been shown that different end-use sectors are demanding different types of new materials. The rate at which new materials are introduced into production depends on a number of economic factors including cost, quality considerations and the nature of competition in customer sectors. It is, however, also shaped by the research and development activities of individual companies and by the position of those companies in the production and marketing chain. The complex interrelationship between the technical considerations involved in materials and process development, and the economics of manufacturing has been analysed using several examples and case-studies.

A most important factor for the future is understanding the implications stemming from the high costs of research and development work on both materials and associated process technologies. First, new materials tend to be applied in new applications, initially within less price-sensitive markets, such as the luxury end of the car market or the space and defence arm of the aerospace industry. As the technologies involved are refined and developed to become cost-effective and appropriate for volume production, these applications are diffused into more price-sensitive customer sectors. Secondly, research and development is mainly undertaken by the larger companies, often in consortia.

Finally, new materials that enjoy the support of end-user companies are more likely to succeed than those which lack support. Where customers are engaged in collaborative research with materials suppliers or are committing their own research and development resources to a particular material, they have a vested interest in their subsequent use.

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Statistical Annex

World Industry Development Indicators

A1/A2

Technical Notes

1. Sources for the following country tables are:

(a) the UNIDO database of Industrial Statistics;

(b) National Accounts Statistics from UN/UNSO (all entries followed by "/na") supplemented by other sources (listed below under item 7.);

(c) Population figures by UN Demographic Statistics and UN *Monthly Bulletin of Statistics*. The population figures used in the GDP per capita forecast (1991-1992) are based on the "World Population Prospects as assessed in 1982" (UN/DIESA 1985), medium variant;

(d) Estimates and forecasts of GDP and MVA (manufacturing value added from National Accounts Statistics and for 28 industrial branches) by UNIDO/PPD/IPP/Global Issues and Policy Perspectives Branch.

2. All values are in millions of US dollars at current prices, except where otherwise indicated. Official exchange rates have been applied in general to generate dollar values. For selected countries and selected periods a correction factor was calculated to compensate temporary overvaluation of the national currency (Argentina, Chile, Dominican Republic, El Salvador, Ghana, Guatemala, Nicaragua, Nigeria, Paraguay, Sierra Leone, Syrian Arab Republic, Trinidad and Tobago, Uganda, Uruguay).

The correction was done by adapting exchange rates to the reported inflation rates.

Exchange rates for Hungary, Poland, and Romania are average market (principal) rates as reported by *International Financial Statistics*.

3. Figures followed by "/c" are in 1980 constant prices.

4. For the centrally planned economies UNSO provides an estimate of GDP based on county reports of NMP. NMP figures are no longer reported. MVA is estimated from industrial activities by applying a reduction factor derived from industrial statistics.

5. There are two parts to the annex. The first part consists of full page reports on 100 countries for which more complete data is available. This is a subset of the sample of 117 countries used to derive the sectoral forecasts of manufacturing value added for 28 industrial branches. Each of these pages contains a diagram of Industrial Structural Change, graphs of GDP and MVA growth rates, described in items 6 and 7 below, and tabular data as described in items 8 to 13 below.

The second part of the annex consists of short tables for each of the remaining countries.

6. The diagram of Industrial Structural Change is based on the value added in 1985 deflated prices. In general the GDP-deflator is used for the conversion. If no GDP-deflator was available the consumer price deflator is used. For each branch an index number for the periods 1980, 1985 and 1990 is calculated relative to 1975. The index number determines the distance from the origin of the star-diagram. For each year the index numbers are connected by a line which reflects the typical "shape" of expansion for the specific country. Since the size of expansion (absolute values of the index numbers) is different in each country, a different scale is used in each diagram. The largest index number of all branches is therefore given below the right end of the horizontal axis. The two numbers in the box on the upper right-hand side are: g, the average annual growth rate for the period 1975 to 1990; and θ, the index of structural change (defined below) for the same period.

7. GDP and MVA growth rates are mainly based on data supplied by UN/UNSO. However when no UNSO figure was reported, a figure was taken from one of the following sources:

(a) National statistical institute of the specific country;

(b) United Nations regional economic commission for the specific country;

(c) *International Financial Statistics* (International Monetary Fund);

(d) *National Accounts, Main Aggregates* (OECD, Department of Economics and Statistics);

(e) *World Outlook* and *Quarterly Economic Review* (The Economist Intelligence Unit);

(f) *World Bank Atlas;*

(g) *Centrally Planned Economies, Economic Overview* (The Conference Board, Inc.);

(h) *Economic Forecast* (North-Holland);

(i) Abecor European Bank Service;

or else estimated on the basis of statistical analysis and other ad hoc information, including various periodicals and newspapers.

Forecast growth rates for 1991 and 1992 for each country were projected using

(a) the long-term trend in GDP;

(b) the cyclical deviations from that trend; and

(c) when it proved significant, GDP in another country or a group of other countries.

Growth rates of aggregate MVA were forecast on the basis of regression techniques relating MVA and GDP. Five different types of regressions are tested for this purpose. The relationship producing the best ex-post forecasting figures was finally selected.

Estimates of sectoral MVA for 1989 to 1992 for each country were based on regression equations which contain GDP, aggregate MVA, lagged own-sector MVA and production indices as independent variables.

These sectoral MVA estimates were constrained to be consistent with the corresponding growth rate of aggregate MVA.

The growth rates of manufacturing value added in 28 industrial branches for the periods 1989 to 1992 were projected only for a sample of 117 countries. Again various sources and UNIDO estimates were used to improve the coverage of the data. The forecasts are based on estimates of the contribution of two components: *(a)* the dependence of the sector on the overall economic situation in the country expressed in terms of GDP; and *(b)* the sector-specific time behaviour expressed in terms of a structure of the value added of the sector.

8. Two figures are reported for manufacturing valued added. One is based on the national income accounts definition and the other on the industrial census definition. The main differences are: (i) included in the national income accounts figure but not included in industrial census figure is activity of establishments with less than some specified number of employees, typically five or ten, but the number is not fixed across countries; (ii) in the industrial census each establishment is considered to be either industrial or non-industrial and all activities for the establishment are similarly classified whereas in the national income accounting framework output is classified as industrial based on the nature of the product.

The industrial census data include the receipts for and exclude the costs of non-industrial activities.

For further information refer to *International Recommendations for Industrial Statistics*, Statistical Papers, Series M, No. 48, Rev. 1 (United Nations publication, Sales No. E.83.XVII.8).

9. The figures under the item "profitability" are defined as follows:

Intermediate input = 100. (gross output—value added)/ gross output

Wages and salaries = 100. (wages and salaries)/gross output

Operating surplus = 100. (value add.—wages and sal.)/ gross output.

10. The items "profitability" and "productivity" are averages across all branches, except that only those branches were included for which all the required data (gross output, value added, wages and salaries, and employment) were available.

11. For the calculation of the structural indices and the value of θ in the diagram of industrial structural change, index numbers of industrial production weighted by 1980 base year values were used.

The measure for structural change, θ, is defined by:

$$\cos\theta = \frac{\sum_i s_i(t)\cdot s_i(t-1)}{\sqrt{\left(\sum_i s_i(t)^2\right)\cdot\left(\sum_i s_i(t-1)^2\right)}}$$

where $s_i(t)$ is the share of the i-th branch in total manufacturing value added in the year t.

The value θ can be interpreted as the angle between the two vectors $s_i(t-1)$ and $s_i(t)$ measured in degrees.

The theoretical maximum value of θ is 90 degrees.

12. The item "MVA growth rate/θ" is the growth rate of real value added per degree of structural change between periods $t-1$ and t.

13. The degree of specialization is defined as follows:

$$h = 100\left(1 + \frac{\sum_i s_i \cdot \ln s_i}{h_{max}}\right)$$

where s_i is defined as above and h_{max} = ln (number of branches), and ln is the natural logarithm.

If the shares of all branches are equal, the degree of specialization equals 0. If only one branch exists the value is 100.

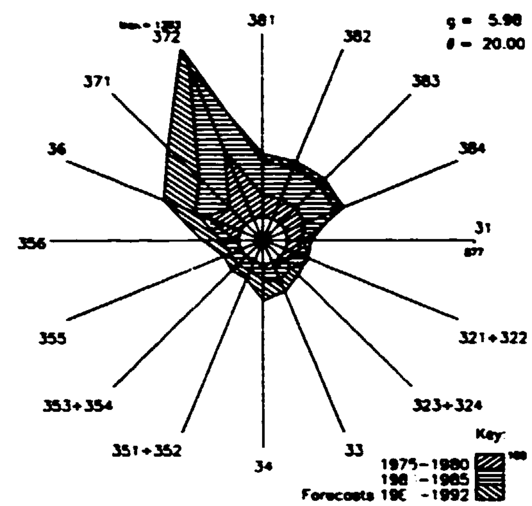
Summary of indicators

/na	value originating from national accounts statistics
/c	in 1980 constant prices
/e	estimated by UNIDO/PPD/IPP/GLO
/f	forecast by UNIDO/PPD/IPP/GLO
...	no value available
-	value is less than half a unit
n.a.	not available.

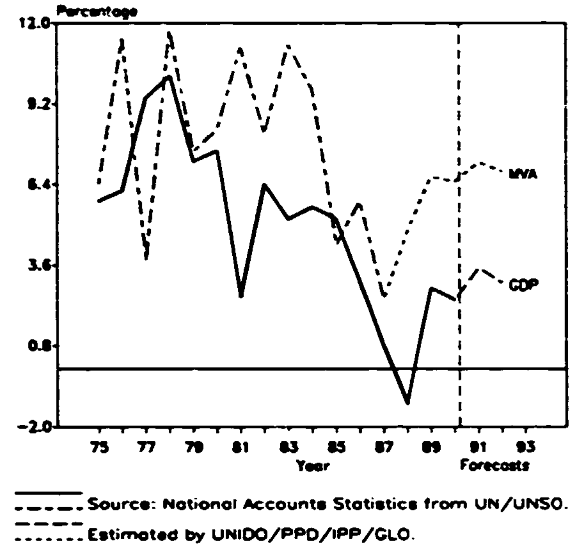
Regional classification of countries and territories:

Country or territory	UNITAD region		Page
AFGHANISTAN	Indian Subcontinent	(IN)	A-109
ALBANIA	Eastern Europe incl. USSR	(EE)	A-109
ALGERIA	North Africa	(AN)	A- 9
ARGENTINA	Latin America	(LA)	A- 10
AUSTRALIA	Other developed countries	(OD)	A- 11
AUSTRIA	Western Europe (Industrialized)	(WE)	A- 12
BAHAMAS	Latin America and the Caribbean	(LA)	A-109
BANGLADESH	Indian Subcontinent	(IN)	A- 13
BARBADOS	Latin America and the Caribbean	(LA)	A-109
BELGIUM	Western Europe (Industrialized)	(WE)	A- 14
BELIZE	Latin America and the Caribbean	(LA)	A-109
BENIN	Tropical Africa (Sub-Sahara)	(TA)	A-109
BERMUDA	North America	(NA)	A-110
BHUTAN	Indian Subcontinent	(IN)	A-110
BOLIVIA	Latin America	(LA)	A- 15
BOTSWANA	Tropical Africa (Sub-Sahara)	(TA)	A-110
BRAZIL	Latin America	(LA)	A- 16
BRUNEI DARUSSALAM	Asia East and South-East, Oceania	(AS)	A-110
BULGARIA	Eastern Europe incl. USSR	(EE)	A- 17
BURKINA FASO	Tropical Africa (Sub-Sahara)	(TA)	A- 18
BURUNDI	Tropical Africa (Sub-Sahara)	(TA)	A- 19
CAMEROON	Tropical Africa (Sub-Sahara)	(TA)	A- 20
CANADA	North America	(NA)	A- 21
CAPE VERDE	Tropical Africa (Sub-Sahara)	(TA)	A-110
CENTRAL AFRICAN REPUBLIC	Tropical Africa (Sub-Sahara)	(TA)	A- 22
CHAD	Tropical Africa (Sub-Sahara)	(TA)	A-110
CHILE	Latin America	(LA)	A- 23
CHINA	Centrally planned Asia	(OA)	A-111
COLOMBIA	Latin America	(LA)	A- 24
COMOROS	Tropical Africa (Sub-Sahara)	(TA)	A-111
CONGO	Tropical Africa (Sub-Sahara)	(TA)	A- 25
COSTA RICA	Latin America	(LA)	A- 26
COTE D'IVOIRE	Tropical Africa (Sub-Sahara)	(TA)	A- 27
CUBA	Latin America	(LA)	A- 28
CYPRUS	Western Asia	(WA)	A- 29
CZECHOSLOVAKIA	Eastern Europe incl. USSR	(EE)	A- 30
DENMARK	Western Europe (Industrialized)	(WE)	A- 31
DJIBOUTI	Tropical Africa (Sub-Sahara)	(TA)	A-111
DOMINICAN REPUBLIC	Latin America	(LA)	A- 32
ECUADOR	Latin America	(LA)	A- 33
EGYPT	North Africa	(AN)	A- 34
EL SALVADOR	Latin America	(LA)	A- 35
EQUATORIAL GUINEA	Tropical Africa (Sub-Sahara)	(TA)	A-111
ETHIOPIA	Tropical Africa (Sub-Sahara)	(TA)	A- 36
FIJI	South-East Asia	(AS)	A- 37
FINLAND	Western Europe (Industrialized)	(WE)	A- 38
FRANCE	Western Europe (Industrialized)	(WE)	A- 39
FRENCH GUIANA	Latin America and the Caribbean	(LA)	A-111
FRENCH POLYNESIA	Asia East and South-East, Oceania	(AS)	A-111
GABON	Tropical Africa (Sub-Sahara)	(TA)	A- 40
GAMBIA	Tropical Africa (Sub-Sahara)	(TA)	A-112
GERMANY, Eastern Part	Western Europe (Industrialized)	(WE)	A- 41
GERMANY, Western Part	Western Europe (Industrialized)	(WE)	A- 42
GHANA	Tropical Africa (Sub-Sahara)	(TA)	A- 43
GREECE	Western Europe (South)	(WE)	A- 44
GUADELOUPE	Latin America and the Caribbean	(LA)	A-112
GUATEMALA	Latin America	(LA)	A- 45
GUINEA	Tropical Africa (Sub-Sahara)	(TA)	A-112
GUINEA-BISSAU	Tropical Africa (Sub-Sahara)	(TA)	A-112
GUYANA	Latin America and the Caribbean	(LA)	A-112
HAITI	Latin America and the Caribbean	(LA)	A-112
HONDURAS	Latin America	(LA)	A- 46
HONG KONG	South-East Asia	(AS)	A- 47
HUNGARY	Eastern Europe incl. USSR	(EE)	A- 48
ICELAND	Western Europe (Industrialized)	(WE)	A- 49
INDIA	Indian Subcontinent	(IN)	A- 50
INDONESIA	South-East Asia	(AS)	A- 51
IRAN (ISLAMIC REPUBLIC OF)	Western Asia	(WA)	A- 52
IRAQ	Western Asia	(WA)	A- 53
IRELAND	Western Europe (Industrialized)	(WE)	A- 54
ISRAEL	Western Europe (South)	(WE)	A- 55
ITALY	Western Europe (Industrialized)	(WE)	A- 56
JAMAICA	Latin America	(LA)	A- 57
JAPAN	Japan	(JP)	A- 58

Industrial structural change
(Index of value added: 1975=100)



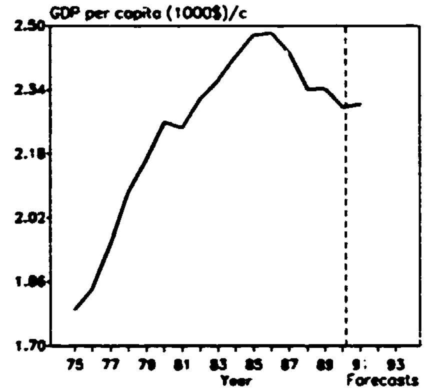
Annual growth rates of GDP and MVA
(Constant 1980 prices)



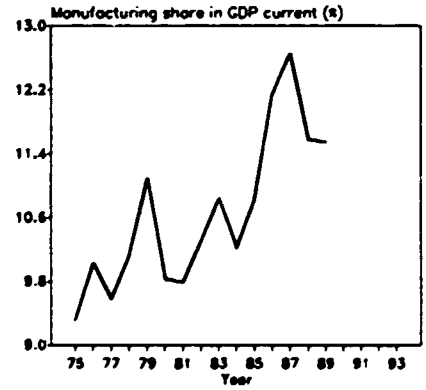
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	42342	53959	56895
Per capita (1980-dollars) /na.c	2259	2477	2342
Manufacturing share (%) /na (current prices)	9.8	10.8	11.5 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	3286	5028	6090 /e
Industrial production index	100	152	161 /e
Value added (millions of dollars)	3644	6157	5997 /e
Gross output (millions of dollars)	9122	13550 /e	13765 /e
Employment (thousands)	312	400 /e	467 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	55 /e	56 /e
Wages and salaries (%)	22	25 /e	28 /e
Operating surplus (%)	18	20 /e	16 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	29246	33907 /e	29445 /e
Value added / worker	11682	15406 /e	12828 /e
Average wage	6523	8521 /e	8199 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.88	3.75	1.66 /e
as a percentage of average θ in 1970-1975	72	70	31 /e
MVA growth rate / θ	2.52	2.00	1.25
Degree of specialization	14.6	13.7	13.6
-VALUE ADDED: (millions of dollars)			
311 Food products	655	852	847 /e
313 Beverages	135	176	165 /e
314 Tobacco products	176	229	211 /e
321 Textiles	291	450	399 /e
322 Wearing apparel	234	362	319 /e
323 Leather and fur products	52	80	84 /e
324 Footwear	90	140	146 /e
331 Wood and wood products	120	205	216 /e
332 Furniture and fixtures	57	97	101 /e
341 Paper and paper products	143	242	266 /e
342 Printing and publishing	16	27	30 /e
351 Industrial chemicals	14	25	26 /e
352 Other chemical products	93	167	172 /e
353 Petroleum refineries	83	150	149 /e
354 Miscellaneous petroleum and coal products	4	7	8 /e
355 Rubber products	17	30	30 /e
356 Plastic products	34	61	66 /e
361 Pottery, china and earthenware	10	14	15 /e
362 Glass and glass products	36	51	55 /e
369 Other non-metal mineral products	355	497	543 /e
371 Iron and steel	323	727	795 /e
372 Non-ferrous metals	19	42	47 /e
381 Metal products	265	598	496 /e
382 Non-electrical machinery	46	105	87 /e
383 Electrical machinery	123	278	231 /e
384 Transport equipment	181	407	338 /e
385 Professional and scientific equipment	30	67	56 /e
390 Other manufacturing industries	42	72	79 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

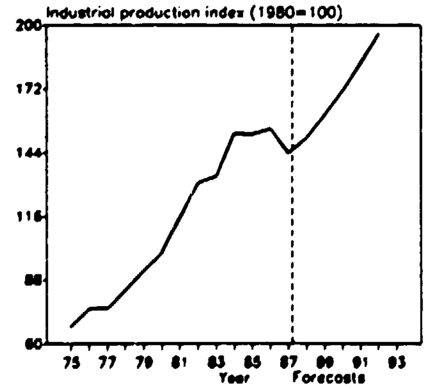
GDP per capita (1000$)/c

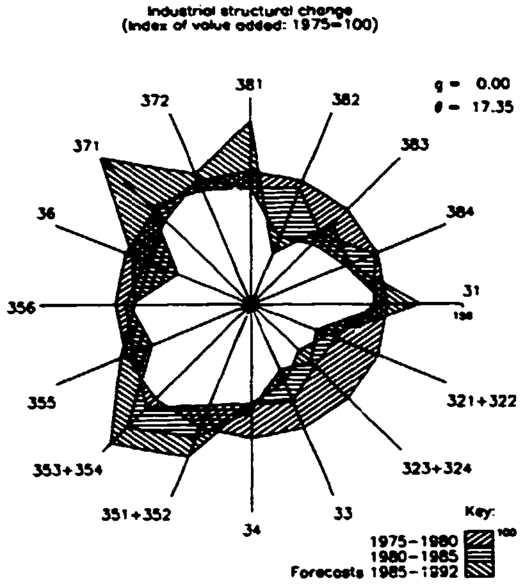


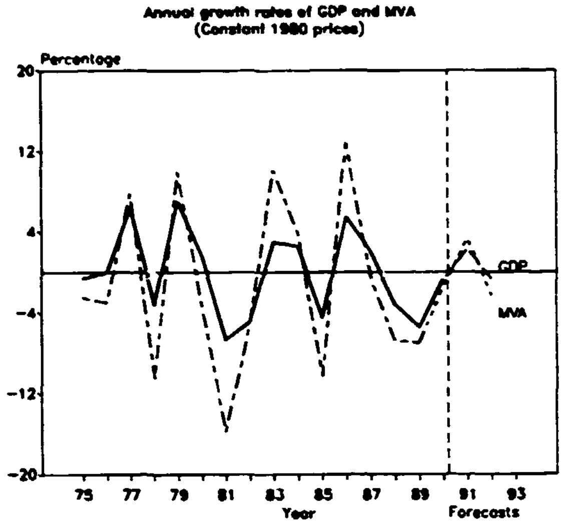
Manufacturing share in GDP current (%)



Industrial production index (1980=100)



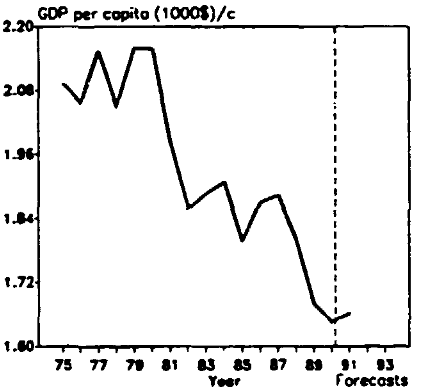


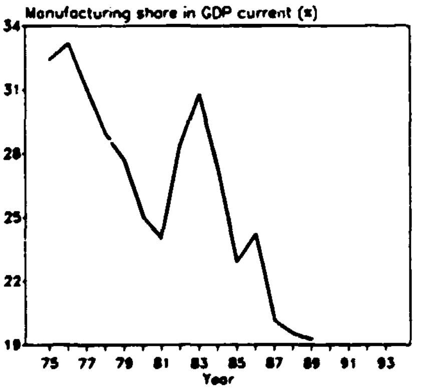


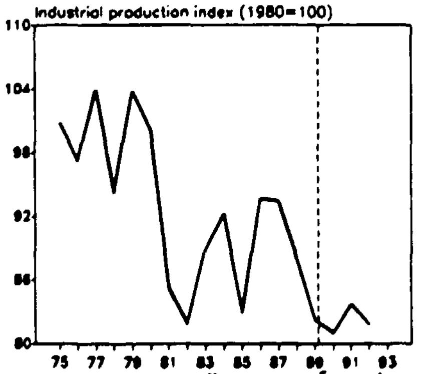
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

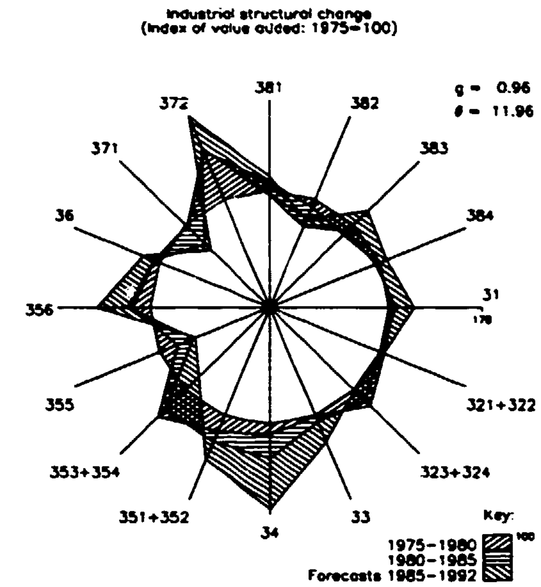
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	60917	54499	53638
Per capita (1980-dollars) /na.c	2157	1797	1680
Manufacturing share (%) /na (current prices)	25.0	22.9	19.2 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	15224	12476	12136
Industrial production index	100	83	82
Value added (millions of dollars)	23158	27310	24712 /e
Gross output (millions of dollars)	43842	52124	43284 /e
Employment (thousands)	1346	1127	1068 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	47	48	43 /e
Wages and salaries (%)	14 /e	11	9 /e
Operating surplus (%)	39 /e	42	48 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	32569	46238	40519 /e
Value added / worker	17203	24226	23134 /e
Average wage	4539 /e	4974	3806 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.04	5.21	3.99 /e
as a percentage of average θ in 1970-1975	153	159	122 /e
MVA growth rate / θ	-0.57	0.00	0.31
Degree of specialization	12.6	14.9	14.3
-VALUE ADDED: (millions of dollars)			
311 Food products	3745	4929	4256 /e
313 Beverages	595	811	1033 /e
314 Tobacco products	301	442	435 /e
321 Textiles	1672	1830	1960 /e
322 Wearing apparel	906	560	403 /e
323 Leather and fur products	285	355	283 /e
324 Footwear	243	243	146 /e
331 Wood and wood products	357	284	237 /e
332 Furniture and fixtures	234	194	232 /e
341 Paper and paper products	547	765	636 /e
342 Printing and publishing	669	808	561 /e
351 Industrial chemicals	866	1322	1271 /e
352 Other chemical products	1139	1846	1409 /e
353 Petroleum refineries	2781	3982	3295 /e
354 Miscellaneous petroleum and coal products	113	167	153 /e
355 Rubber products	289	295	272 /e
356 Plastic products	419	489	371 /e
361 Pottery, china and earthenware	190	128	149 /e
362 Glass and glass products	197	153	210 /e
369 Other non-metal mineral products	648	590	740 /e
371 Iron and steel	1003	1406	1523 /e
372 Non-ferrous metals	232	254	229 /e
381 Metal products	1257	1510	1593 /e
382 Non-electrical machinery	1318	915	640 /e
383 Electrical machinery	855	904	914 /e
384 Transport equipment	2119	1942	1586 /e
385 Professional and scientific equipment	81	93	91 /e
390 Other manufacturing industries	97	93	84 /e

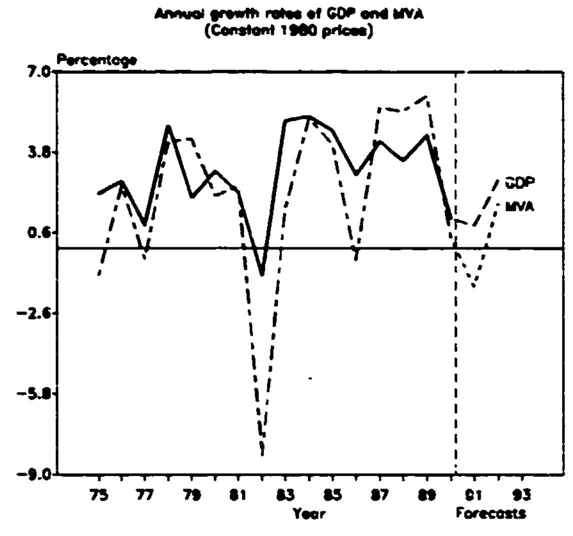
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.







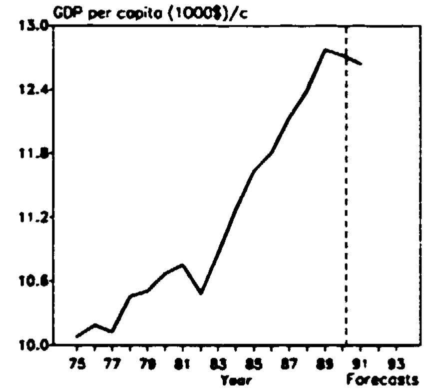


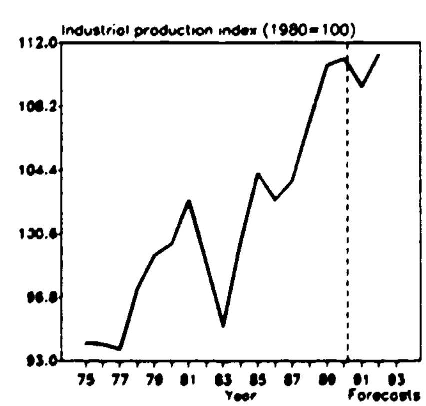


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

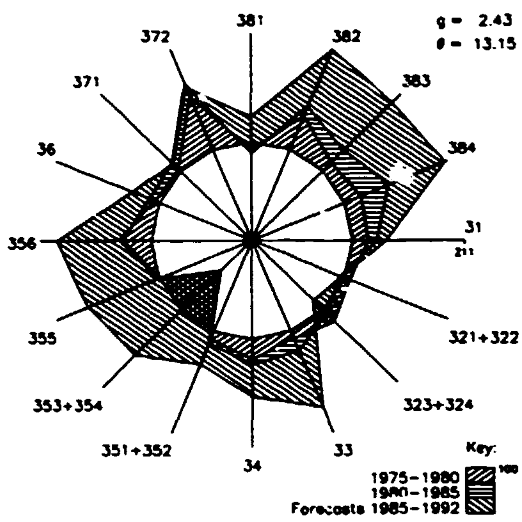
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	156855	183396	212701
Per capita (1980-dollars) /na,c	10673	11638	12772
Manufacturing share (%) /na (current prices)	19.2	17.8	16.9
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	30202	31557	37077
Industrial production index	100	104	111
Value added (millions of dollars)	29173	26900	44957
Gross output (millions of dollars)	75474	69329	120330
Employment (thousands)	1139	1012	1060
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	61	63
Wages and salaries (%)	20	19	17
Operating surplus (%)	18	20	21
-PRODUCTIVITY: (dollars)			
Gross output / worker	66263	68477	113488
Value added / worker	25613	26569	42401
Average wage	13356	12999	19134
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.78	4.48	2.43 /e
as a percentage of average θ in 1970-1975	96	154	84 /e
MVA growth rate / θ	0.34	-0.02	1.35
Degree of specialization	11.1	11.1	11.3
-VALUE ADDED: (millions of dollars)			
311 Food products	3993	3764	6306
313 Beverages	785	847	1391
314 Tobacco products	248	179	279
321 Textiles	1050	955	1624
322 Wearing apparel	821	722	1204
323 Leather and fur products	93	76	132
324 Footwear	223	205	300
331 Wood and wood products	1052	1028	1652
332 Furniture and fixtures	505	507	937
341 Paper and paper products	744	703	1362
342 Printing and publishing	1818	2131	3749
351 Industrial chemicals	969	982	1590
352 Other chemical products	1186	1191	1995
353 Petroleum refineries	323	285	277
354 Miscellaneous petroleum and coal products	30	25	27
355 Rubber products	341	264	437
356 Plastic products	831	808	1536
361 Pottery, china and earthenware	46	41	73
362 Glass and glass products	246	254	428
369 Other non-metal mineral products	1183	1086	1755
371 Iron and steel	1920	1391	2002
372 Non-ferrous metals	1473	1409	2287
381 Metal products	2467	2041	3740
382 Non-electrical machinery	2091	1575	2636
383 Electrical machinery	1361	1329	2385
384 Transport equipment	2830	2579	3967
385 Professional and scientific equipment	290	279	494
390 Other manufacturing industries	263	246	395

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

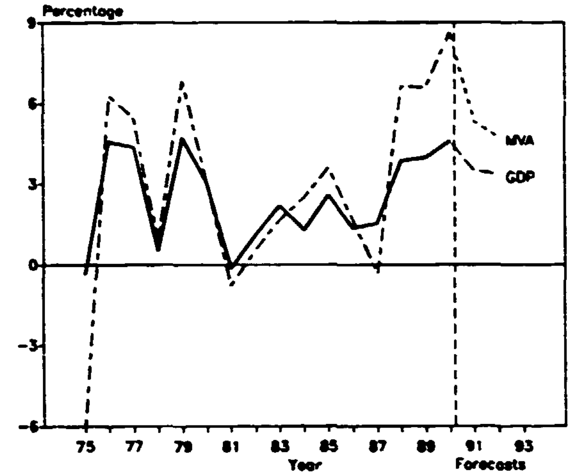




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

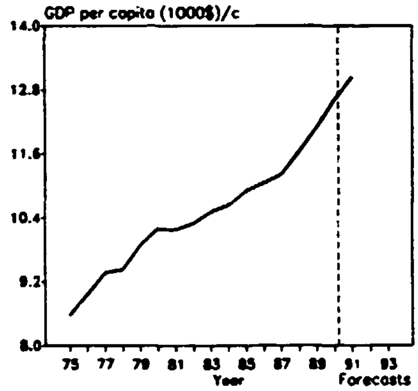


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

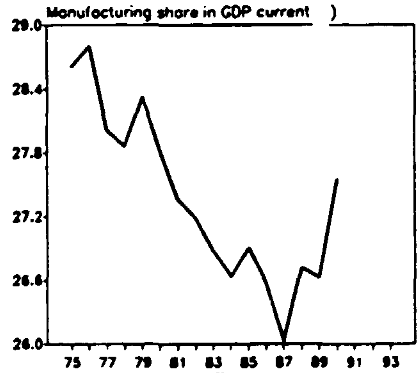
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	76882	82399	91386
Per capita (1980-dollars) /na,c	10183	10902	12084
Manufacturing share (%) /na (current prices)	27.8	26.9	26.6
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	21384	23037	26524
Industrial production index	100	111	126
Value added (millions of dollars)	17987	15108	28903
Gross output (millions of dollars)	54666	45959	80980
Employment (thousands)	824	783	758
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67	67	64
Wages and salaries (%)	19	18	18 /e
Operating surplus (%)	14	15	17 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	66355	58711	106842
Value added / worker	21834	19370	38133
Average wage	12799	10738	19579 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.18	4.99	4.29
as a percentage of average θ in 1970-1975	74	89	76
MVA growth rate / θ	0.49	0.25	0.56
Degree of specialization	10.1	10.2	9.9
-VALUE ADDED: (millions of dollars)			
311 Food products	1752	1472	2549 /e
313 Beverages	474	380	665 /e
314 Tobacco products	807	725	1234
321 Textiles	904	657	1132
322 Wearing apparel	512	353	552
323 Leather and fur products	63	45	61 /e
324 Footwear	223	157	221 /e
331 Wood and wood products	192	298	545 /e
332 Furniture and fixtures	965	733	1645 /e
341 Paper and paper products	645	509	990 /e
342 Printing and publishing	726	626	1257 /e
351 Industrial chemicals	663	584	1123 /e
352 Other chemical products	534	398	786 /e
353 Petroleum refineries	80	72	472
354 Miscellaneous petroleum and coal products	35	27	55 /e
355 Rubber products	258	200	514 /e
356 Plastic products	281	215	491 /e
361 Pottery, china and earthenware	63	42	92
362 Glass and glass products	244	237	391
369 Other non-metal mineral products	894	724	1343
371 Iron and steel	1225	1056	1843
372 Non-ferrous metals	280	241	396
381 Metal products	1542	1170	2534
382 Non-electrical machinery	1766	1502	2690
383 Electrical machinery	1615	1472	2985
384 Transport equipment	943	941	1812
385 Professional and scientific equipment	161	144	270 /e
390 Other manufacturing industries	143	130	262 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

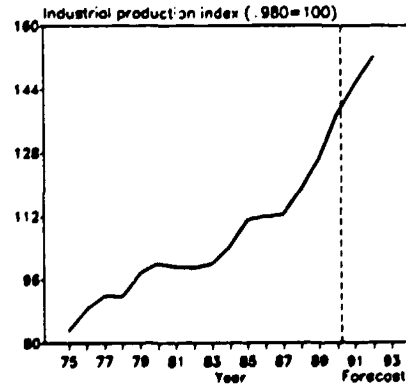
GDP per capita (1000$)/c

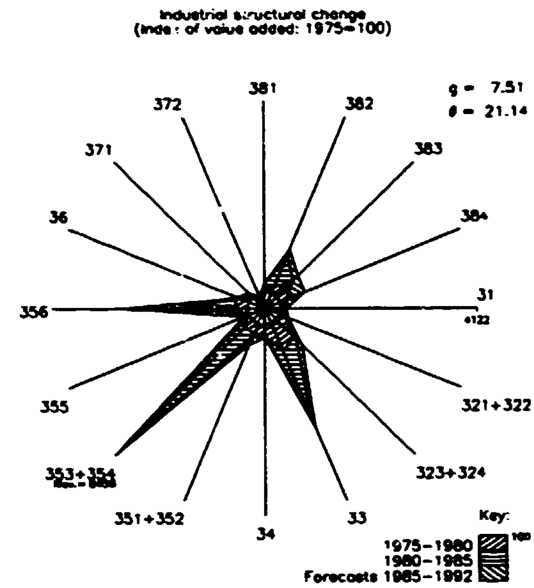


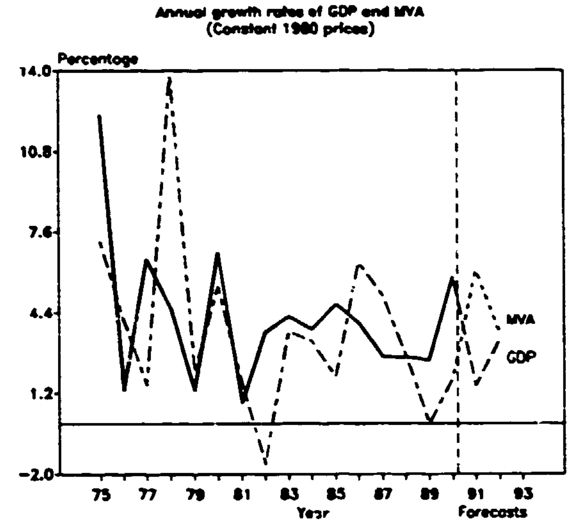
Manufacturing share in GDP current)



Industrial production index (1980=100)



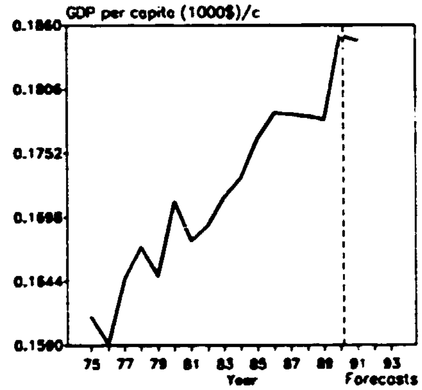


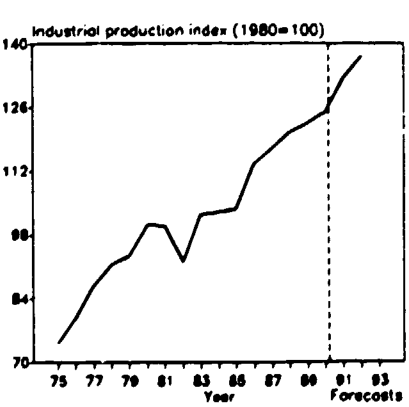


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

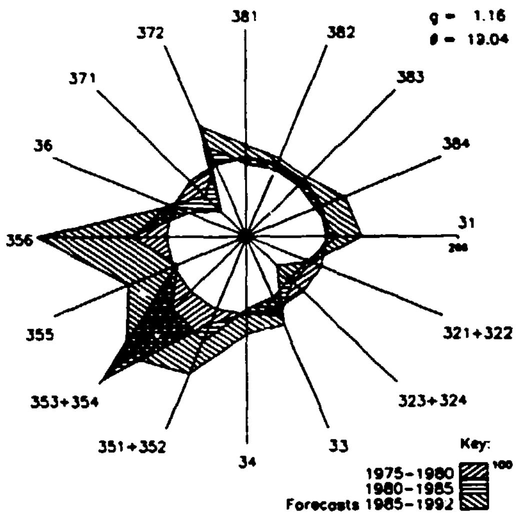
	1980	1985	1989
GDP:/na,c (millions of 1980-dollars)	15094	17846	20032
Per capita (1980-dollars) /na,c	171	176	178
Manufacturing share (%) /na (current prices)	9.9	8.3	7.4
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	1479	1612	1851
Industrial production index	100	103	122
Value added (millions of dollars)	834	863	1226 /e
Gross output (millions of dollars)	2253	2498	3121 /e
Employment (thousands)	412	469	466 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	63	65	61 /e
Wages and salaries (%)	12	10	12 /e
Operating surplus (%)	25	24	27 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	5466	5331	6694 /e
Value added / worker	2023	1842	2628 /e
Average wage	634	551	810 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.86	8.02	5.86 /e
as a percentage of average θ in 1970-1975	75	87	64 /e
MVA growth rate / θ	3.14	0.21	0.29
Degree of specialization	36.0	25.3	27.4
-VALUE ADDED:(millions of dollars)			
311 Food products	78	98	101
313 Beverages	7	6	12
314 Tobacco products	111	109	158
321 Textiles	336	230	370
322 Wearing apparel	-	8	11 /e
323 Leather and fur products	18	14	22 /e
324 Footwear	4	10	13 /e
331 Wood and wood products	3	10	10 /e
332 Furniture and fixtures	1	2	3 /e
341 Paper and paper products	23	19	23
342 Printing and publishing	6	8	11 /e
351 Industrial chemicals	33	70	113 /e
352 Other chemical products	97	86	154 /e
353 Petroleum refineries	2	75	70
354 Miscellaneous petroleum and coal products	1	2	3 /e
355 Rubber products	4	1	6
356 Plastic products	-	2	3 /e
361 Pottery, china and earthenware	2	4	4 /e
362 Glass and glass products	4	4	5
369 Other non-metal mineral products	14	7	12 /e
371 Iron and steel	39	36	29
372 Non-ferrous metals	-	-	- /e
381 Metal products	9	13	16 /e
382 Non-electrical machinery	4	17	19 /e
383 Electrical machinery	19	18	24
384 Transport equipment	11	10	28
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	8	7	7 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

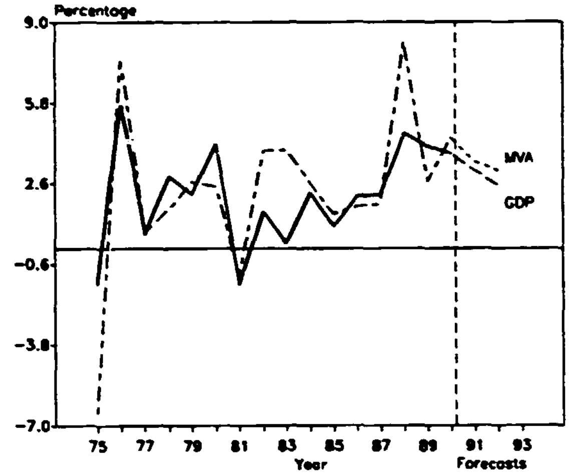




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

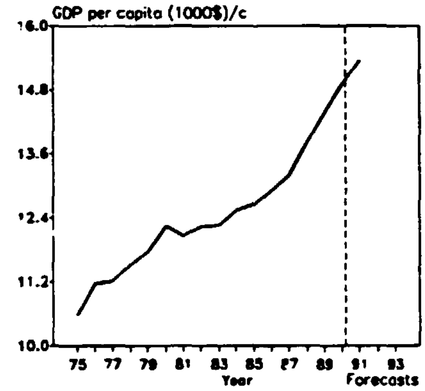


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

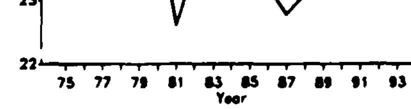
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	120573	124661	141464
Per capita (1980-dollars) /na,c	12238	12644	14366
Manufacturing share (%) /na (current prices)	24.2	23.5	23.3
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	29453	32724	37645
Industrial production index	100	106	123
Value added (millions of dollars)	28089	17368	33454
Gross output (millions of dollars)	86206	60250	116888
Employment (thousands)	868 /e	753 /e	718 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67	71	71
Wages and salaries (%)	16 /e	13 /e	12 /e
Operating surplus (%)	16 /e	16 /e	16 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	99316 /e	80013 /e	162831 /e
Value added / worker	32360 /e	23066 /e	46603 /e
Average wage	16145 /e	10646 /e	19824 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.55	2.83	2.15 /e
as a percentage of average θ in 1970-1975	53	59	45 /e
MVA growth rate / θ	0.17	-0.37	1.19
Degree of specialization	12.5	14.0	13.8
-VALUE ADDED: (millions of dollars)			
311 Food products	3991	2885	5588
313 Beverages	547	394	627
314 Tobacco products	198	128	188
321 Textiles	1443	920	1612
322 Wearing apparel	670	381	694
323 Leather and fur products	109	72	81
324 Footwear	65	34	41
331 Wood and wood products	226	111	266 /e
332 Furniture and fixtures	1122	576	1257 /e
341 Paper and paper products	612	404	823 /e
342 Printing and publishing	927	546	1111
351 Industrial chemicals	2401	1905	3603 /e
352 Other chemical products	663	492	960 /e
353 Petroleum refineries	510	169	467
354 Miscellaneous petroleum and coal products	78	26	39
355 Rubber products	191	125	308 /e
356 Plastic products	814	542	1431 /e
361 Pottery, china and earthenware	117 /e	57 /e	147
362 Glass and glass products	441 /e	216 /e	464
369 Other non-metal mineral products	717 /e	351 /e	722
371 Iron and steel	2267	940	1548
372 Non-ferrous metals	486	379	738
381 Metal products	2079	1244	2374
382 Non-electrical machinery	2455	1468	2615
383 Electrical machinery	2312	1383	2433
384 Transport equipment	1883	1127	2443
385 Professional and scientific equipment	196	117	148
390 Other manufacturing industries	568	378	725 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

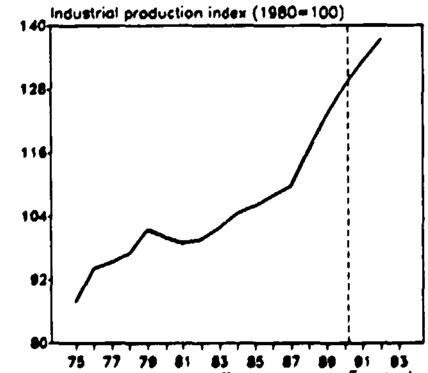
GDP per capita (1000$)/c



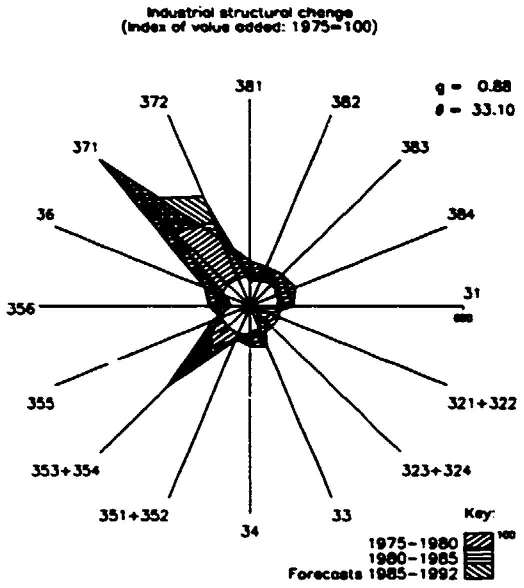
Manufacturing share in GDP current (%)

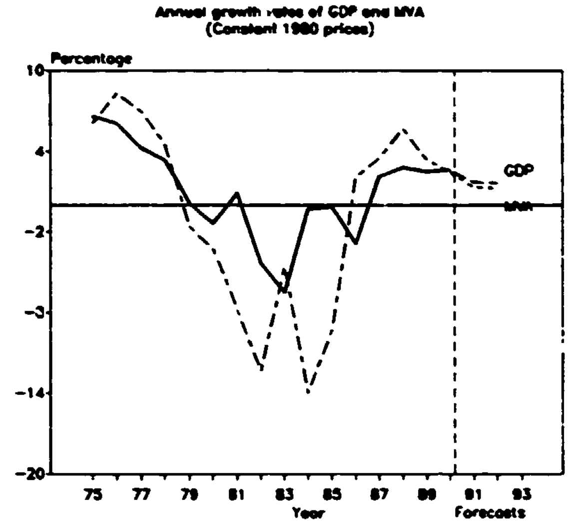


Industrial production index (1980=100)



BOLIVIA

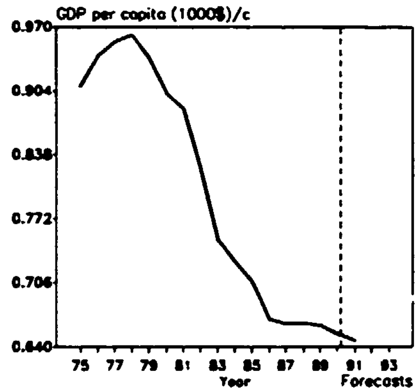


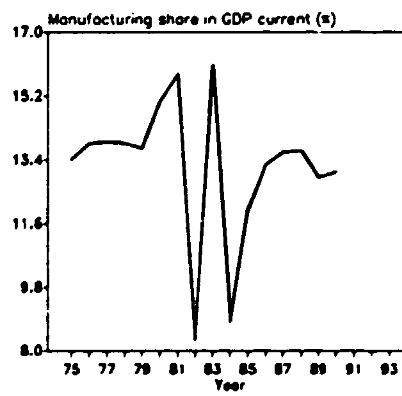


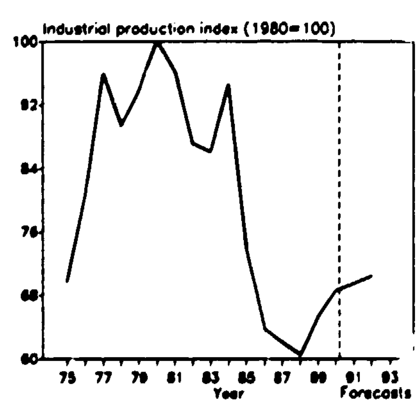
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	5018	4508	4709
Per capita (1980-dollars) /na,c	901	708	662
Manufacturing share (%) /na (current prices)	15.1	12.0	12.9
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	734	442	510
Industrial production index	100	74	65
Value added (millions of dollars)	834	818	883 /e
Gross output (millions of dollars)	2465	1956	1840 /e
Employment (thousands)	102	137	161 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	66	58	52 /e
Wages and salaries (%)	10	11	12 /e
Operating surplus (%)	24	31	36 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	24222	14325	11434 /e
Value added / worker	8200	5988	5487 /e
Average wage	2438	1555	1408 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	9.81	6.75	5.62 /e
as a percentage of average θ in 1970-1975	140	96	80 /e
MVA growth rate / θ	0.67	-0.93	-0.35
Degree of specialization	25.4	28.0	32.4
-VALUE ADDED: (millions of dollars)			
311 Food products	243	261	270 /e
313 Beverages	62	37	58 /e
314 Tobacco products	21	4	5 /e
321 Textiles	37	35	13 /e
322 Wearing apparel	47	30	26 /e
323 Leather and fur products	5	4	4 /e
324 Footwear	24	20	18 /e
331 Wood and wood products	24	21	22 /e
332 Furniture and fixtures	21	18	18 /e
341 Paper and paper products	1	1	2 /e
342 Printing and publishing	15	15	14 /e
351 Industrial chemicals	3	7	7 /e
352 Other chemical products	31	45	44 /e
353 Petroleum refineries	159	152	233 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	2	3	3 /e
356 Plastic products	12	9	7 /e
361 Pottery, china and earthenware	4	3	3 /e
362 Glass and glass products	11	9	9 /e
369 Other non-metal mineral products	25	36	18 /e
371 Iron and steel	12	9	9 /e
372 Non-ferrous metals	37	68	69 /e
381 Metal products	14	11	11 /e
382 Non-electrical machinery	6	6	6 /e
383 Electrical machinery	3	3	3 /e
384 Transport equipment	5	5	4 /e
385 Professional and scientific equipment	1	1	1 /e
390 Other manufacturing industries	9	5	5 /e

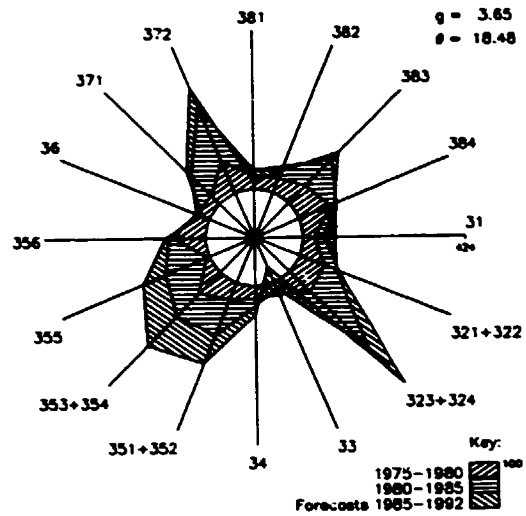
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



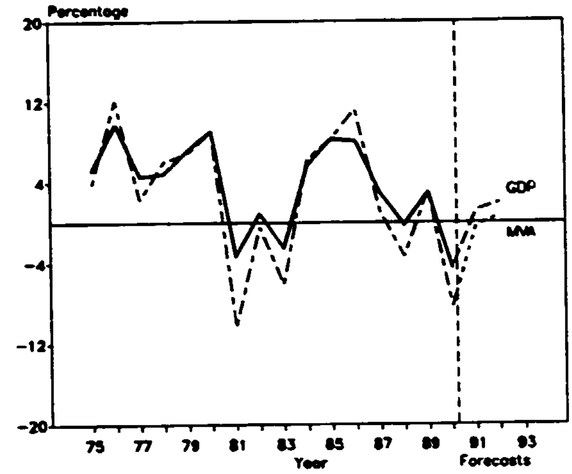




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

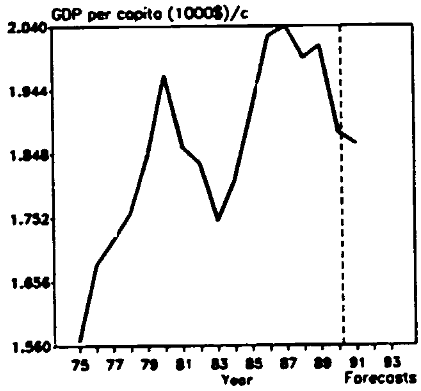


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

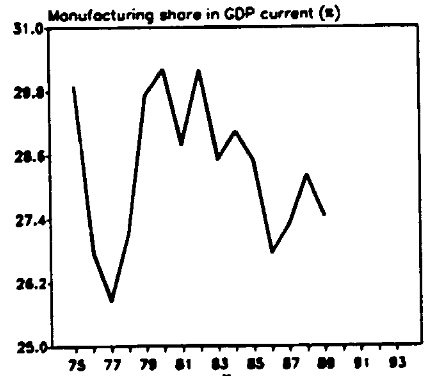
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	238472	259434	296273
Per capita (1980-dollars) /na,c	1966	1914	2010
Manufacturing share (%) /na (current prices)	30.2	28.5	27.4 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	67943	65434	73225
Industrial production index	100	98	112
Value added (millions of dollars)	71690	74568	148882 /e
Gross output (millions of dollars)	176174	169004	330962 /e
Employment (thousands)	4449	4067	4165 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	59	56	55 /e
Wages and salaries (%)	7	9	9 /e
Operating surplus (%)	34	35	36 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	39599	41559	79462 /e
Value added / worker	16114	18337	35745 /e
Average wage	2773	3720	7008 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.04	6.03	5.20 /e
as a percentage of average θ in 1970-1975	66	98	85 /e
MVA growth rate / θ	1.63	0.94	1.03
Degree of specialization	9.0	9.9	9.9
-VALUE ADDED:(millions of dollars)			
311 Food products	7996	9259	14703 /e
313 Beverages	1375	957	1418 /e
314 Tobacco products	495	587	962 /e
321 Textiles	4860	4799	10016 /e
322 Wearing apparel	2307	2036	4198 /e
323 Leather and fur products	309	464	1023 /e
324 Footwear	985	1666	3572 /e
331 Wood and wood products	1903	1220	1619 /e
332 Furniture and fixtures	1087	949	1206 /e
341 Paper and paper products	2238	2260	4904 /e
342 Printing and publishing	1901	1496	3172 /e
351 Industrial chemicals	3428	4417	9823 /e
352 Other chemical products	3644	4451	9773 /e
353 Petroleum refineries	3075	4307	9365 /e
354 Miscellaneous petroleum and coal products	1216	572	1296 /e
355 Rubber products	941	1420	3154 /e
356 Plastic products	1994	1728	39[illegible] /e
361 Pottery, china and earthenware	190	168	323 /e
362 Glass and glass products	558	525	1022 /e
369 Other non-metal mineral products	3447	2617	4966 /e
371 Iron and steel	4128	4927	10707 /e
372 Non-ferrous metals	1115	1564	3476 /e
381 Metal products	3599	3168	5893 /e
382 Non-electrical machinery	7171	6964	13879 /e
383 Electrical machinery	4536	5598	11893 /e
384 Transport equipment	5625	4964	9678 /e
385 Professional and scientific equipment	453	660	1422 /e
390 Other manufacturing industries	1216	837	1628 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

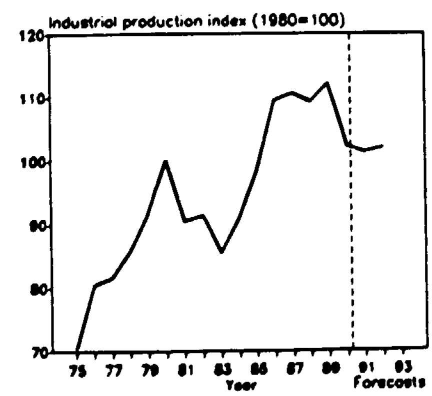
GDP per capita (1000$)/c



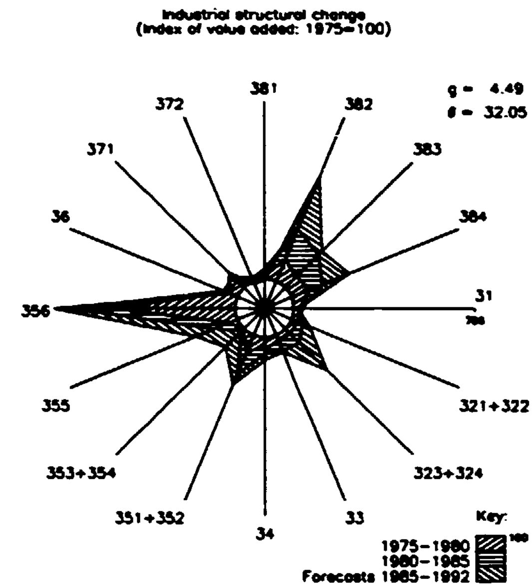
Manufacturing share in GDP current (%)

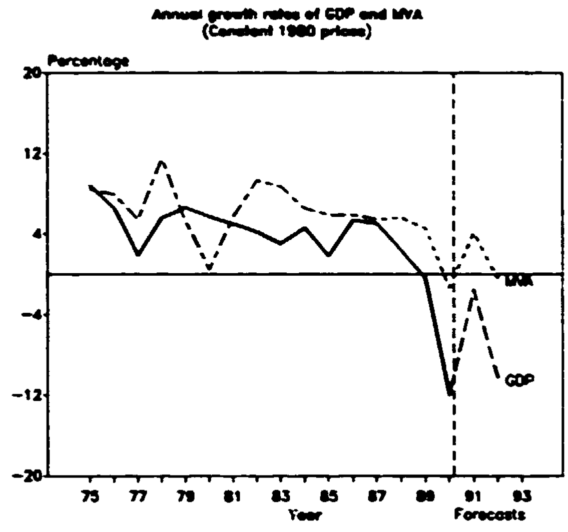


Industrial production index (1980=100)



BULGARIA

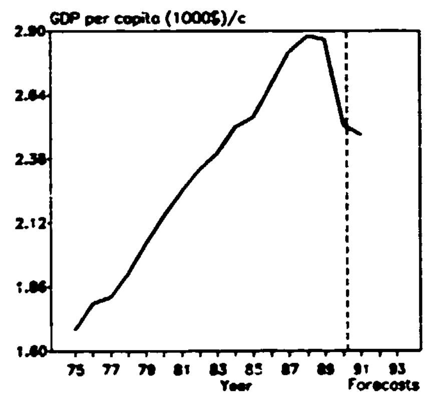


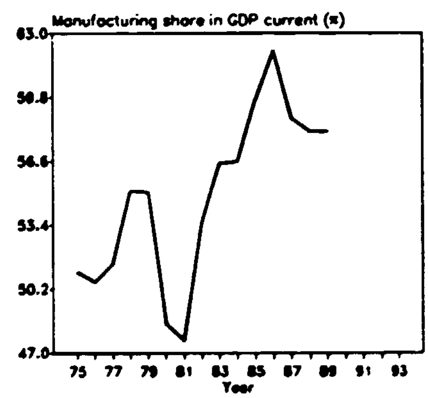


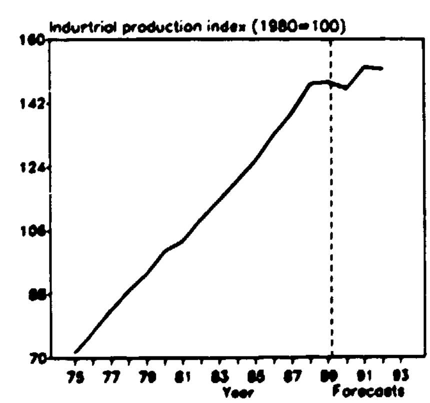
——— - - - Source: National Accounts Statistics from UN/UNSO.
- - - ...... Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	19031	22837	25776
Per capita (1980-dollars) /na,c	2147	2549	2863
Manufacturing share (%) /na (current prices)	48.5	59.6	58.1 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	8069	11433	...
Industrial production index	100	125	148
Value added (millions of dollars)/c	11771	14754	17410
Gross output (millions of dollars)	22430 /e	38422 /e	20969 /e
Employment (thousands)	1260	1316	1315 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY:(dollars)			
Gross output / worker	28789 /e	48036	25749 /e
Value added / worker /c	9675	11745	13733 /e
Average wage	1737 /e	2677 /e	1558 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.90	2.86 /e	3.13 /e
as a percentage of average θ in 1970-1975	89	88 /e	96 /e
MVA growth rate / θ	2.30	1.61	1.39
Degree of specialization	11.4	11.8	13.4
-VALUE ADDED:(millions of dollars)/c			
311 Food products	1870	1945	2094
313 Beverages	308	357	351
314 Tobacco products	426	472	438
321 Textiles	904	1003	1193
322 Wearing apparel	517	626	843
323 Leather and fur products	84	110	134
324 Footwear	156	218	329
331 Wood and wood products	248	258	270
332 Furniture and fixtures	[illegible]	347	405
341 Paper and paper products	119	141	140
342 Printing and publishing	83	91	108
351 Industrial chemicals	404	573	549
352 Other chemical products	291	486	623
353 Petroleum refineries	...	...	...
354 Miscellaneous petroleum and coal products	126	134	181 /e
355 Rubber products	227	323	406
356 Plastic products	110	140 /e	162 /e
361 Pottery, china and earthenware	45	40	52
362 Glass and glass products	121	140	137
369 Other non-metal mineral products	469	507	479
371 Iron and steel	447	513	531
372 Non-ferrous metals	189	199	192 /e
381 Metal products	484	600	551
382 Non-electrical machinery	1463 /e	2400 /e	3475 /e
383 Electrical machinery	743	1241	1479
384 Transport equipment	567	726	828
385 Professional and scientific equipment	200 /e	310 /e	448 /e
390 Other manufacturing industries	937	863	1012

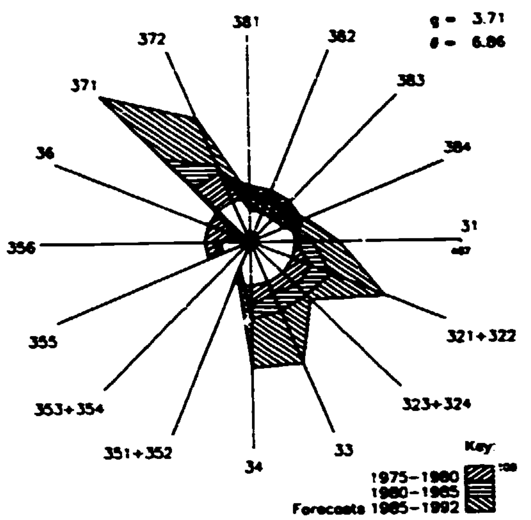
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



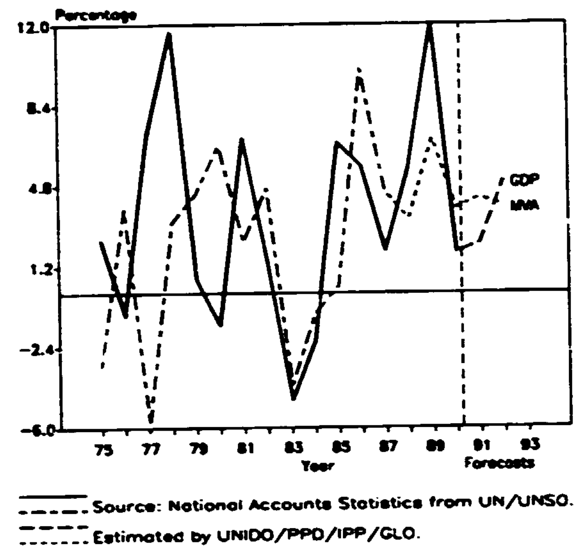




Industrial structural change (index of value added: 1975=100)



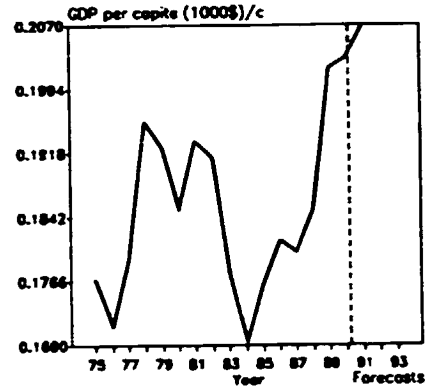
Annual growth rates of GDP and MVA (Constant 1980 prices)



	1980	1985	1989
GDP:/na.c (millions of 1980-dollars)	1287	1388	1767
Per capita (1980-dollars) /na.c	185	176	202
Manufacturing share (%) /na (current prices)	11.0	10.8	12.5 /c
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	141	144	183 /e
Industrial production index	100	110	140 /e
Value added (millions of dollars)	144	128 /e	218 /e
Gross output (millions of dollars)	331	319 /e	524 /e
Employment (thousands)	8	9 /e	10 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	63	60 /e	58 /e
Wages and salaries (%)	8	7 /e	7 /e
Operating surplus (%)	28	33 /e	35 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	47326	36190 /e	54487 /e
Value added / worker	17465	14514 /e	22679 /e
Average wage	4021	2552 /e	3669 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.80	3.03 /e	1.00 /e
as a percentage of average θ in 1970-1975	226	244 /e	81 /e
MVA growth rate / θ	0.49	1.72	4.89
Degree of specialization	36.7	43.5	45.4
-VALUE ADDED: (millions of dollars)			
311 Food products	55	61 /e	108 /e
313 Beverages	29	21 /e	33 /e
314 Tobacco products	1	1 /e	2 /e
321 Textiles	20	18 /e	34 /e
322 Wearing apparel	2	2 /e	4 /e
323 Leather and fur products	2	1 /e	2 /e
324 Footwear	3	3 /e	4 /e
331 Wood and wood products	-	- /e	- /e
332 Furniture and fixtures	2	2 /e	3 /e
341 Paper and paper products	-	- /e	- /e
342 Printing and publishing	1	1 /e	2 /e
351 Industrial chemicals	1	1 /e	1 /e
352 Other chemical products	-	- /e	- /e
353 Petroleum refineries	-	- /e	- /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	4	2 /e	3 /e
356 Plastic products	2	1 /e	2 /e
361 Pottery, china and earthenware	-	- /e	- /e
362 Glass and glass products	-	- /e	- /e
369 Other non-metal mineral products	-	- /e	- /e
371 Iron and steel	1 /e	1 /e	2 /e
372 Non-ferrous metals	- /e	- /e	1 /e
381 Metal products	1	- /e	1 /e
382 Non-electrical machinery	1	- /e	- /e
383 Electrical machinery	1	- /e	1 /e
384 Transport equipment	3	1 /e	2 /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	12	9 /e	12 /e

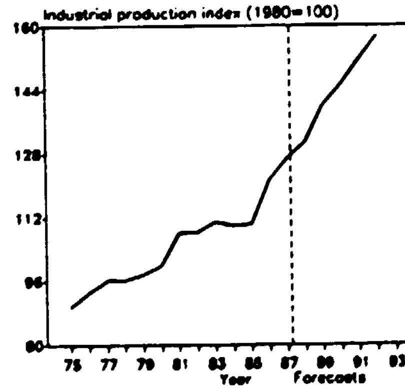
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

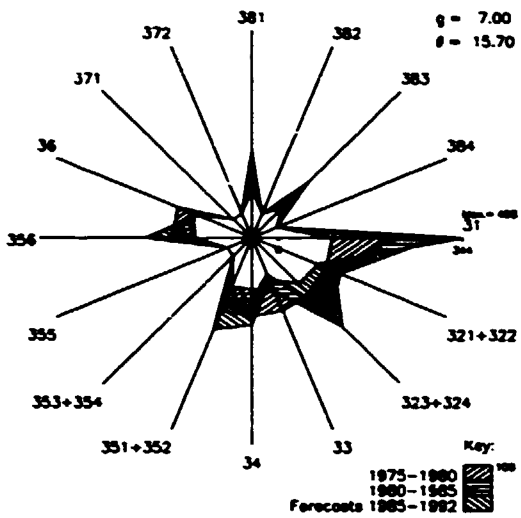


Manufacturing share in GDP current (%)

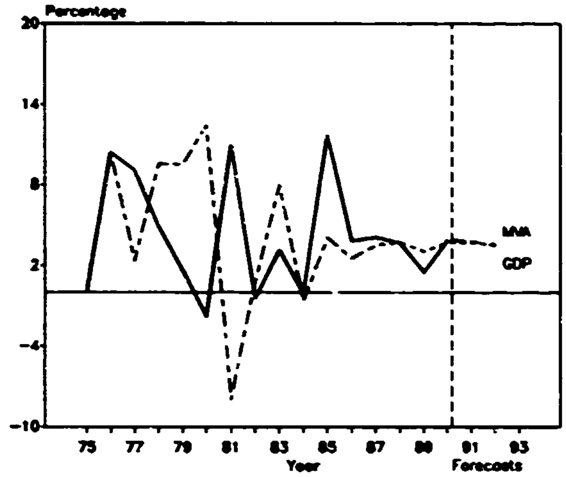
Industrial production index (1980=100)



Industrial structural change
(Index of value added. 1975=100)



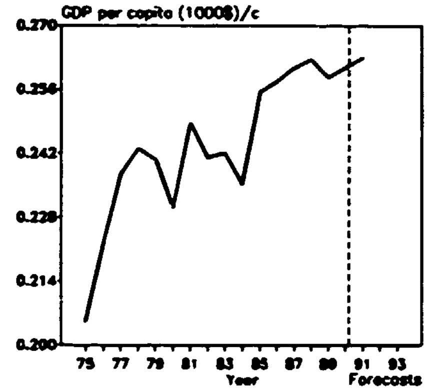
Annual growth rates of GDP and MVA
(Constant 1980 prices)

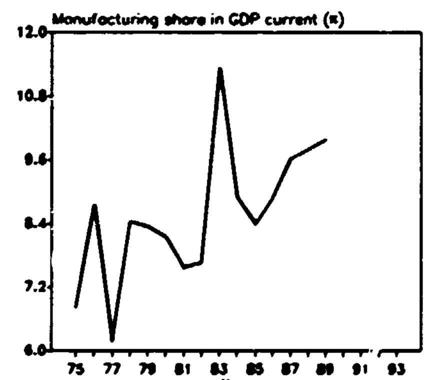


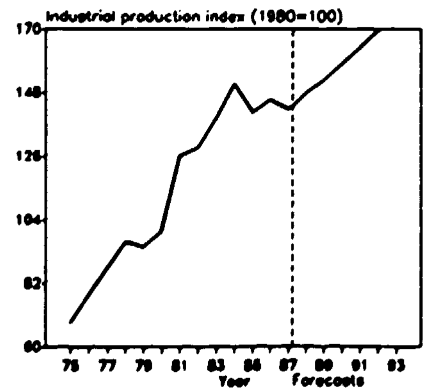
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	951	1208	1374
Per capita (1980-dollars) /na,c	230	[illegible]	259
Manufacturing share (%) /na (current prices)	8.1	8.4	10.0 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	86	89	101 /e
Industrial production index	100	141	152 /e
Value added (millions of dollars)	56	78 /e	96 /e
Gross output (millions of dollars)	95	133 /e	152 /e
Employment (thousands)	3	5 /e	5 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	41	41 /e	37 /e
Wages and salaries (%)	9 /e	8 /e	6 /e
Operating surplus (%)	51 /e	50 /e	57 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	27640	28503 /e	29956 /e
Value added / worker	16370	16728 /e	18869 /e
Average wage	2367 /e	2396 /e	1822 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.66 /e	2.09 /e	1.10 /e
as a percentage of average θ in 1970-1975	107 /e	33 /e	18 /e
MVA growth rate / θ	1.41	3.12	5.17
Degree of specialization	37.0	37.8	41.0
-VALUE ADDED: (millions of dollars)			
311 Food products	26 /e	34 /e	41 /e
313 Beverages	12 /e	19 /e	26 /e
314 Tobacco products	6 /e	9 /e	13 /e
321 Textiles	2	2 /e	2 /e
322 Wearing apparel	3	3 /e	3 /e
323 Leather and fur products	1	1 /e	- /e
324 Footwear	-	- /e	- /e
331 Wood and wood products	- /e	- /e	- /e
332 Furniture and fixtures	- /e	- /e	- /e
341 Paper and paper products	-	- /e	- /e
342 Printing and publishing	1	1 /e	1 /e
351 Industrial chemicals	1	2 /e	3 /e
352 Other chemical products	-	1 /e	1 /e
353 Petroleum refineries	-	- /e	- /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	-	- /e	- /e
356 Plastic products	-	- /e	- /e
361 Pottery, china and earthenware	-	- /e	- /e
362 Glass and glass products	-	- /e	- /e
369 Other non-metal mineral products	1	2 /e	1 /e
371 Iron and steel	-	- /e	- /e
372 Non-ferrous metals	-	- /e	- /e
381 Metal products	2	3 /e	4 /e
382 Non-electrical machinery	-	- /e	- /e
383 Electrical machinery	-	- /e	- /e
384 Transport equipment	-	- /e	- /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	-	- /e	- /e

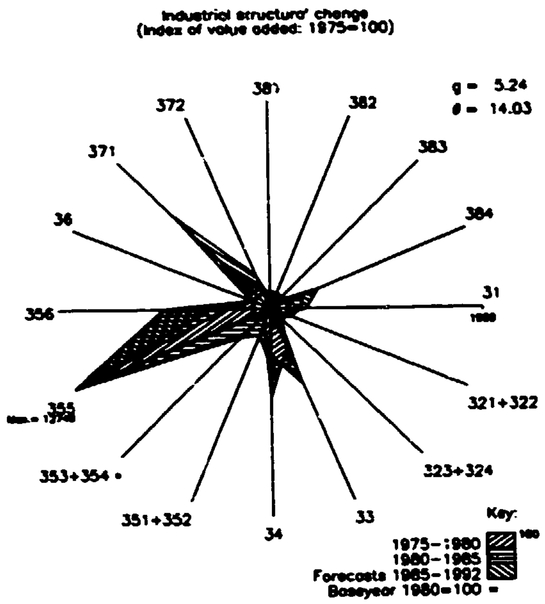
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

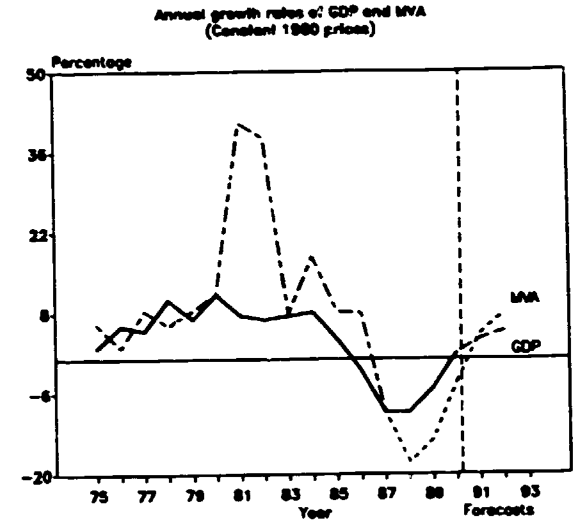






CAMEROON

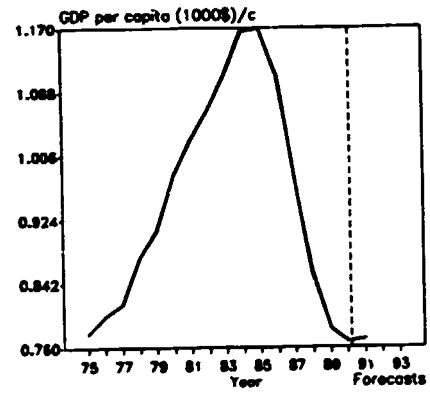


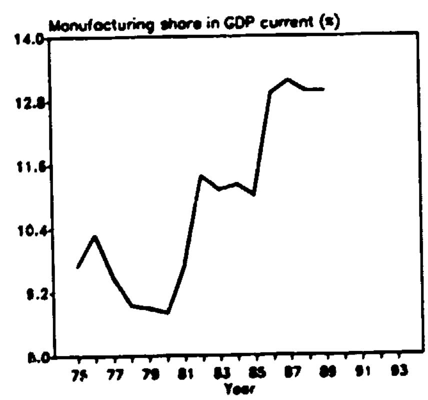


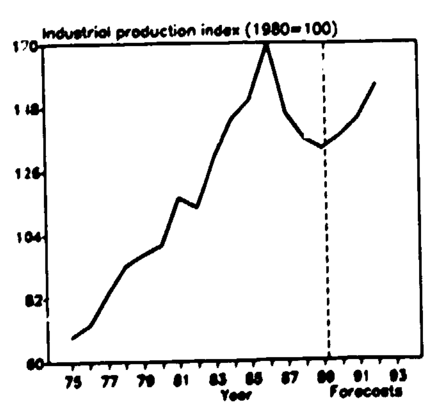
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	8502	11746	8969
Per capita (1980-dollars) /na,c	983	1169	784
Manufacturing share (%) /na (current prices)	8.8	11.0	13.0 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	[illegible]	2209	1527 /e
Industrial production index	100	150	133
Value added (millions of dollars)	707	698 /e	1192 /e
Gross output (millions of dollars)	1708	1638 /e	2845 /e
Employment (thousands)	51	57 /e	50 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	57 /e	58 /e
Wages and salaries (%)	14	13 /e	13 /e
Operating surplus (%)	27	30 /e	29 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	33774	28757 /e	56873 /e
Value added / worker	13979	12249 /e	23831 /e
Average wage	4842	3641 /e	7446 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	8.82	4.03 /e	4.47 /e
as a percentage of average θ in 1970-1975	102	46 /e	52 /e
MVA growth rate / θ	1.38	1.29	0.14
Degree of specialization	23.9	22.3	25.7
-VALUE ADDED: (millions of dollars)			
311 Food products	187	151 /e	393 /e
313 Beverages	183	168 /e	211 /e
314 Tobacco products	24	20 /e	30 /e
321 Textiles	36	41 /e	48 /e
322 Wearing apparel	10	12 /e	17 /e
323 Leather and fur products	7	3 /e	3 /e
324 Footwear	10	4 /e	5 /e
331 Wood and wood products	30	49 /e	57 /e
332 Furniture and fixtures	13	22 /e	26 /e
341 Paper and paper products	17	7 /e	17 /e
342 Printing and publishing	20	7 /e	10 /e
351 Industrial chemicals	12	24 /e	28 /e
352 Other chemical products	15	30 /e	60 /e
353 Petroleum refineries	3 /e	6 /e	9 /e
354 Miscellaneous petroleum and coal products	- /e	- /e	- /e
355 Rubber products	4	7 /e	19 /e
356 Plastic products	24	49 /e	62 /e
361 Pottery, china and earthenware	6	5 /e	12 /e
362 Glass and glass products	4	4 /e	6 /e
369 Other non-metal mineral products	12	10 /e	17 /e
371 Iron and steel	24	28 /e	73 /e
372 Non-ferrous metals	19	21 /e	48 /e
381 Metal products	13	7 /e	9 /e
382 Non-electrical machinery	18	10 /e	11 /e
383 Electrical machinery	4	2 /e	3 /e
384 Transport equipment	3	5 /e	10 /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	11	5 /e	6 /e

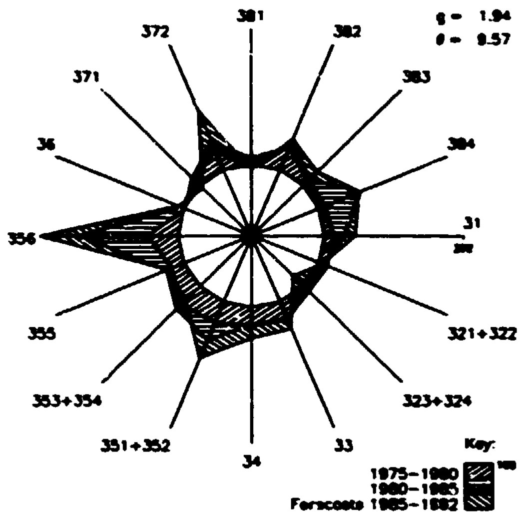
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



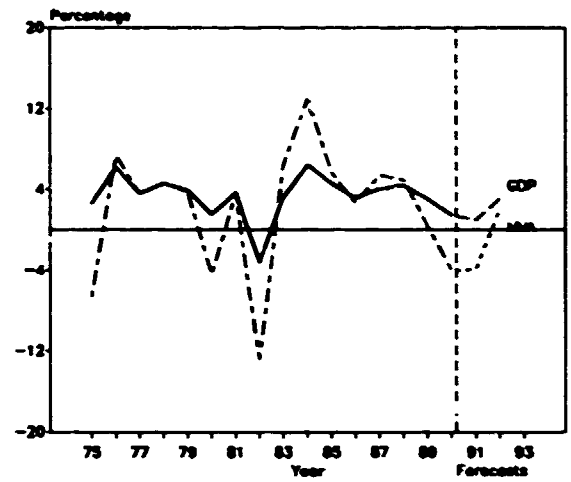




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

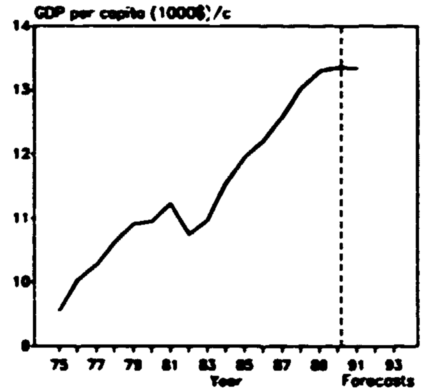


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	263242	303192	349717
Per capita (1980-dollars) /na,c	10949	11947	13295
Manufacturing share (%) /na (current prices)	17.9	17.2	16.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	47085	53990	61504
Industrial production index	100	111	124
Value added (millions of dollars)	59803	74209	115275
Gross output (millions of dollars)	167211	211017	308240
Employment (thousands)	1853	1765	1892
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	65	63
Wages and salaries (%)	17	16	16 /e
Operating surplus (%)	19	19	22 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	90238	119577	162896
Value added / worker	32274	42062	60920
Average wage	15296	19168	25879 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.41	4.85	2.68
as a percentage of average θ in 1970-1975	71	101	56
MVA growth rate / θ	1.06	0.41	1.44
Degree of specialization	10.3	11.0	11.4
-VALUE ADDED: (millions of dollars)			
311 Food products	6142	8001	11887
313 Beverages	1660	2189	3001
314 Tobacco products	479	608	862
321 Textiles	2130	2152	3331
322 Wearing apparel	1694	1933	2791
323 Leather and fur products	154	154	169
324 Footwear	299	344	396
331 Wood and wood products	2968	3236	5741 /e
332 Furniture and fixtures	1044	1332	2072 /e
341 Paper and paper products	5714	5410	10215
342 Printing and publishing	3064	4617	6743
351 Industrial chemicals	2164	2570	4206
352 Other chemical products	2421	3756	5898 /e
353 Petroleum refineries	1531	1867	2092 /e
354 Miscellaneous petroleum and coal products	111	132	147 /e
355 Rubber products	873	1069	1566 /e
356 Plastic products	873	1654	2757 /e
361 Pottery, china and earthenware	43	29	120
362 Glass and glass products	386	578	773
369 Other non-metal mineral products	1497	1713	2940
371 Iron and steel	2852	2906	4152
372 Non-ferrous metals	2190	2284	4046
381 Metal products	4414	4363	6818
382 Non-electrical machinery	3952	4912	7564
383 Electrical machinery	3849	4631	7737
384 Transport equipment	5911	10068	14608
385 Professional and scientific equipment	667	669	931
390 Other manufacturing industries	932	1223	1732 /e

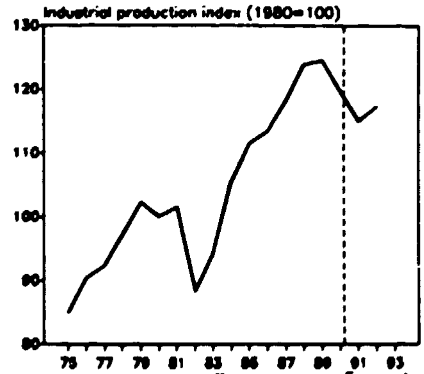
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

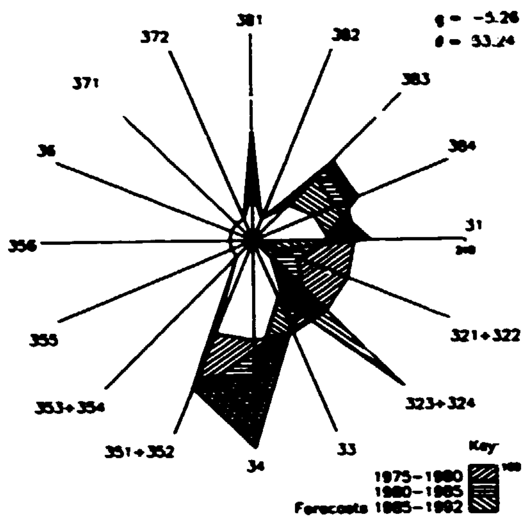


Manufacturing share in GDP current (%)

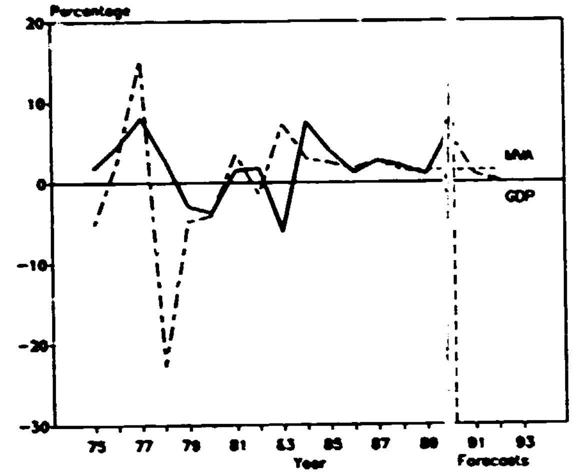
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

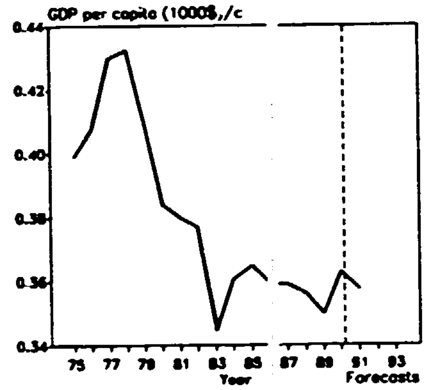


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

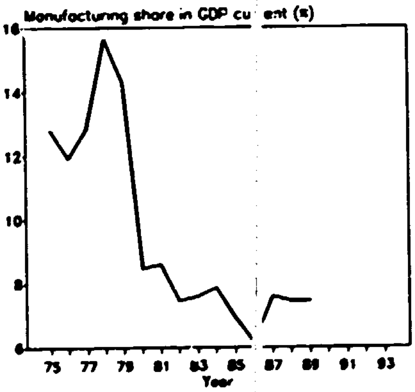
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	891	966	1033
Per capita (1980-dollars) /na.c	384	365	350
Manufacturing share (%) /na (current prices)	8.5	6.9	7.4 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	76	87	94 /e
Industrial production index	100	112	118 /e
Value added (millions of dollars)	35 /e	33	24 /e
Gross output (millions of dollars)	98 /e	108	104 /e
Employment (thousands)	6 /e	8	5 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64 /e	70	77 /e
Wages and salaries (%)	16 /e	15 /e	18 /e
Operating surplus (%)	19 /e	15 /e	5 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	16613 /e	13858	20988 /e
Value added / worker	5933 /e	4157	4799 /e
Average wage	2703 /e	2030 /e	3822 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	9.74 /e	15.89 /e	11.75 /e
as a percentage of average θ in 1970-1975	165 /e	269 /e	199 /e
MVA growth rate / θ	-0.62	0.34	-0.63
Degree of specialization	21.6	25.4	7.8
-VALUE ADDED: (millions of dollars)			
311 Food products	5	8	8 /e
313 Beverages	3	4	4 /e
314 Tobacco products	4	6	7 /e
321 Textiles	5 /e	- /e	-7 /e
322 Wearing apparel	1 /e	- /e	-1 /e
323 Leather and fur products	- /e	- /e	- /e
324 Footwear	-	-	- /e
331 Wood and wood products	11 /e	8	6
332 Furniture and fixtures	-	1	- /e
341 Paper and paper products	-	-	- /e
342 Printing and publishing	1	2	1 /e
351 Industrial chemicals	1	1	1 /e
352 Other chemical products	2	1	2 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	-	-	- /e
356 Plastic products	-	-	- /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	-	-	- /e
369 Other non-metal mineral products	-	-	- /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	1	-	- /e
382 Non-electrical machinery	-	-	- /e
383 Electrical machinery	-	-	- /e
384 Transport equipment	2	1	1 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	-	1	2 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

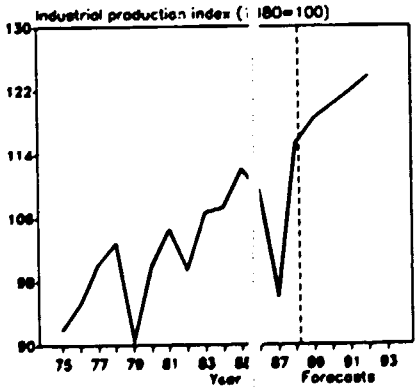
GDP per capita (1000$,/c



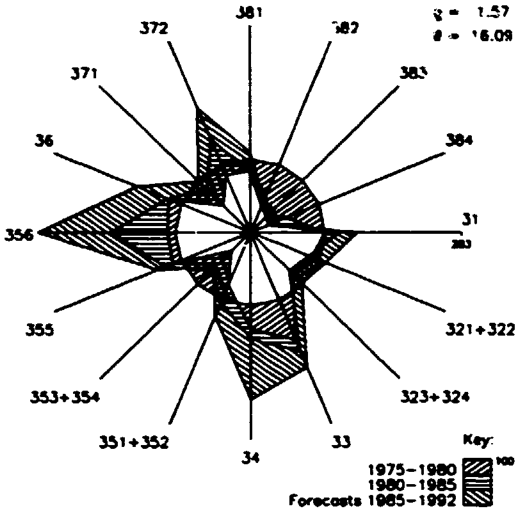
Manufacturing share in GDP current (%)



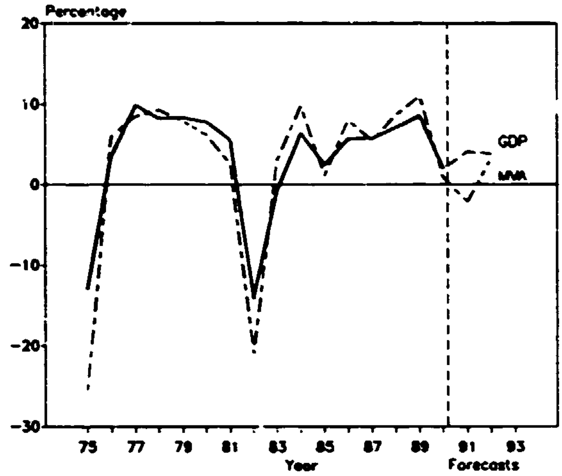
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

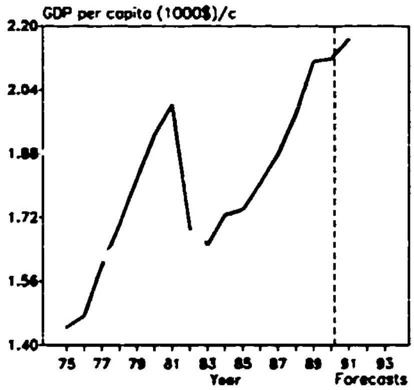


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

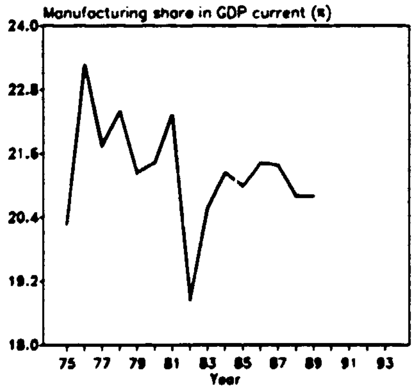
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	21489	21075	27360
Per capita (1980-dollars) /na,c	1928	1739	2111
Manufacturing share (%) /na (current prices)	21.4	21.0	20.8 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	4607	4275	5872
Industrial production index	100	100	130
Value added (millions of dollars)	4991	4712	6345 /e
Gross output (millions of dollars)	10790	10477	15605 /e
Employment (thousands)	206	185	222 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	54	55	59 /e
Wages and salaries (%)	9 /e	6	7 /e
Operating surplus (%)	38 /e	39	34 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	52264	56625	70365 /e
Value added / worker	24175	25468	28610 /e
Average wage	4444 /e	3498	4816 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	11.13	7.41	3.83 /e
as a percentage of average θ in 1970-1975	59	39	20 /e
MVA growth rate / θ	-0.31	0.73	1.51
Degree of specialization	16.0	20.4	20.8
-VALUE ADDED: (millions of dollars)			
311 Food products	827	805	1182 /e
313 Beverages	289	177	261 /e
314 Tobacco products	214	205	99 /e
321 Textiles	234	162	252 /e
322 Wearing apparel	111	83	122 /e
323 Leather and fur products	22	18	20 /e
324 Footwear	77	51	77 /e
331 Wood and wood products	153	143	159 /e
332 Furniture and fixtures	37	14	34 /e
341 Paper and paper products	281	278	479 /e
342 Printing and publishing	182	104	154 /e
351 Industrial chemicals	55	94	88 /e
352 Other chemical products	324	289	411 /e
353 Petroleum refineries	184	277	234 /e
354 Miscellaneous petroleum and coal products	27	47	78 /e
355 Rubber products	60	49	65 /e
356 Plastic products	50	63	99 /e
361 Pottery, china and earthenware	14	9	14 /e
362 Glass and glass products	38	27	46 /e
369 Other non-metal mineral products	146	115	182 /e
371 Iron and steel	188	226	300 /e
372 Non-ferrous metals	966	1175	1540 /e
381 Metal products	181	130	208 /e
382 Non-electrical machinery	96	50	72 /e
383 Electrical machinery	90	61	96 /e
384 Transport equipment	127	49	64 /e
385 Professional and scientific equipment	5	4	5 /e
390 Other manufacturing industries	13	7	7 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

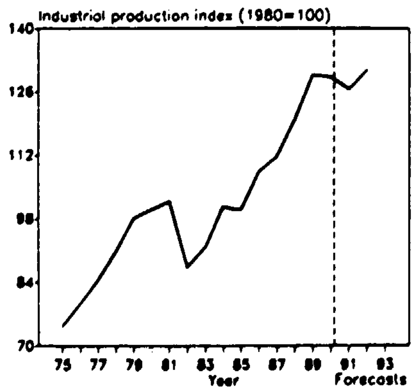
GDP per capita (1000$)/c



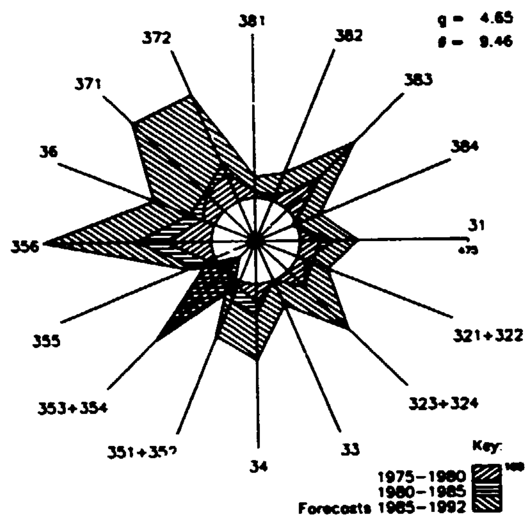
Manufacturing share in GDP current (%)



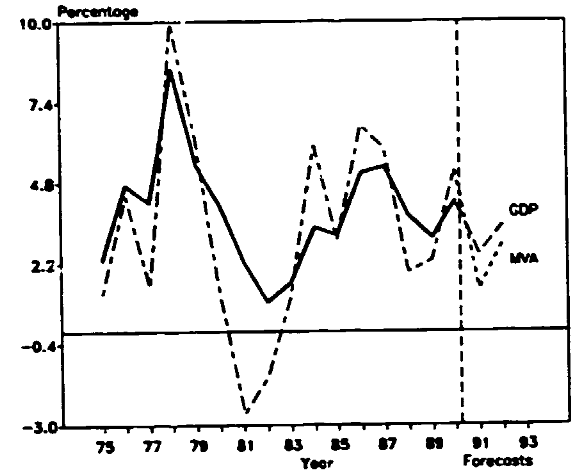
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

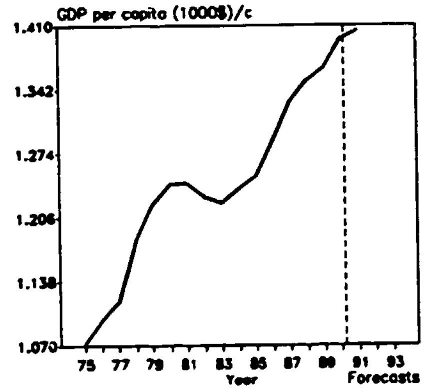


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

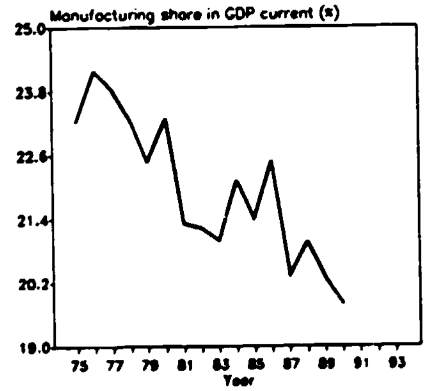
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	33400	37325	44145
Per capita (1980-dollars) /na,c	1241	1249	1366
Manufacturing share (%) /na (current prices)	23.3	21.4	20.3
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	7772	8230	9691
Industrial production index	100	108	127
Value added (millions of dollars)	7131	6711	7871 /e
Gross output (millions of dollars)	16453	16814	20177 /e
Employment (thousands)	508	440	478 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	57	60	61 /e
Wages and salaries (%)	8	7	6 /e
Operating surplus (%)	35	33	33 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	32374	38206	42230 /e
Value added / worker	14031	15248	16474 /e
Average wage	2583	2724	2364 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	8.39	6.18	7.25 /e
as a percentage of average θ in 1970-1975	136	100	118 /e
MVA growth rate / θ	0.86	0.15	1.03
Degree of specialization	14.6	14.7	13.3
-VALUE ADDED: (millions of dollars)			
311 Food products	961	1166	1326 /e
313 Beverages	1021	1032	969 /e
314 Tobacco products	160	224	153 /e
321 Textiles	803	619	772 /e
322 Wearing apparel	241	206	228 /e
323 Leather and fur products	59	47	53 /e
324 Footwear	50	54	96 /e
331 Wood and wood products	50	46	57 /e
332 Furniture and fixtures	34	29	39 /e
341 Paper and paper products	227	274	293 /e
342 Printing and publishing	186	180	240 /e
351 Industrial chemicals	303	406	496 /e
352 Other chemical products	419	457	556 /e
353 Petroleum refineries	773	90	104 /e
354 Miscellaneous petroleum and coal products	17	28	33 /e
355 Rubber products	117	138	136 /e
356 Plastic products	141	169	226 /e
361 Pottery, china and earthenware	44	46	60 /e
362 Glass and glass products	76	92	108 /e
369 Other non-metal mineral products	232	264	327 /e
371 Iron and steel	217	206	387 /e
372 Non-ferrous metals	34	36	52 /e
381 Metal products	260	242	244 /e
382 Non-electrical machinery	120	114	143 /e
383 Electrical machinery	244	211	281 /e
384 Transport equipment	256	221	368 /e
385 Professional and scientific equipment	26	38	55 /e
390 Other manufacturing industries	72	78	83 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

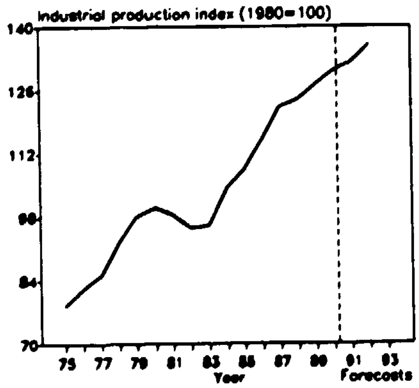
GDP per capita (1000$)/c

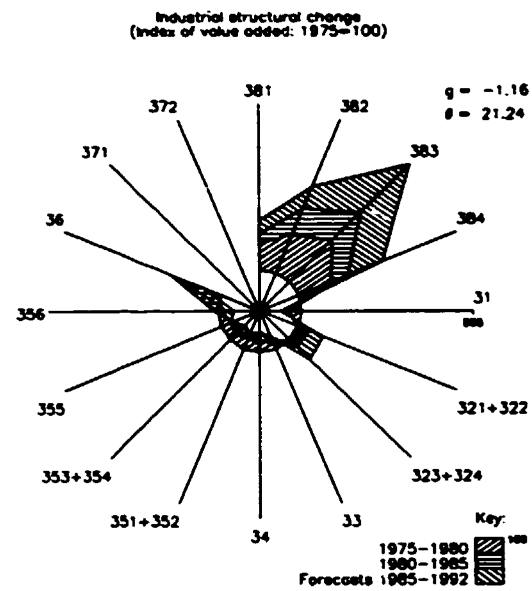


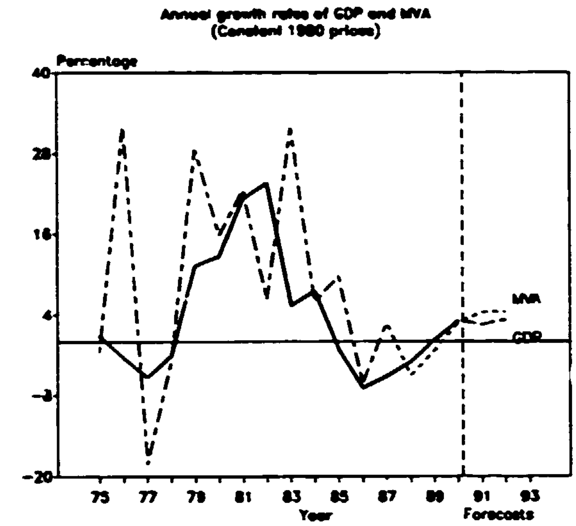
Manufacturing share in GDP current (%)



Industrial production index (1980=100)



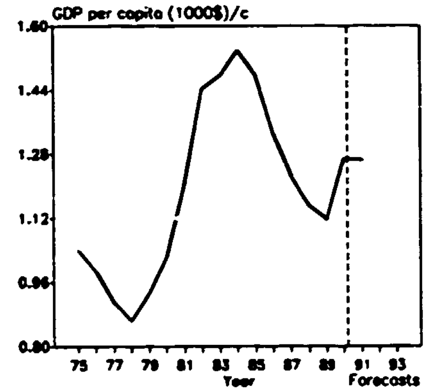


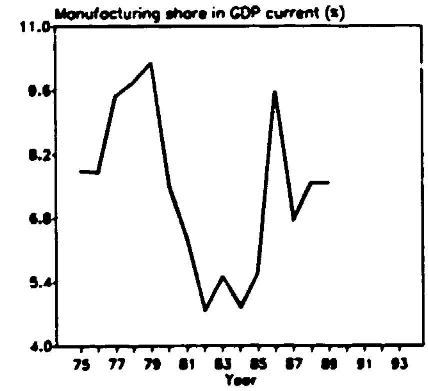


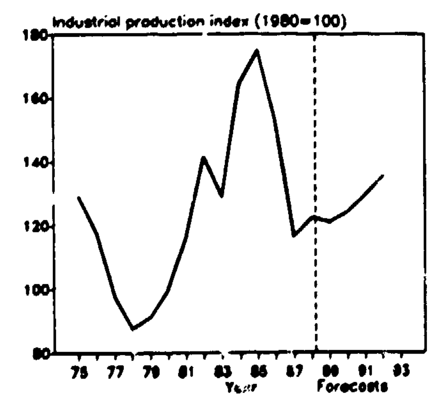
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

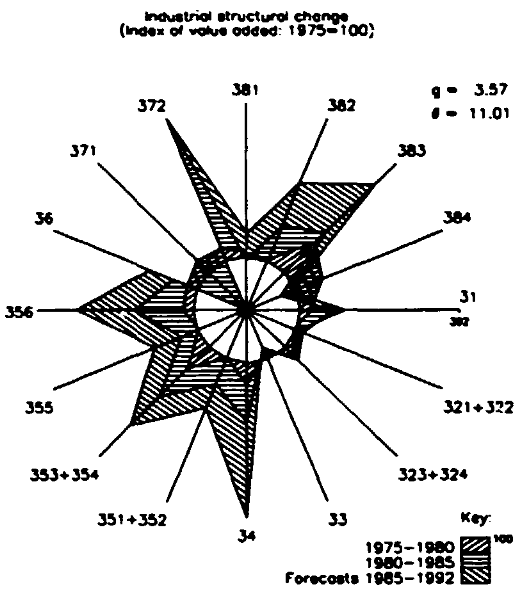
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	1706	2860	2455
Per capita (1980-dollars) /na,c	1022	1474	1116
Manufacturing share (%) /na (current prices)	7.5	5.6	7.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	128	256	231 /e
Industrial production index	100	175	121 /e
Value added (millions of dollars)	60 /e	56	80 /e
Gross output (millions of dollars)	169 /e	170	281 /e
Employment (thousands)	5 /e	9	9 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64 /e	67	72 /e
Wages and salaries (%)	13 /e	16 /e	17 /e
Operating surplus (%)	23 /e	17 /e	11 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	31519 /e	19386	30826 /e
Value added / worker	11286 /e	6368	8736 /e
Average wage	3948 /e	3086 /e	5234 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.86 /e	10.71 /e	4.57 /e
as a percentage of average θ in 1970-1975	64 /e	100 /e	43 /e
MVA growth rate / θ	-0.77	0.37	-1.25
Degree of specialization	15.7	16.8	13.9
-VALUE ADDED: (millions of dollars)			
311 Food products	10 /e	10	11 /e
313 Beverages	11 /e	11	13 /e
314 Tobacco products	3 /e	3	5 /e
321 Textiles	4 /e	3 /e	6 /e
322 Wearing apparel	1 /e	1 /e	2 /e
323 Leather and fur products	- /e	- /e	- /e
324 Footwear	3 /e	2	5 /e
331 Wood and wood products	5 /e	5 /e	7 /e
332 Furniture and fixtures	3 /e	3 /e	4 /e
341 Paper and paper products	1 /e	1	1 /e
342 Printing and publishing	1 /e	1	1 /e
351 Industrial chemicals	1 /e	1 /e	1 /e
352 Other chemical products	3 /e	2 /e	3 /e
353 Petroleum refineries	1 /e	1 /e	1 /e
354 Miscellaneous petroleum and coal products	- /e	- /e	- /e
355 Rubber products	1 /e	1 /e	1 /e
356 Plastic products	- /e	- /e	- /e
361 Pottery, china and earthenware	- /e	- /e	- /e
362 Glass and glass products	- /e	- /e	- /e
369 Other non-metal mineral products	1 /e	2 /e	2 /e
371 Iron and steel	- /e	-	- /e
372 Non-ferrous metals	- /e	-	- /e
381 Metal products	4 /e	4 /e	7 /e
382 Non-electrical machinery	1 /e	2 /e	3 /e
383 Electrical machinery	2 /e	2 /e	3 /e
384 Transport equipment	3 /e	2	4 /e
385 Professional and scientific equipment	- /e	-	- /e
390 Other manufacturing industries	- /e	-	- /e

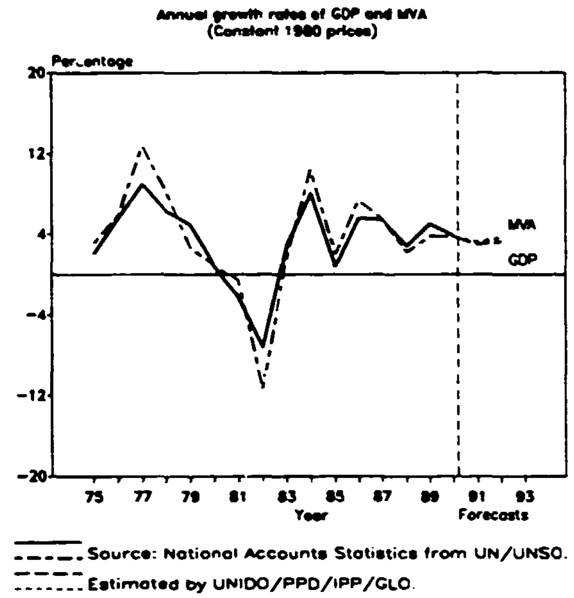
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.





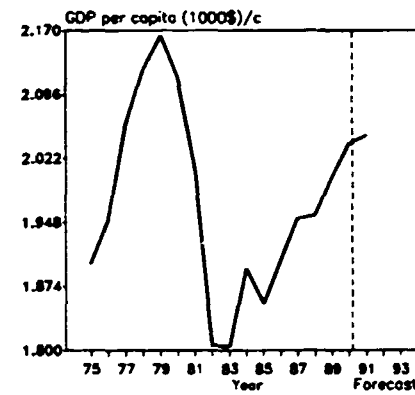


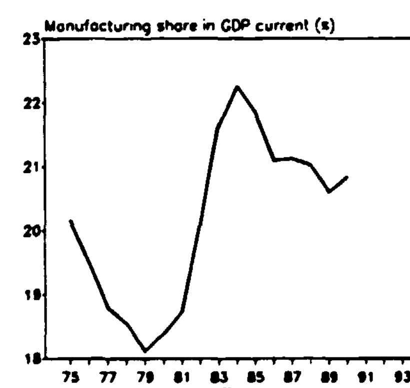


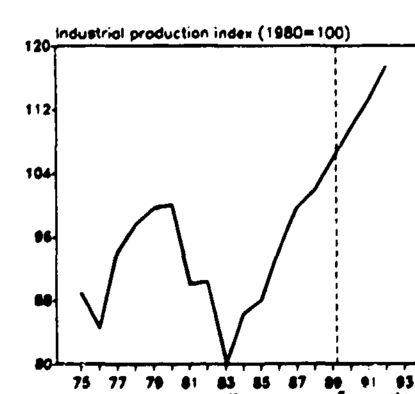


	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	4832	4900	5884
Per capita (1980-dollars) /na,c	2114	1854	2001
Manufacturing share (%) /na (current prices)	18.4	21.9	20.6
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	893	908	1090
Industrial production index	100	88	106
Value added (millions of dollars)	788	761	944
Gross output (millions of dollars)	2743	2466	3145
Employment (thousands)	59 /e	97 /e	114 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	71	69	70
Wages and salaries (%)	12	10 /e	9 /e
Operating surplus (%)	16	21 /e	21 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	43225 /e	23782 /e	25703 /e
Value added / worker	12637 /e	7406 /e	7772 /e
Average wage	5396 /e	2406 /e	2420 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.85	7.04	3.32
as a percentage of average θ in 1970-1975	81	199	94
MVA growth rate / θ	1.02	0.76	0.79
Degree of specialization	20.4	20.7	21.6
-VALUE ADDED: (millions of dollars)			
311 Food products	241	247	297
313 Beverages	96	94	116
314 Tobacco products	24	28	16
321 Textiles	33	23	28
322 Wearing apparel	31	34	29
323 Leather and fur products	7	5	6
324 Footwear	10	9	10
331 Wood and wood products	30	25	21
332 Furniture and fixtures	26	14	24
341 Paper and paper products	20	22	39
342 Printing and publishing	18	21	36
351 Industrial chemicals	19	26	34
352 Other chemical products	40	42	52
353 Petroleum refineries	40	45	55
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	14	15	19
356 Plastic products	19	26	38
361 Pottery, china and earthenware	1	2	2
362 Glass and glass products	3	7	8
369 Other non-metal mineral products	25	19	30
371 Iron and steel	4	-	- /e
372 Non-ferrous metals	1	-	- /e
381 Metal products	18	12	20
382 Non-electrical machinery	8	10	15
383 Electrical machinery	25	21	33
384 Transport equipment	31	10	14
385 Professional and scientific equipment	-	-	2 /e
390 Other manufacturing industries	2	3	3

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.







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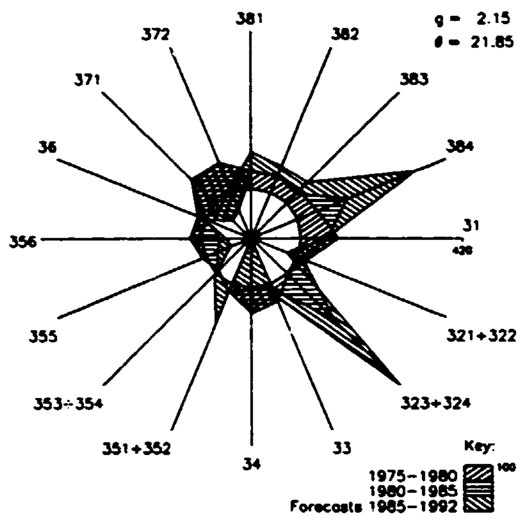
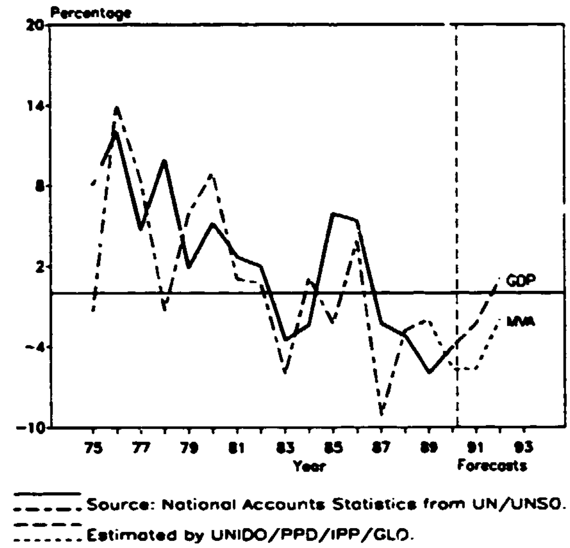
Industrial structural change
(Index of value added: 1975=100)

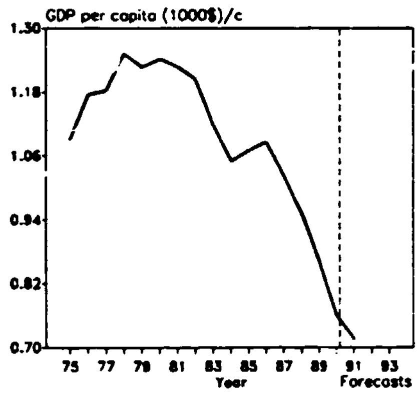


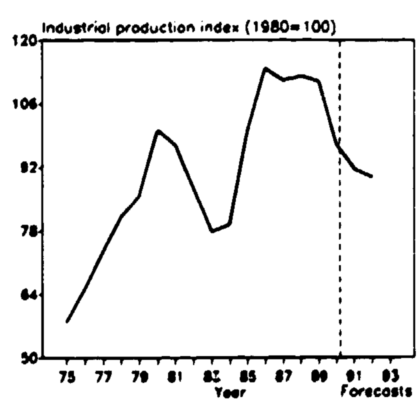
Annual growth rates of GDP and MVA
(Constant 1980 prices)



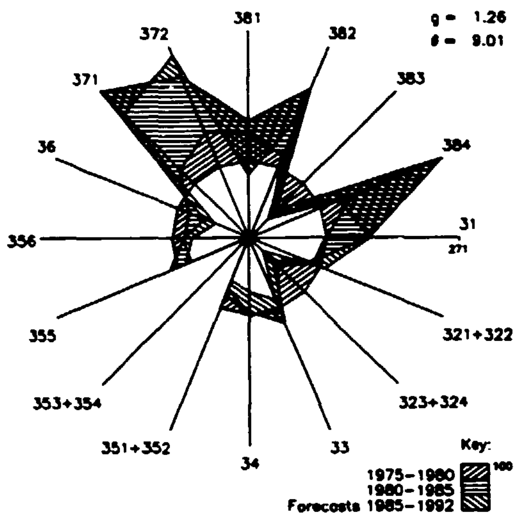
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	10176	10632	9962
Per capita (1980-dollars) /na.c	.42	1070	862
Manufacturing share (%) /na (current prices)	11.2	13.0	13.9 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1141	1078	970
Industrial production index	100	100	111
Value added (millions of dollars)	1273 /e	763 /e	1334 /e
Gross output (millions of dollars)	4006 /e	2989 /e	6031 /e
Employment (thousands)	67 /e	53 /e	50 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	68 /e	74 /e	78 /e
Wages and salaries (%)	10 /e	9 /e	9 /e
Operating surplus (%)	22 /e	16 /e	14 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	59631 /e	56007 /e	'24054 /e
Value added / worker	18950 /e	14306 /e	27435 /e
Average wage	5744 /e	5152 /e	10586 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.82 /e	4.59 /e	2.41 /e
as a percentage of average θ in 1970-1975	84 /e	49 /e	26 /e
MVA growth rate / θ	0.77	-0.09	0.89
Degree of specialization	23.5	25.1	23.7
-VALUE ADDED: (millions of dollars)			
311 Food products	303 /e	167 /e	278 /e
313 Beverages	75	43 /e	85 /e
314 Tobacco products	66 /e	30 /e	40 /e
321 Textiles	169 /e	100 /e	138 /e
322 Wearing apparel	8 /e	5 /e	7 /e
323 Leather and fur products	3 /e	4 /e	10 /e
324 Footwear	8 /e	10 /e	23 /e
331 Wood and wood products	67 /e	33 /e	59 /e
332 Furniture and fixtures	21 /e	10 /e	18 /e
341 Paper and paper products	14 /e	7 /e	...
342 Printing and publishing	22 /e	9 /e	...
351 Industrial chemicals	22 /e	11 /e	18 /e
352 Other chemical products	53 /e	36 /e	82 /e
353 Petroleum refineries	181 /e	115 /e	201 /e
354 Miscellaneous petroleum and coal products	- /e	- /e	- /e
355 Rubber products	4	2 /e	2 /e
356 Plastic products	1 /e	- /e	- /e
361 Pottery, china and earthenware	2 /e	2 /e	4 /e
362 Glass and glass products	- /e	- /e	- /e
369 Other non-metal mineral products	27 /e	14 /e	24 /e
371 Iron and steel	5 /e	1 /e	2 /e
372 Non-ferrous metals	3 /e	1 /e	2 /e
381 Metal products	70	43 /e	85 /e
382 Non-electrical machinery	3	2 /e	3 /e
383 Electrical machinery	20	12 /e	22 /e
384 Transport equipment	106	94 /e	209 /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	20	14 /e	21 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

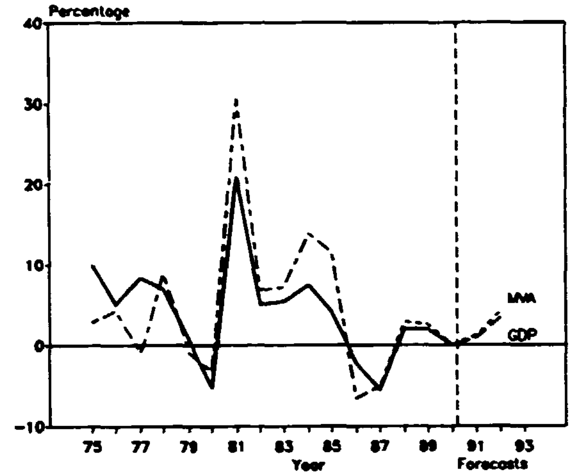




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

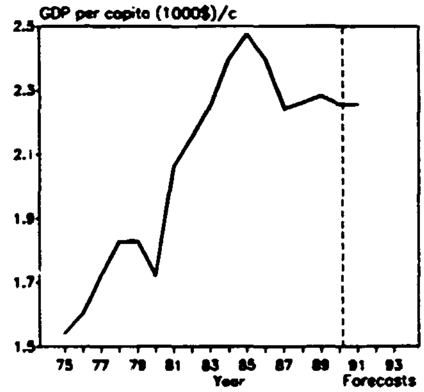


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	16653	24937	23969
Per capita (1980-dollars) /na.c	1721	2474	2282
Manufacturing share (%) /na (current prices)	35.8	34.1	33.6 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	5735	10899	1020, /e
Industrial production index	100	130	125 /e
Value added (millions of dollars)	4882	5120	5255
Gross output (millions of dollars)	9725	12032	13485
Employment (thousands)	501	654	700
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	50	57	61
Wages and salaries (%)	13 /e	14 /e	14 /e
Operating surplus (%)	37 /e	29 /e	25 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	19420	18386	19270
Value added / worker	9748	7824	7510
Average wage	2606 /e	2514 /e	2770 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.82 /e	3.37	3.52
as a percentage of average θ in 1970-1975	115 /e	138	144
MVA growth rate / θ	-0.22	2.03	0.08
Degree of specialization	26.0	31.4	34.5
-VALUE ADDED: (millions of dollars)			
311 Food products	665	957	905
313 Beverages	246	273	314
314 Tobacco products	1805	2004	2303
321 Textiles	50	40	95
322 Wearing apparel	146	98	79
323 Leather and fur products	53	32	27
324 Footwear	79	48	41
331 Wood and wood products	58	53	44
332 Furniture and fixtures	48	43	37
341 Paper and paper products	46	44	10
342 Printing and publishing	96	59	72
351 Industrial chemicals	72 /e	48 /e	55 /e
352 Other chemical products	329 /e	230 /e	237 /e
353 Petroleum refineries	...	...	...
354 Miscellaneous petroleum and coal products	...	...	...
355 Rubber products	101 /e	56 /e	72 /e
356 Plastic products	87 /e	67 /e	69 /e
361 Pottery, china and earthenware	8	6	7
362 Glass and glass products	17	13	18
369 Other non-metal mineral products	188	104	104
371 Iron and steel	27	44	36
372 Non-ferrous metals	41	48	57
381 Metal products	108	92	68
382 Non-electrical machinery	122 /e	170 /e	149 /e
383 Electrical machinery	60	58	52
384 Transport equipment	231 /e	325 /e	205 /e
385 Professional and scientific equipment	9 /e	21 /e	13 /e
390 Other manufacturing industries	201	188	187

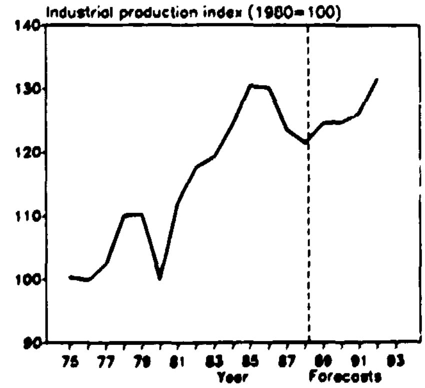
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

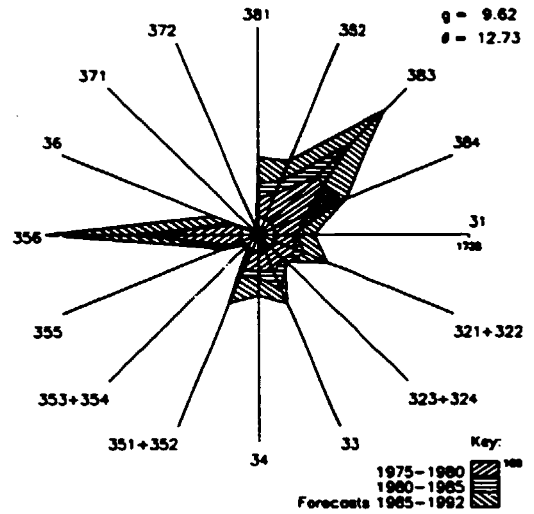


Manufacturing share in GDP current (%)

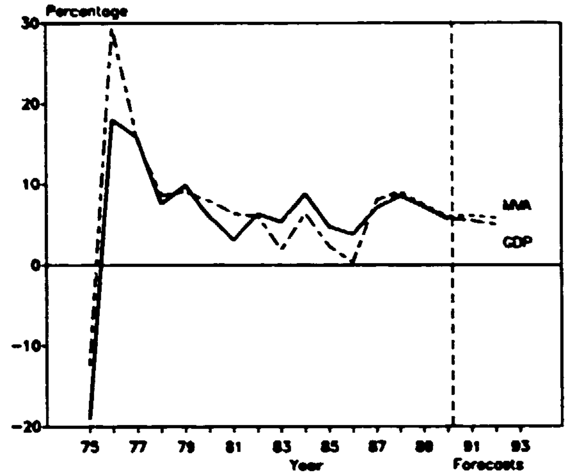
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



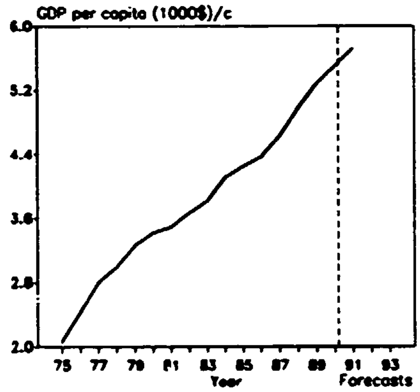
Annual growth rates of GDP and MVA
(Constant 1980 prices)

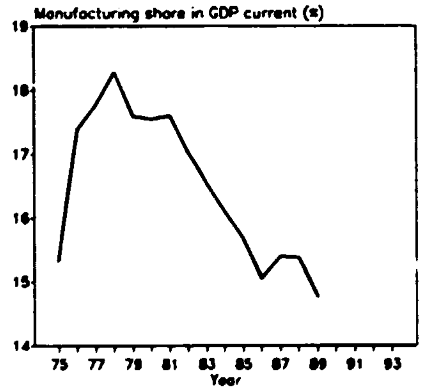


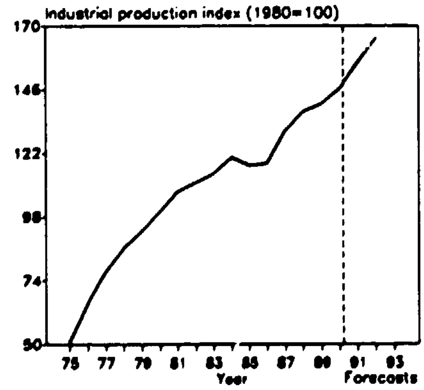
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	2154	2831	3660
Per capita (1980-dollars) /na,c	3419	4251	5274
Manufacturing share (%) /na (current prices)	17.5	15.7	14.8 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	378	473	601 /e
Industrial production index	100	117	140
Value added (millions of dollars)	406	378	670
Gross output (millions of dollars)	1134	1122	1855
Employment (thousands)	34	39	43
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	66	64
Wages and salaries (%)	13	16	17
Operating surplus (%)	22	18	19
-PRODUCTIVITY: (dollars)			
Gross output / worker	33325	28963	43605
Value added / worker	11923	9762	15761
Average wage	4479	4579	7283
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.28	4.59	4.37
as a percentage of average θ in 1970-1975	102	64	61
MVA growth rate / θ	3.03	0.70	1.41
Degree of specialization	11.3	11.7	13.0
-VALUE ADDED: (millions of dollars)			
311 Food products	42	49	85
313 Beverages	37	29	62
314 Tobacco products	36	26	37
321 Textiles	16	14	28
322 Wearing apparel	53	54	97
323 Leather and fur products	5	6	9
324 Footwear	21	19	26
331 Wood and wood products	19	23	35
332 Furniture and fixtures	17	22	30
341 Paper and paper products	11	8	12
342 Printing and publishing	15	18	30
351 Industrial chemicals	3	2	5
352 Other chemical products	12	12	24
353 Petroleum refineries	6	5	6
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	3	2	3
356 Plastic products	11	11	21
361 Pottery, china and earthenware	-	1	2
362 Glass and glass products	-	-	1
369 Other non-metal mineral products	44	24	59
371 Iron and steel	-	-	-
372 Non-ferrous metals	-	-	-
381 Metal products	23	28	45
382 Non-electrical machinery	11	12	20
383 Electrical machinery	5	6	11
384 Transport equipment	8	4	8
385 Professional and scientific equipment	-	-	-
390 Other manufacturing industries	7	7	16

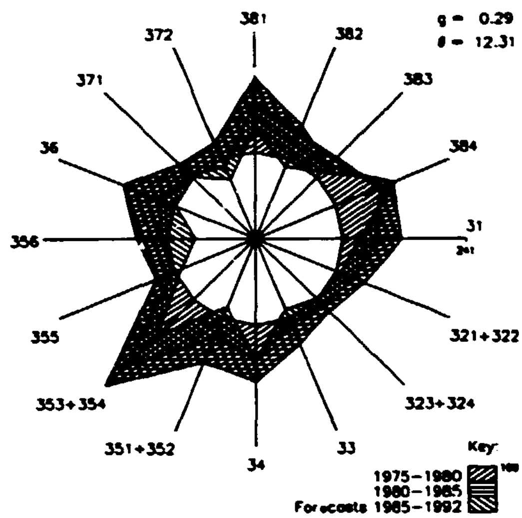
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



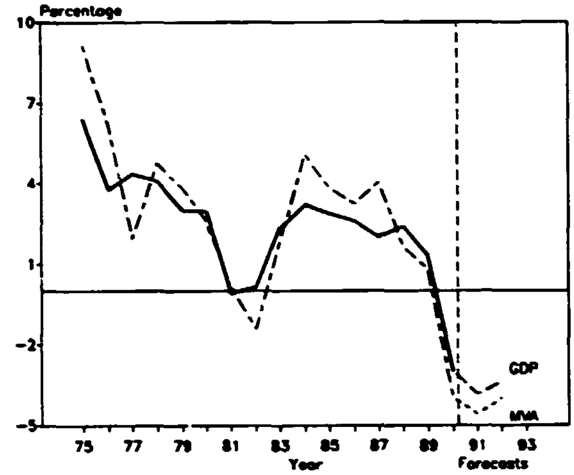




Industrial structural change
(Index of value added: 1975=100)



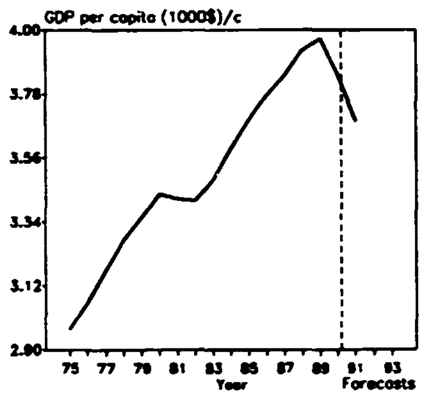
Annual growth rates of GDP and MVA
(Constant 1980 prices)

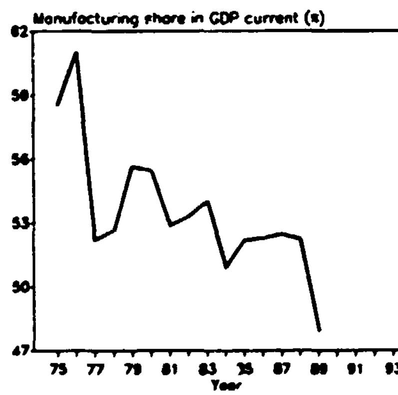


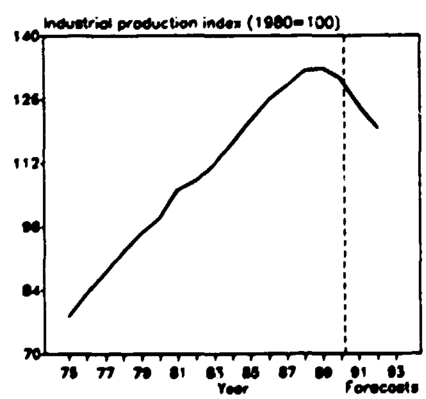
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	52602	57166	62060
Per capita (1980-dollars) /na,c	3435	3688	3970
Manufacturing share (%) /na (current prices)	55.4	52.2	47.9 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	29036	31831	35035
Industrial production index	100	121	133
Value added (millions of dollars)	17193	13083	15456
Gross output (millions of dollars)	41415	45108	53480
Employment (thousands)	2518	2588	2572
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	58	71	71
Wages and salaries (%)	13	12	12
Operating surplus (%)	28	17	17
-PRODUCTIVITY: (dollars)			
Gross output / worker	16448	17430	20793
Value added / worker	6828	5055	6010
Average wage	2217	2058	2522
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.32	2.96	3.12
as a percentage of average θ in 1970-1975	112	100	105
MVA growth rate / θ	2.34	-0.72	0.49
Degree of specialization	15.9	17.0	15.7
-VALUE ADDED: (millions of dollars)			
311 Food products	1257	911	1126
313 Beverages	285	209	272
314 Tobacco products	33	23	27
321 Textiles	1100	848	1046
322 Wearing apparel	271	236	281
323 Leather and fur products	94	69	94
324 Footwear	299	244	306
331 Wood and wood products	387	259	318
332 Furniture and fixtures	210	162	183
341 Paper and paper products	391	287	391
342 Printing and publishing	136	103	141
351 Industrial chemicals	1262	862	875
352 Other chemical products	178	130	162
353 Petroleum refineries	497	390	429
354 Miscellaneous petroleum and coal products	120	74	92
355 Rubber products	214	158	203
356 Plastic products	50	34	32
361 Pottery, china and earthenware	45	39	40
362 Glass and glass products	422	263	361
369 Other non-metal mineral products	773	488	574
371 Iron and steel	1753	1312	1910
372 Non-ferrous metals	327	214	264
381 Metal products	792	590	710
382 Non-electrical machinery	3452	2827	2866
383 Electrical machinery	853	828	1025
384 Transport equipment	1677	1315	1441
385 Professional and scientific equipment	94	67	94
390 Other manufacturing industries	223	140	194

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

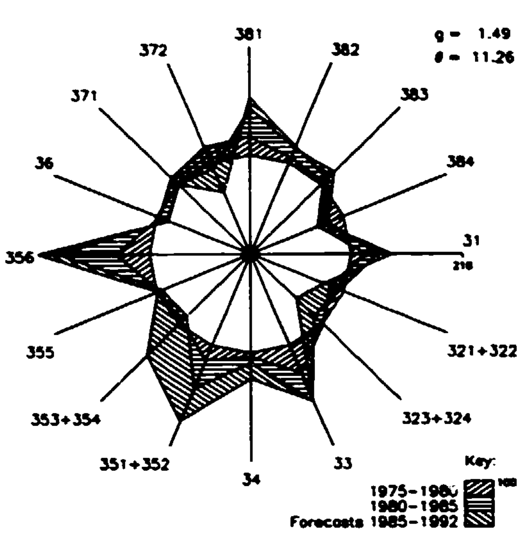




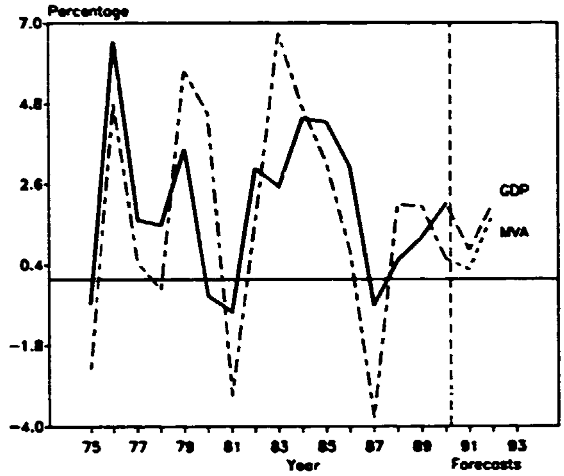


DENMARK

Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

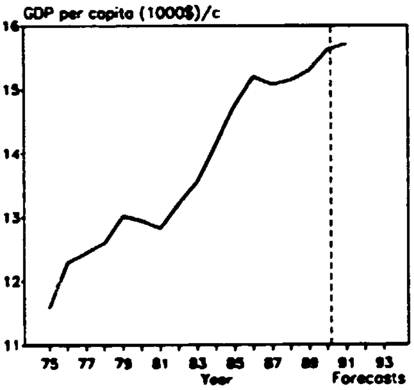


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

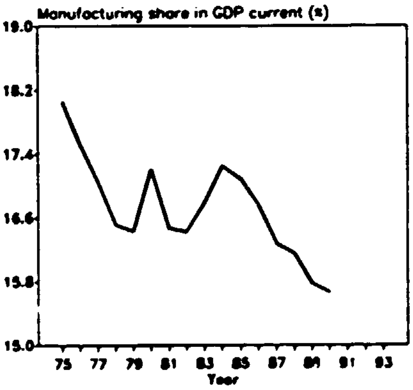
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	66321	75577	78631
Per capita (1980-dollars) /na,c	12943	14752	15301
Manufacturing share (%) /na (current prices)	17.2	17.1	15.8
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	11411	12938	13060
Industrial production index	100	121	130
Value added (millions of dollars)	12774	11184	20189
Gross output (millions of dollars)	31526	27652	46393
Employment (thousands)	381	405	390
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	60	56
Wages and salaries (%)	23	21	22
Operating surplus (%)	18	19	21
-PRODUCTIVITY: (dollars)			
Gross output / worker	82745	68311	118806
Value added / worker	33526	27629	51701
Average wage	19040	14310	26400
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.95	2.95	2.22
as a percentage of average θ in 1970-1975	95	95	72
MVA growth rate / θ	0.43	0.83	0.92
Degree of specialization	14.4	14.9	14.6
-VALUE ADDED: (millions of dollars)			
311 Food products	2344	2022	3609
313 Beverages	490	386	625
314 Tobacco products	109	96	225
321 Textiles	423	375	622
322 Wearing apparel	231	199	247
323 Leather and fur products	30	20	25
324 Footwear	62	43	54
331 Wood and wood products	285	219	447
332 Furniture and fixtures	330	371	618
341 Paper and paper products	315	275	557
342 Printing and publishing	941	752	1454
351 Industrial chemicals	551	498	924
352 Other chemical products	586	618	1259
353 Petroleum refineries	66	55	170
354 Miscellaneous petroleum and coal products	99	63	184
355 Rubber products	79	59	109
356 Plastic products	267	29'	546
361 Pottery, china and earthenware	87	41	56
362 Glass and glass products	98	60	96
369 Other non-metal mineral products	627	478	892
371 Iron and steel	175	124	242
372 Non-ferrous metals	71	46	66
381 Metal products	912	882	1636
382 Non-electrical machinery	1718	1475	2572
383 Electrical machinery	712	631	1082
384 Transport equipment	663	589	861
385 Professional and scientific equipment	284	304	568
390 Other manufacturing industries	219	211	444

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

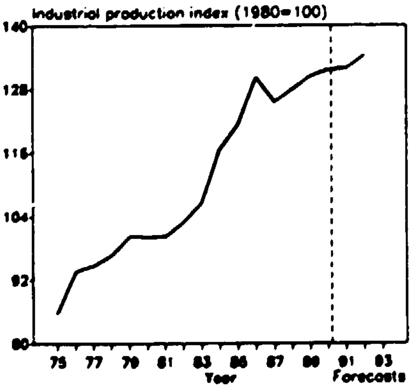
GDP per capita (1000$)/c



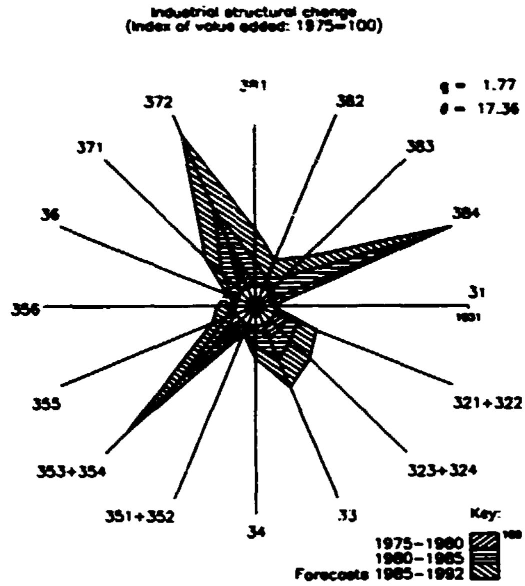
Manufacturing share in GDP current (%)

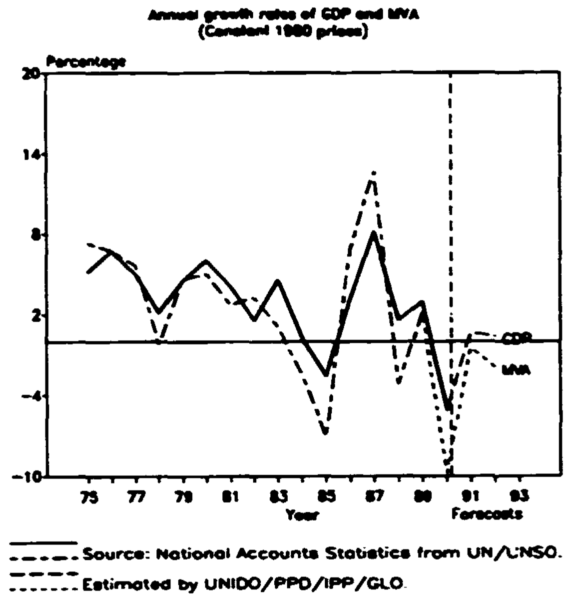


Industrial production index (1980=100)



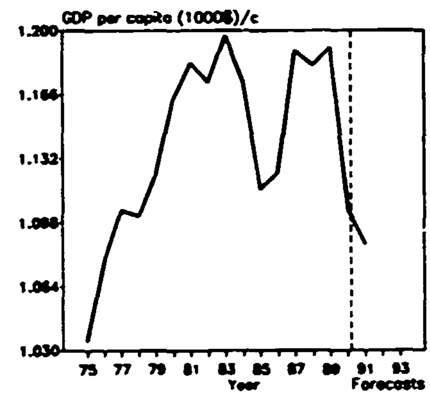
DOMINICAN REPUBLIC

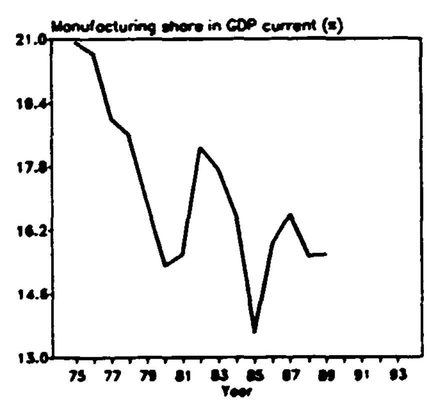


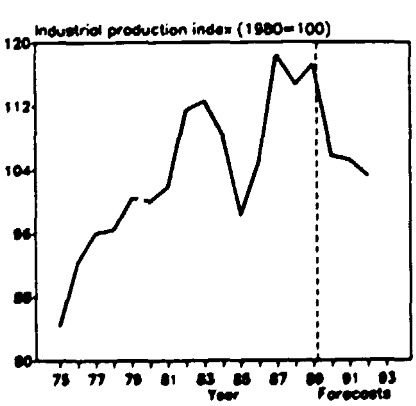


	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	6631	7159	8358
Per capita (1980-dollars) /na,c	1164	1116	1191
Manufacturing share (%) /na (current prices)	15.3	13.6	15.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	1015	986	1175
Industrial production index	100	98	117
Value added (millions of dollars)	1013	815 /e	1252 /e
Gross output (millions of dollars)	2376	1894 /e	2887 /e
Employment (thousands)	146	131	133 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	57	57 /e	57 /e
Wages and salaries (%)	11	7 /e	6 /e
Operating surplus (%)	31	36 /e	38 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	16284	14427 /e	21786 /e
Value added / worker	6940	6211 /e	9451 /e
Average wage	1867	998	1230 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.23	3.09 /e	1.77 /e
as a percentage of average θ in 1970-1975	63	87 /e	50 /e
MVA growth rate / θ	-0.63	1.19	1.74
Degree of specialization	39.0	29.3	26.5
-VALUE ADDED: (millions of dollars)			
311 Food products	510	300 /e	400 /e
313 Beverages	103	106 /e	167 /e
314 Tobacco products	50	50 /e	81 /e
321 Textiles	29	30 /e	53 /e
322 Wearing apparel	13	9 /e	11 /e
323 Leather and fur products	11	9 /e	15 /e
324 Footwear	13	15 /e	26 /e
331 Wood and wood products	2	3 /e	3 /e
332 Furniture and fixtures	11	13 /e	23 /e
341 Paper and paper products	19	23 /e	38 /e
342 Printing and publishing	14	15 /e	24 /e
351 Industrial chemicals	18	14 /e	20 /e
352 Other chemical products	41	31 /e	49 /e
353 Petroleum refineries	66	77 /e	138 /e
354 Miscellaneous petroleum and coal products	1	- /e	- /e
355 Rubber products	6	7 /e	11 /e
356 Plastic products	21	16 /e	28 /e
361 Pottery, china and earthenware	1	1 /e	1 /e
362 Glass and glass products	3	5 /e	8 /e
369 Other non-metal mineral products	32	30 /e	47 /e
371 Iron and steel	10	15 /e	25 /e
372 Non-ferrous metals	1	1 /e	2 /e
381 Metal products	21	31 /e	55 /e
382 Non-electrical machinery	5	4 /e	8 /e
383 Electrical machinery	7	7 /e	13 /e
384 Transport equipment	-	- /e	- /e
385 Professional and scientific equipment	1	1 /e	1 /e
390 Other manufacturing industries	2	2 /e	3 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

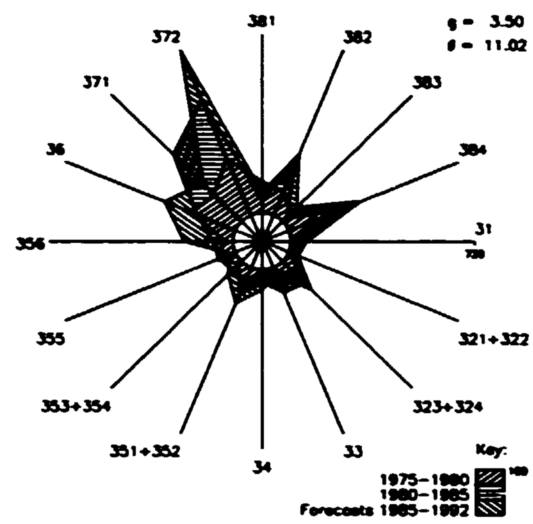




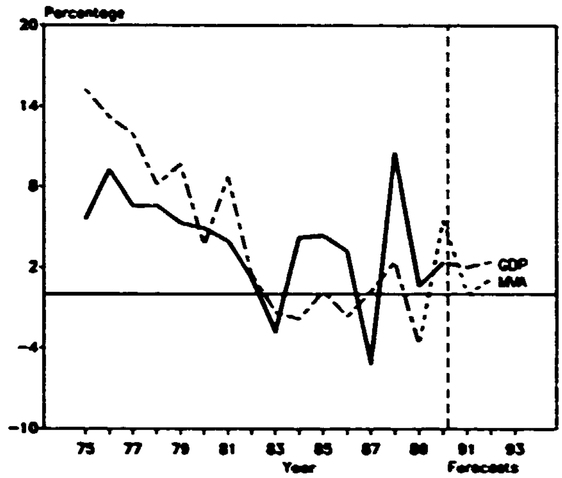


ECUADOR

Industrial structural change
(Index of value added: 1975=100)



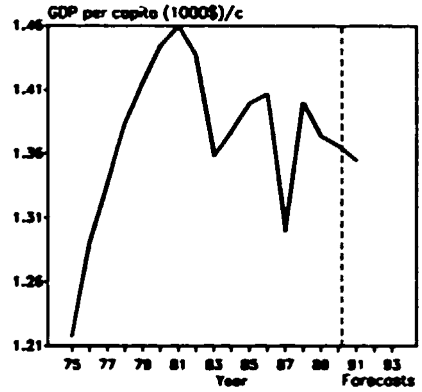
Annual growth rates of GDP and MVA
(Constant 1980 prices)

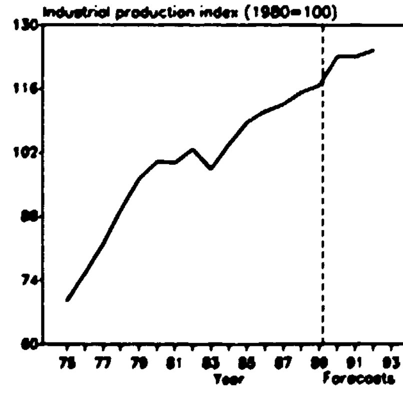


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

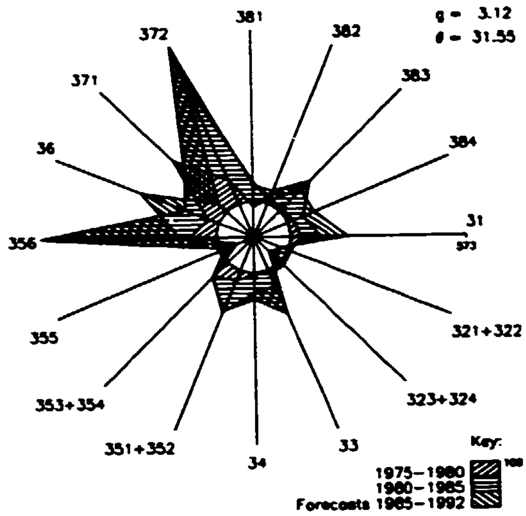
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	11733	13040	14184
Per capita (1980-dollars) /na,c	1444	1399	1374
Manufacturing share (%) /na (current prices)	17.7	18.9	21.8
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	2072	2219	2156
Industrial production index	100	109	117
Value added (millions of dollars)	1289	1322	1022 /e
Gross output (millions of dollars)	3571	4379	3894 /e
Employment (thousands)	112	97	113 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	70	74 /e
Wages and salaries (%)	14	12	9 /e
Operating surplus (%)	22	18	17 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	31961	45232	34409 /e
Value added / worker	11536	13654	9030 /e
Average wage	4547	5393	3118 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.08	8.86	5.21 /e
as a percentage of average θ in 1970-1975	210	154	91 /e
MVA growth rate / θ	0.91	-0.23	0.96
Degree of specialization	17.2	16.7	19.5
-VALUE ADDED: (millions of dollars)			
311 Food products	294	328	302 /e
313 Beverages	96	65	38 /e
314 Tobacco products	46	17	12 /e
321 Textiles	134	146	100 /e
322 Wearing apparel	20	15	10 /e
323 Leather and fur products	7	6	4 /e
324 Footwear	6	7	6 /e
331 Wood and wood products	35	18	19 /e
332 Furniture and fixtures	28	23	12 /e
341 Paper and paper products	42	41	33 /e
342 Printing and publishing	40	35	34 /e
351 Industrial chemicals	25	32	33 /e
352 Other chemical products	90	76	55 /e
353 Petroleum refineries	29	38	32 /e
354 Miscellaneous petroleum and coal products	4	14	12 /e
355 Rubber products	25	29	12 /e
356 Plastic products	34	57	46 /e
361 Pottery, china and earthenware	7	15	10 /e
362 Glass and glass products	9	15	10 /e
369 Other non-metal mineral products	100	101	78 /e
371 Iron and steel	25	56	20 /e
372 Non-ferrous metals	5	10	7 /e
381 Metal products	93	78	54 /e
382 Non-electrical machinery	4	[illegible]	4 /e
383 Electrical machinery	59	58	51 /e
384 Transport equipment	23	23	17 /e
385 Professional and scientific equipment	2	9	8 /e
390 Other manufacturing industries	7	5	6 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

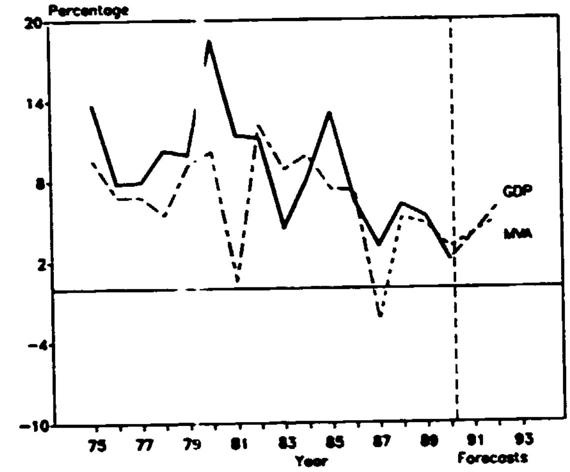




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

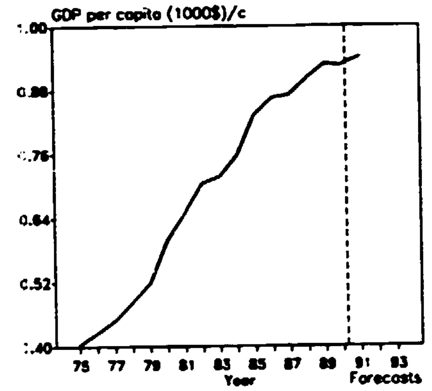


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

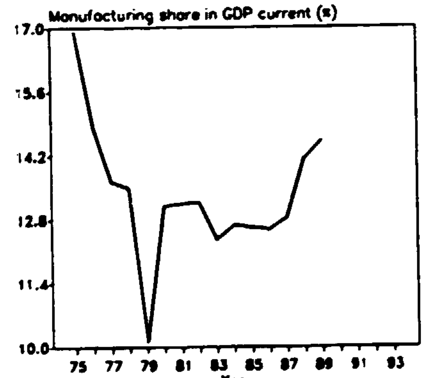
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	24499	38751	47546
Per capita (1980-dollars) /na,c	599	833	928
Manufacturing share (%) /na (current prices)	13.1	12.6	14.5 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	3220	4664	5381 /e
Industrial production index	100	162	159
Value added (millions of dollars)	2243	5467	7121 /e
Gross output (millions of dollars)	8856	18995	26751 /e
Employment (thousands)	868	917	968 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	75	71	73 /e
Wages and salaries (%)	14	16	15 /e
Operating surplus (%)	11	13	11 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	10205	20708	27648 /e
Value added / worker	2585	5961	7360 /e
Average wage	1473	3336	4257 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.87	15.59	8.35 /e
as a percentage of average θ in 1970-1975	97	220	118 /e
MVA growth rate / θ	0.60	0.31	0.07
Degree of specialization	22.6	14.8	16.6
-VALUE ADDED: (millions of dollars)			
311 Food products	391	789	1364 /e
313 Beverages	18	132	270 /e
314 Tobacco products	26	245	300 /e
321 Textiles	641	919	1170 /e
322 Wearing apparel	7	28	36 /e
323 Leather and fur products	3	13	30 /e
324 Footwear	28	18	27 /e
331 Wood and wood products	11	45	33 /e
332 Furniture and fixtures	9	36	29 /e
341 Paper and paper products	54	142	135 /e
342 Printing and publishing	50	189	199 /e
351 Industrial chemicals	87	272	292 /e
352 Other chemical products	110	384	506 /e
353 Petroleum refineries	50	110	141 /e
354 Miscellaneous petroleum and coal products	77	145	174 /e
355 Rubber products	16	52	52 /e
356 Plastic products	42	-39	143 /e
361 Pottery, china and earthenware	8	22	75 /e
362 Glass and glass products	22	41	74 /e
369 Other non-metal mineral products	99	312	525 /e
371 Iron and steel	112	184	123 /e
372 Non-ferrous metals	81	523	421 /e
381 Metal products	53	178	248 /e
382 Non-electrical machinery	68	156	129 /e
383 Electrical machinery	88	338	308 /e
384 Transport equipment	82	199	284 /e
385 Professional and scientific equipment	5	25	27 /e
390 Other manufacturing industries	2	11	13 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

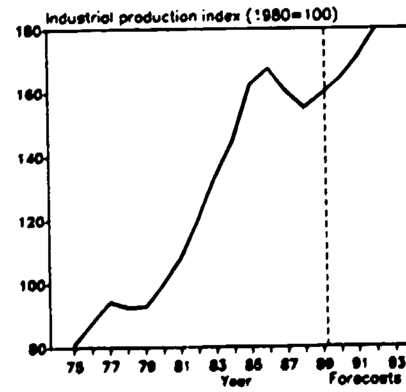
GDP per capita (1000$)/c



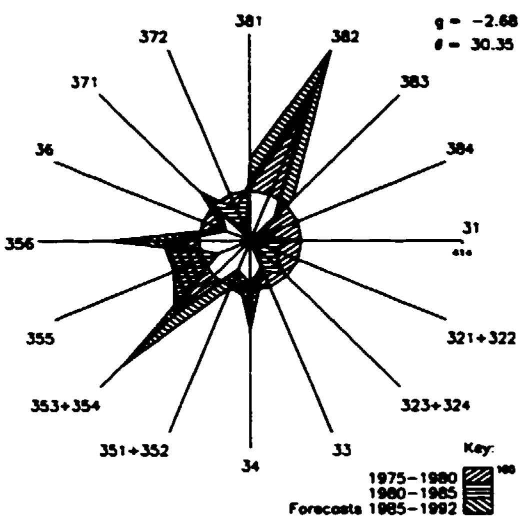
Manufacturing share in GDP current (%)



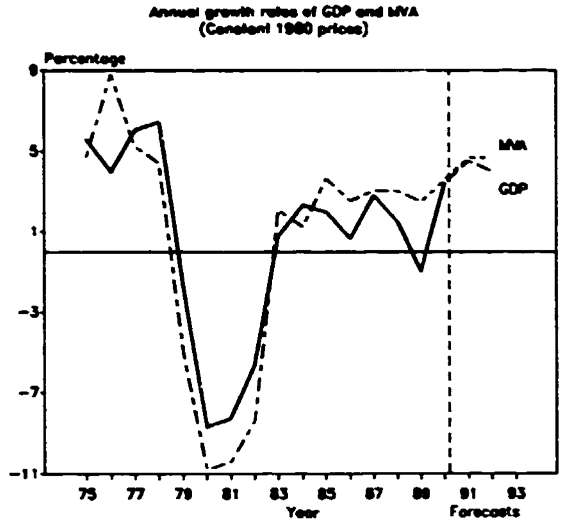
Industrial production index (1980=100)



Industrial structural change
(index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

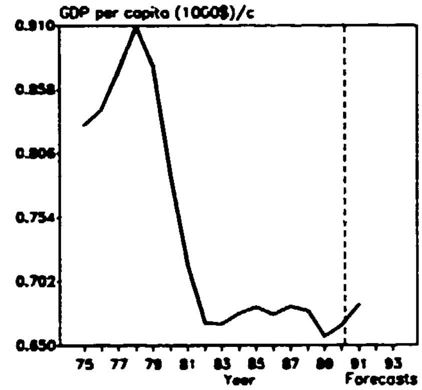


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

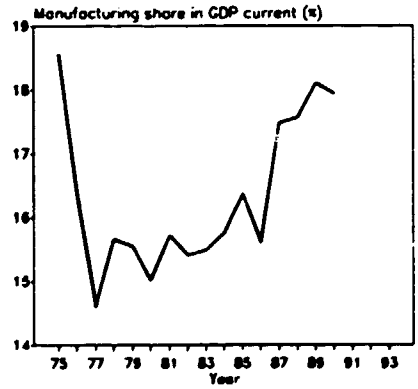
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	3567	3247	3375
Per capita (1980-dollars) /na,c	788	681	657
Manufacturing share (%) /na (current prices)	15.0	16.4	18.1
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	536	471	525
Industrial production index	100	83	93
Value added (millions of dollars)	448	393	735 /e
Gross output (millions of dollars)	1130	860	1587 /e
Employment (thousands)	39	25	25 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	54	54 /e
Wages and salaries (%)	12	9 /e	9 /e
Operating surplus (%)	27	37 /e	38 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	28857	34129	63062 /e
Value added / worker	11426	15596	29222 /e
Average wage	3583	3048 /e	5427 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	11.59	9.32	5.12 /e
as a percentage of average θ in 1970-1975	262	211	116 /e
MVA growth rate / θ	-0.32	-0.77	0.44
Degree of specialization	19.1	18.0	19.5
-VALUE ADDED: (millions of dollars)			
311 Food products	78	55	81 /e
313 Beverages	63	59	108 /e
314 Tobacco products	26	29	47 /e
321 Textiles	62	40	59 /e
322 Wearing apparel	16	10	19 /e
323 Leather and fur products	5	5	8 /e
324 Footwear	13	1	1 /e
331 Wood and wood products	1	-	- /e
332 Furniture and fixtures	3	4	7 /e
341 Paper and paper products	40	24	51 /e
342 Printing and publishing	8	8	12 /e
351 Industrial chemicals	4	7	11 /e
352 Other chemical products	46	57	129 /e
353 Petroleum refineries	14	20	47 /e
354 Miscellaneous petroleum and coal products	2	-	2 /e
355 Rubber products	4	3	4 /e
356 Plastic products	13	15	36 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	-	-	- /e
369 Other non-metal mineral products	11	13	23 /e
371 Iron and steel	9	7	14 /e
372 Non-ferrous metals	1	1	1 /e
381 Metal products	10	12	26 /e
382 Non-electrical machinery	6	7	15 /e
383 Electrical machinery	9	12	27 /e
384 Transport equipment	1	-	1 /e
385 Professional and scientific equipment	-	1	1 /e
390 Other manufacturing industries	4	2	5 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

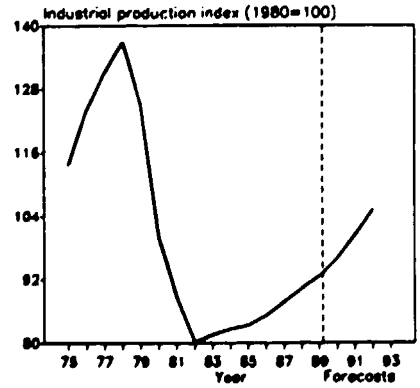
GDP per capita (1000$)/c

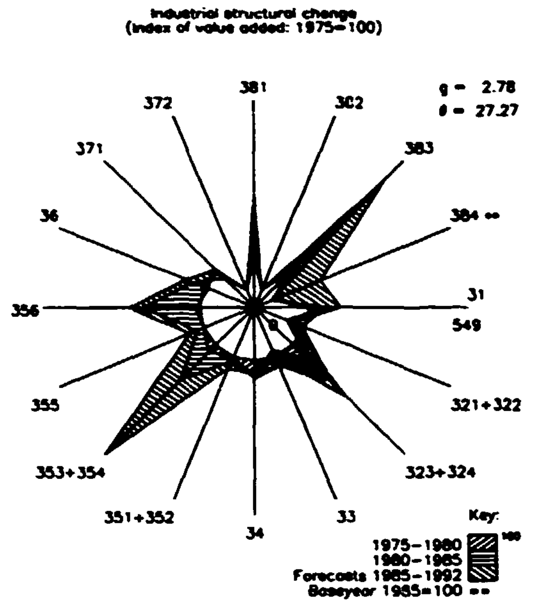


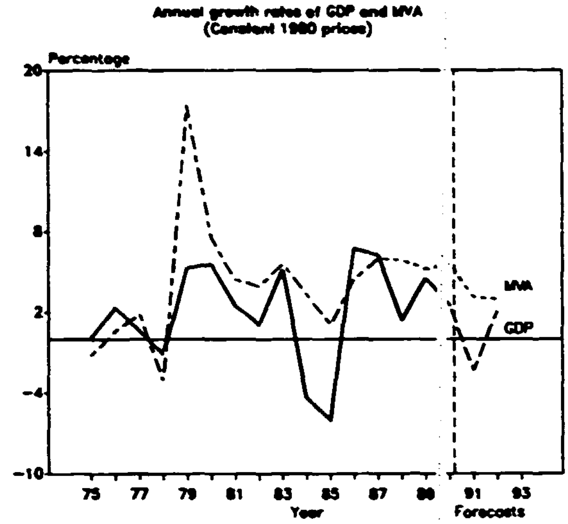
Manufacturing share in GDP current (%)



Industrial production index (1980=100)



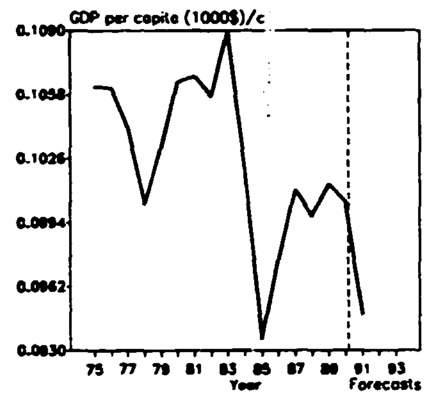


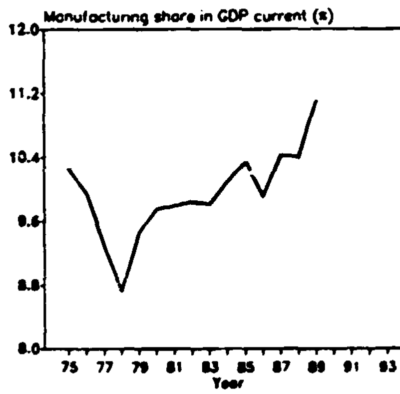


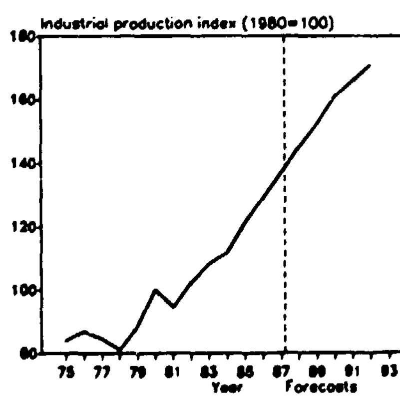
Source: National Accounts Statistics fr m UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	4123	4034	4847
Per capita (1980-dollars) /na,c	106	94	101
Manufacturing share (%) /na (current prices)	9.8	10.3	11.1 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	401	480	591 /e
Industrial production index	100	121	152 /e
Value added (millions of dollars)	459	577	868 /e
Gross output (millions of dollars)	1016	1375	1848 /e
Employment (thousands)	77	88	102 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	55	58	53 /e
Wages and salaries (%)	8	9	9 /e
Operating surplus (%)	37	33	38 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	13263	15628	18083 /e
Value added / worker	5993	6557	8490 /e
Average wage	1079	1332	1631 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	9.90	5.78	5.49 /e
as a percentage of average θ in 1970-1975	172	100	95 /e
MVA growth rate / θ	0.59	-0.43	0.52
Degree of specialization	25.8	21.7	22.4
-VALUE ADDED:(millions of dollars)			
311 Food products	110	114	152 /e
313 Beverages	83	141	198 /e
314 Tobacco products	30	35	69 /e
321 Textiles	106	89	114 /e
322 Wearing apparel	3	11	12 /e
323 Leather and fur products	14	13	32 /e
324 Footwear	10	10	13 /e
331 Wood and wood products	8	6	9 /e
332 Furniture and fixtures	2	4	6 /e
341 Paper and paper products	9	9	6 /e
342 Printing and publishing	11	17	21 /e
351 Industrial chemicals	1	1	2 /e
352 Other chemical products	13	21	25 /e
353 Petroleum refineries	20	54	112 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	8	13	14 /e
356 Plastic products	3	11	13 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	2	4	5 /e
369 Other non-metal mineral products	8	19	22 /e
371 Iron and steel	9	8	13 /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	7	12	14 /e
382 Non-electrical machinery	-	-	- /e
383 Electrical machinery	-	1	1 /e
384 Transport equipment	-	7	14 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	-	-	- /e

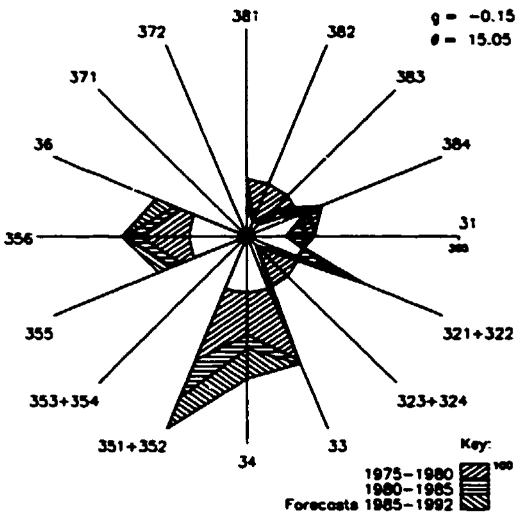
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



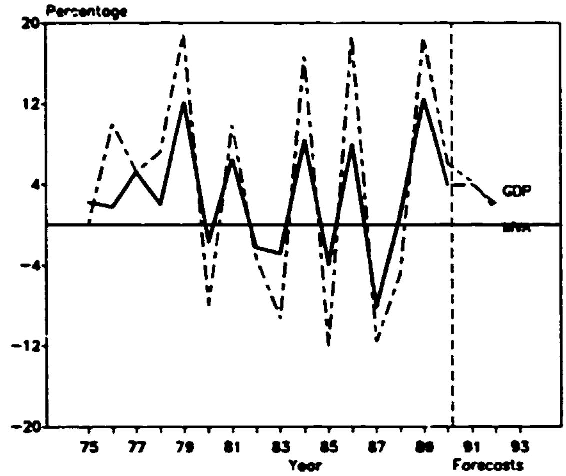




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)



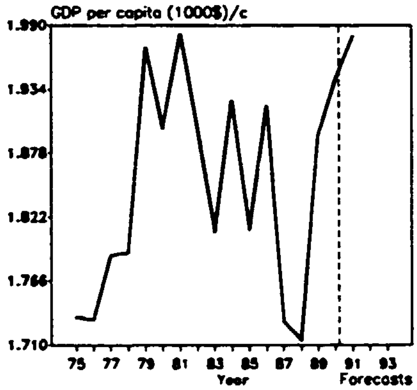
Source: National Accounts Statistics from UN/UNSO.

Estimated by UNIDO/PPD/IPP/GLO.

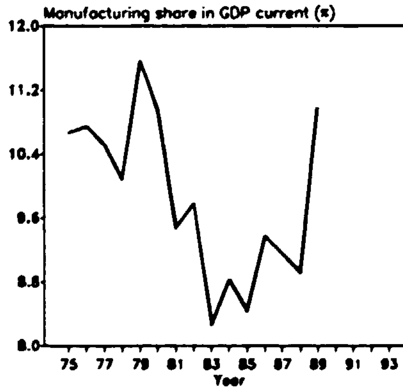
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	1204	1268	1424
Per capita (1980-dollars) /na,c	1900	1811	1894
Manufacturing share (%) /na (current prices)	10.9	8.4	11.0 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	132	131	155
Industrial production index	100	89	101
Value added (millions of dollars)	121	90	98 /e
Gross output (millions of dollars)	489	395	461 /e
Employment (thousands)	13	13	15 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	75	77	79 /e
Wages and salaries (%)	11	13	13 /e
Operating surplus (%)	14	9	9 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	38543	29825	31654 /e
Value added / worker	9577	5808	6767 /e
Average wage	4114	3990	4061 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.75	6.69	2.04 /e
as a percentage of average θ in 1970-1975	81	145	44 /e
MVA growth rate / θ	1.43	-0.67	0.90
Degree of specialization	40.4	24.3	20.9
-VALUE ADDED: (millions of dollars)			
311 Food products	71	37	36 /e
313 Beverages	6	7	9 /e
314 Tobacco products	2	2	2 /e
321 Textiles	-	-	- /e
322 Wearing apparel	2	4	5 /e
323 Leather and fur products	-	-	- /e
324 Footwear	-	-	- /e
331 Wood and wood products	7	6	6 /e
332 Furniture and fixtures	3	3	4 /e
341 Paper and paper products	2	2	3 /e
342 Printing and publishing	4	5	6 /e
351 Industrial chemicals	-	-	- /e
352 Other chemical products	4	5	6 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	1	1	1 /e
356 Plastic products	2	2	2 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	-	-	- /e
369 Other non-metal mineral products	6	7	8 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	6	4	4 /e
382 Non-electrical machinery	1	1	1 /e
383 Electrical machinery	-	1	1 /e
384 Transport equipment	4	3	4 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	-	1	1 /e

For sourc.s, footnotes and comments see "Technical notes" at the beginning of this Annex.

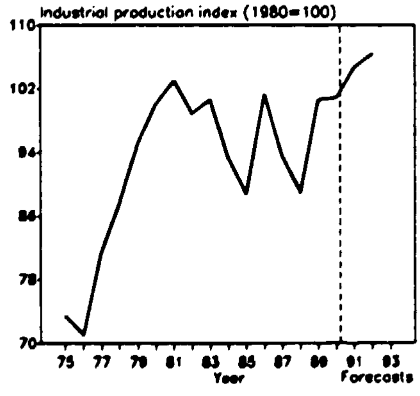
GDP per capita (1000$)/c



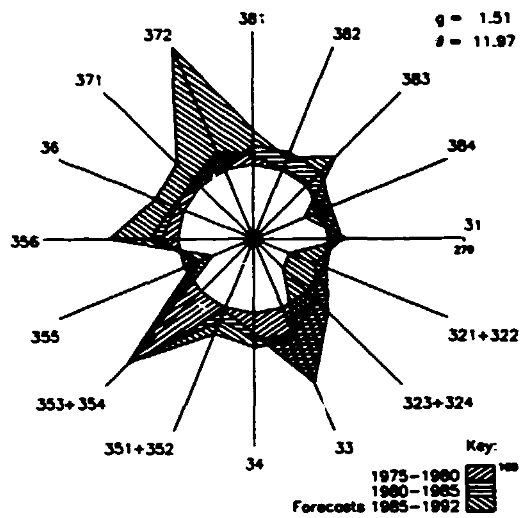
Manufacturing share in GDP current (%)



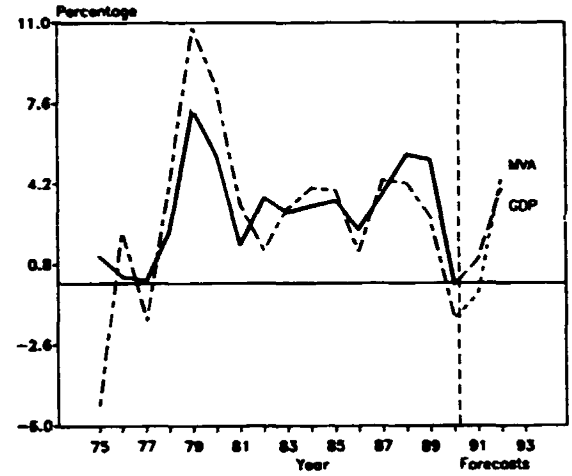
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

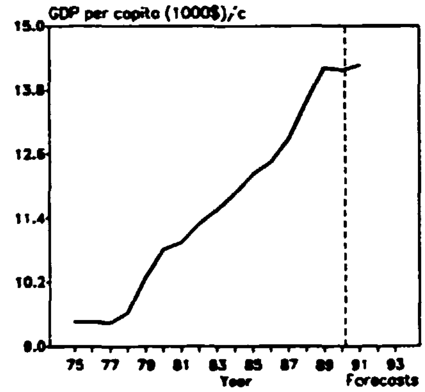


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

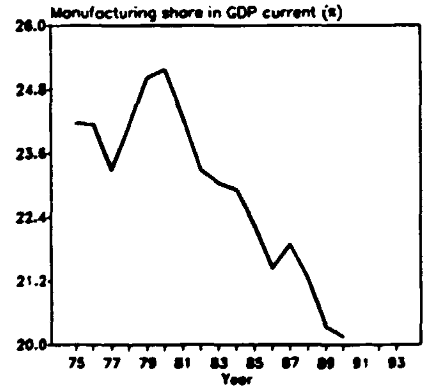
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	51696	59902	70546
Per capita (1980-dollars) /na,c	10815	12217	14212
Manufacturing share (%) /na (current prices)	25.2	22.3	20.3
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	12998	15184	17203
Industrial production index	100	115	132
Value added (millions of dollars)	14343	13598	24435
Gross output (millions of dollars)	40839	36968	65600
Employment (thousands)	531	496	443
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	65	63	63
Wages and salaries (%)	15	16	16
Operating surplus (%)	20	21	21
-PRODUCTIVITY: (dollars)			
Gross output / worker	76910	74563	148110
Value added / worker	27012	27426	55170
Average wage	11904	11888	23659
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.33	5.51	4.94
as a percentage of average θ in 1970-1975	85	74	67
MVA growth rate / θ	0.58	0.17	0.19
Degree of specialization	13.3	13.8	14.1
-VALUE ADDED: (millions of dollars)			
311 Food products	1402	1418	2321
313 Beverages	225	227	568
314 Tobacco products	46	58	119
321 Textiles	469	310	412
322 Wearing apparel	499	434	422
323 Leather and fur products	54	37	45
324 Footwear	134	106	98
331 Wood and wood products	1196	662	1297
332 Furniture and fixtures	257	215	475
341 Paper and paper products	2088	1846	3890
342 Printing and publishing	1080	1223	1853
351 Industrial chemicals	555	561	1244
352 Other chemical products	349	371	623
353 Petroleum refineries	445	384	536
354 Miscellaneous petroleum and coal products	46	47	93
355 Rubber products	106	84	124
356 Plastic products	164	168	322
361 Pottery, china and earthenware	46	40	72
362 Glass and glass products	106	77	144
369 Other non-metal mineral products	434	432	940
371 Iron and steel	544	463	942
372 Non-ferrous metals	142	103	445
381 Metal products	756	766	1618
382 Non-electrical machinery	1469	1618	2622
383 Electrical machinery	694	763	1556
384 Transport equipment	823	915	1206
385 Professional and scientific equipment	110	166	293
390 Other manufacturing industries	107	111	157

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

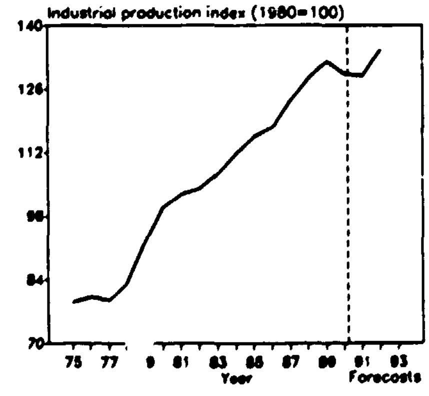
GDP per capita (1000$)/c



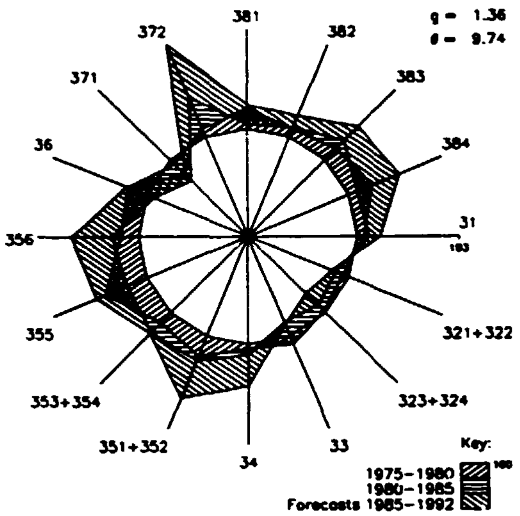
Manufacturing share in GDP current (%)



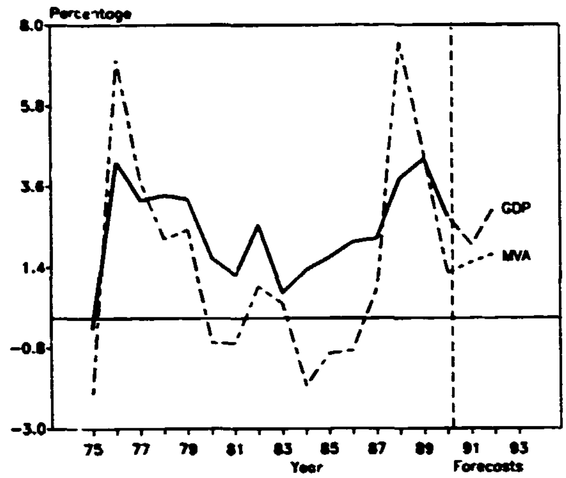
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

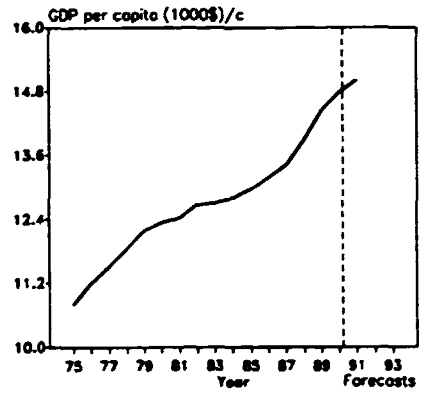


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

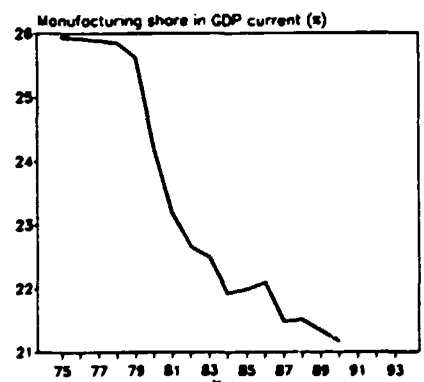
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	664529	715031	807893
Per capita (1980-dollars) /na,c	12333	12960	14439
Manufacturing share (%) /na (current prices)	24.2	22.0	21.3
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	160795	157263	176468
Industrial production index	100	95	106
Value added (millions of dollars)	161552	115430	205249
Gross output (millions of dollars)	453636	326412	550124
Employment (thousands)	5103	4470	4185
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	65	63
Wages and salaries (%)	24	23	23
Operating surplus (%)	11	12	14
-PRODUCTIVITY: (dollars)			
Gross output / worker	88896	73020	131464
Value added / worker	31658	25822	49049
Average wage	21643	17129	30708
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.70	2.83	2.61
as a percentage of average θ in 1970-1975	84	64	59
MVA growth rate / θ	0.57	-0.15	0.90
Degree of specialization	10.4	11.1	11.4
-VALUE ADDED: (millions of dollars)			
311 Food products	15952	12825	21240
313 Beverages	3486	2268	3588
314 Tobacco products	1497	948	1518
321 Textiles	6130	4239	6839
322 Wearing apparel	4742	3104	4850
323 Leather and fur products	757	527	828
324 Footwear	1411	929	1190
331 Wood and wood products	2888	1704	2700
332 Furniture and fixtures	2846	1632	2958
341 Paper and paper products	3592	2817	5053
342 Printing and publishing	6660	5069	10309
351 Industrial chemicals	6462	4669	9403
352 Other chemical products	6302	4996	9366
353 Petroleum refineries	9973	8127	12962
354 Miscellaneous petroleum and coal products	118	78	144
355 Rubber products	2483	1544	2767
356 Plastic products	3083	2415	4934
361 Pottery, china and earthenware	639	367	657
362 Glass and glass products	2170	1366	2572
369 Other non-metal mineral products	5653	3153	6425
371 Iron and steel	6741	3788	7026
372 Non-ferrous metals	2479	2340	4949
381 Metal products	12119	7792	14213
382 Non-electrical machinery	16245	11998	19822
383 Electrical machinery	14411	11491	19148
384 Transport equipment	17733	11316	24029
385 Professional and scientific equipment	2206	1752	3431
390 Other manufacturing industries	2772	2178	2337

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

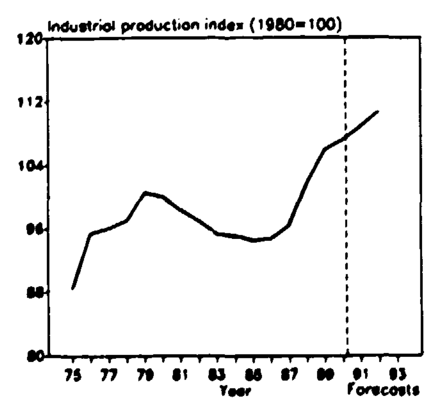
GDP per capita (1000$)/c



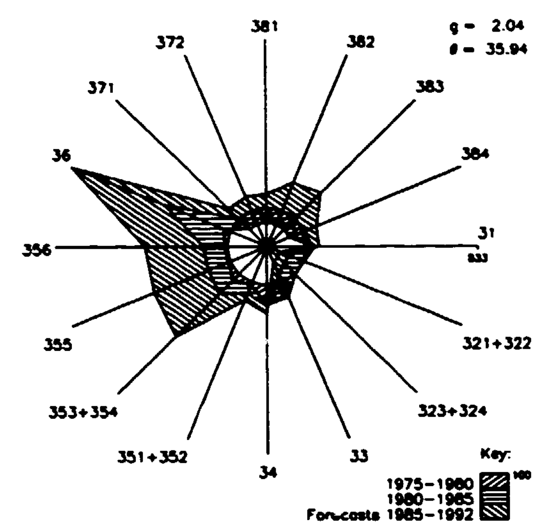
Manufacturing share in GDP current (%)



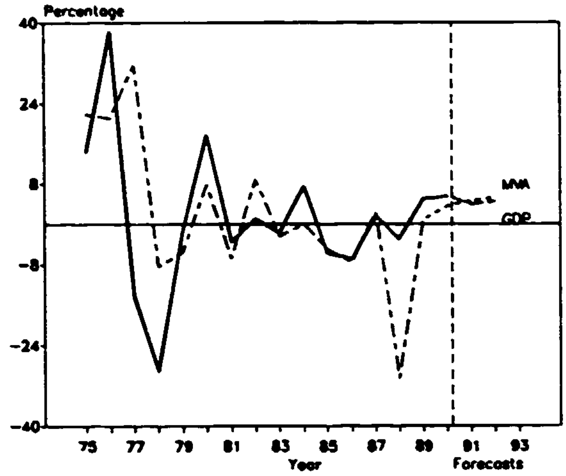
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

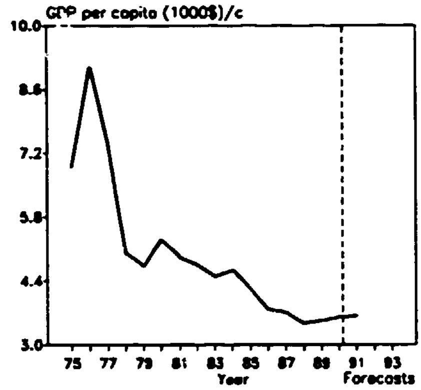


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

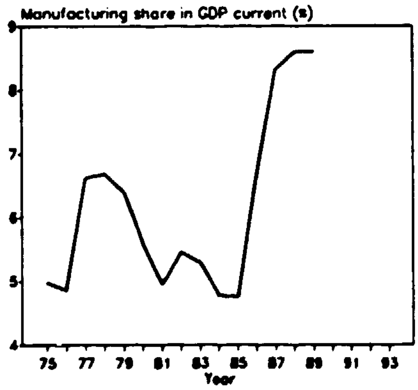
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	4281	4150	3989
Per capita (1980-dollars) /na,c	5305	4209	3521
Manufacturing share (%) /na (current prices)	5.6	4.8	8.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	301	283	...
Industrial production index	100	94	94
Value added (millions of dollars)	224	178 /e	275 /e
Gross output (millions of dollars)	690	593 /e	978 /e
Employment (thousands)	18	17 /e	17 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	68	70 /e	72 /e
Wages and salaries (%)	16	18 /e	17 /e
Operating surplus (%)	16	12 /e	12 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	38481	35795 /e	57509 /e
Value added / worker	12470	10732 /e	16189 /e
Average wage	6283	6435 /e	9520 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	13.61 /e	6.21 /e	4.07 /e
as a percentage of average θ in 1970-1975	161 /e	73 /e	48 /e
MVA growth rate / θ	0.14	0.21	0.41
Degree of specialization	21.0	15.6	16.5
-VALUE ADDED:(millions of dollars)			
311 Food products	18	18 /e	31 /e
313 Beverages	19	12 /e	14 /e
314 Tobacco products	17	10 /e	12 /e
321 Textiles	3	1 /e	1 /e
322 Wearing apparel	5	2 /e	3 /e
323 Leather and fur products	1	- /e	- /e
324 Footwear	1	- /e	- /e
331 Wood and wood products	64	27 /e	27 /e
332 Furniture and fixtures	9	4 /e	4 /e
341 Paper and paper products	2	1 /e	3 /e
342 Printing and publishing	3	2 /e	3 /e
351 Industrial chemicals	6	5 /e	6 /e
352 Other chemical products	3	3 /e	6 /e
353 Petroleum refineries	18	19 /e	40 /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	-	- /e	- /e
356 Plastic products	-	- /e	- /e
361 Pottery, china and earthenware	-	- /e	- /e
362 Glass and glass products	1	1 /e	2 /e
369 Other non-metal mineral products	8	14 /e	30 /e
371 Iron and steel	3	4 /e	5 /e
372 Non-ferrous metals	3	4 /e	5 /e
381 Metal products	13	16 /e	25 /e
382 Non-electrical machinery	2	2 /e	4 /e
383 Electrical machinery	8	10 /e	21 /e
384 Transport equipment	11	13 /e	20 /e
385 Professional and scientific equipment	1	1 /e	2 /e
390 Other manufacturing industries	5	6 /e	9 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

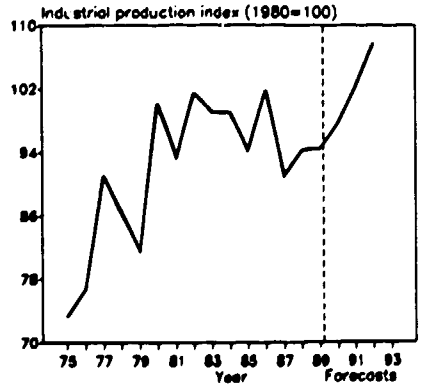
GDP per capita (1000$)/c

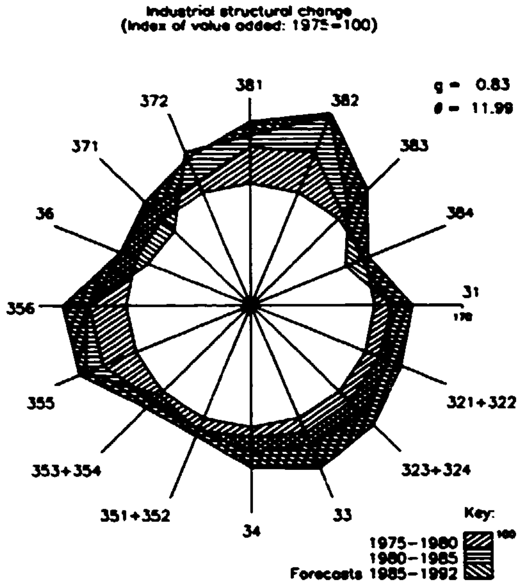


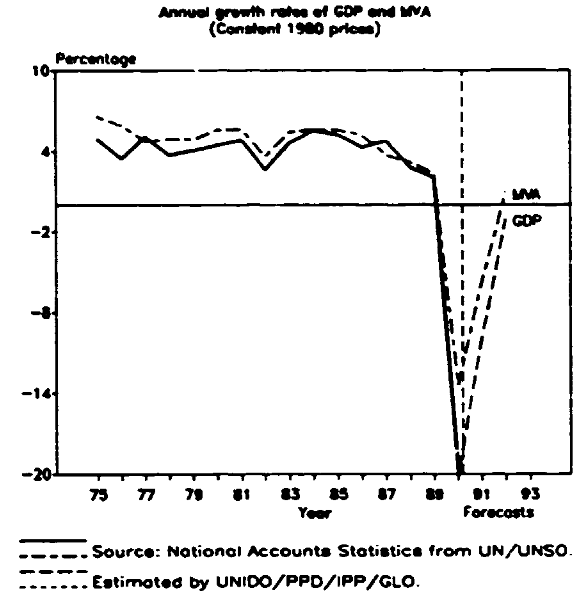
Manufacturing share in GDP current (%)



Industrial production index (1980=100)

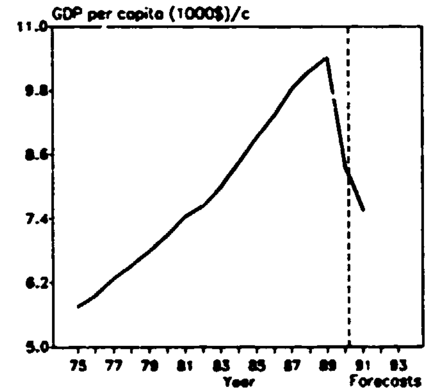


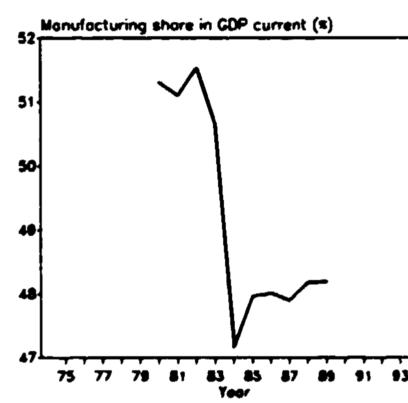


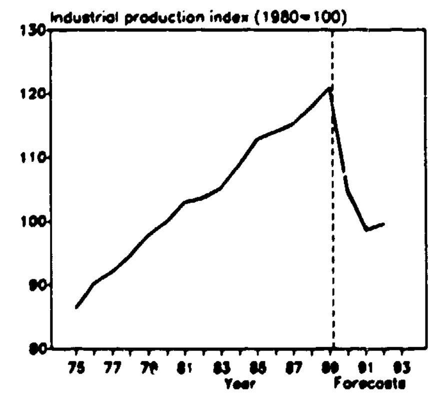


	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	118723	148286	169853
Per capita (1980-dollars) /na,c	7093	8909	10413
Manufacturing share (%) /na (current prices)	51.3	48.0	48.2 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	60486 /e	77757 /e	89551
Industrial production index	100	113	121
Value added (millions of dollars)/c	76600	86430	92565
Gross output (millions of dollars)	123851 /e	159661 /e	240954
Employment (thousands)	2895 /e	2988 /e	2933
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY: (dollars)			
Gross output / worker	42781 /e	53434 /e	82153
Value added / worker /c	26460 /e	28926 /e	31560
Average wage	6322 /e	4836 /e	7917 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	1.99	1.61	1.57
as a percentage of average θ in 1970-1975	98	79	77
MVA growth rate / θ	1.48	1.52	1.35
Degree of specialization	13.2	14.0	14.4
-VALUE ADDED: (millions of dollars)/c			
311 Food products	6043	7070	6949
313 Beverages	1040	1207	1352
314 Tobacco products	254	236	203
321 Textiles	6276	6841	7469
322 Wearing apparel	2199	2485	2925
323 Leather and fur products	839	923	1032
324 Footwear	631	694	776
331 Wood and wood products	1178	1378	1519
332 Furniture and fixtures	1081	1265	1395
341 Paper and paper products	931	1089	1219
342 Printing and publishing	727	748	777
351 Industrial chemicals	8697	9132	9915
352 Other chemical products	1220	1269	1220
353 Petroleum refineries	2853	3052	2996
354 Miscellaneous petroleum and coal products	141	145	142
355 Rubber products	3202	3715	4227
356 Plastic products	1528	1773	2017
361 Pottery, china and earthenware	616	629	604
362 Glass and glass products	473	477	477
369 Other non-metal mineral products	1768	1768	1927
371 Iron and steel	2661	2783	2810
372 Non-ferrous metals	884	1061	1113
381 Metal products	3171	3679	4313
382 Non-electrical machinery	9960	12537	14726
383 Electrical machinery	7480	9499	10172
384 Transport equipment	6898	7311	6691
385 Professional and scientific equipment	3264	3036	2937
390 Other manufacturing industries	608	638	681 /e

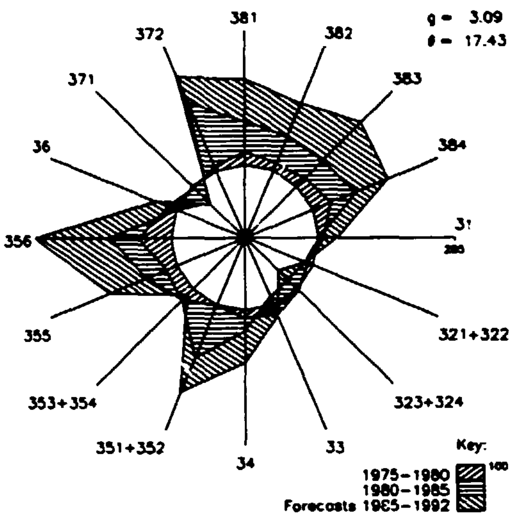
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



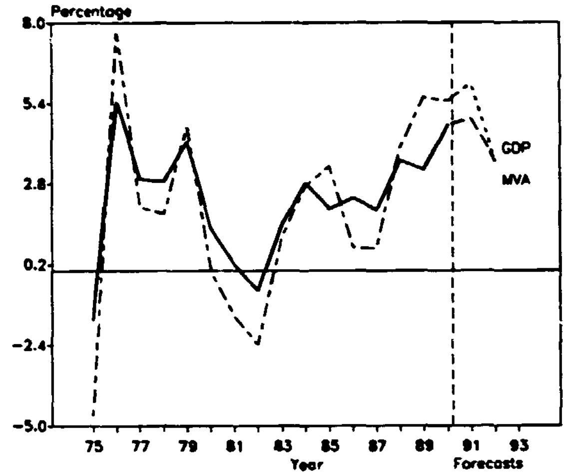




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

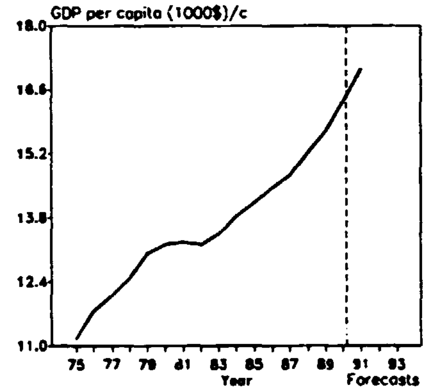


———— Source: National Accounts Statistics from UN/UNSO.
- - - - - - Estimated by UNIDO/PPD/IPP/GLO.

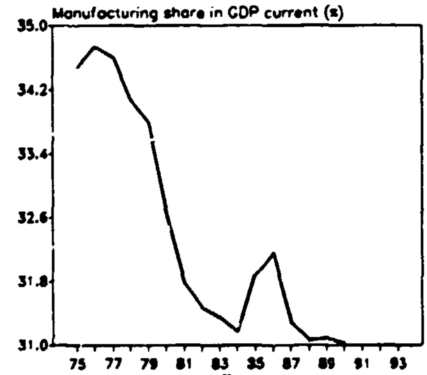
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	813498	861650	961194
Per capita (1980-dollars) /na,c	13213	14120	15687
Manufacturing share (%) /na (current prices)	32.6	31.9	31.1
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	265589	274175	305461
Industrial production index	100	104	118
Value added (millions of dollars)	265588	224215	433240
Gross output (millions of dollars)	632160	490046	879040
Employment (thousands)	7229	6614	6910
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	58	54	51
Wages and salaries (%)	21	19	20
Operating surplus (%)	21	27	29
-PRODUCTIVITY: (dollars)			
Gross output / worker	87448	74092	127213
Value added / worker	36739	33900	62698
Average wage	18471	14124	25605
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.72	3.47	1.86
as a percentage of average θ in 1970-1975	80	102	55
MVA growth rate / θ	0.83	0.95	1.74
Degree of specialization	12.1	14.5	15.4
-VALUE ADDED: (millions of dollars)			
311 Food products	18570	10829	21142
313 Beverages	6452	5048	9178
314 Tobacco products	6909	5720	9629
321 Textiles	6964	5510	9706
322 Wearing apparel	4934	2802	4487
323 Leather and fur products	935	499	740
324 Footwear	1205	727	1046
331 Wood and wood products	4485	2429	4246 /e
332 Furniture and fixtures	5548	3084	6749 /e
341 Paper and paper products	5099	5221	10141
342 Printing and publishing	6150	4141	7846
351 Industrial chemicals	13944	16569	32552 /e
352 Other chemical products	8003	11596	23060 /e
353 Petroleum refineries	14637	10126	14303 /e
354 Miscellaneous petroleum and coal products	990	986	1348 /e
355 Rubber products	3201	2880	5975 /e
356 Plastic products	6095	5639	12530 /e
361 Pottery, china and earthenware	1304	669	1219
362 Glass and glass products	2492	1916	4131
369 Other non-metal mineral products	7937	4874	9970
371 Iron and steel	18872	9538	16377
372 Non-ferrous metals	2508	3414	6720
381 Metal products	14455	14161	29594
382 Non-electrical machinery	34263	33811	65194
383 Electrical machinery	30601	28329	61328
384 Transport equipment	31232	29076	55334
385 Professional and scientific equipment	6206	3448	6337
390 Other manufacturing industries	1700	1175	2357 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

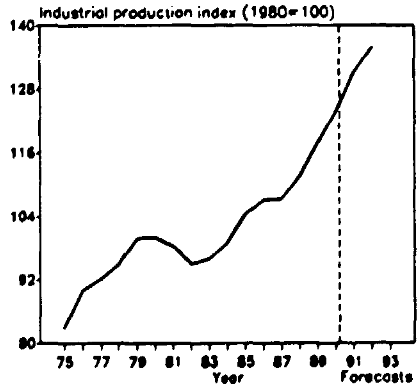
GDP per capita (1000$)/c



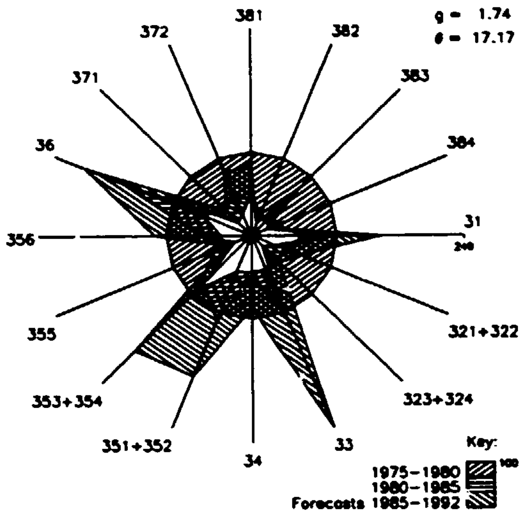
Manufacturing share in GDP current (%)



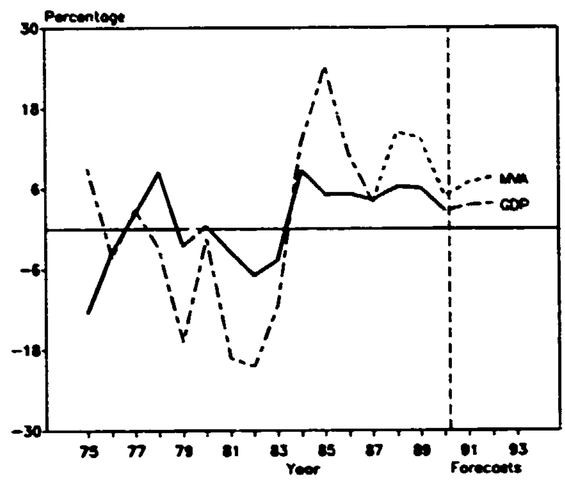
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

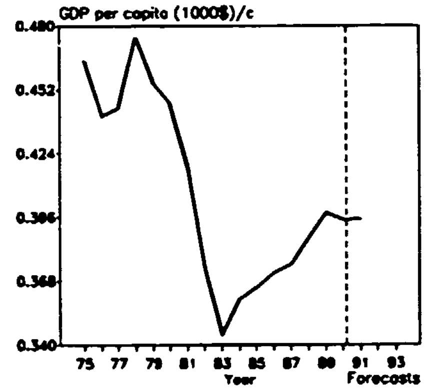


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

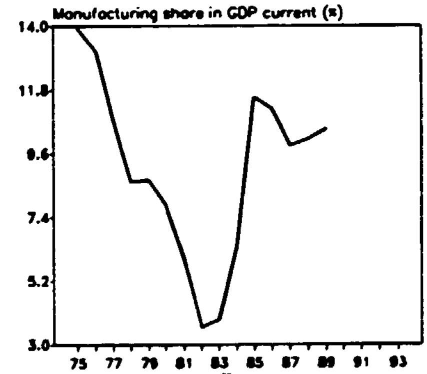
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	4788	4686	5795
Per capita (1980-dollars) /na,c	446	365	398
Manufacturing share (%) /na (current prices)	7.8	11.5	10.4 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	274	299	449 /e
Industrial production index	100	70	111 /e
Value added (millions of dollars)	244	338	498 /e
Gross output (millions of dollars)	505	696	950 /e
Employment (thousands)	80	61	68 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	52	51	48 /e
Wages and salaries (%)	10	6	7 /e
Operating surplus (%)	39	42	46 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	6293	11351	14045 /e
Value added / worker	3034	5517	7360 /e
Average wage	606	711	961 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	13.44	14.29	7.74 /e
as a percentage of average θ in 1970-1975	114	121	66 /e
MVA growth rate / θ	-0.69	1.03	3.37
Degree of specialization	23.1	26.3	26.8
-VALUE ADDED: (millions of dollars)			
311 Food products	20	35	45 /e
313 Beverages	38	51	72 /e
314 Tobacco products	32	68	77 /e
321 Textiles	22	18	27 /e
322 Wearing apparel	3	1	1 /e
323 Leather and fur products	1	-	1 /e
324 Footwear	1	-	1 /e
331 Wood and wood products	16	41	78 /e
332 Furniture and fixtures	2	2	3 /e
341 Paper and paper products	1	2	3 /e
342 Printing and publishing	5	4	6 /e
351 Industrial chemicals	2	1	1 /e
352 Other chemical products	9	26	33 /e
353 Petroleum refineries	37	34	63 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	5	2	2 /e
356 Plastic products	1	2	3 /e
361 Pottery, china and earthenware	1	-	- /e
362 Glass and glass products	-	1	2 /e
369 Other non-metal mineral products	6	16	16 /e
371 Iron and steel	1	1	1 /e
372 Non-ferrous metals	29	16	45 /e
381 Metal products	7	8	11 /e
382 Non-electrical machinery	-	-	- /e
383 Electrical machinery	2	3	4 /e
384 Transport equipment	3	2	2 /e
385 Professional and scientific equipment	1	1	1 /e
390 Other manufacturing industries	-	-	- /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

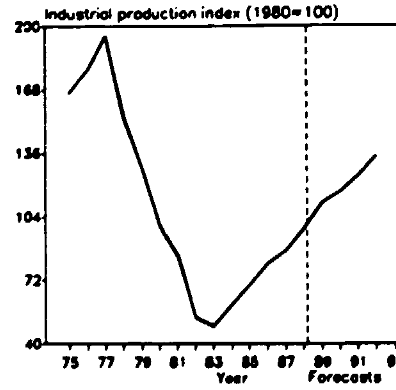
GDP per capita (1000$)/c



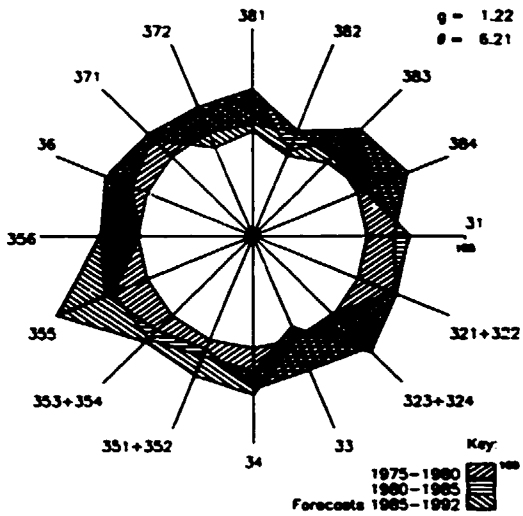
Manufacturing share in GDP current (%)



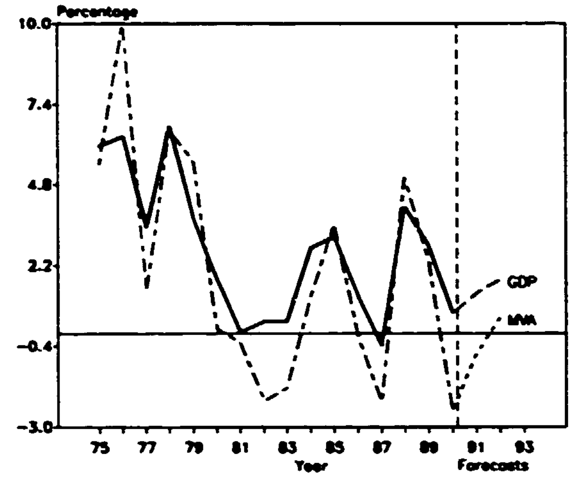
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

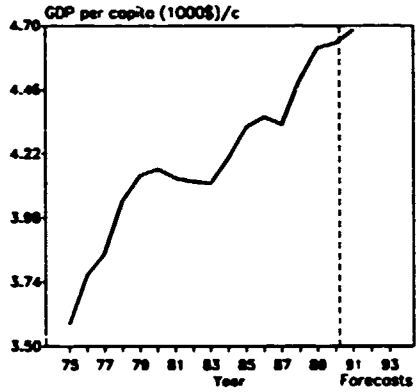


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

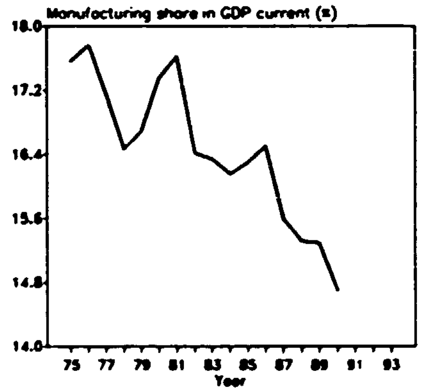
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	40147	42903	46298
Per capita (1980-dollars) /na,c	4163	4318	4616
Manufacturing share (%) /na (current prices)	17.4	16.3	15.3
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	8968	7000	7353
Industrial production index	100	98	102
Value added (millions of dollars)	7591	5759	9261
Gross output (millions of dollars)	25525	20633	31109
Employment (thousands)	474	441	425 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	70	72	70
Wages and salaries (%)	12	12	12 /e
Operating surplus (%)	18	16	18 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	53865	46766	73235 /e
Value added / worker	16018	13052	21801 /e
Average wage	6247	5539	8595 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.56	4.41	4.13
as a percentage of average θ in 1970-1975	59	74	69
MVA growth rate / θ	1.50	-0.16	0.17
Degree of specialization	10.9	11.8	12.1
-VALUE ADDED: (millions of dollars)			
311 Food products	1039	897	1514
313 Beverages	264	246	432
314 Tobacco products	138	114	141
321 Textiles	1063	820	1366
322 Wearing apparel	494	409	573
323 Leather and fur products	106	88	139
324 Footwear	111	88	102
331 Wood and wood products	241	114	246 /e
332 Furniture and fixtures	148	93	130 /e
341 Paper and paper products	126	101	222
342 Printing and publishing	216	138	223
351 Industrial chemicals	185	197	337 /e
352 Other chemical products	339	241	440 /e
353 Petroleum refineries	153	140	220 /e
354 Miscellaneous petroleum and coal products	37	22	42 /e
355 Rubber products	77	58	128
356 Plastic products	214	126	298
361 Pottery, china and earthenware	67	48	65
362 Glass and glass products	53	24	41
369 Other non-metal mineral products	483	321	540
371 Iron and steel	203	155	281
372 Non-ferrous metals	245	184	209
381 Metal products	512	387	523
382 Non-electrical machinery	181	116	193
383 Electrical machinery	334	248	318
384 Transport equipment	483	286	415
385 Professional and scientific equipment	10	7	9
390 Other manufacturing industries	73	91	113 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

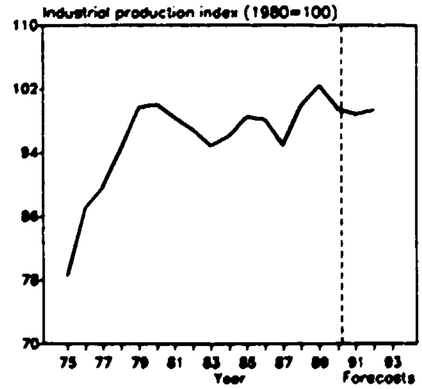
GDP per capita (1000$)/c



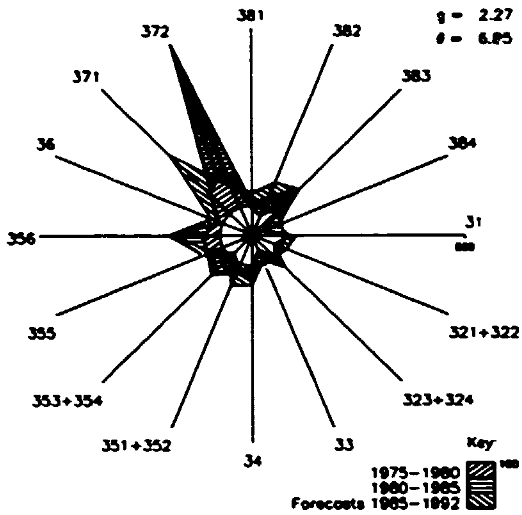
Manufacturing share in GDP current (%)



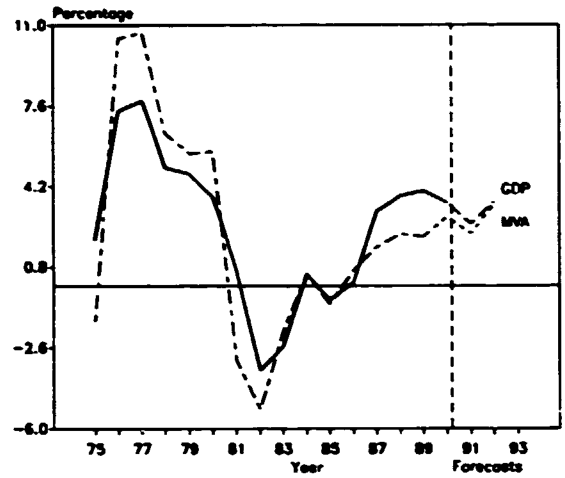
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

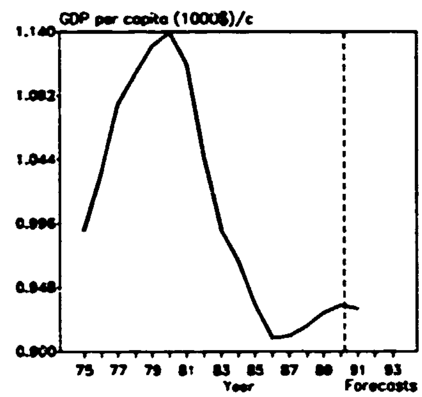


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	7879	7446	8301
Per capita (1980-dollars) /na.c	1139	935	929
Manufacturing share (%) /na (current prices)	11.8	11.2	10.3
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1312	1179	1258
Industrial production index	100	102	136
Value added (millions of dollars)	794	906	919 /e
Gross output (millions of dollars)	1968	2196	2250 /e
Employment (thousands)	82	73	90 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	59	59 /e
Wages and salaries (%)	9	9 /e	8 /e
Operating surplus (%)	31	32 /e	33 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	23872	30057	24871 /e
Value added / worker	9635	12408	10161 /e
Average wage	2166	2773 /e	1973 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.10 /e	6.85	6.01 /e
as a percentage of average θ in 1970-1975	89 /e	120	105 /e
MVA growth rate / θ	0.72	-0.22	1.23
Degree of specialization	20.4	24.6	21.7
-VALUE ADDED: (millions of dollars)			
311 Food products	204	276	248 /e
313 Beverages	91	90	58 /e
314 Tobacco products	14	15	24 /e
321 Textiles	45	71	64 /e
322 Wearing apparel	19	13	30 /e
323 Leather and fur products	3	3	4 /e
324 Footwear	15	12	8 /e
331 Wood and wood products	10	7	11 /e
332 Furniture and fixtures	4	3	6 /e
341 Paper and paper products	19	21	15 /e
342 Printing and publishing	34	34	45 /e
351 Industrial chemicals	28	28	33 /e
352 Other chemical products	110	121	147 /e
353 Petroleum refineries	14	8	8 /e
354 Miscellaneous petroleum and coal products	2	-	- /e
355 Rubber products	21	24	24 /e
356 Plastic products	19	37	34 /e
361 Pottery, china and earthenware	2	8	9 /e
362 Glass and glass products	22	17	16 /e
369 Other non-metal mineral products	34	41	36 /e
371 Iron and steel	16	21	29 /e
372 Non-ferrous metals	1	-	- /e
381 Metal products	23	23	26 /e
382 Non-electrical machinery	6	4	7 /e
383 Electrical machinery	25	19	27 /e
384 Transport equipment	8	5	4 /e
385 Professional and scientific equipment	1	1	1 /e
390 Other manufacturing industries	4	3	5 /e

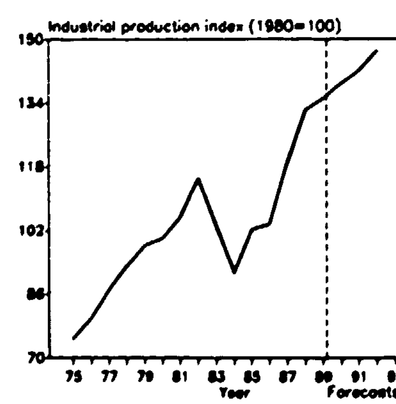
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

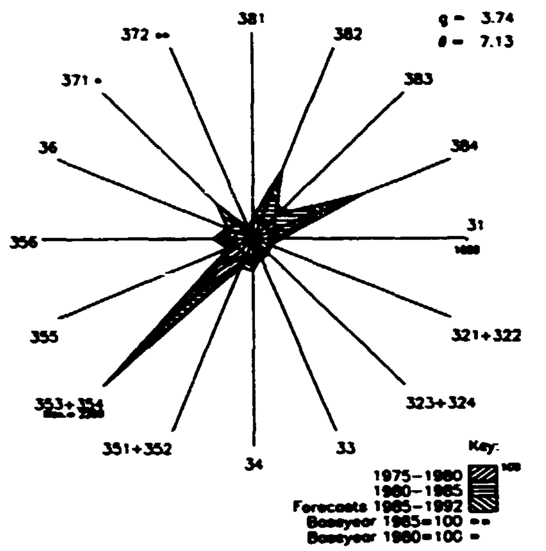


Manufacturing share in GDP current (%)

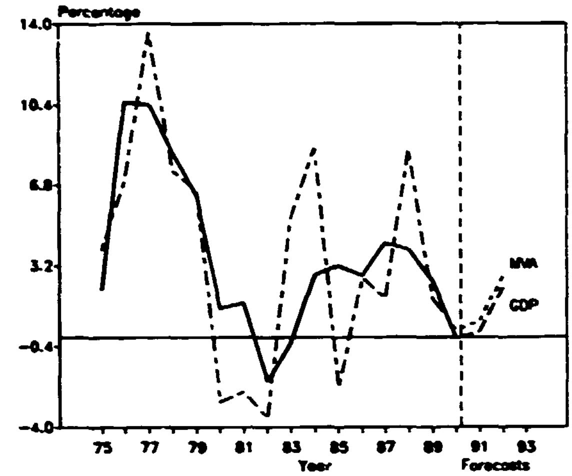
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

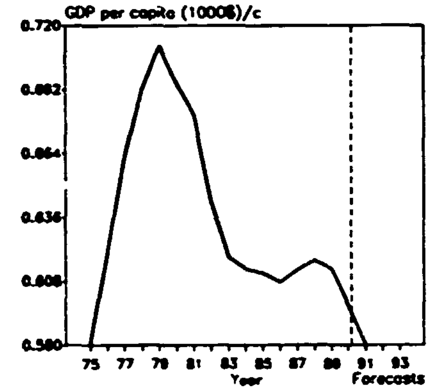


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

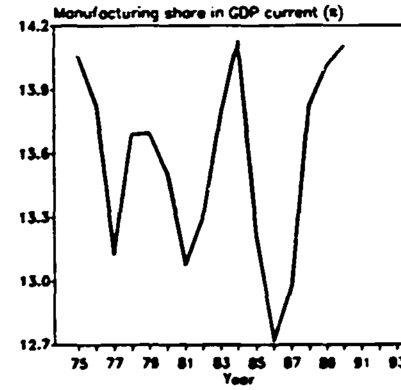
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	2544	2680	3055
Per capita (1980-dollars) /na,c	695	611	613
Manufacturing share (%) /na (current prices)	13.5	13.2	14.0
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	344	361	415
Industrial production index	100	110	138
Value added (millions of dollars)	300 /e	493	715 /e
Gross output (millions of dollars)	1032 /e	1611	2468 /e
Employment (thousands)	55	64	69 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	71 /e	69	71 /e
Wages and salaries (%)	11 /e	13	11 /e
Operating surplus (%)	18 /e	18	17 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	18730 /e	25167	35870 /e
Value added / worker	5450 /e	7707	10386 /e
Average wage	2013 /e	3173	4112 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	1.93 /e	4.34 /e	3.33 /e
as a percentage of average θ in 1970-1975	34 /e	76 /e	58 /e
MVA growth rate / θ	3.46	0.77	1.00
Degree of specialization	24.0	22.4	22.2
-VALUE ADDED: (millions of dollars)			
311 Food products	75 /e	129	213 /e
313 Beverages	65 /e	79	111 /e
314 Tobacco products	19 /e	42	47 /e
321 Textiles	12 /e	13	22 /e
322 Wearing apparel	9 /e	14	17 /e
323 Leather and fur products	3 /e	2	4 /e
324 Footwear	2 /e	2	4 /e
331 Wood and wood products	25 /e	30	37 /e
332 Furniture and fixtures	5 /e	8	10 /e
341 Paper and paper products	5 /e	9	18 /e
342 Printing and publishing	8 /e	13	18 /e
351 Industrial chemicals	1 /e	2	3 /e
352 Other chemical products	12 /e	20	31 /e
353 Petroleum refineries	7 /e	38	41 /e
354 Miscellaneous petroleum and coal products	- /e	-	- /e
355 Rubber products	5 /e	8	12 /e
356 Plastic products	8 /e	18	28 /e
361 Pottery, china and earthenware	- /e	-	- /e
362 Glass and glass products	- /e	-	- /e
369 Other non-metal mineral products	17 /e	24	40 /e
371 Iron and steel	1 /e	1	4 /e
372 Non-ferrous metals	- /e	1	1 /e
381 Metal products	15 /e	21	27 /e
382 Non-electrical machinery	1 /e	3	5 /e
383 Electrical machinery	3 /e	8	9 /e
384 Transport equipment	- /e	2	3 /e
385 Professional and scientific equipment	- /e	1	1 /e
390 Other manufacturing industries	1 /e	5	8 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

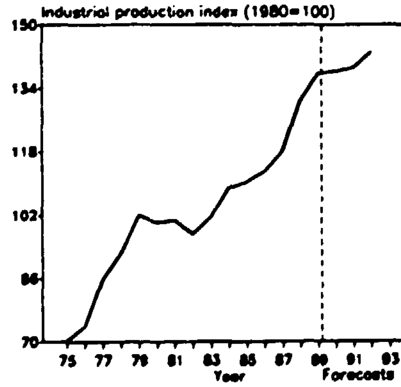
GDP per capita (1000$)/c



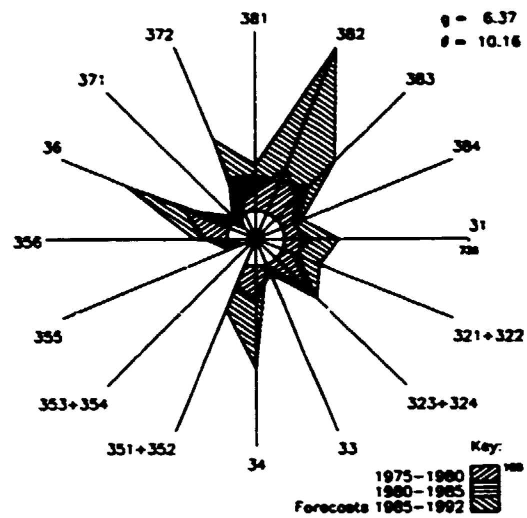
Manufacturing share in GDP current (%)



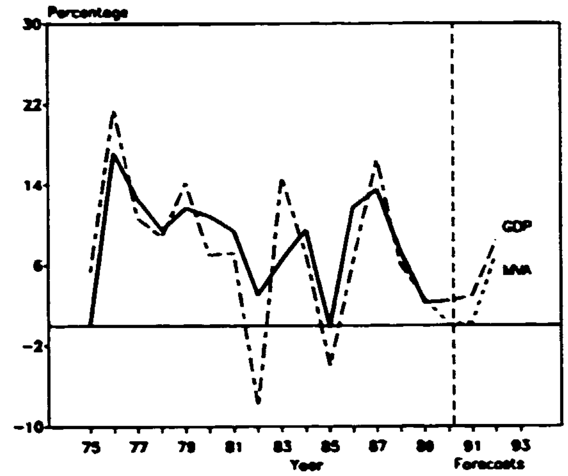
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

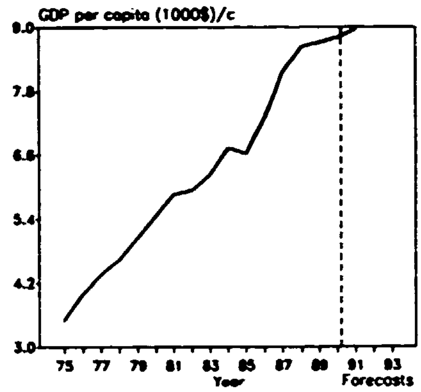


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	27526	36134	50314
Per capita (1980-dollars) /na.c	5463	6622	8702
Manufacturing share (%) /na (current prices)	22.3	20.3	20.6 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	6134	7132	9615
Industrial production index	100	129	185
Value added (millions of dollars)	7343	6582	12630
Gross output (millions of dollars)	22187	22835	46744
Employment (thousands)	937	908	981 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67	71	73
Wages and salaries (%)	17	18	15 /e
Operating surplus (%)	16	11	12 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	23686	25140	47647 /e
Value added / worker	7840	7246	12874 /e
Average wage	4079	4583	7260 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.54	4.42	4.64
as a percentage of average θ in 1970-1975	61	59	62
MVA growth rate / θ	3.20	-0.36	1.57
Degree of specialization	24.2	22.6	22.6
-VALUE ADDED: (millions of dollars)			
311 Food products	161	171	315
313 Beverages	99	125	161
314 Tobacco products	81	127	222
321 Textiles	1027	964	1964
322 Wearing apparel	1920	1594	2736
323 Leather and fur products	43	26	51 /e
324 Footwear	59	62	70 /e
331 Wood and wood products	45	32	41 /e
332 Furniture and fixtures	62	54	77 /e
341 Paper and paper products	110	90	287
342 Printing and publishing	290	360	713
351 Industrial chemicals	40	36	79 /e
352 Other chemical products	77	71	138 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	29	17	16
356 Plastic products	563	612	771
361 Pottery, china and earthenware	5	3	9 /e
362 Glass and glass products	10	17	25 /e
369 Other non-metal mineral products	56	47	113 /e
371 Iron and steel	31	17	23 /e
372 Non-ferrous metals	35	20	58 /e
381 Metal products	638	460	898
382 Non-electrical machinery	188	236	709
383 Electrical machinery	987	752	1836
384 Transport equipment	176	157	262
385 Professional and scientific equipment	362	289	567
390 Other manufacturing industries	250	253	501

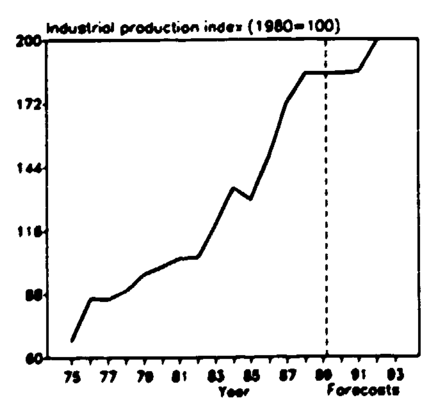
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

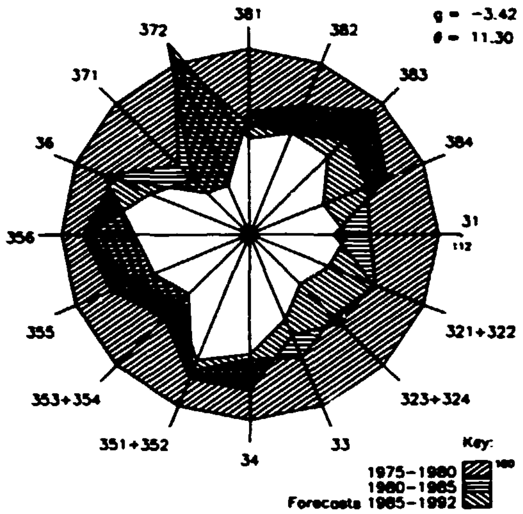


Manufacturing share in GDP current (%)

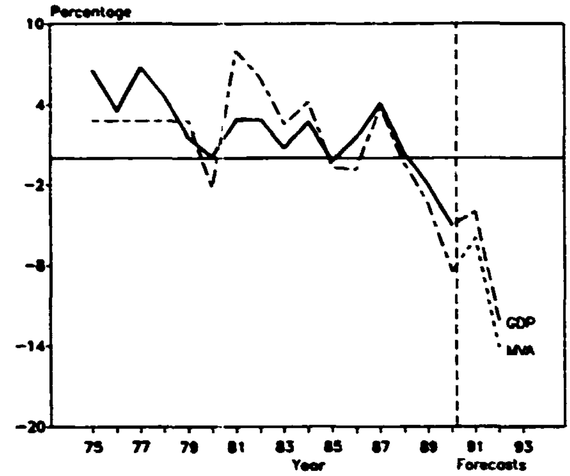
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

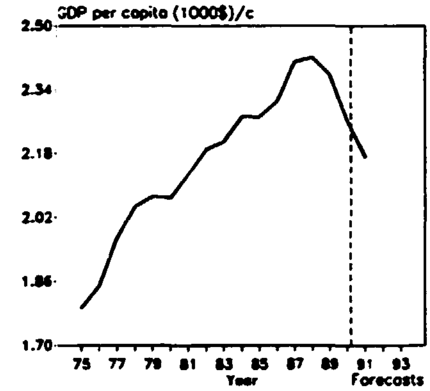


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	22165	24184	25114
Per capita (1980-dollars) /na,c	2069	2271	2376
Manufacturing share (%) /na (current prices)	26.4	26.4	24.5 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	5856	7101	7031
Industrial production index	100	111	120
Value added (millions of dollars)	5907	5356	7109
Gross output (millions of dollars)	24898	21690	24737
Employment (thousands)	1384	1278	1171
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	76	75	71
Wages and salaries (%)	8	8	10
Operating surplus (%)	16	16	19
-PRODUCTIVITY: (dollars)			
Gross output / worker	17990	16972	21124
Value added / worker	4268	4191	6071
Average wage	1437	1403	2159
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.34	4.99	6.80
as a percentage of average θ in 1970-1975	103	96	130
MVA growth rate / θ	-1.29	0.05	0.08
Degree of specialization	9.0	10.0	8.9
-VALUE ADDED: (millions of dollars)			
311 Food products	555	281	524
313 Beverages	83	107	130
314 Tobacco products	27	28	37
321 Textiles	353	325	326
322 Wearing apparel	194	158	187
323 Leather and fur products	48	39	40
324 Footwear	73	85	77
331 Wood and wood products	81	42	71
332 Furniture and fixtures	101	92	112
341 Paper and paper products	94	106	118
342 Printing and publishing	83	94	141
351 Industrial chemicals	417	320	517
352 Other chemical products	242	303	400
353 Petroleum refineries	156	196	272
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	55	71	100
356 Plastic products	61	80	133
361 Pottery, china and earthenware	57	46	58
362 Glass and glass products	70	71	81
369 Other non-metal mineral products	204	161	200
371 Iron and steel	370	200	456
372 Non-ferrous metals	216	54	306
381 Metal products	214	216	281
382 Non-electrical machinery	497	569	761
383 Electrical machinery	655	758	814
384 Transport equipment	486	507	461
385 Professional and scientific equipment	272	287	362
390 Other manufacturing industries	237	164	144

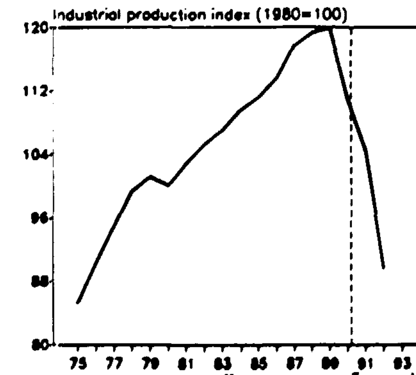
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

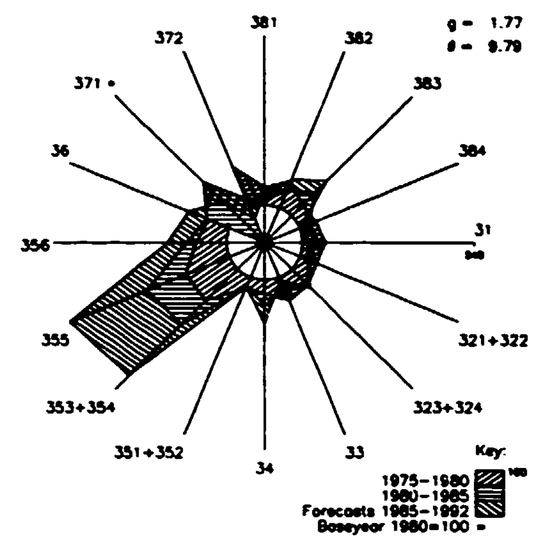


Manufacturing share in GDP current (%)

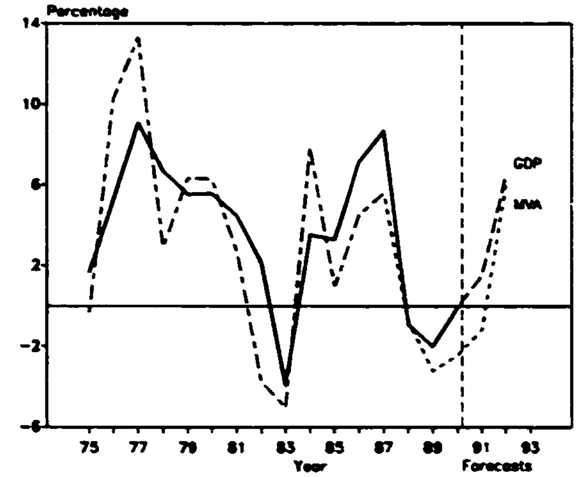
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

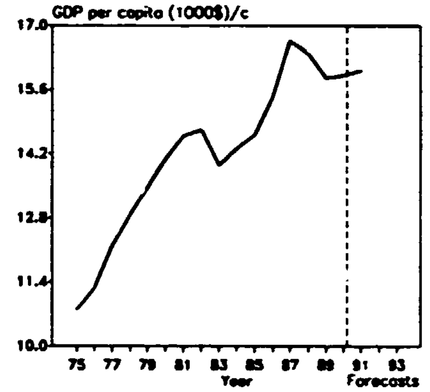


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

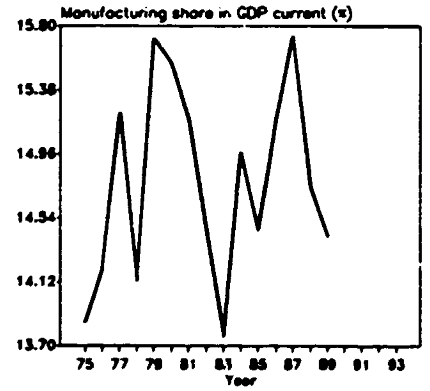
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	3226	3534	3994
Per capita (1980-dollars) /na,c	14089	14603	15850
Manufacturing share (%) /na (current prices)	15.6	14.5	14.4 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	652	666	706 /e
Industrial production index	100	102	108 /e
Value added (millions of dollars)	765	553	880 /e
Gross output (millions of dollars)	1969	1629	2728 /e
Employment (thousands)	28	30	32 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	66	68 /e
Wages and salaries (%)	20 /e	19 /e	22 /e
Operating surplus (%)	19 /e	15 /e	10 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	69709	54610	85759 /e
Value added / worker	27097	18556	27667 /e
Average wage	13687 /e	10407 /e	18732 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.44	4.37	2.72 /e
as a percentage of average θ in 1970-1975	76	135	84 /e
MVA growth rate / θ	4.0C	-0.42	0.20
Degree of specialization	31.8	27.8	25.3
-VALUE ADDED: (millions of dollars)			
311 Food products	330	221	323 /e
313 Beverages	11	10	24 /e
314 Tobacco products	...	...	...
321 Textiles	26	21	29 /e
322 Wearing apparel	17	11	17 /e
323 Leather and fur products	8	6	11 /e
324 Footwear	1	1	2 /e
331 Wood and wood products	-	-	1 /e
332 Furniture and fixtures	53	32	50 /e
341 Paper and paper products	5	5	10 /e
342 Printing and publishing	36	37	69 /e
351 Industrial chemicals	11	9	14 /e
352 Other chemical products	11	9	15 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	5	6	14 /e
356 Plastic products	12	11	23 /e
361 Pottery, china and earthenware	1	-	1 /e
362 Glass and glass products	4	3	5 /e
369 Other non-metal mineral products	22	19	37 /e
371 Iron and steel	6	11	9 /e
372 Non-ferrous metals	50	24	24 /e
381 Metal products	22 /e	14 /e	29 /e
382 Non-electrical machinery	48 /e	33 /e	69 /e
383 Electrical machinery	15	16	30 /e
384 Transport equipment	66	47	64 /e
385 Professional and scientific equipment	2	1	2 /e
390 Other manufacturing industries	3	4	9 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

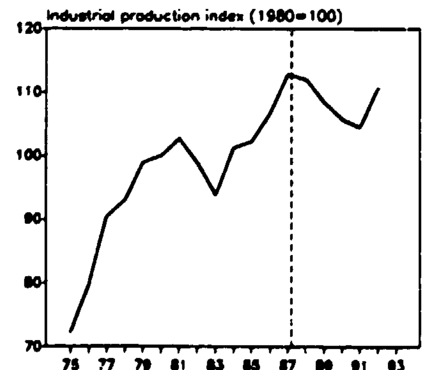
GDP per capita (1000$)/c

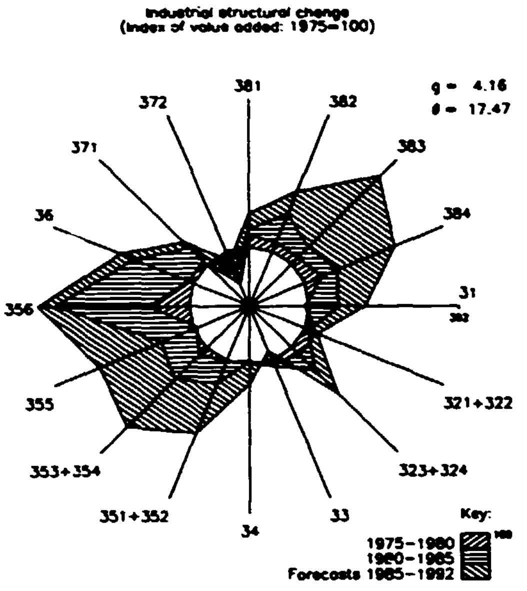


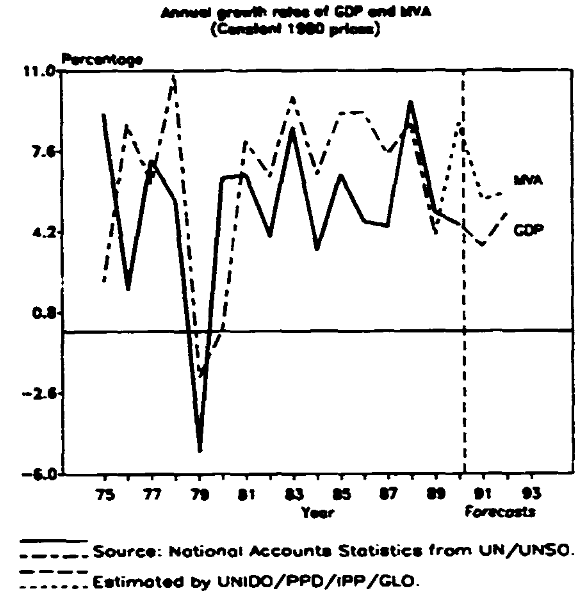
Manufacturing share in GDP current (%)



Industrial production index (1980=100)

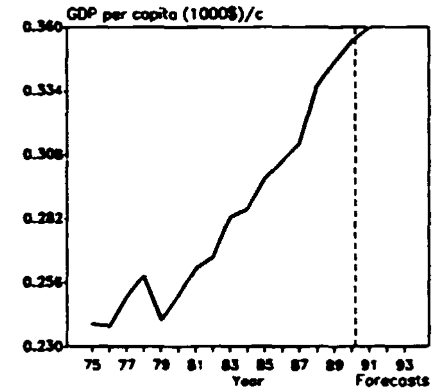


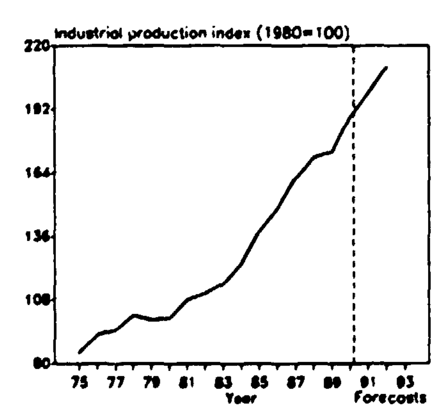




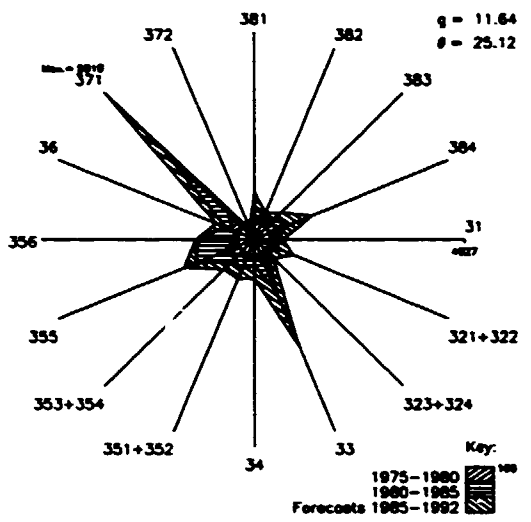
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	172723	229337	288716
Per capita (1980-dollars) /na,c	251	298	346
Manufacturing share (%) /na (current prices)	15.9	16.4	15.8 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	27526	40538	53829
Industrial production index	100	138	173
Value added (millions of dollars)	13086	15526	19551
Gross output (millions of dollars)	71387	88304	111915
Employment (thousands)	6992	6581	6880 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	82	82	83
Wages and salaries (%)	9	8	8 /e
Operating surplus (%)	9	9	9 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	10210	13418	16266 /e
Value added / worker	1872	2359	2842 /e
Average wage	949	1135	1340 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.85	7.59	5.11
as a percentage of average θ in 1970-1975	78	122	82
MVA growth rate / θ	0.42	0.68	0.89
Degree of specialization	19.3	16.9	16.9
-VALUE ADDED: (millions of dollars)			
311 Food products	899	1436	1699
313 Beverages	99	135	153
314 Tobacco products	196	230	227
321 Textiles	2642	2135	2295
322 Wearing apparel	62	87	143
323 Leather and fur products	48	52	58
324 Footwear	37	52	66
331 Wood and wood products	74	73	54
332 Furniture and fixtures	8	7	6
341 Paper and paper products	296	233	343
342 Printing and publishing	258	280	322 /e
351 Industrial chemicals	778	1200	1595
352 Other chemical products	1062	1146	1722
353 Petroleum refineries	203	344	504
354 Miscellaneous petroleum and coal products	151	152	165 /e
355 Rubber products	234	363	537
356 Plastic products	93	166	157 /e
361 Pottery, china and earthenware	47	27	50 /e
362 Glass and glass products	67	101	93 /e
369 Other non-metal mineral products	399	775	764
371 Iron and steel	1489	1790	1825
372 Non-ferrous metals	81	115	160
381 Metal products	421	425	467
382 Non-electrical machinery	1130	1506	1634
383 Electrical machinery	1061	1201	2210
384 Transport equipment	1088	1231	1836
385 Professional and scientific equipment	92	118	352
390 Other manufacturing industries	72	146	117 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

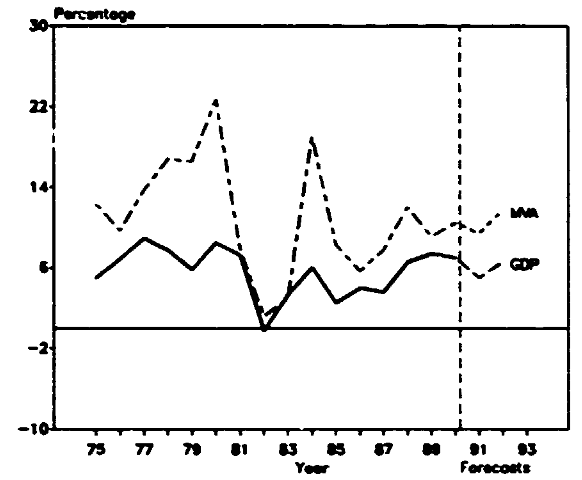




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

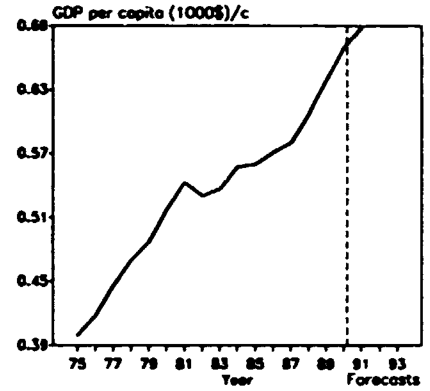


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

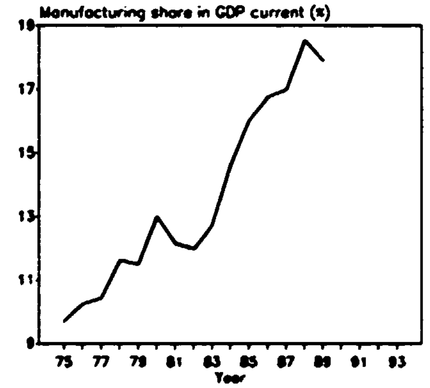
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	78013	93677	115436
Per capita (1980-dollars) /na,c	517	560	638
Manufacturing share (%) /na (current prices)	13.0	16.0	17.9 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	10133	14676	20432
Industrial production index	100	108	155
Value added (millions of dollars)	4376	8098	9027 /e
Gross output (millions of dollars)	13205	22558	24834 /e
Employment (thousands)	963	1672	1905 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	69	69	68 /e
Wages and salaries (%)	7	7	7 /e
Operating surplus (%)	25	24	25 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	11293	12401	12103 /e
Value added / worker	3528	3880	3912 /e
Average wage	743	920	898 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.26	11.70	6.33 /e
as a percentage of average θ in 1970-1975	108	103	56 /e
MVA growth rate / θ	1.10	1.36	2.28
Degree of specialization	20.4	16.6	16.4
-VALUE ADDED: (millions of dollars)			
311 Food products	376	870	759 /e
313 Beverages	51	77	92 /e
314 Tobacco products	649	741	981 /e
321 Textiles	420	687	852 /e
322 Wearing apparel	15	106	160 /e
323 Leather and fur products	5	14	29 /e
324 Footwear	26	31	34 /e
331 Wood and wood products	239	612	860 /e
332 Furniture and fixtures	6	18	25 /e
341 Paper and paper products	51	110	97 /e
342 Printing and publishing	51	92	166 /e
351 Industrial chemicals	145	428	454 /e
352 Other chemical products	241	388	387 /e
353 Petroleum refineries	978	1611	1575 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	164	328	252 /e
356 Plastic products	25	175	115 /e
361 Pottery, china and earthenware	8	24	29 /e
362 Glass and glass products	36	98	93 /e
369 Other non-metal mineral products	200	262	253 /e
371 Iron and steel	107	469	704 /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	118	278	329 /e
382 Non-electrical machinery	53	76	66 /e
383 Electrical machinery	180	246	224 /e
384 Transport equipment	217	331	466 /e
385 Professional and scientific equipment	2	4	4 /e
390 Other manufacturing industries	13	24	30 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

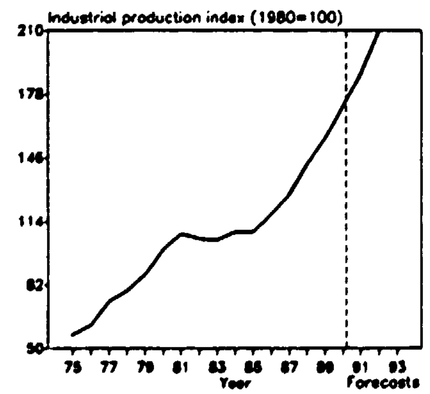
GDP per capita (1000$)/c



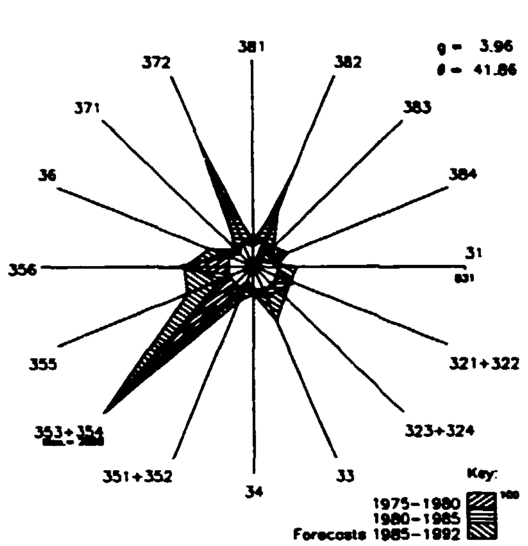
Manufacturing share in GDP current (%)



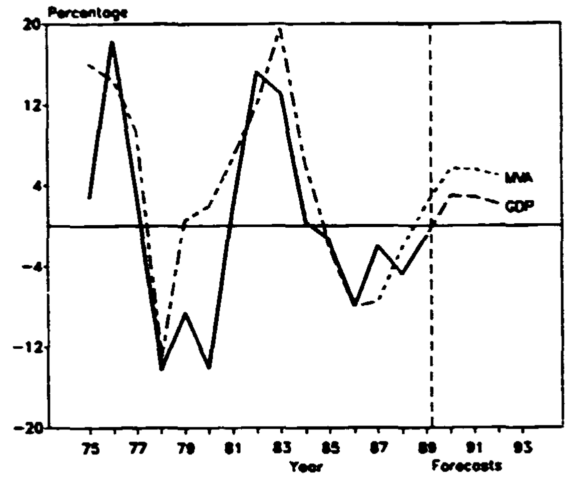
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

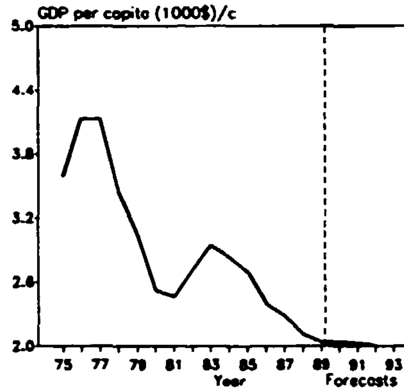


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	98081	128079	108798
Per capita (1980-dollars) /na.c	2521	2690	2038
Manufacturing share (%) /na (current prices)	8.7	8.2	7.8 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	8528	12620	10733 /e
Industrial production index	100	135	115 /e
Value added (millions of dollars)	8186	14287 /e	41280 /e
Gross output (millions of dollars)	15871	27051 /e	70483 /e
Employment (thousands)	470	614	737 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	48	47 /e	41 /e
Wages and salaries (%)	29	26 /e	23 /e
Operating surplus (%)	23	27 /e	36 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	33756	44065 /e	95619 /e
Value added / worker	17411	23274 /e	56002 /e
Average wage	9668	11260	21523 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	10.82 /e	5.27 /e	6.96 /e
as a percentage of average θ in 1970-1975	162 /e	79 /e	104 /e
MVA growth rate / θ	0.46	1.06	0.07
Degree of specialization	20.3	19.3	19.2
-VALUE ADDED: (millions of dollars)			
311 Food products	930	1259	3026 /e
313 Beverages	145	302	841 /e
314 Tobacco products	190	103	3497 /e
321 Textiles	1329	2119	4872 /e
322 Wearing apparel	78	76	563 /e
323 Leather and fur products	36	67	349 /e
324 Footwear	100	165	434 /e
331 Wood and wood products	68	120	501 /e
332 Furniture and fixtures	33	48	171 /e
341 Paper and paper products	135	261	380 /e
342 Printing and publishing	80	97	438 /e
351 Industrial chemicals	93	232	715 /e
352 Other chemical products	278	606	1966 /e
353 Petroleum refineries	1652	2928 /e	9311 /e
354 Miscellaneous petroleum and coal products	2	32	164 /e
355 Rubber products	93	180	807 /e
356 Plastic products	198	236	558 /e
361 Pottery, china and earthenware	45	76	134 /e
362 Glass and glass products	115	167	331 /e
369 Other non-metal mineral products	819	1368	4891 /e
371 Iron and steel	367	713	1517 /e
372 Non-ferrous metals	48	191	712 /e
381 Metal products	319	556	1159 /e
382 Non-electrical machinery	208	632	2130 /e
383 Electrical machinery	391	749	634 /e
384 Transport equipment	399	927	996 /e
385 Professional and scientific equipment	24	55	81 /e
390 Other manufacturing industries	11	26	92 /e

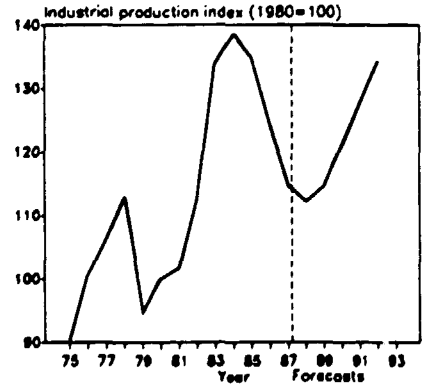
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

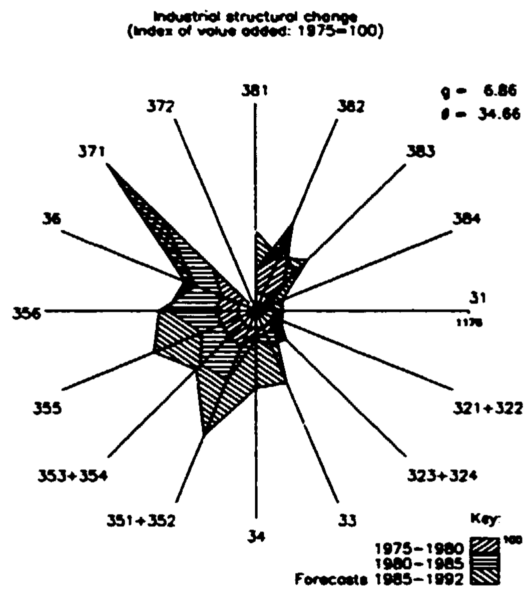
GDP per capita (1000$)/c

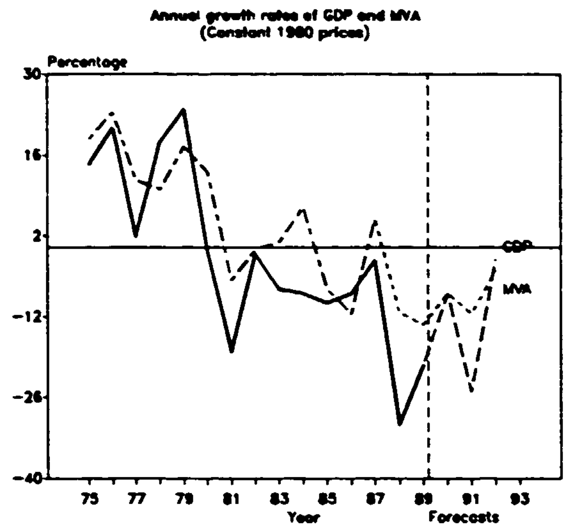


Manufacturing share in GDP current (%)

Industrial production index (1980=100)



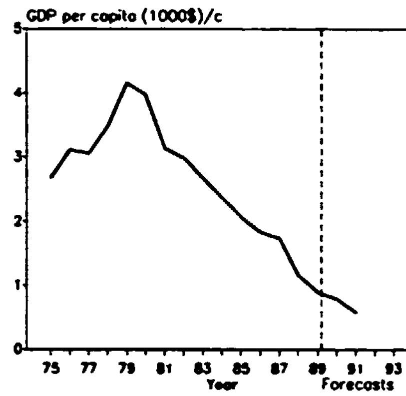


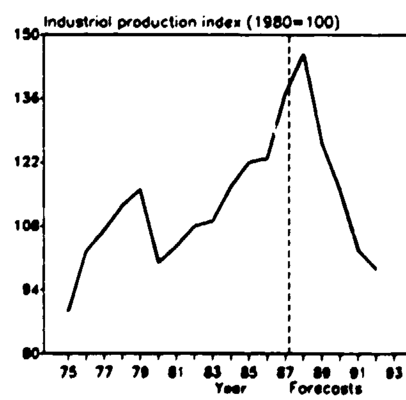


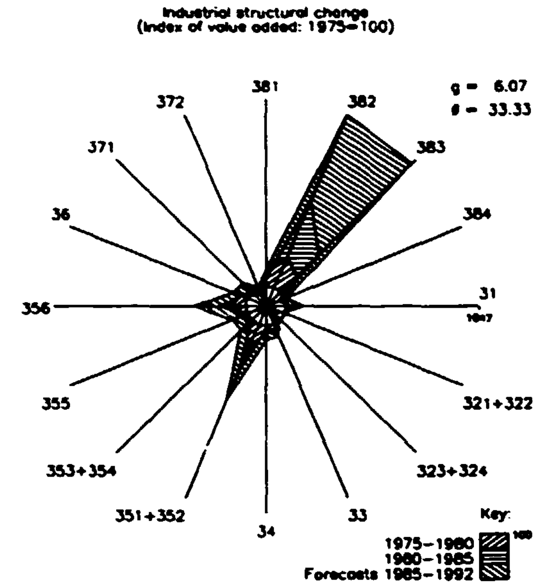
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

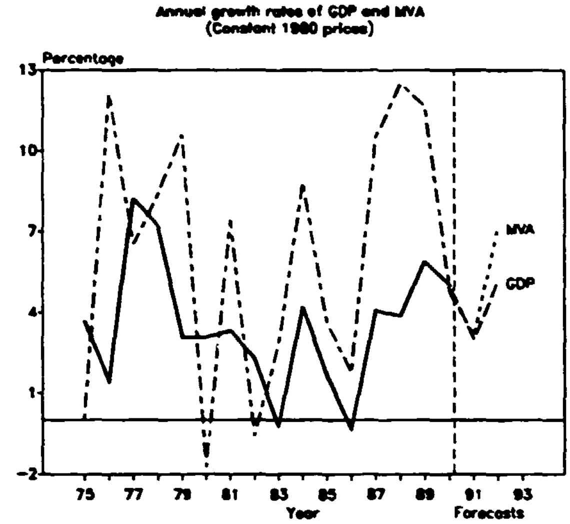
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	52749	32831	16272
Per capita (1980-dollars) /na,c	3969	2065	890
Manufacturing share (%) /na (current prices)	4.5	9.3	16.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	2363	2223	1584 /e
Industrial production index	100	122	126 /e
Value added (millions of dollars)	1851 /e	3676	6119 /e
Gross output (millions of dollars)	4882 /e	7162	11771 /e
Employment (thousands)	177	174	195 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	62 /e	49	48 /e
Wages and salaries (%)	13 /e	13	13 /e
Operating surplus (%)	24 /e	39	39 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	27961 /e	41090	60482 /e
Value added / worker	10627 /e	21088	31439 /e
Average wage	3700	5242	8126 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.22 /e	4.47 /e	4.89 /e
as a percantage of average θ in 1970-1975	47 /e	29 /e	32 /e
MVA growth rate / θ	1.41	2.25	1.40
Degree of specialization	20.4	24.2	23.0
-VALUE ADDED:(millions of dollars)			
311 Food products	196 /e	396	530 /e
313 Beverages	74 /e	125	162 /e
314 Tobacco products	90 /e	140	226 /e
321 Textiles	192 /e	248	376 /e
322 Wearing apparel	32 /e	53	74 /e
323 Leather and fur products	20 /e	1	2 /e
324 Footwear	16 /e	81	88 /e
331 Wood and wood products	1 /e	1	2 /e
332 Furniture and fixtures	7 /e	13	30 /e
341 Paper and paper products	40 /e	52	155 /e
342 Printing and publishing	21 /e	33	88 /e
351 Industrial chemicals	69 /e	151	291 /e
352 Other chemical products	162 /e	389	876 /e
353 Petroleum refineries	335 /e	868	1386 /e
354 Miscellaneous petroleum and coal products	25 /e	40	91 /e
355 Rubber products	5 /e	10	21 /e
356 Plastic products	12 /e	33	57 /e
361 Pottery, china and earthenware	1 /e	1	2 /e
362 Glass and glass products	17 /e	35	51 /e
369 Other non-metal mineral products	213 /e	565	828 /e
371 Iron and steel	5 /e	20 /e	25 /e
372 Non-ferrous metals	- /e	- /e	- /e
381 Metal products	38 /e	47	105 /e
382 Non-electrical machinery	157 /e	149	211 /e
383 Electrical machinery	111 /e	185	340 /e
384 Transport equipment	12 /e	40	103 /e
385 Professional and scientific equipment	1 /e	-	- /e
390 Other manufacturing industries	1 /e	-	- /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.





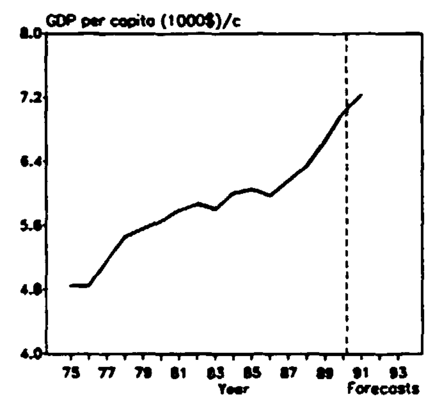


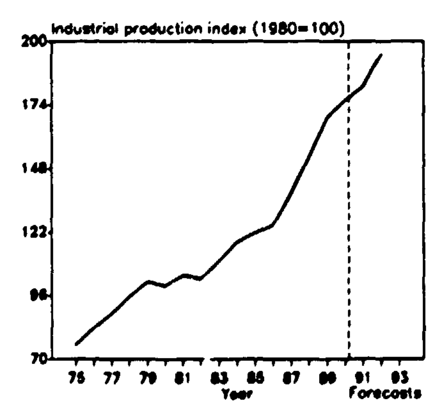


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

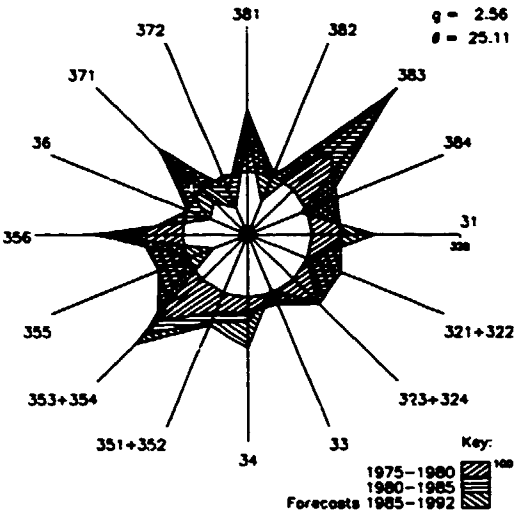
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	19261	21503	24521
Per capita (1980-dollars) /na,c	5662	6052	6654
Manufacturing share (%) /na (current prices)	23.4	25.4	25.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	4525	5600	7911
Industrial production index	100	122	169
Value added (millions of dollars)	5700	5988	12416
Gross output (millions of dollars)	15905	15394	28159
Employment (thousands)	225	186	188 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	61	56
Wages and salaries (%)	16	13	12 /e
Operating surplus (%)	20	26	33 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	70785	82578	149465 /e
Value added / worker	25369	32126	65903 /e
Average wage	11067	10455	17194 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.50	4.53	4.08
as a percentage of average θ in 1970-1975	98	98	89
MVA growth rate / θ	1.65	C.84	1.65
Degree of specialization	14.9	18.8	21.0
-VALUE ADDED: (millions of dollars)			
311 Food products	1264	1194	2420
313 Beverages	325	331	660
314 Tobacco products	83	83	125
321 Textiles	266	181	297
322 Wearing apparel	147	118	158
323 Leather and fur products	23	12	15 /e
324 Footwear	42	22	21 /e
331 Wood and wood products	93	66	130 /e
332 Furniture and fixtures	59	40	58 /e
341 Paper and paper products	105	75	154
342 Printing and publishing	265	219	447
351 Industrial chemicals	236	315	592 /e
352 Other chemical products	536	716	1328 /e
353 Petroleum refineries	22	15	34t
354 Miscellaneous petroleum and coal products	-	-	-t
355 Rubber products	52	48	96 /e
356 Plastic products	113	128	256 /e
361 Pottery, china and earthenware	28	13	31 /e
362 Glass and glass products	109	113	181 /e
369 Other non-metal mineral products	322	260	464 /e
371 Iron and steel	31	37	84 /e
372 Non-ferrous metals	15	8	21 /e
381 Metal products	336	216	377
382 Non-electrical machinery	449	864	1932
383 Electrical machinery	337	512	1697
384 Transport equipment	190	116	276
385 Professional and scientific equipment	168	261	483
390 Other manufacturing industries	79	39	82 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

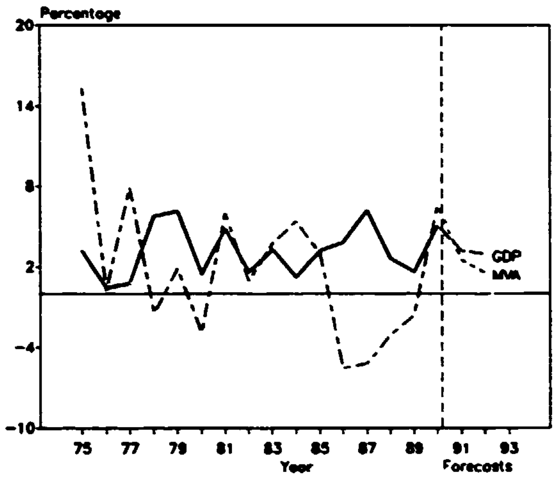




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

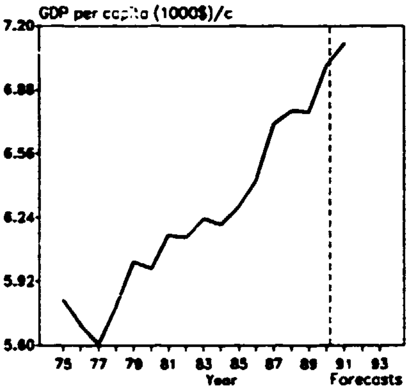


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

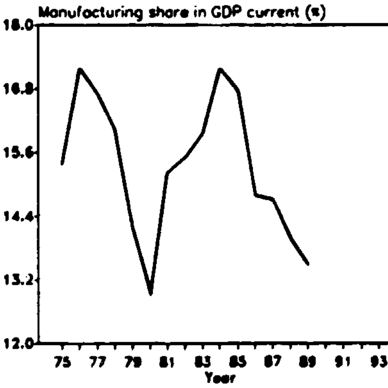
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	23200	26653	30642
Per capita (1980-dollars) /na,c	5982	6296	6769
Manufacturing share (%) /na (current prices)	12.9	16.7	13.5 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	4200	5059	4321
Industrial production index	100	119	125
Value added (millions of dollars)	6490	6655	8869 /e
Gross output (millions of dollars)	14332	16351	23742
Employment (thousands)	259	252	269
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	55	59	63 /e
Wages and salaries (%)	24	24	17
Operating surplus (%)	21	17	21 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	55422	55940	88294
Value added / worker	25096	22768	32982 /e
Average wage	13433	13373	14577
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.50	6.41	6.11 /e
as a percentage of average θ in 1970-1975	102	119	113 /e
MVA growth rate / θ	1.76	0.87	1.38
Degree of specialization	14.8	18.3	13.1
-VALUE ADDED: (millions of dollars)			
311 Food products	706	748	1228 /e
313 Beverages	66	56	127 /e
314 Tobacco products	24	10	16 /e
321 Textiles	422	243	332 /e
322 Wearing apparel	293	229	325 /e
323 Leather and fur products	18	13	16 /e
324 Footwear	38	42	60 /e
331 Wood and wood products	112	78	105 /e
332 Furniture and fixtures	90	81	129 /e
341 Paper and paper products	150	135	233 /e
342 Printing and publishing	184	227	406 /e
351 Industrial chemicals	256	317	419 /e
352 Other chemical products	250	241	342 /e
353 Petroleum refineries	93	106	142 /e
354 Miscellaneous petroleum and coal products	93	106	142 /e
355 Rubber products	104	64	63 /e
356 Plastic products	212	290	386 /e
361 Pottery, china and earthenware	26	25	24 /e
362 Glass and glass products	30	23	19 /e
369 Other non-metal mineral products	239	143	229 /e
371 Iron and steel	148	118	82 /e
372 Non-ferrous metals	61	36	55 /e
381 Metal products	1060	967	1153 /e
382 Non-electrical machinery	245	224	239 /e
383 Electrical machinery	831	1415	1846 /e
384 Transport equipment	610	522	507 /e
385 Professional and scientific equipment	66	129	147 /e
390 Other manufacturing industries	63	67	96 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

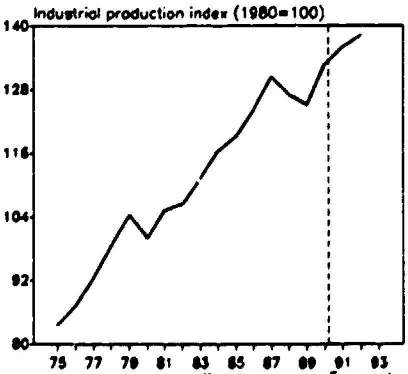
GDP per capita (1000$)/c



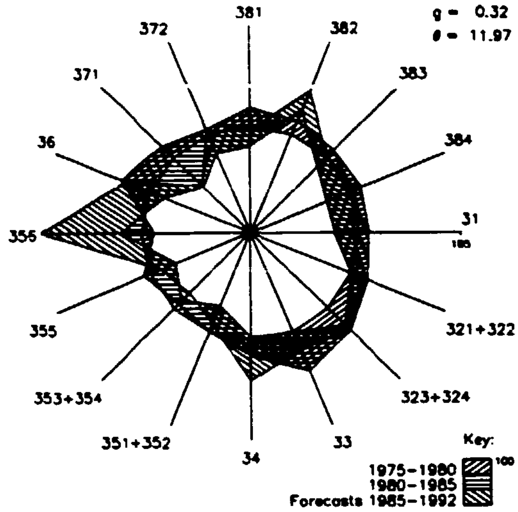
Manufacturing share in GDP current (%)



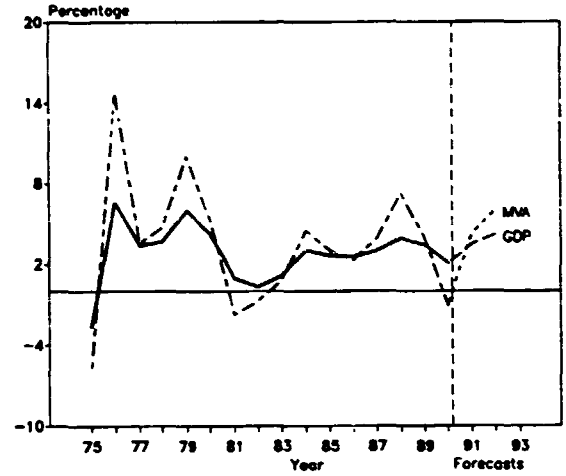
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

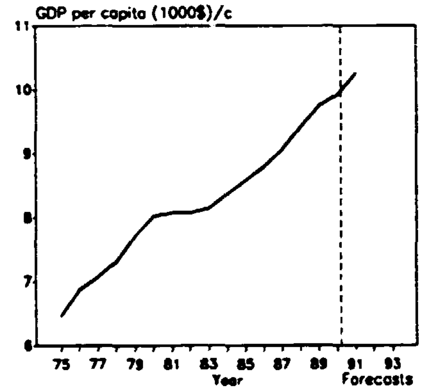


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

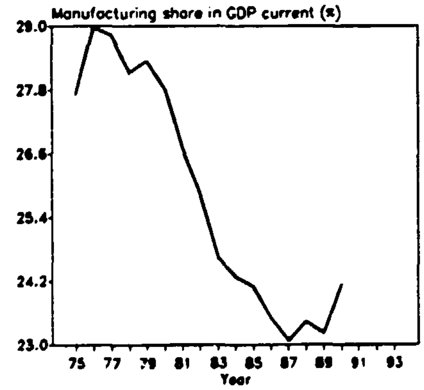
	1980	1985	1989
GDP:/na,c (millions of 1980-dollars)	452646	490149	556069
Per capita (1980-dollars) /na,c	8021	8578	9740
Manufacturing share (%) /na (current prices)	27.8	24.1	23.2
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	125880	133161	157782
Industrial production index	100	96	113
Value added (millions of dollars)	97032	64726	132099
Gross output (millions of dollars)	250912	212912	403868
Employment (thousands)	3333	2875	2906 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	61	70	67
Wages and salaries (%)	15	13	13 /e
Operating surplus (%)	24	17	20 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	75281	74057	139000 /e
Value added / worker	29112	22513	45465 /e
Average wage	10926	9556	17976 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.83	6.13	2.14
as a percentage of average θ in 1970-1975	62	134	47
MVA growth rate / θ	0.90	-0.80	1.14
Degree of specialization	10.1	10.9	10.8
-VALUE ADDED:(millions of dollars)			
311 Food products	6362	3618	6957
313 Beverages	1672	1354	2782
314 Tobacco products	307	224	617
321 Textiles	6716	5062	9716
322 Wearing apparel	3197	2322	4465
323 Leather and fur products	718	560	1122
324 Footwear	1495	1260	1895
331 Wood and wood products	1318	786	1464
332 Furniture and fixtures	1936	1257	2474
341 Paper and paper products	2260	1661	3172
342 Printing and publishing	3017	2271	5666
351 Industrial chemicals	5983	3994	7802
352 Other chemical products	4439	2696	6095
353 Petroleum refineries	1275	1065	1580
354 Miscellaneous petroleum and coal products	58	42	63
355 Rubber products	1832	1107	2255 /e
356 Plastic products	1465	1729	4242 /e
361 Pottery, china and earthenware	1897	1139	2642
362 Glass and glass products	1116	666	1465
369 Other non-metal mineral products	3667	2043	4870
371 Iron and steel	8354	3846	7164
372 Non-ferrous metals	1315	875	1923
381 Metal products	5687	3406	6915
382 Non-electrical machinery	9326	8914	17036
383 Electrical machinery	8435	5813	11934
384 Transport equipment	10280	6172	14095
385 Professional and scientific equipment	2032	550	1245
390 Other manufacturing industries	871	297	442 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

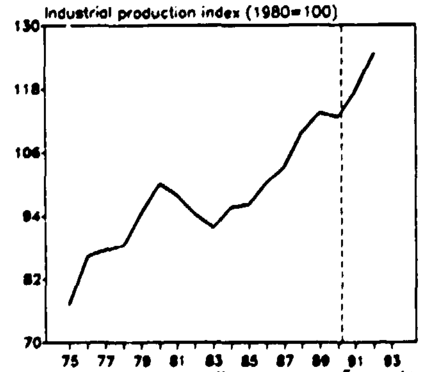
GDP per capita (1000$)/c



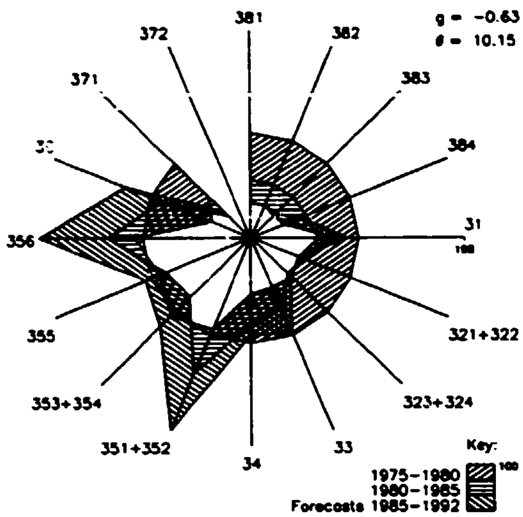
Manufacturing share in GDP current (%)



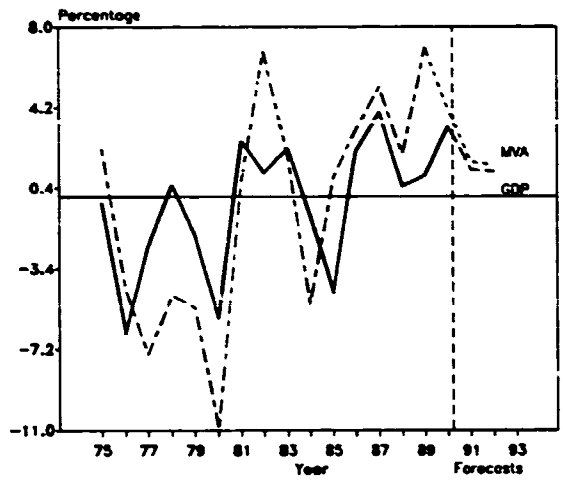
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



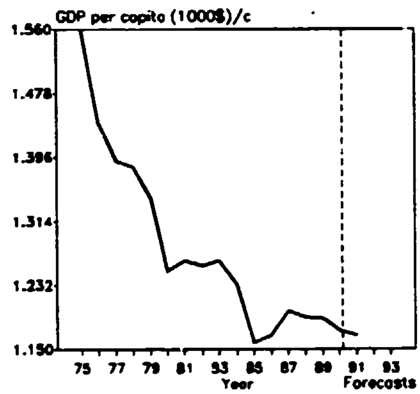
Annual growth rates of GDP and MVA
(Constant 1980 prices)

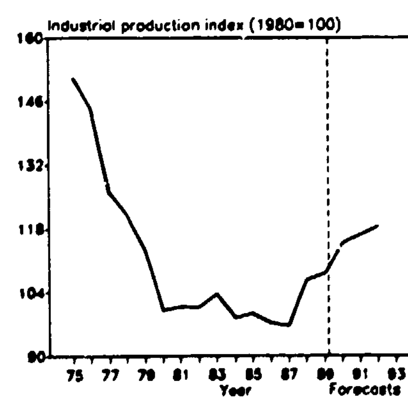


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

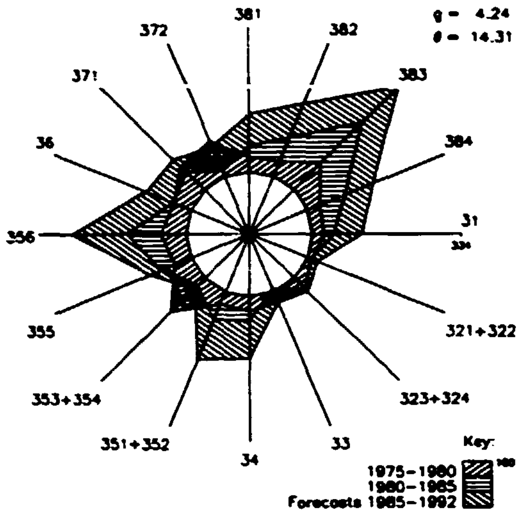
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	2667	2678	2887
Per capita (1980-dollars) /na,c	1250	1158	1189
Manufacturing share (%) /na (current prices)	16.6	20.0	20.2
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	433	455	540
Industrial production index	100	99	108
Value added (millions of dollars)	434 /e	344 /e	554 /e
Gross output (millions of dollars)	2151 /e	2052 /e	4090 /e
Employment (thousands)	44 /e	43 /e	45 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	80 /e	84 /e	87 /e
Wages and salaries (%)	9 /e	8 /e	7 /e
Operating surplus (%)	10 /e	9 /e	7 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	48701 /e	47574 /e	90881 /e
Value added / worker	9801 /e	7945 /e	12279 /e
Average wage	4595 /e	3748 /e	6169 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.20 /e	7.26 /e	2.29 /e
as a percentage of average θ in 1970-1975	115 /e	135 /e	42 /e
MVA growth rate / θ	-1.32	0.44	1.00
Degree of specialization	19.4	20.8	20.4
-VALUE ADDED:(millions of dollars)			
311 Food products	78	80 /e	122 /e
313 Beverages	63	47 /e	77 /e
314 Tobacco products	61	46 /e	71 /e
321 Textiles	3	2 /e	3 /e
322 Wearing apparel	15	11 /e	15 /e
323 Leather and fur products	2	2 /e	4 /e
324 Footwear	8	4 /e	5 /e
331 Wood and wood products	3	2 /e	3 /e
332 Furniture and fixtures	12	13 /e	25 /e
341 Paper and paper products	3 /e	12 /e	21 /e
342 Printing and publishing	18 /e	10 /e	13 /e
351 Industrial chemicals	8 /e	9 /e	14 /e
352 Other chemical products	27 /e	28 /e	50 /e
353 Petroleum refineries	55	26 /e	46 /e
354 Miscellaneous petroleum and coal products	9 /e	7 /e	12 /e
355 Rubber products	2 /e	1 /e	2 /e
356 Plastic products	1 /e	1 /e	2 /e
361 Pottery, china and earthenware	1 /e	1 /e	2 /e
362 Glass and glass products	2 /e	3 /e	6 /e
369 Other non-metal mineral products	9 /e	14 /e	25 /e
371 Iron and steel	12 /e	4 /e	7 /e
372 Non-ferrous metals	- /e	- /e	- /e
381 Metal products	14 /e	6 /e	9 /e
382 Non-electrical machinery	3 /e	1 /e	2 /e
383 Electrical machinery	7 /e	3 /e	4 /e
384 Transport equipment	15 /e	6 /e	12 /e
385 Professional and scientific equipment	- /e	- /e	- /e
390 Other manufacturing industries	4	3 /e	5 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

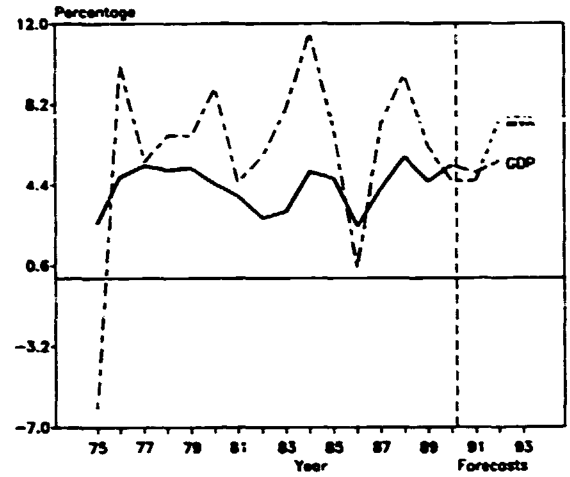




Industrial structural change
(Index of value added: 1975=100)



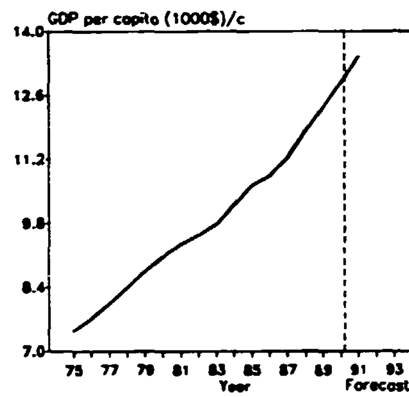
Annual growth rates of GDP and MVA
(Constant 1980 prices)

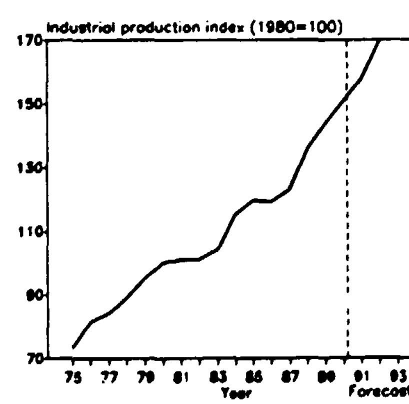


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

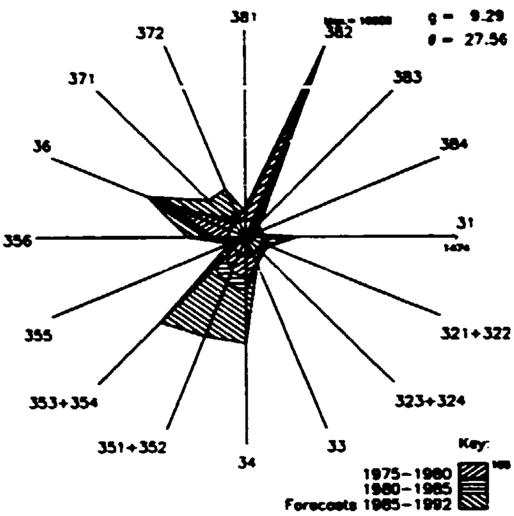
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	1059262	1283335	1514879
Per capita (1980-dollars) /na,c	9068	10620	12318
Manufacturing share (%) /na (current prices)	29.2	29.5	28.9
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	309747	441537	553948
Industrial production index	100	119	144
Value added (millions of dollars)	339234	412504	872034
Gross output (millions of dollars)	970569	1114673	2177567
Employment (thousands)	10253	10646	10776
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	65	63	60
Wages and salaries (%)	12	13	13
Operating surplus (%)	23	24	27
-PRODUCTIVITY:(dollars)			
Gross output / worker	94662	104704	202076
Value added / worker	33086	38747	80924
Average wage	11522	13663	26840
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.96	3.12	2.39
as a percentage of average θ in 1970-1975	69	72	55
MVA growth rate / θ	1.82	1.07	1.64
Degree of specialization	11.8	15.1	15.3
-VALUE ADDED:(millions of dollars)			
311 Food products	25889	32032	66758
313 Beverages	5015	5307	10351
314 Tobacco products	1888	700	2153
321 Textiles	15436	15259	27602
322 Wearing apparel	5156	5622	11851
323 Leather and fur products	886	981	1841
324 Footwear	697	658	1399
331 Wood and wood products	8997	6888	13852
332 Furniture and fixtures	3788	3798	8539
341 Paper and paper products	9310	9759	23014
342 Printing and publishing	17099	20789	46289
351 Industrial chemicals	13809	16811	39619
352 Other chemical products	15471	19758	47072
353 Petroleum refineries	6620	4596	6516
354 Miscellaneous petroleum and coal products	1063	713	1663
355 Rubber products	4150	5077	10606
356 Plastic products	9478	13570	30176
361 Pottery, china and earthenware	1623	1627	3037
362 Glass and glass products	2876	4029	8930
369 Other non-metal mineral products	12566	12321	26616
371 Iron and steel	26444	25224	49993
372 Non-ferrous metals	7458	5236	11963
381 Metal products	22409	26356	58962
382 Non-electrical machinery	39270	53680	116636
383 Electrical machinery	38868	63176	133067
384 Transport equipment	32107	46168	88489
385 Professional and scientific equipment	5686	6972	12417
390 Other manufacturing industries	5178	6510	12757

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

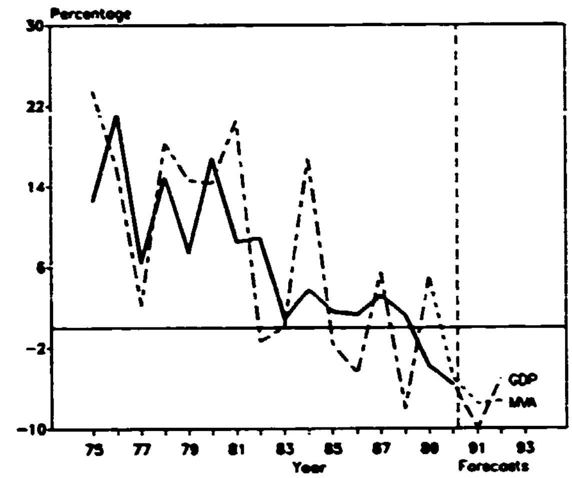




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

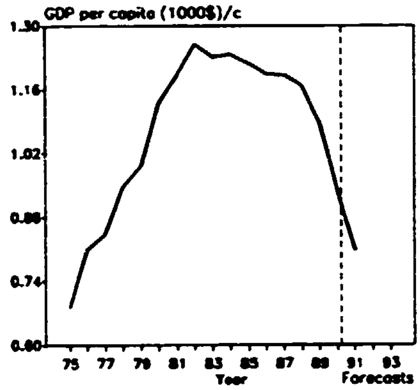


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	3303	4147	4213
Per capita (1980-dollars) /na,c	1130	1217	1086
Manufacturing share (%) /na (current prices)	8.9	10.3	9.7 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	427	584	566
Industrial production index	100	158	154
Value added (millions of dollars)	406	581	827 /e
Gross output (millions of dollars)	917	1997	2041 /e
Employment (thousands)	25	42	45 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	56	71	59 /e
Wages and salaries (%)	12	9	9 /e
Operating surplus (%)	32	20	31 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	37178	47681	45221 /e
Value added / worker	16452	13862	18329 /e
Average wage	4418	4326	4202 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.81	6.91	9.01 /e
as a percentage of average θ in 1970-1975	77	41	54 /e
MVA growth rate / θ	1.23	1.16	1.08
Degree of specialization	19.4	21.1	22.4
-VALUE ADDED: (millions of dollars)			
311 Food products	24	48	53 /e
313 Beverages	20	27	31 /e
314 Tobacco products	50	92	100 /e
321 Textiles	10	14	13 /e
322 Wearing apparel	8	10	12 /e
323 Leather and fur products	2	2	3 /e
324 Footwear	8	8	5 /e
331 Wood and wood products	7	7	7 /e
332 Furniture and fixtures	11	11	12 /e
341 Paper and paper products	9	9	20 /e
342 Printing and publishing	7	11	14 /e
351 Industrial chemicals	10	14	42 /e
352 Other chemical products	20	28	45 /e
353 Petroleum refineries	53	87	213 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	-	-	1 /e
356 Plastic products	12	13	18 /e
361 Pottery, china and earthenware	2	3	5 /e
362 Glass and glass products	2	3	4 /e
369 Other non-metal mineral products	98	123	128 /e
371 Iron and steel	11 /e	8	20 /e
372 Non-ferrous metals	5 /e	4	9 /e
381 Metal products	26 /e	31	22 /e
382 Non-electrical machinery	2 /e	4	8 /e
383 Electrical machinery	2	2	5 /e
384 Transport equipment	-	1	2 /e
385 Professional and scientific equipment	-	-	1 /e
390 Other manufacturing industries	7	23	33 /e

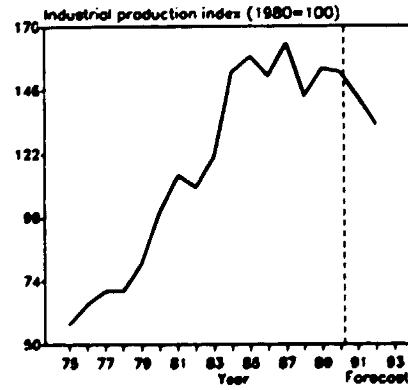
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

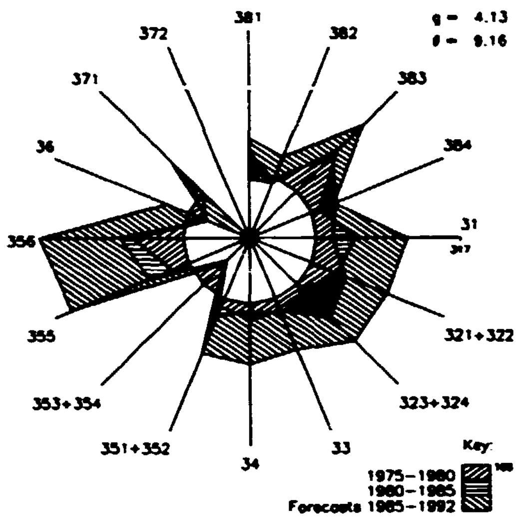


Manufacturing share in GDP current (%)

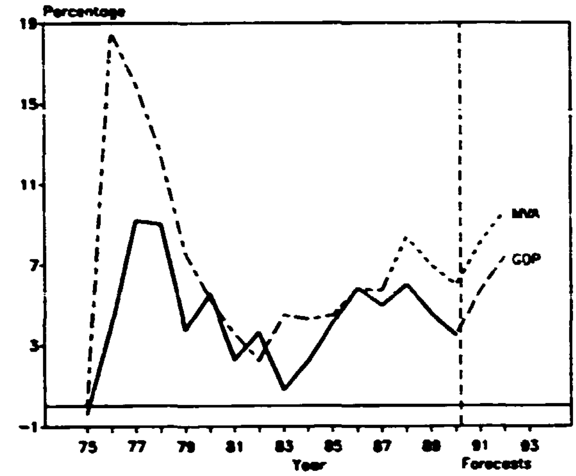
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

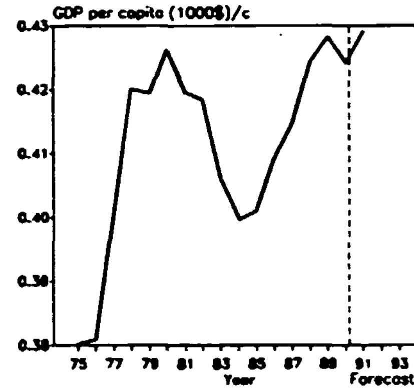


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

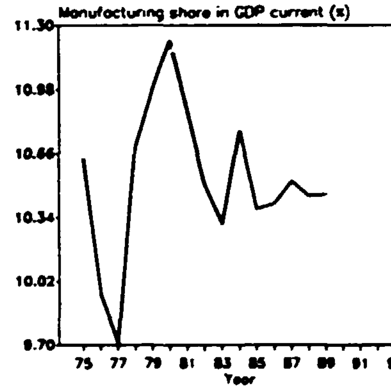
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	7088	8059	9924
Per capita (1980-dollars) /na,c	426	401	428
Manufacturing share (%) /na (current prices)	11.2	10.4	10.5 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	796	960	1245 /e
Industrial production index	100	111	139
Value added (millions of dollars)	755	671	892 /e
Gross output (millions of dollars)	3744	4368	6830 /e
Employment (thousands)	143	163	189 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	80	85	87 /e
Wages and salaries (%)	9	7 /e	6 /e
Operating surplus (%)	12	9 /e	7 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	26154	26839	36059 /e
Value added / worker	5278	4122	4711 /e
Average wage	2269	1795 /e	2066 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.06	5.16	1.98 /e
as a percentage of average θ in 1970-1975	96	70	27 /e
MVA growth rate / θ	0.68	0.21	2.55
Degree of specialization	15.3	17.7	18.1
-VALUE ADDED: (millions of dollars)			
311 Food products	177	185	261 /e
313 Beverages	56 /e	61 /e	70 /e
314 Tobacco products	19 /e	25 /e	23 /e
321 Textiles	59	40	55 /e
322 Wearing apparel	17	19	25 /e
323 Leather and fur products	6	3	5 /e
324 Footwear	9	6	10 /e
331 Wood and wood products	20	17	20 /e
332 Furniture and fixtures	9	8	12 /e
341 Paper and paper products	34	23	36 /e
342 Printing and publishing	22	19	27 /e
351 Industrial chemicals	25	16	21 /e
352 Other chemical products	39	47	57 /e
353 Petroleum refineries	15	10	12 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	25	27	40 /e
356 Plastic products	14	13	18 /e
361 Pottery, china and earthenware	1	-	1 /e
362 Glass and glass products	3	4	5 /e
369 Other non-metal mineral products	20	17	31 /e
371 Iron and steel	12	6	8b/e
372 Non-ferrous metals	-	-	-b/e
381 Metal products	55	32	45 /e
382 Non-electrical machinery	6	4	6 /e
383 Electrical machinery	40	36	41 /e
384 Transport equipment	64	43	52 /e
385 Professional and scientific equipment	1	1	1 /e
390 Other manufacturing industries	6	8	14 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

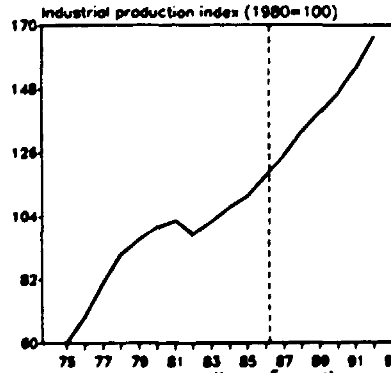
GDP per capita (1000$)/c



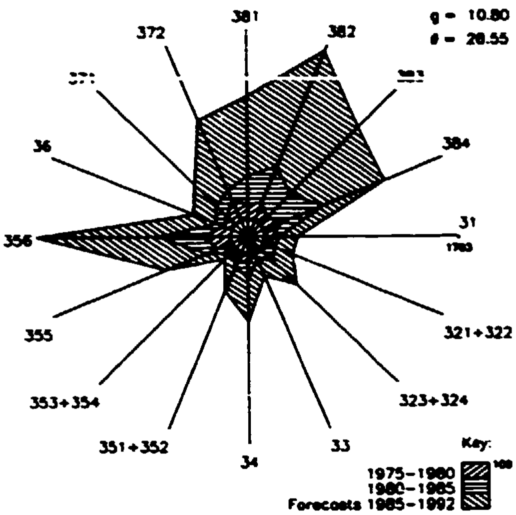
Manufacturing share in GDP current (%)



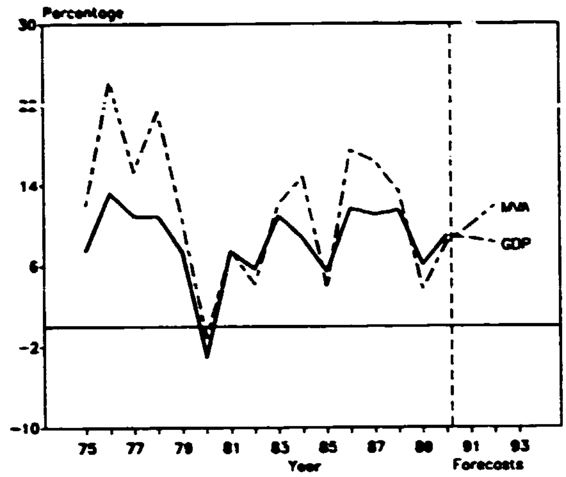
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

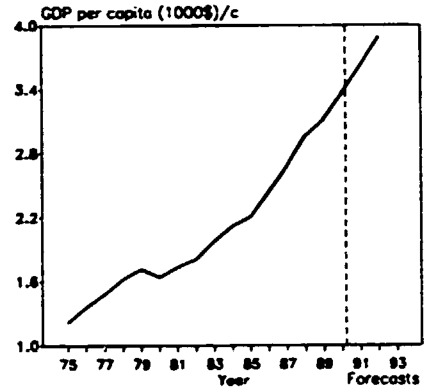


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

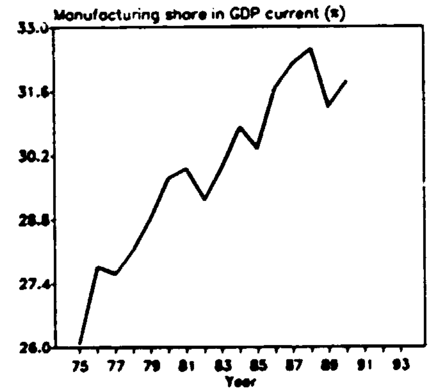
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	62419	90009	132085
Per capita (1980-dollars) /na.c	1637	2206	3114
Manufacturing share (%) /na (current prices)	29.7	30.3	31.3
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	18462	27666	44457
Industrial production index	100	171	304
Value added (millions of dollars)	19520	30731	78922
Gross output (millions of dollars)	59725	88541	219760
Employment (thousands)	2015	2395	3137 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67	65	64
Wages and salaries (%)	10	9	10 /e
Operating surplus (%)	23	25	26 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	29645	36963	70063 /e
Value added / worker	9689	12829	25162 /e
Average wage	2837	3476	7221 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.55	4.81	3.52 /e
as a percentage of average θ in 1970-1975	79	50	37 /e
MVA growth rate / θ	1.58	2.16	3.33
Degree of specialization	9.1	9.5	10.3
-VALUE ADDED: (millions of dollars)			
311 Food products	1526	2048	4693 /e
313 Beverages	571	764	1679 /e
314 Tobacco products	1143	1442	2736 /e
321 Textiles	2649	3295	7004 /e
322 Wearing apparel	906	1293	3045 /e
323 Leather and fur products	138	270	307 /e
324 Footwear	112	211	498 /e
331 Wood and wood products	239	262	601 /e
332 Furniture and fixtures	100	203	627 /e
341 Paper and paper products	426	682	1967 /e
342 Printing and publishing	440	732	1852 /e
351 Industrial chemicals	998	1275	2862 /e
352 Other chemical products	1016	1422	3615 /e
353 Petroleum refineries	757	1079	2064 /e
354 Miscellaneous petroleum and coal products	211	291	480 /e
355 Rubber products	657	910	2364 /e
356 Plastic products	369	709	2144 /e
361 Pottery, china and earthenware	89	107	245 /e
362 Glass and glass products	198	307	666 /e
369 Other non-metal mineral products	838	1064	2513 /e
371 Iron and steel	1256	2040	5297 /e
372 Non-ferrous metals	266	334	1270 /e
381 Metal products	635	1237	3707 /e
382 Non-electrical machinery	672	1463	4996 /e
383 Electrical machinery	1587	3621	12257 /e
384 Transport equipment	1162	2791	6429 /e
385 Professional and scientific equipment	214	290	932 /e
390 Other manufacturing industries	367	598	1572

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

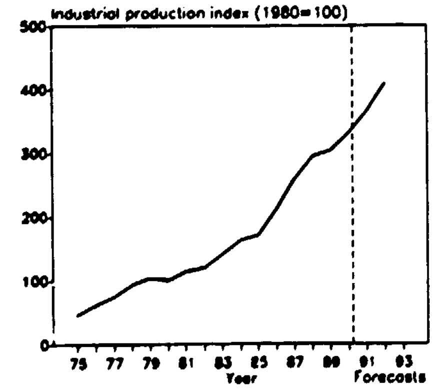
GDP per capita (1000$)/c



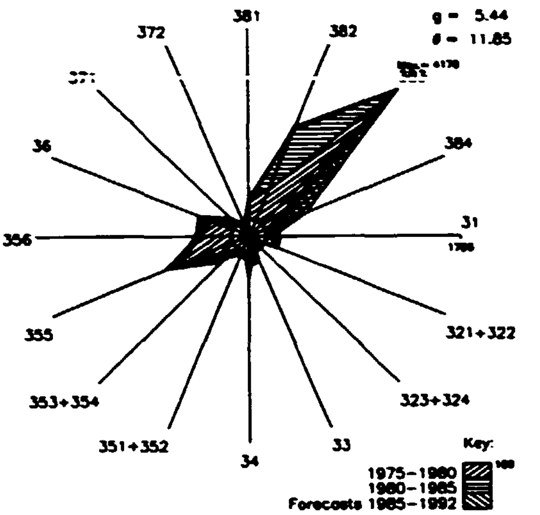
Manufacturing share in GDP current (%)



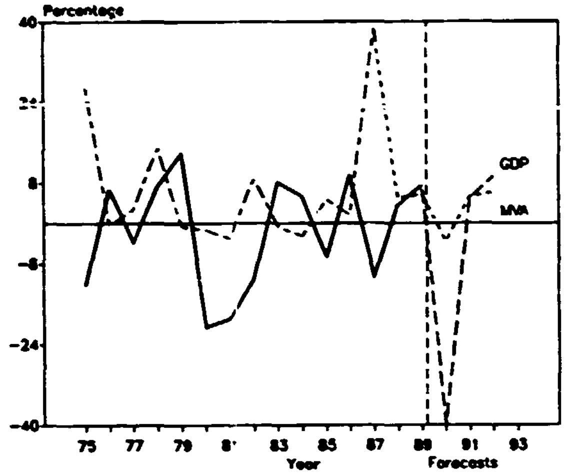
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

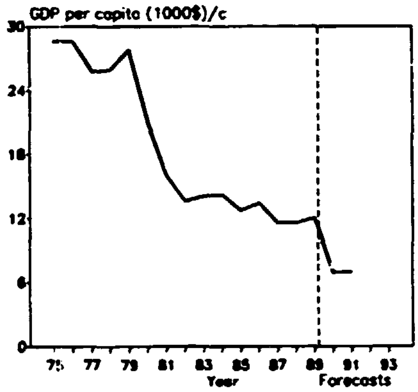


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

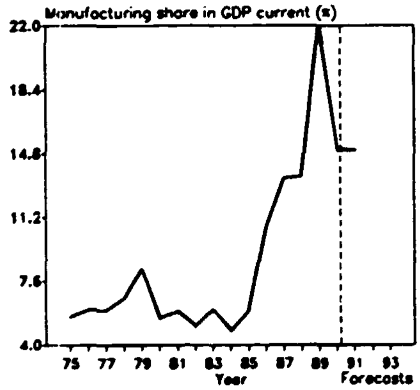
	1980	1985	1989
GDP:/na.c (millions of 1980-dollars)	28670	21911	23810
Per capita (1980-dollars) /na.c	20851	12731	12044
Manufacturing share (%) /na (current prices)	5.5	5.9	22.0
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1581	1689	2639 /e
Industrial production index	100	139	176
Value added (millions of dollars)	1752	1276	2359 /e
Gross output (millions of dollars)	6218	7440	6296 /e
Employment (thousands)	43	46	50 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	72	83	63 /e
Wages and salaries (%)	6	7	12 /e
Operating surplus (%)	22	10	26 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	144834	163413	124743 /e
Value added / worker	40802	28014	46750 /e
Average wage	9037	11999	14573 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.80	17.43	7.01 /e
as a percentage of average θ in 1970-1975	61	157	63 /e
MVA growth rate / θ	2.84	-0.35	2.45
Degree of specialization	39.7	31.2	50.3
-VALUE ADDED:(millions of dollars)			
311 Food products	96	101	146 /e
313 Beverages	20	31	38 /e
314 Tobacco products	-	-	- /e
321 Textiles	7	8	12 /e
322 Wearing apparel	84	75	87 /e
323 Leather and fur products	-	-	- /e
324 Footwear	-	-	- /e
331 Wood and wood products	40	14	10 /e
332 Furniture and fixtures	41	31	27 /e
341 Paper and paper products	5	12	22 /e
342 Printing and publishing	40	52	47 /e
351 Industrial chemicals	118	56	64 /e
352 Other chemical products	13	16	18 /e
353 Petroleum refineries	915	561	1506 /e
354 Miscellaneous petroleum and coal products	1	1	1 /e
355 Rubber products	5	5	5 /e
356 Plastic products	24	24	27 /e
361 Pottery, china and earthenware	2	-	4 /e
362 Glass and glass products	2	4	3 /e
369 Other non-metal mineral products	143	115	146 /e
371 Iron and steel	7	14	16 /e
372 Non-ferrous metals	-	-	3 /e
381 Metal products	99	88	98 /e
382 Non-electrical machinery	10	30	28 /e
383 Electrical machinery	22	16	21 /e
384 Transport equipment	45	12	19 /e
385 Professional and scientific equipment	5	5 /e	7 /e
390 Other manufacturing industries	7	5	4 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

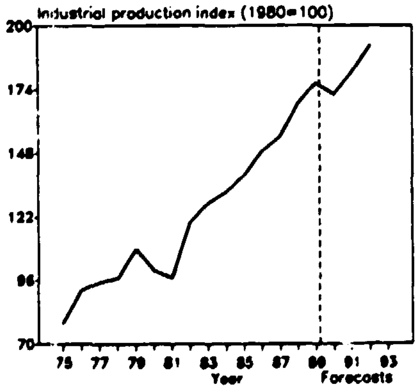
GDP per capita (1000$)/c



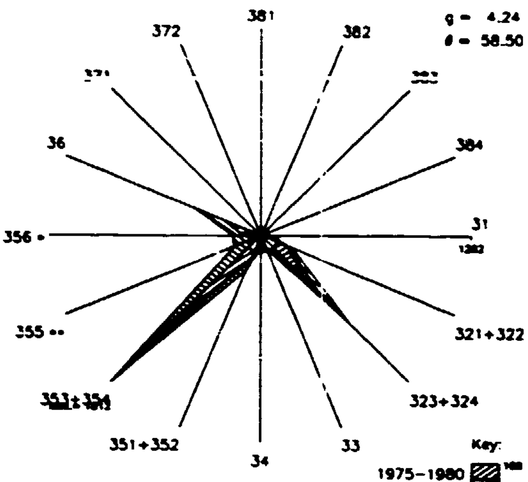
Manufacturing share in GDP current (%)



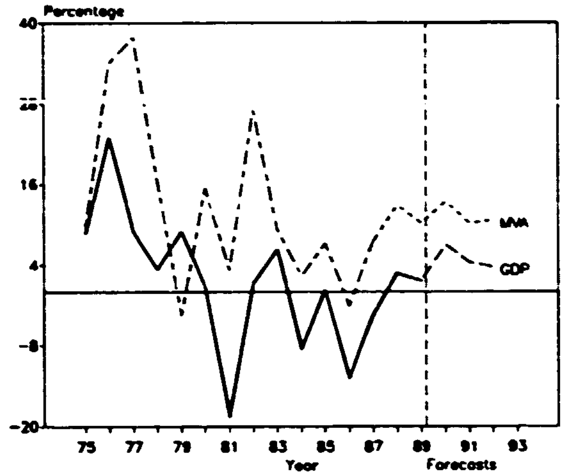
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



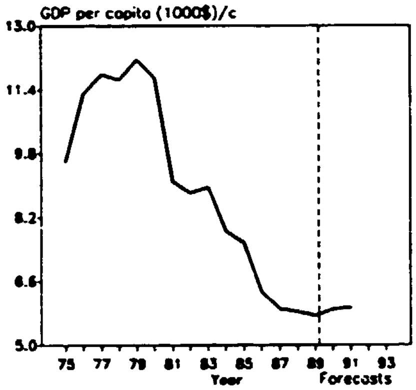
Annual growth rates of GDP and MVA
(Constant 1980 prices)



	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	35592	28585	25127
Per capita (1980-dollars) /na.c	11692	7550	5730
Manufacturing share (%) /na (current prices)	1.8	4.4	8.5 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	723	1136	1486 /e
Industrial production index	100	144	135 /e
Value added (millions of dollars)	358	566 /e	930 /e
Gross output (millions of dollars)	1177	1906 /e	3312 /e
Employment (thousands)	18 /e	21 /e	24 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	70	70 /e	72 /e
Wages and salaries (%)	13	13 /e	13 /e
Operating surplus (%)	17	16 /e	15 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	64393 /e	89594 /e	138218 /e
Value added / worker	19581 /e	26589 /e	38817 /e
Average wage	8325 /e	11835 /e	17776 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.75 /e	2.81 /e	2.16 /e
as a percentage of average θ in 1970-1975	163 /e	36 /e	28 /e
MVA growth rate / θ	0.46	1.25	2.11
Degree of specialization	18.9	25.4	30.9
-VALUE ADDED: (millions of dollars)			
311 Food products	35	48 /e	69 /e
313 Beverages	17	21 /e	30 /e
314 Tobacco products	55	65 /e	75 /e
321 Textiles	14	19 /e	30 /e
322 Wearing apparel	5 /e	5 /e	5 /e
323 Leather and fur products	7	13 /e	26 /e
324 Footwear	14	27 /e	40 /e
331 Wood and wood products	3 /e	4 /e	4 /e
332 Furniture and fixtures	2 /e	3 /e	5 /e
341 Paper and paper products	3	4 /e	6 /e
342 Printing and publishing	-	6 /e	6 /e
351 Industrial chemicals	35	53 /e	102 /e
352 Other chemical products	21	19 /e	19 /e
353 Petroleum refineries	81	156 /e	288 /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	-	- /e	- /e
356 Plastic products	2	3 /e	5 /n
361 Pottery, china and earthenware	1	1 /e	1 /e
362 Glass and glass products	-	- /e	- /e
369 Other non-metal mineral products	51	102 /e	202 /e
371 Iron and steel	-	- /e	- /e
372 Non-ferrous metals	-	- /e	- /e
381 Metal products	3	3 /e	3 /e
382 Non-electrical machinery	-	- /e	- /e
383 Electrical machinery	-	- /e	- /e
384 Transport equipment	-	- /e	- /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	9	12 /e	15 /e

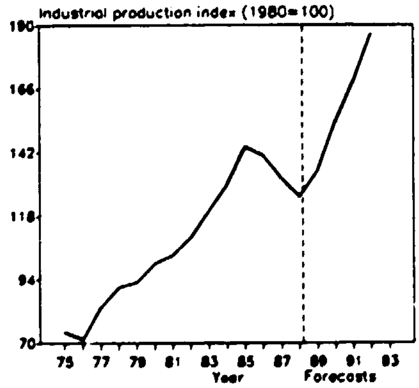
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

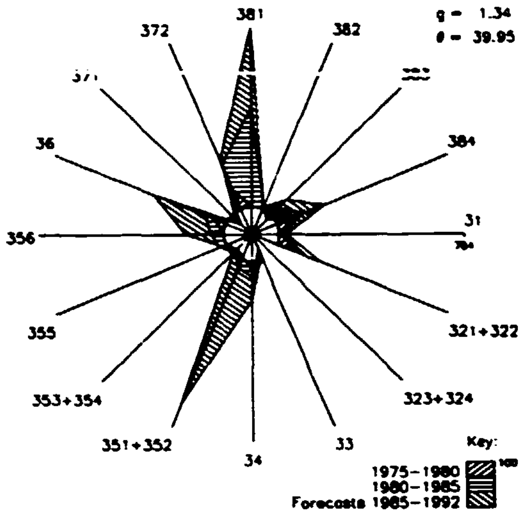


Manufacturing share in GDP current (%)

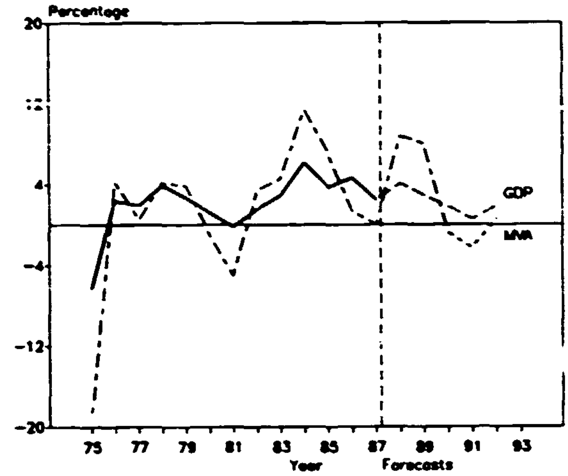
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

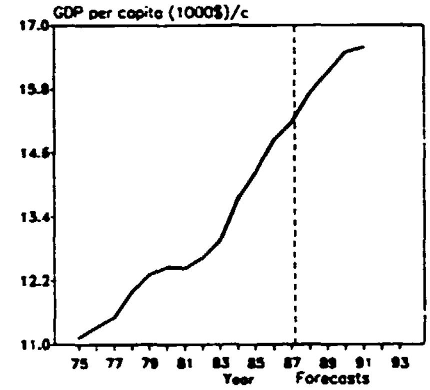


——— Source: National Accounts Statistics from UN/UNSO.
- - - - Estimated by UNIDO/PPD/IPP/GLO.

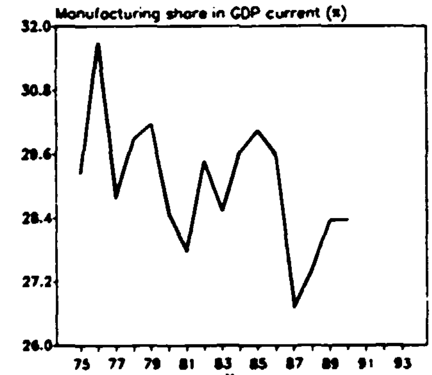
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	4546	5219	5995 /e
Per capita (1980-dollars) /na.c	12454	14221	16114 /e
Manufacturing share (%) /na (current prices)	28.5	30.0	28.4
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1293	1583	1885
Industrial production index	100	118	141
Value added (millions of dollars)	1168	933	1796 /e
Gross output (millions of dollars)	3269	2806	4893
Employment (thousands)	38	35	33
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	67	63 /e
Wages and salaries (%)	23 /e	17 /e	16 /e
Operating surplus (%)	13 /e	16 /e	21 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	86605	80784	147533
Value added / worker	30957	26865	54144 /e
Average wage	20109 /e	13604 /e	23564 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.06 /e	3.01 /e	5.77 /e
as a percentage of average θ in 1970-1975	115 /e	113 /e	217 /e
MVA growth rate / θ	-0.60	0.98	0.82
Degree of specialization	37.4	34.0	24.3
-VALUE ADDED: (millions of dollars)			
311 Food products	31	20	37
313 Beverages	32 /e	24 /e	43 /e
314 Tobacco products	9 /e	6 /e	9 /e
321 Textiles	24	14	28 /e
322 Wearing apparel	5	3	6 /e
323 Leather and fur products	-	-	- /e
324 Footwear	-	-	- /e
331 Wood and wood products	2 /e	1 /e	1 /e
332 Furniture and fixtures	3 /e	1 /e	2 /e
341 Paper and paper products	14 /e	12 /e	24 /e
342 Printing and publishing	18 /e	14 /e	27 /e
351 Industrial chemicals	39 /e	37 /e	242 /e
352 Other chemical products	3	7	105 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	2 /e	2 /e	3 /e
355 Rubber products	114 /e	104 /e	144 /e
356 Plastic products	18 /e	18 /e	41 /e
361 Pottery, china and earthenware	11 /e	10 /e	25 /e
362 Glass and glass products	15 /e	15 /e	46 /e
369 Other non-metal mineral products	43 /e	35 /e	98 /e
371 Iron and steel	592	415	540
372 Non-ferrous metals	32	34	59
381 Metal products	24	78	172
382 Non-electrical machinery	98	69	100
383 Electrical machinery	19	7	23 /e
384 Transport equipment	7	4	9
385 Professional and scientific equipment	10	4	9 /e
390 Other manufacturing industries	1 /e	- /e	- /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

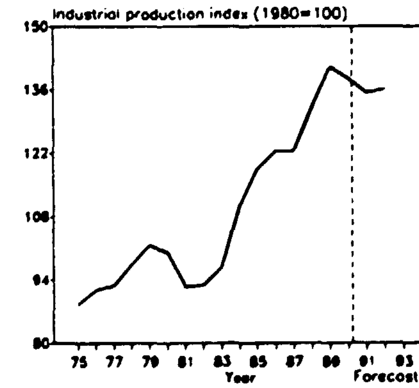
GDP per capita (1000$)/c



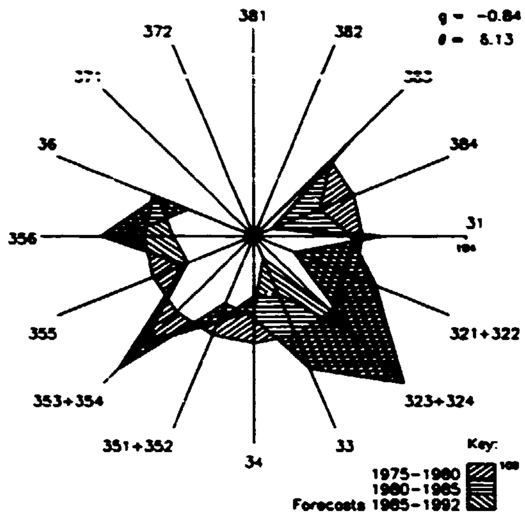
Manufacturing share in GDP current (%)



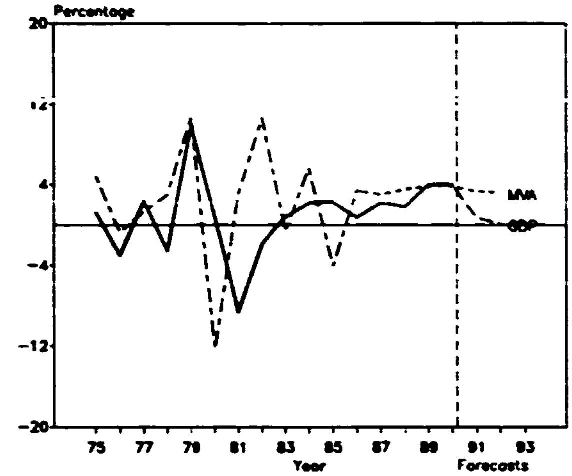
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

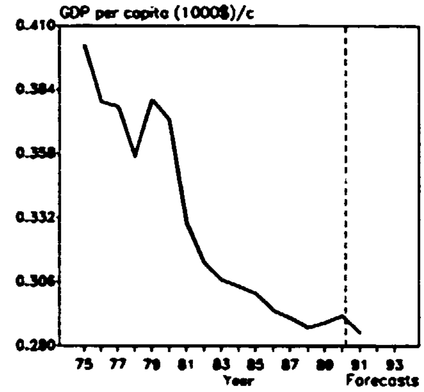


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	3265	3086	3364
Per capita (1980-dollars) /na,c	372	301	289
Manufacturing share (%) /na (current prices)	11.3	9.9	8.1 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	365	419	480 /e
Industrial production index	100	89	98 /e
Value added (millions of dollars)	221	133	103 /e
Gross output (millions of dollars)	569	328	276 /e
Employment (thousands)	41	47	45 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	59	63 /e
Wages and salaries (%)	15	16	13 /e
Operating surplus (%)	24	25	25 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	14040	6925	6170 /e
Value added / worker	5452	2813	2310 /e
Average wage	2083	1097	786 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.69	13.79	17.62 /e
as a percentage of average θ in 1970-1975	111	199	254 /e
MVA growth rate / θ	0.15	-0.33	-0.16
Degree of specialization	22.4	24.8	28.5
-VALUE ADDED: (millions of dollars)			
311 Food products	23	45	18 /e
313 Beverages	34	16	16 /e
314 Tobacco products	3	3	1 /e
321 Textiles	67	16	33 /e
322 Wearing apparel	19	6	2 /e
323 Leather and fur products	3	1	1 /e
324 Footwear	8	5	3 /e
331 Wood and wood products	2	1	- /e
332 Furniture and fixtures	2	1	- /e
341 Paper and paper products	4	3	4 /e
342 Printing and publishing	6	2	1 /e
351 Industrial chemicals	1	1	- /e
352 Other chemical products	10	11	8 /e
353 Petroleum refineries	11	7 /e	6 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	1	1	- /e
356 Plastic products	3	2	1 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	2	-	- /e
369 Other non-metal mineral products	2	2	2 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	9	5	3 /e
382 Non-electrical machinery	-	-	- /e
383 Electrical machinery	3	3	2 /e
384 Transport equipment	7	2	1 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	2	1	- /e

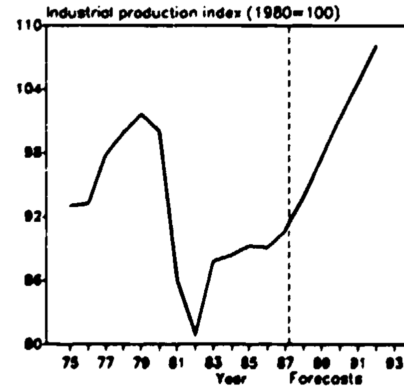
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

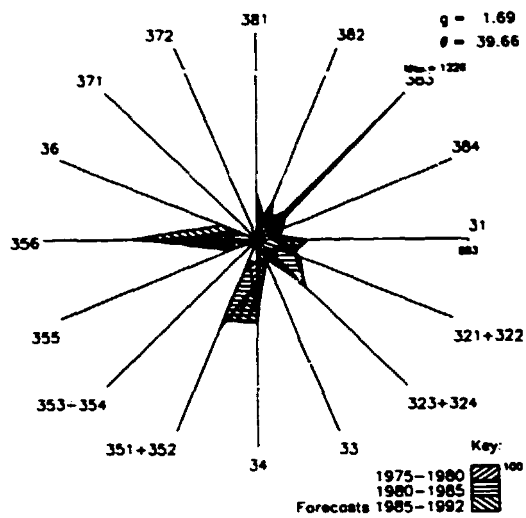


Manufacturing share in GDP current (%)

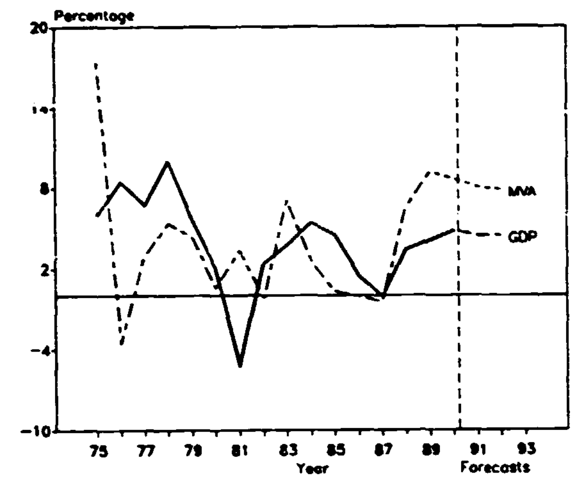
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

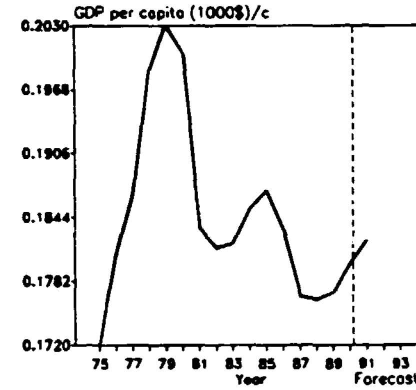


——— Source: National Accounts Statistics from UN/UNSO.
------- Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	1238	1372	1496
Per capita (1980-dollars) /na.c	200	187	177
Manufacturing share (%) /na (current prices)	13.5	14.3	15.6
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	155	177	204
Industrial production index	100	121	140
Value added (millions of dollars)	123	90	110 /e
Gross output (millions of dollars)	340	330	458 /e
Employment (thousands)	39	31	41 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	73	76 /e
Wages and salaries (%)	12	10	10 /e
Operating surplus (%)	24	18	14 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	8783	10745	11097 /e
Value added / worker	3174	2923	2671 /e
Average wage	1046	1035	1116 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	10.58 /e	14.12	10.85 /e
as a percentage of average θ in 1970-1975	118 /e	157	121 /e
MVA growth rate / θ	1.20	-0.07	-0.41
Degree of specialization	27.7	16.7	18.9
-VALUE ADDED: (millions of dollars)			
311 Food products	54	14	18 /e
313 Beverages	8	7	9 /e
314 Tobacco products	9	5	7 /e
321 Textiles	12	14	15 /e
322 Wearing apparel	2	1	1 /e
323 Leather and fur products	-	-	- /e
324 Footwear	1	3	4 /e
331 Wood and wood products	2	2	1 /e
332 Furniture and fixtures	1	1	1 /e
341 Paper and paper products	2	2	- /e
342 Printing and publishing	8	6	7 /e
351 Industrial chemicals	2	8	6 /e
352 Other chemical products	5	14	24 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	1	1	- /e
356 Plastic products	2	2	4 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	-	-	- /e
369 Other non-metal mineral products	3	1	7 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	6	6	3 /e
382 Non-electrical machinery	-	1	2 /e
383 Electrical machinery	5	1	1 /e
384 Transport equipment	1	1	1 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	-	-	- /e

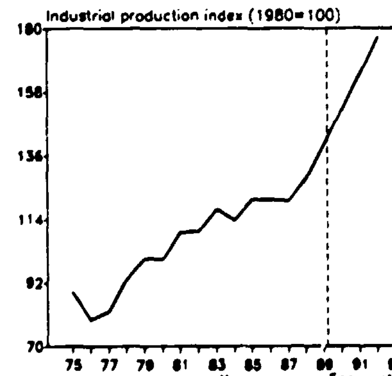
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

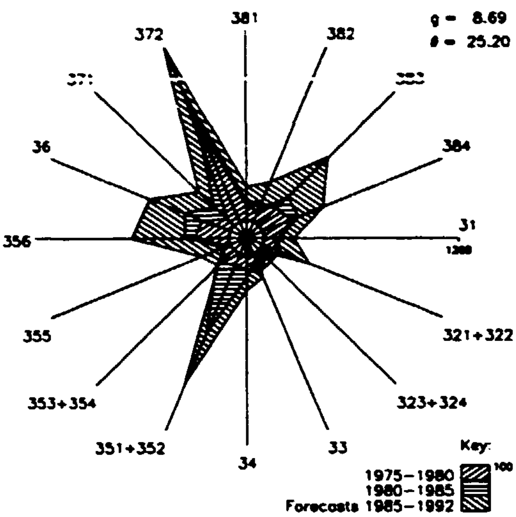


Manufacturing share in GDP current (%)

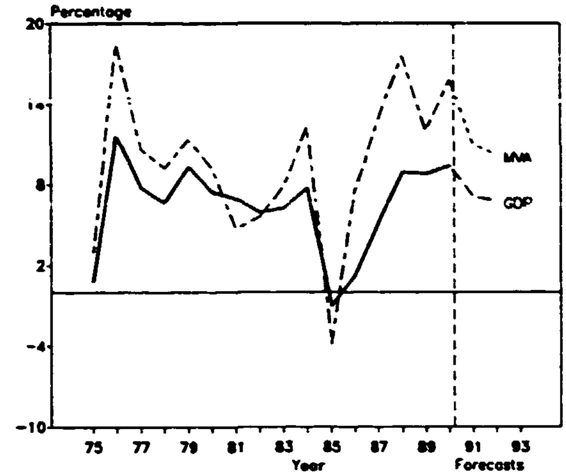
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



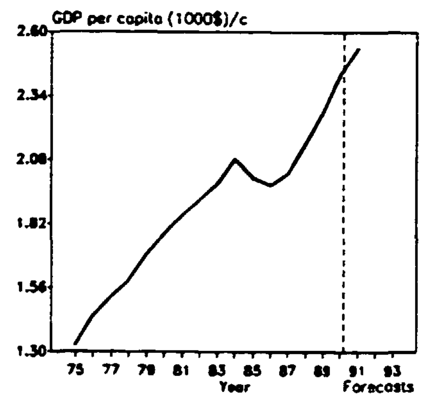
Annual growth rates of GDP and MVA
(Constant 1980 prices)

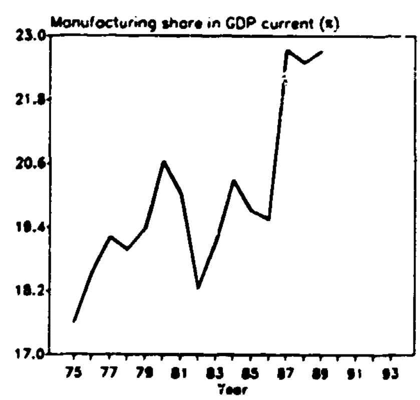


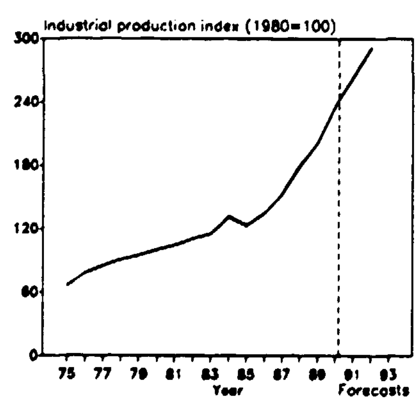
——— - - - Source: National Accounts Statistics from UN/UNSO.
- - - - ...... Estimated by UNIDO/PPD/IPP/GLO.

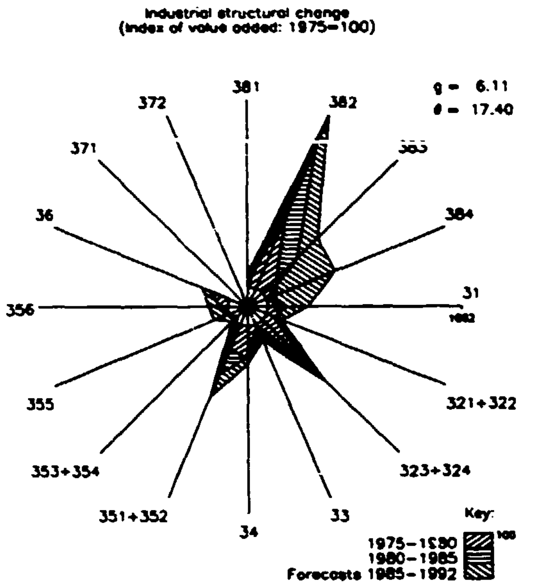
	1980		1985	1989	
GDP: /na,c (millions of 1980-dollars)	24487		31439	39659	
Per capita (1980-dollars) /na,c	1779		2005	2273	
Manufacturing share (%) /na (current prices)	20.6		19.7	22.7	/e
MANUFACTURING:					
Value added /na,c (millions of 1980-dollars)	5054		6511	10403	
Industrial production index	100		123	202	
Value added (millions of dollars)	3804	/e	4879	6769	/e
Gross output (millions of dollars)	14959	/e	18359	27511	/e
Employment (thousands)	521	/e	473	620	/e
-PROFITABILITY: (in percent of gross output)					
Intermediate input (%)	75	/e	73	75	/e
Wages and salaries (%)	7	/e	8	7	/e
Operating surplus (%)	18	/e	19	18	/e
-PRODUCTIVITY: (dollars)					
Gross output / worker	28707	/e	38789	44382	/e
Value added / worker	7300	/e	10308	10920	/e
Average wage	2041	/e	3084	2899	/e
-STRUCTURAL INDICES:					
Structural change θ (5-year average in degrees)	5.17	/e	8.00	4.98	/e
as a percentage of average θ in 1970-1975	49	/e	76	47	/e
MVA growth rate / θ	3.08		0.41	1.31	
Degree of specialization	15.6		15.3	15.9	
-VALUE ADDED: (millions of dollars)					
311 Food products	707	/e	703	965	/e
313 Beverages	112	/e	122	135	/e
314 Tobacco products	101	/e	205	160	/e
321 Textiles	190	/e	133	250	/e
322 Wearing apparel	73	/e	100	199	/e
323 Leather and fur products	3	/e	2	3	/e
324 Footwear	11	/e	5	4	/e
331 Wood and wood products	403	/e	263	422	/e
332 Furniture and fixtures	37	/e	40	49	/e
341 Paper and paper products	36	/e	55	105	/e
342 Printing and publishing	155	/e	197	183	/e
351 Industrial chemicals	79	/e	616	777	/e
352 Other chemical products	120	/e	153	198	/e
353 Petroleum refineries	116	/e	137	112	/e
354 Miscellaneous petroleum and coal products	2	/e	21	21	/e
355 Rubber products	295	/e	250	510	/e
356 Plastic products	70	/e	92	144	/e
361 Pottery, china and earthenware	10	/e	13	29	/e
362 Glass and glass products	25	/e	23	44	/e
369 Other non-metal mineral products	180	/e	297	348	/e
371 Iron and steel	80	/e	153	182	/e
372 Non-ferrous metals	43	/e	35	48	/e
381 Metal products	145	/e	147	185	/e
382 Non-electrical machinery	124	/e	99	175	/e
383 Electrical machinery	472	/e	738	1153	/e
384 Transport equipment	164	/e	211	249	/e
385 Professional and scientific equipment	25	/e	30	60	/e
390 Other manufacturing industries	25	/e	39	57	/e

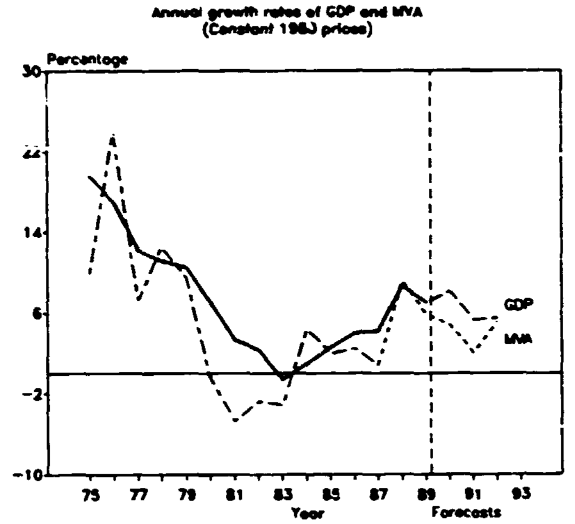
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.







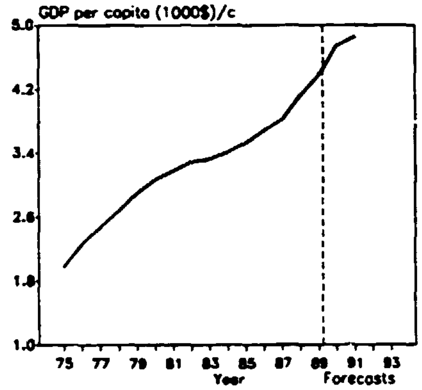


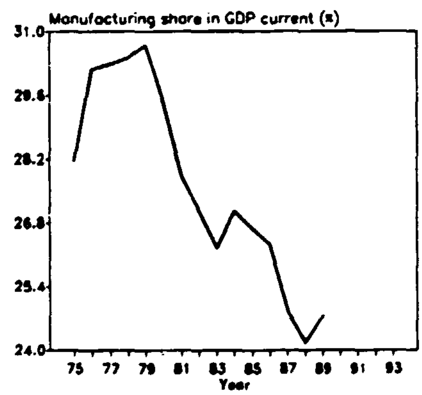


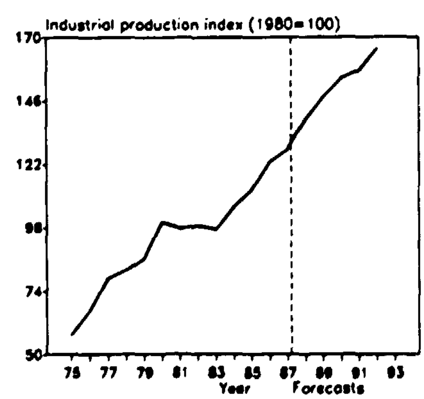
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	1120	1218	1534
Per capita (1980-dollars) /na.c	3068	3530	4370
Manufacturing share (%) /na (current prices)	29.4	26.7	24.7 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	330	315	376 /e
Industrial production index	100	112	147 /e
Value added (millions of dollars)	302	265	452 /e
Gross output (millions of dollars)	706	650	1140 /e
Employment (thousands)	29	26	29 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	57	59	60 /e
Wages and salaries (%)	22	20	19 /e
Operating surplus (%)	21	20	20 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	24517	25438	39103 /e
Value added / worker	10481	10390	15498 /e
Average wage	5283	5199	7608 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.54	5.63	4.15 /e
as a percentage of average θ in 1970-1975	36	37	27 /e
MVA growth rate / θ	2.43	0.12	1.22
Degree of specialization	18.3	17.7	16.5
-VALUE ADDED: (millions of dollars)			
311 Food products	20	25	50 /e
313 Beverages	20	22	42 /e
314 Tobacco products	8	8	7 /e
321 Textiles	17	8	11 /e
322 Wearing apparel	88	65	97 /e
323 Leather and fur products	4	1	1 /e
324 Footwear	8	9	15 /e
331 Wood and wood products	2	1	2 /e
332 Furniture and fixtures	14	9	17 /e
341 Paper and paper products	2	3	4 /e
342 Printing and publishing	22	17	24 /e
351 Industrial chemicals	1	2	3 /e
352 Other chemical products	5	6	9 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	10	7	16 /e
356 Plastic products	6	4	8 /e
361 Pottery, china and earthenware	1	-	1 /e
362 Glass and glass products	2	1	2 /e
369 Other non-metal mineral products	6	7	9 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	14	10	17 /e
382 Non-electrical machinery	5	8	11 /e
383 Electrical machinery	22	31	50 /e
384 Transport equipment	6	3	19 /e
385 Professional and scientific equipment	12	12	17 /e
390 Other manufacturing industries	8	5	21 /e

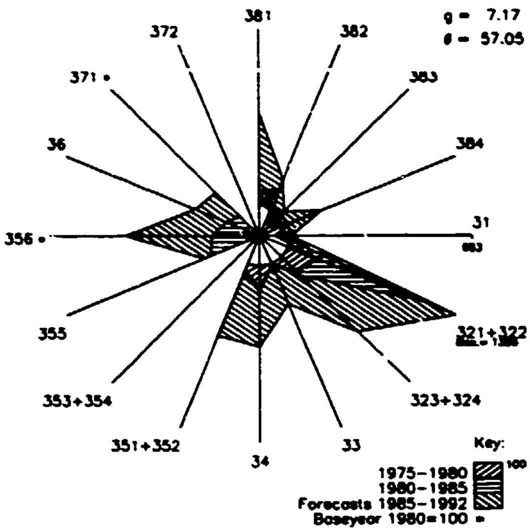
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



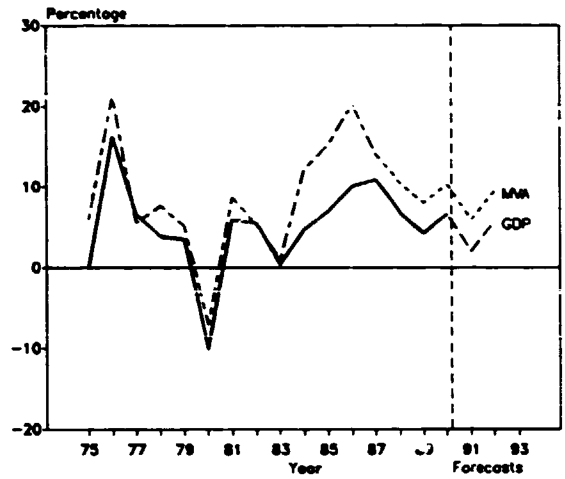




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

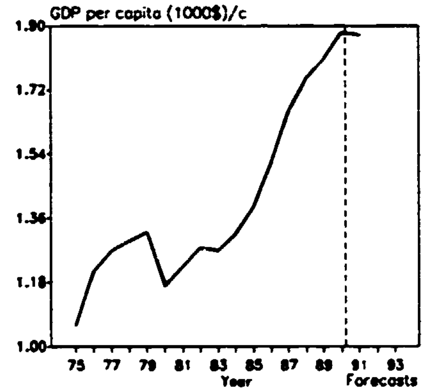


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

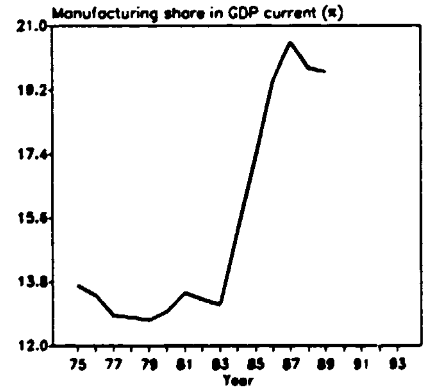
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	1132	1422	1931
Per capita (1980-dollars) /na,c	1170	1392	1805
Manufacturing share (%) /na (current prices)	13.0	17.2	19.7 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	147	219	359 /e
Industrial production index	100	138	177 /e
Value added (millions of dollars)	136	172	393
Gross output (millions of dollars)	633	729	1451
Employment (thousands)	43	75	115
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	79	76	73
Wages and salaries (%)	11	11	12
Operating surplus (%)	10	13	15
-PRODUCTIVITY:(dollars)			
Gross output / worker	14745	9771	12622
Value added / worker	3163	2309	3458
Average wage	1654	1066	1566
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.55	6.91	5.17
as a percentage of average θ in 1970-1975	233	213	160
MVA growth rate / θ	-0.22	1.59	3.56
Degree of specialization	21.2	35.0	33.1
-VALUE ADDED:(millions of dollars)			
311 Food products	36	43	67
313 Beverages	10	7	21
314 Tobacco products	2	4	6
321 Textiles	9	10	22
322 Wearing apparel	28	68	172
323 Leather and fur products	1	1	5
324 Footwear	2	2	3
331 Wood and wood products	1	1	2
332 Furniture and fixtures	2	1	3
341 Paper and paper products	1	2	2
342 Printing and publishing	5	4	8
351 Industrial chemicals	3	3	10
352 Other chemical products	4	4	8
353 Petroleum refineries	-	-	-
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	1	1	1
356 Plastic products	1	2	5
361 Pottery, china and earthenware	-	-	-
362 Glass and glass products	-	-	-
369 Other non-metal mineral products	6	4	8
371 Iron and steel	3	2	5
372 Non-ferrous metals	-	-	-
381 Metal products	5	3	10
382 Non-electrical machinery	3	1	4
383 Electrical machinery	3	2	5
384 Transport equipment	2	1	4
385 Professional and scientific equipment	2	3	13
390 Other manufacturing industries	4	5	13

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

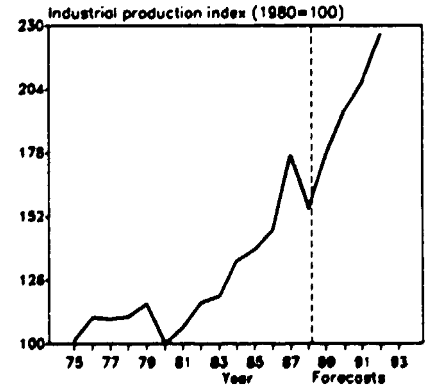
GDP per capita (1000$)/c



Manufacturing share in GDP current (%)

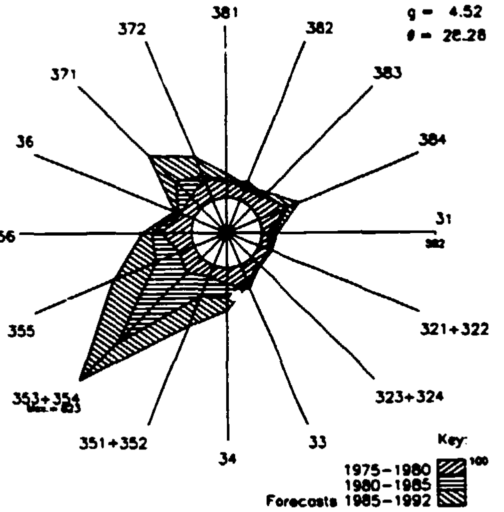


Industrial production index (1980=100)

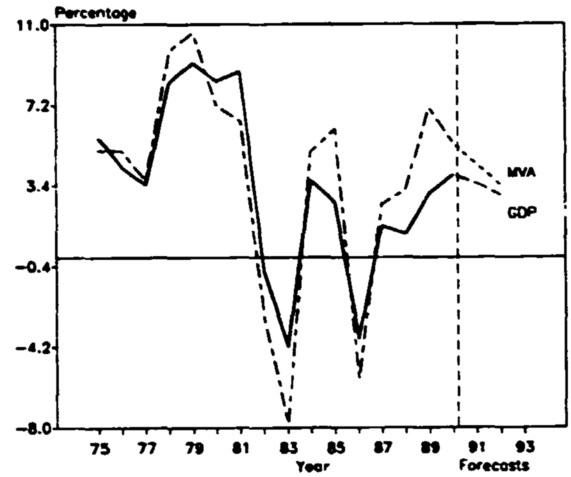


MEXICO

Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

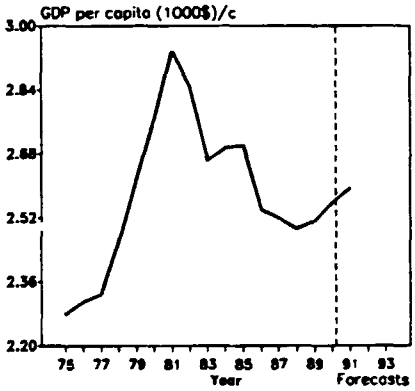


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

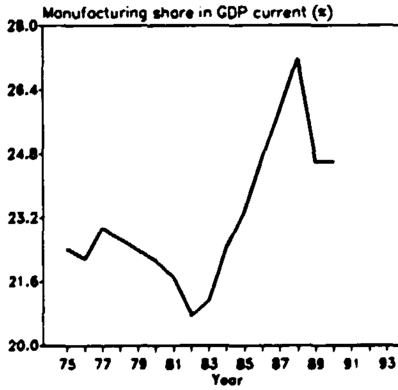
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	194766	214370	217876
Per capita (1980-dollars) /na,c	2766	2701	2512
Manufacturing share (%) /na (current prices)	22.1	23.4	24.6
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	43200	45924	49050
Industrial production index	100	103	104
Value added (millions of dollars)	43048	44987 /e	54706 /e
Gross output (millions of dollars)	102047	103810 /e	126238 /e
Employment (thousands)	2417	2214 /e	2005 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	58	57 /e	57 /e
Wages and salaries (%)	14	8 /e	6 /e
Operating surplus (%)	28	35 /e	37 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	42221	46888 /e	62970 /e
Value added / worker	17811	20319 /e	27289 /e
Average wage	5846	3947 /e	3925 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.56	4.86 /e	2.71 /e
as a percentage of average θ in 1970-1975	108	148 /e	82 /e
MVA growth rate / θ	1.79	0.85	1.14
Degree of specialization	8.9	9.5	10.3
-VALUE ADDED:(millions of dollars)			
311 Food products	6989	6765 /e	7084 /e
313 Beverages	2723	2673 /e	2922 /e
314 Tobacco products	623	722 /e	892 /e
321 Textiles	3133	2865 /e	3208 /e
322 Wearing apparel	1277	1068 /e	987 /e
323 Leather and fur products	366	399 /e	543 /e
324 Footwear	845	623 /e	552 /e
331 Wood and wood products	919	805 /e	975 /e
332 Furniture and fixtures	784	463 /e	366 /e
341 Paper and paper products	1189	1191 /e	1319 /e
342 Printing and publishing	1050	1236 /e	1447 /e
351 Industrial chemicals	2235	3086 /e	4652 /e
352 Other chemical products	2235	2541 /e	3115 /e
353 Petroleum refineries	1917	4480 /e	7265 /e
354 Miscellaneous petroleum and coal products	222	465 /e	705 /e
355 Rubber products	767	976 /e	1465 /e
356 Plastic products	754	754 /e	822 /e
361 Pottery, china and earthenware	383	417 /e	490 /e
362 Glass and glass products	566	531 /e	689 /e
369 Other non-metal mineral products	1464	1254 /e	1132 /e
371 Iron and steel	2070	2520 /e	3389 /e
372 Non-ferrous metals	562	513 /e	634 /e
381 Metal products	1961	1738 /e	1913 /e
382 Non-electrical machinery	2074	1522 /e	1600 /e
383 Electrical machinery	1900	1591 /e	1768 /e
384 Transport equipment	2980	2650 /e	3044 /e
385 Professional and scientific equipment	305	360 /e	514 /e
390 Other manufacturing industries	754	777 /e	1153 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

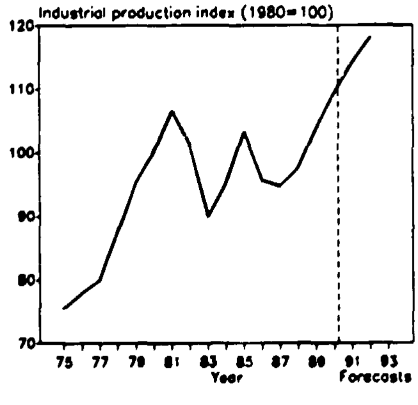
GDP per capita (1000$)/c



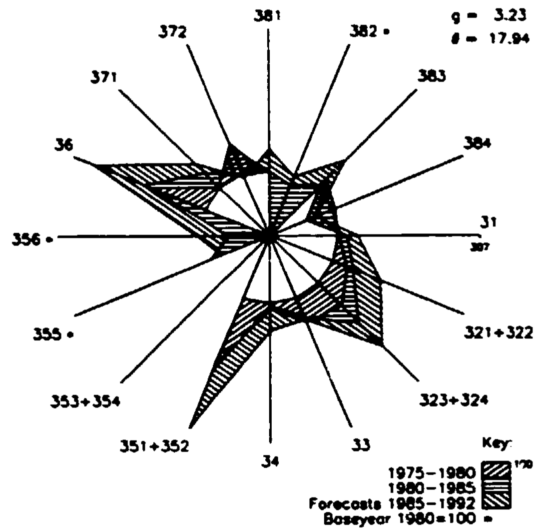
Manufacturing share in GDP current (%)



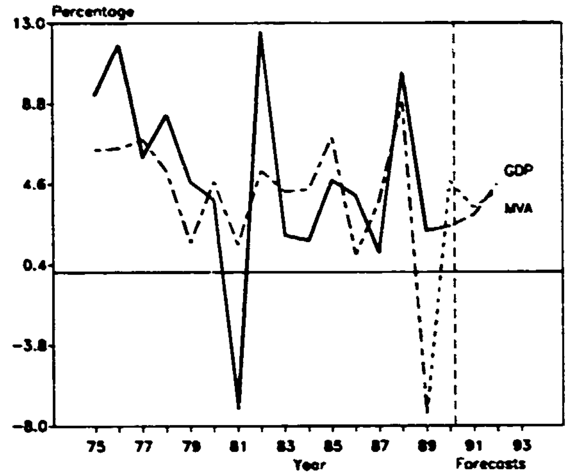
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



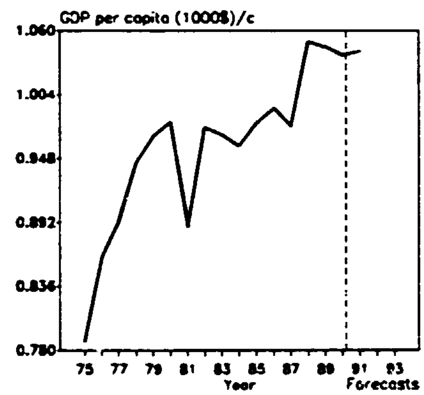
Annual growth rates of GDP and MVA
(Constant 1980 prices)

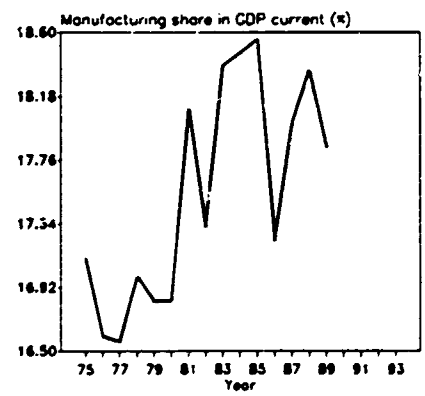


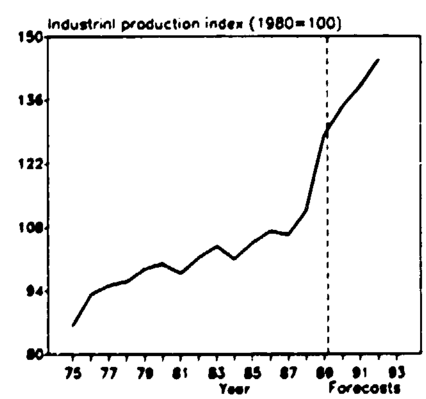
———— Source: National Accounts Statistics from UN/UNSO.
– – – –
.... Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	18997	21562	25545
Per capita (1980-dollars) /na.c	980	979	1046
Manufacturing share (%) /na (current prices)	15.8	18.6	17.8 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	3197	3974	4193
Industrial production index	100	104	128
Value added (millions of dollars)	1544	989 /e	1601 /e
Gross output (millions of dollars)	7038	5956	10273
Employment (thousands)	191	252	330 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	78	83 /e	84 /e
Wages and salaries (%)	12	10	9 /e
Operating surplus (%)	10	6 /e	7 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	36921	23589	31149 /e
Value added / worker	8102	3918 /e	4854 /e
Average wage	4455	2423	2707 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.69 /e	3.17 /e	1.84 /e
as a percentage of average θ in 1970-1975	307 /e	171 /e	99 /e
MVA growth rate / θ	1.11	0.17	2.22
Degree of specialization	16.6	18.9	18.7
-VALUE ADDED: (millions of dollars)			
311 Food products	304	214 /e	308 /e
313 Beverages	62	36 /e	62 /e
314 Tobacco products	38	31 /e	45 /e
321 Textiles	202	128 /e	223 /e
322 Wearing apparel	32	30 /e	44 /e
323 Leather and fur products	15	10 /e	17 /e
324 Footwear	24	20 /e	29 /e
331 Wood and wood products	30	24 /e	35 /e
332 Furniture and fixtures	19	5 /e	5 /e
341 Paper and paper products	64	32 /e	58 /e
342 Printing and publishing	26	21 /e	34 /e
351 Industrial chemicals	127	86 /e	155 /e
352 Other chemical products	97	60 /e	100 /e
353 Petroleum refineries	...	...	...
354 Miscellaneous petroleum and coal products	...	...	...
355 Rubber products	34	19 /e	25 /e
356 Plastic products	20	7 /e	14 /e
361 Pottery, china and earthenware	6	2 /e	3 /e
362 Glass and glass products	10	2 /e	3 /e
369 Other non-metal mineral products	154	108 /e	178 /e
371 Iron and steel	7	6 /e	9 /e
372 Non-ferrous metals	8	3 /e	5 /e
381 Metal products	110	71 /e	120 /e
382 Non-electrical machinery	30	15 /e	24 /e
383 Electrical machinery	61	34 /e	62 /e
384 Transport equipment	62	22 /e	41 /e
385 Professional and scientific equipment	1	1 /e	1 /e
390 Other manufacturing industries	2	1 /e	1 /e

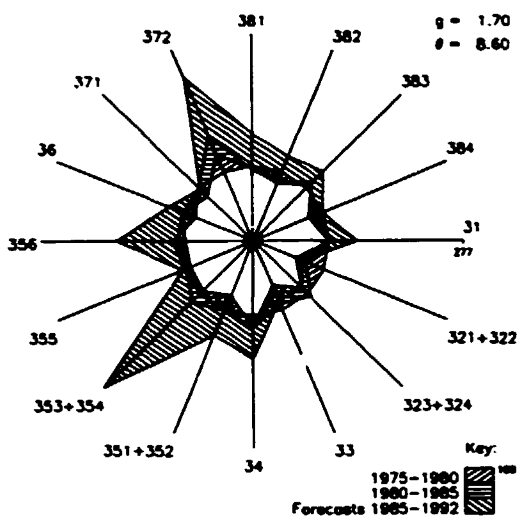
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



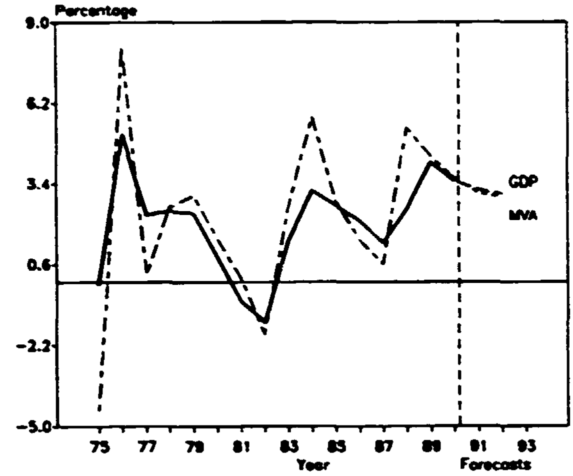




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

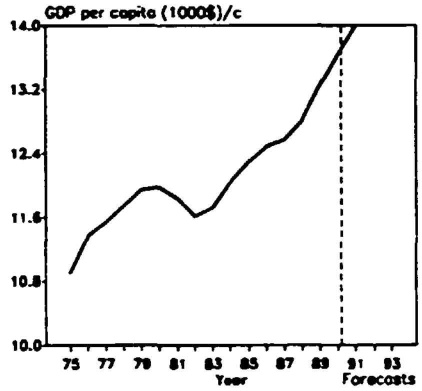


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

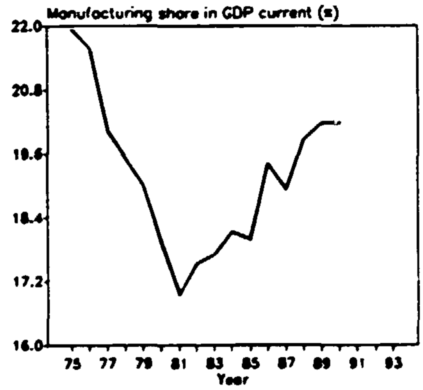
	1980	1985	1989
GDP:/na.c (millions of 1980-dollars)	169386	178038	196641
Per capita (1980-dollars) /na.c	11976	12291	13238
Manufacturing share (%) /na (current prices)	17.9	18.0	20.2
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	30365	33253	37293
Industrial production index	100	106	118
Value added (millions of dollars)	29080	21919	43865
Gross output (millions of dollars)	109617	85086	134303
Employment (thousands)	945	842	888
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	73	74	67
Wages and salaries (%)	15	13	14 /e
Operating surplus (%)	11	13	18 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	115997	101052	151242
Value added / worker	30772	26032	49398
Average wage	17892	13097	21459 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.83	3.42	2.31
as a percentage of average θ in 1970-1975	68	82	56
MVA growth rate / θ	-0.37	0.17	2.30
Degree of specialization	15.4	16.0	15.2
-VALUE ADDED:(millions of dollars)			
311 Food products	4562	3388	6627
313 Beverages	654	458	961
314 Tobacco products	282	238	605
321 Textiles	734	485	925
322 Wearing apparel	372	190	290
323 Leather and fur products	68	46	95
324 Footwear	118	69	102
331 Wood and wood products	594	308	565 /e
332 Furniture and fixtures	418	216	491 /e
341 Paper and paper products	805	647	1282
342 Printing and publishing	2480	1771	3434
351 Industrial chemicals	2263	2163	4396 /e
352 Other chemical products	913	802	1566 /e
353 Petroleum refineries	533	515	1617 /e
354 Miscellaneous petroleum and coal products	101	54	206 /e
355 Rubber products	156	122	214 /e
356 Plastic products	472	413	1024 /e
361 Pottery, china and earthenware	15	8	13 /e
362 Glass and glass products	176	106	237 /e
369 Other non-metal mineral products	1081	653	1512 /e
371 Iron and steel	734	663	1006 /e
372 Non-ferrous metals	518	461	946 /e
381 Metal products	2455	1780	3781
382 Non-electrical machinery	2369	1774	3700
383 Electrical machinery	3687	2864	4963
384 Transport equipment	1927	1244	2418
385 Professional and scientific equipment	382	319	585 /e
390 Other manufacturing industries	211	174	316 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

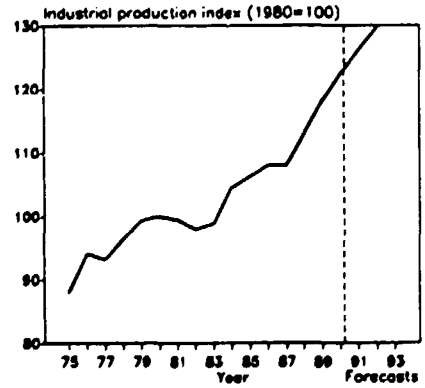
GDP per capita (1000$)/c

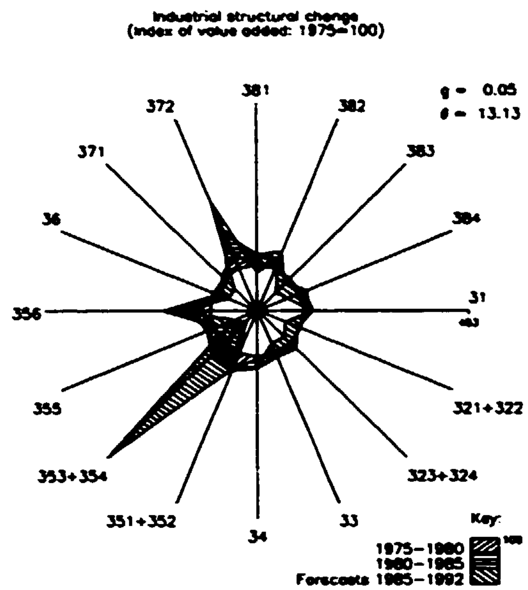


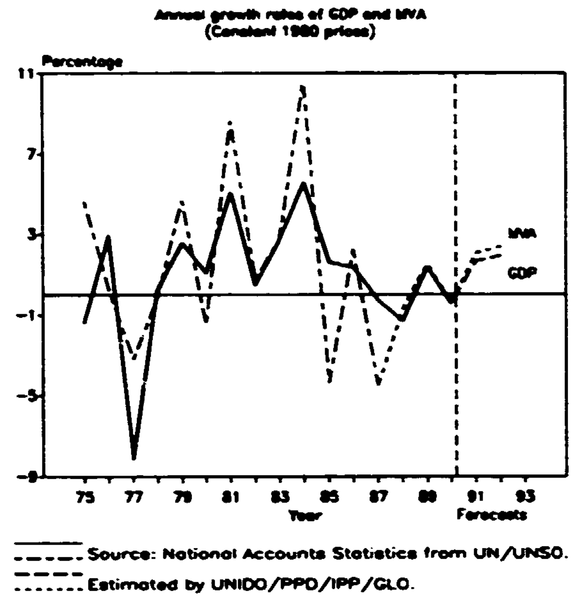
Manufacturing share in GDP current (%)



Industrial production index (1980=100)

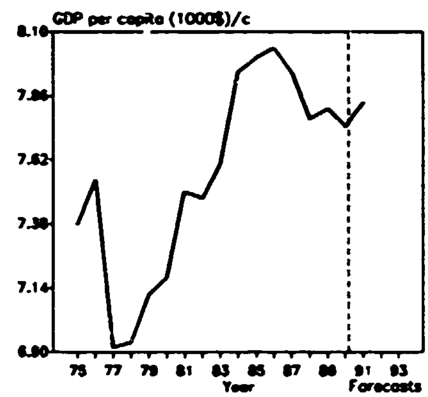


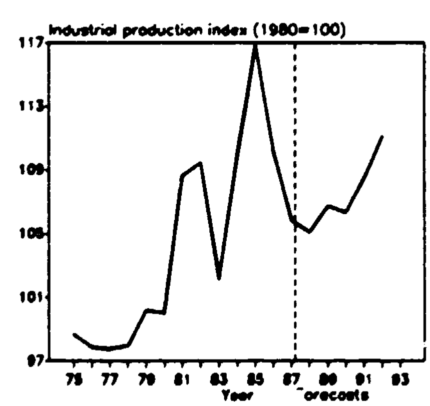




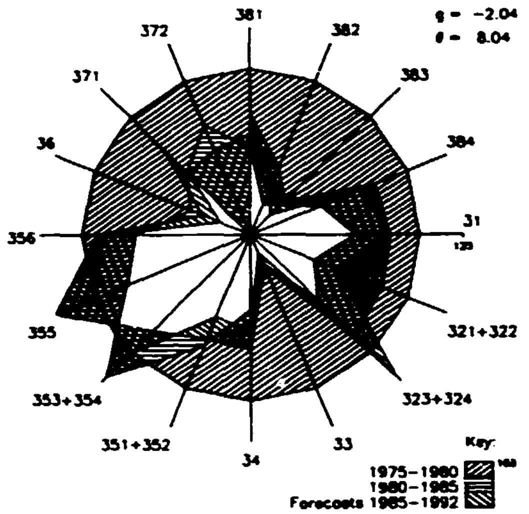
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	22344	25989	26270
Per capita (1980-dollars) /na,c	7178	8002	7811
Manufacturing share (%) /na (current prices)	22.1	22.2	18.9 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	4948	5886	5795 /e
Industrial production index	100	117	107 /e
Value added (millions of dollars)	4756	4657	7065 /e
Gross output (millions of dollars)	14790	15399	23069 /e
Employment (thousands)	285	280	214
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	68	70	69 /e
Wages and salaries (%)	21	18	15 /e
Operating surplus (%)	11	12	15 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	51964	55005	107586 /e
Value added / worker	16711	16636	32962 /e
Average wage	11050	9833	16535 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.08	2.29	4.45 /e
as a percentage of average θ in 1970-1975	36	40	78 /e
MVA growth rate / θ	0.64	0.75	-0.71
Degree of specialization	14.6	14.7	14.5
-VALUE ADDED:(millions of dollars)			
311 Food products	1098	1082	1677 /e
313 Beverages	110	93	208 /e
314 Tobacco products	30	19	56 /e
321 Textiles	222	193	237 /e
322 Wearing apparel	185	170	237 /e
323 Leather and fur products	45	46	67 /e
324 Footwear	56	46	45 /e
331 Wood and wood products	253	257	327 /e
332 Furniture and fixtures	92	96	125 /e
341 Paper and paper products	266	276	464 /e
342 Printing and publishing	294	326	546 /e
351 Industrial chemicals	140	134	237 /e
352 Other chemical products	155	142	202 /e
353 Petroleum refineries	26	-1	236 /e
354 Miscellaneous petroleum and coal products	9	7	12 /e
355 Rubber products	96	70	72 /e
356 Plastic products	110	138	206 /e
361 Pottery, china and earthenware	13	11	16 /e
362 Glass and glass products	44	41	61 /e
369 Other non-metal mineral products	114	127	172 /e
371 Iron and steel	93	71	86 /e
372 Non-ferrous metals	82	102	201 /e
381 Metal products	371	404	496 /e
382 Non-electrical machinery	236	264	393 /e
383 Electrical machinery	239	200	249 /e
384 Transport equipment	318	274	319 /e
385 Professional and scientific equipment	14	20	24 /e
390 Other manufacturing industries	45	48	92 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

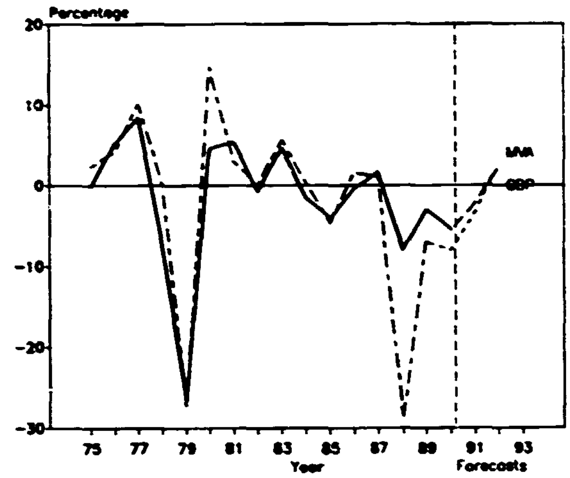




Industrial structural change
(Index of value added: 1975=100)



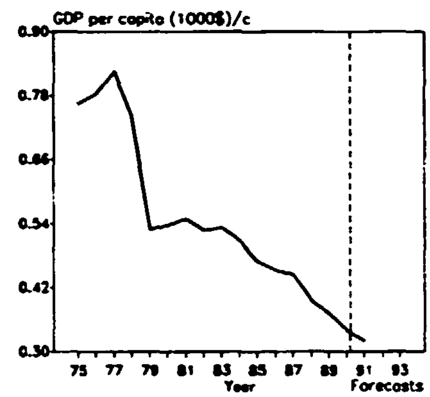
Annual growth rates of GDP and MVA
(Constant 1980 prices)

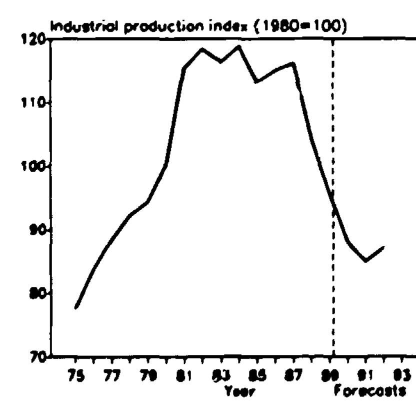


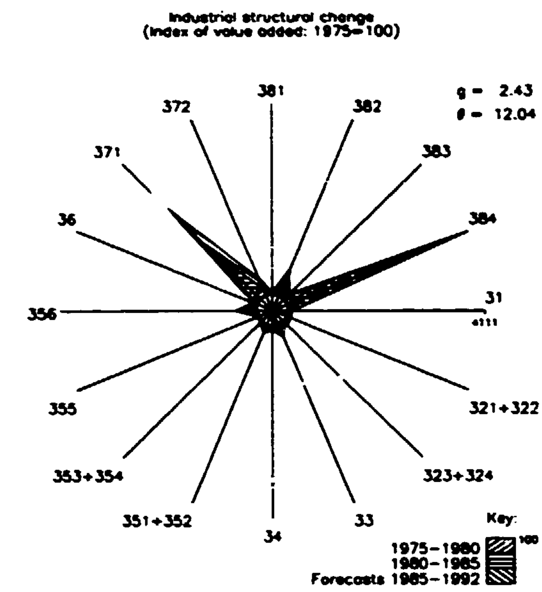
——— Source: National Accounts Statistics from UN/UNSO.
- - - - - - Estimated by UNIDO/PPD/IPP/GLO.

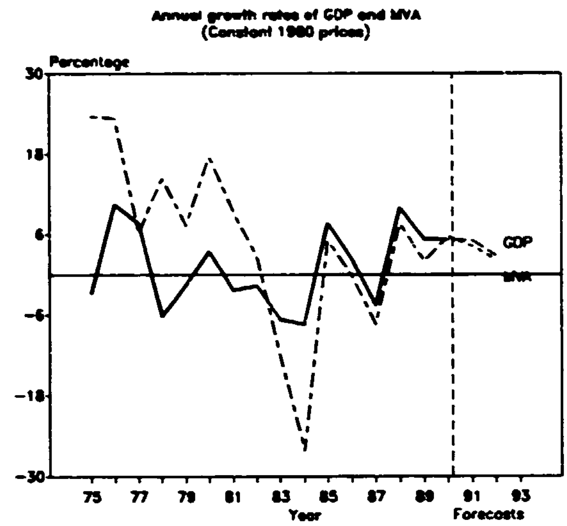
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	1489	1537	1389
Per capita (1980-dollars) /na,c	537	470	371
Manufacturing share (%) /na (current prices)	25.6	27.6	17.0 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	382	398	270
Industrial production index	100	113	96
Value added (millions of dollars)	242	982	...
Gross output (millions of dollars)	612	1587	...
Employment (thousands)	34	39	45 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	38	...
Wages and salaries (%)	12	10	...
Operating surplus (%)	28	52	...
-PRODUCTIVITY: (dollars)			
Gross output / worker	18017	40773	...
Value added / worker	7132	25225	...
Average wage	2078	4152	...
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.80	12.88	4.80 /e
as a percentage of average θ in 1970-1975	164	271	101 /e
MVA growth rate / θ	-1.09	0.38	-0.59
Degree of specialization	27.7	29.6	30.7
-VALUE ADDED: (millions of dollars)			
311 Food products	52	268	...
313 Beverages	48	227	...
314 Tobacco products	28	64	...
321 Textiles	9	70	...
322 Wearing apparel	4	23	...
323 Leather and fur products	2	6	...
324 Footwear	4	27	...
331 Wood and wood products	3	10	...
332 Furniture and fixtures	1	4	...
341 Paper and paper products	1	3	...
342 Printing and publishing	4	22	...
351 Industrial chemicals	11	23	...
352 Other chemical products	14	56	...
353 Petroleum refineries	35	78	...
354 Miscellaneous petroleum and coal products	-	1	...
355 Rubber products	1	6	...
356 Plastic products	4	20	...
361 Pottery, china and earthenware	-	2	...
362 Glass and glass products	-	1	...
369 Other non-metal mineral products	7	17	...
371 Iron and steel	-	1	...
372 Non-ferrous metals	-	-	...
381 Metal products	9	40	...
382 Non-electrical machinery	-	3	...
383 Electrical machinery	1	5	...
384 Transport equipment	1	3	...
385 Professional and scientific equipment	1	-	...
390 Other manufacturing industries	-	2	...

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.





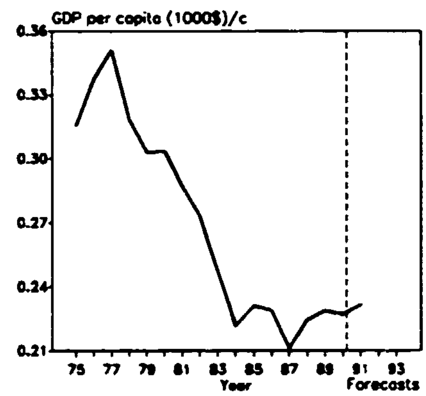


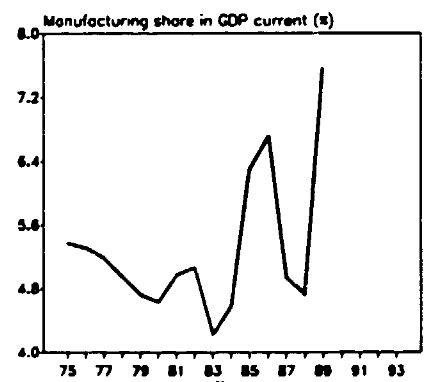


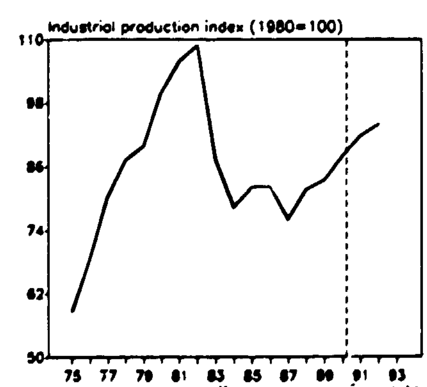
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	23795	21255	24009
Per capita (1980-dollars) /na,c	303	231	229
Manufacturing share (%) /na (current prices)	4.6	6.3	7.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	1161	889	903
Industrial production index	100	82	83
Value added (millions of dollars)	2422	1232 /e	2283 /e
Gross output (millions of dollars)	4740	3762 /e	4294 /e
Employment (thousands)	432	315 /e	363 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	49	67 /e	47 /e
Wages and salaries (%)	11 /e	9 /e	10 /e
Operating surplus (%)	40 /e	24 /e	43 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	10966	12206 /e	11819 /e
Value added / worker	5604	3999 /e	6283 /e
Average wage	1226 /e	1053 /e	1202 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	16.32 /e	21.89 /e	2.01 /e
as a percentage of average θ in 1970-1975	150 /e	201 /e	18 /e
MVA growth rate / θ	1.12	-0.60	3.90
Degree of specialization	18.6	19.4	21.0
-VALUE ADDED: (millions of dollars)			
311 Food products	149	139 /e	288 /e
313 Beverages	267	235 /e	453 /e
314 Tobacco products	96	26 /e	38 /e
321 Textiles	231	175 /e	370 /e
322 Wearing apparel	3	3 /e	5 /e
323 Leather and fur products	12	17 /e	[illegible] /e
324 Footwear	12	13 /e	22 /e
331 Wood and wood products	88	4 /e	6 /e
332 Furniture and fixtures	56	12 /e	20 /e
341 Paper and paper products	38	33 /e	62 /e
342 Printing and publishing	75	28 /e	60 /e
351 Industrial chemicals	30	10 /e	14 /e
352 Other chemical products	265	109 /e	179 /e
353 Petroleum refineries	71 /e	51 /e	70 /e
354 Miscellaneous petroleum and coal products	7 /e	5 /e	7 /e
355 Rubber products	26	21 /e	35 /e
356 Plastic products	98	22 /e	30 /e
361 Pottery, china and earthenware	-	- /e	- /e
362 Glass and glass products	24	7 /e	14 /e
369 Other non-metal mineral products	87	84 /e	136 /e
371 Iron and steel	3	18 /e	38 /e
372 Non-ferrous metals	33	27	57 /e
381 Metal products	140	96 /e	176 /e
382 Non-electrical machinery	23	13 /e	28 /e
383 Electrical machinery	46	27 /e	52 /e
384 Transport equipment	526	52 /e	82 /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	13	5 /e	10 /e

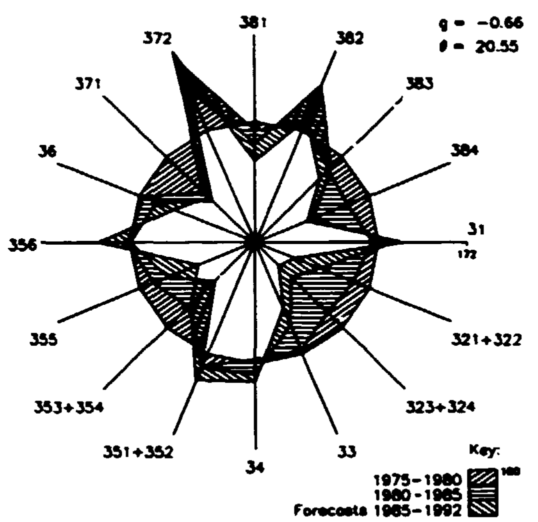
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



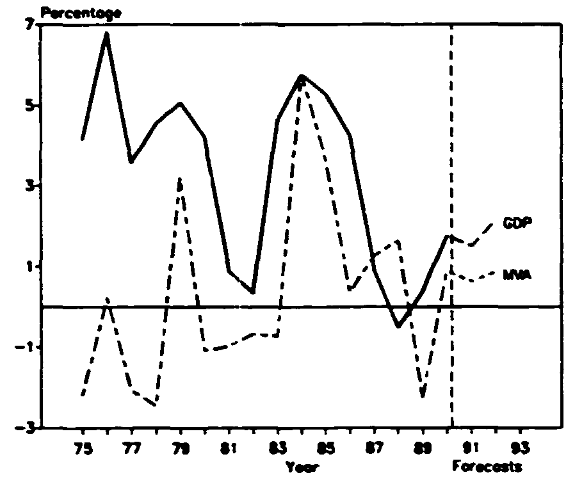




Industrial structural change
(Index of value added: 1975=100)



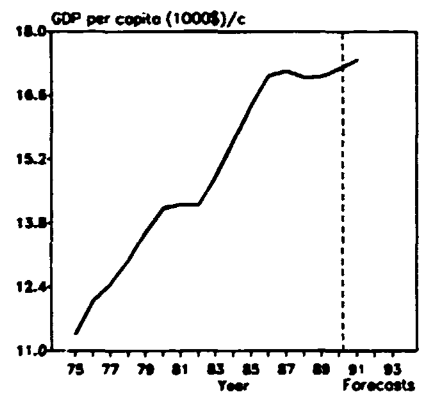
Annual growth rates of GDP and MVA
(Constant 1980 prices)

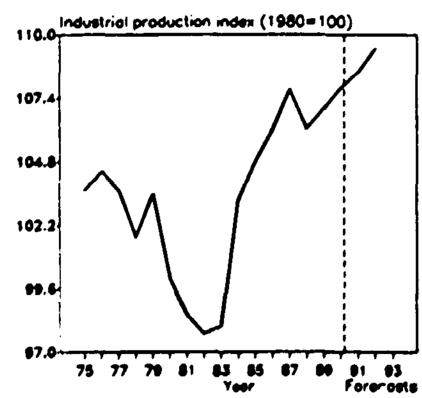


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

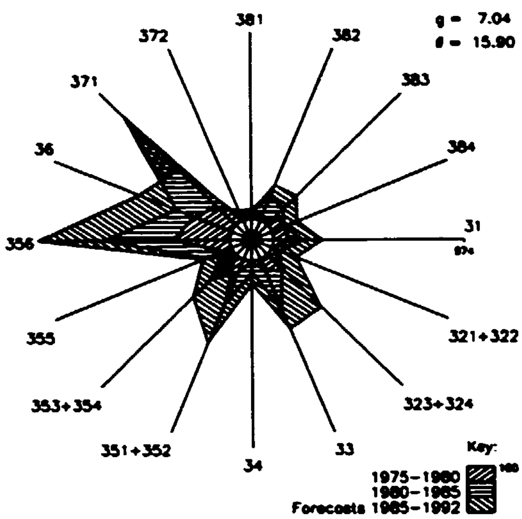
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	57713	68041	71442
Per capita (1980-dollars) /na,c	14125	16383	17006
Manufacturing share (%) /na (current prices)	16.0	14.0	14.5
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	9240	9889	9982
Industrial production index	100	105	107
Value added (millions of dollars)	9338	7948	12753
Gross output (millions of dollars)	31936	28185	44190
Employment (thousands)	354	312	276
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	71	72	71
Wages and salaries (%)	18	16	16
Operating surplus (%)	12	12	13
-PRODUCTIVITY: (dollars)			
Gross output / worker	90239	90309	160283
Value added / worker	26387	25465	46256
Average wage	15916	14784	25143
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.11	6.97	5.37
as a percentage of average θ in 1970-1975	83	113	87
MVA growth rate / θ	-0.19	-0.10	0.02
Degree of specialization	12.2	13.9	14.1
-VALUE ADDED: (millions of dollars)			
311 Food products	908	922	1592
313 Beverages	292	297	556
314 Tobacco products	168	220	400
321 Textiles	213	126	159
322 Wearing apparel	101	59	49
323 Leather and fur products	18	9	13
324 Footwear	24	9	10
331 Wood and wood products	587	365	545
332 Furniture and fixtures	196	164	206
341 Paper and paper products	452	400	729
342 Printing and publishing	668	717	1212
351 Industrial chemicals	452	422	713
352 Other chemical products	227	184	353
353 Petroleum refineries	103	24	97
354 Miscellaneous petroleum and coal products	53	58	58
355 Rubber products	51	38	51
356 Plastic products	170	147	226
361 Pottery, china and earthenware	28	17	25
362 Glass and glass products	55	50	67
369 Other non-metal mineral products	281	215	314
371 Iron and steel	385	276	494
372 Non-ferrous metals	743	560	1192
381 Metal products	596	465	688
382 Non-electrical machinery	933	1079	1359
383 Electrical machinery	547	498	702
384 Transport equipment	1000	566	805
385 Professional and scientific equipment	32	38	71
390 Other manufacturing industries	59	42	68

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

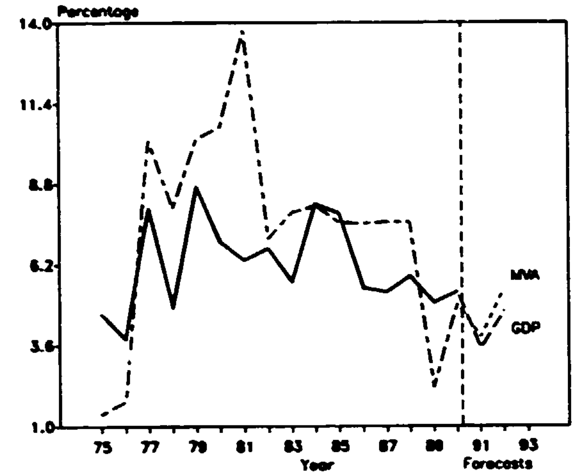




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

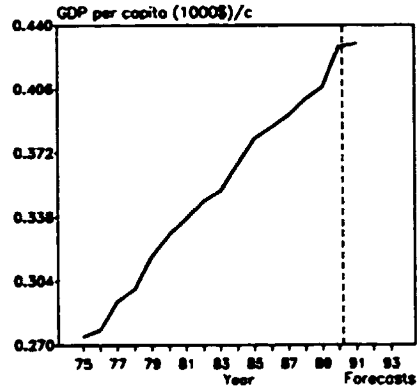


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

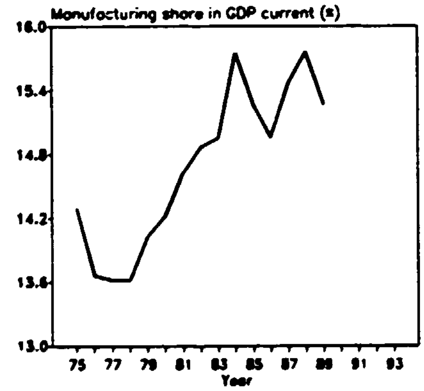
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	28020	39177	48319
Per capita (1980-dollars) /na,c	328	380	407
Manufacturing share (%) /na (current prices)	14.2	15.3	15.3 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	4097	6256	7958
Industrial production index	100	136	153
Value added (millions of dollars)	2423	3238	3907 /e
Gross output (millions of dollars)	7144	10132	12052 /e
Employment (thousands)	452	493	534 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	66	68	68 /e
Wages and salaries (%)	7	6	7 /e
Operating surplus (%)	27	26	25 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	15807	20565	22587 /e
Value added / worker	5361	6571	7321 /e
Average wage	1122	1324	1582 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.28	9.34	6.19 /e
as a percentage of average θ in 1970-1975	92	137	91 /e
MVA growth rate / θ	1.51	0.85	0.87
Degree of specialization	23.2	23.4	22.4
-VALUE ADDED: (millions of dollars)			
311 Food products	431	580	711 /e
313 Beverages	45	74	89 /e
314 Tobacco products	300	372	415 /e
321 Textiles	483	562	704 /e
322 Wearing apparel	7	18	47 /e
323 Leather and fur products	41	35	70 /e
324 Footwear	4	3	6 /e
331 Wood and wood products	4	9	12 /e
332 Furniture and fixtures	3	6	3 /e
341 Paper and paper products	29	33	46 /e
342 Printing and publishing	24	36	34 /e
351 Industrial chemicals	127	281	347 /e
352 Other chemical products	156	230	316 /e
353 Petroleum refineries	158	45	214 /e
354 Miscellaneous petroleum and coal products	9	17	16 /e
355 Rubber products	28	41	51 /e
356 Plastic products	12	21	24 /e
361 Pottery, china and earthenware	5	8	10 /e
362 Glass and glass products	11	17	22 /e
369 Other non-metal mineral products	171	199	260 /e
371 Iron and steel	99	342	156 /e
372 Non-ferrous metals	1	1	1 /e
381 Metal products	38	33	30 /e
382 Non-electrical machinery	43	80	89 /e
383 Electrical machinery	78	98	119 /e
384 Transport equipment	97	83	97 /e
385 Professional and scientific equipment	6	8	5 /e
390 Other manufacturing industries	11	11	12 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

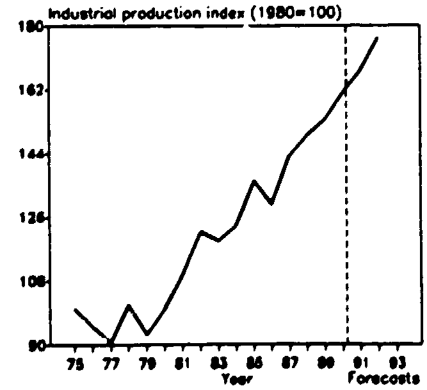
GDP per capita (1000$)/c



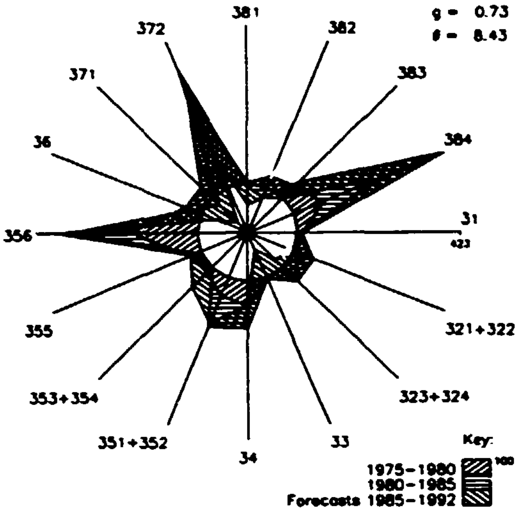
Manufacturing share in GDP current (%)



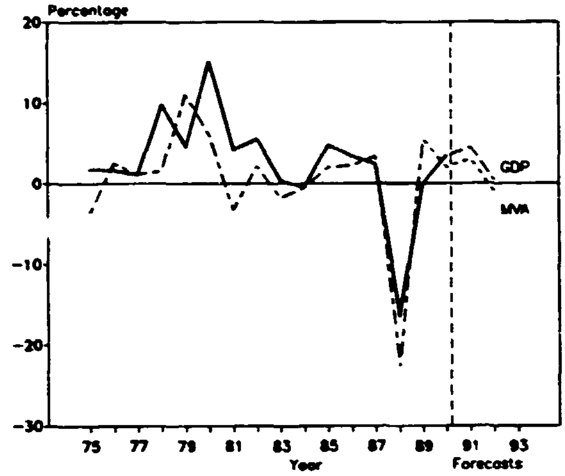
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

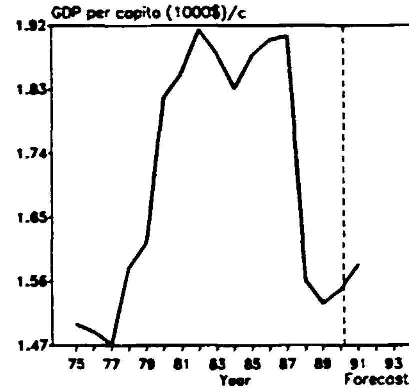


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	3559	4094	3623
Per capita (1980-dollars) /na,c	1818	1877	1529
Manufacturing share (%) /na (current prices)	10.0	8.6	7.7
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	356	351	302
Industrial production index	100	106	90
Value added (millions of dollars)	477	585	486 /e
Gross output (millions of dollars)	1473	1765	1353 /e
Employment (thousands)	31	36	31 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	68	67	64 /e
Wages and salaries (%)	8	11	13 /e
Operating surplus (%)	24	22	23 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	46756	48890	43455 /e
Value added / worker	15159	16203	15610 /e
Average wage	3805	5558	5479 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.56	4.46	4.10 /e
as a percentage of average θ in 1970-1975	87	69	64 /e
MVA growth rate / θ	0.74	0.25	-0.93
Degree of specialization	24.2	22.8	26.5
-VALUE ADDED: (millions of dollars)			
311 Food products	155	179	159 /e
313 Beverages	52	63	64 /e
314 Tobacco products	26	31	25 /e
321 Textiles	4	3	4 /e
322 Wearing apparel	31	27	20 /e
323 Leather and fur products	4	4	2 /e
324 Footwear	7	9	6 /e
331 Wood and wood products	8	8	3 /e
332 Furniture and fixtures	8	11	4 /e
341 Paper and paper products	20	34	22 /e
342 Printing and publishing	22	30	23 /e
351 Industrial chemicals	4	10	6 /e
352 Other chemical products	26	42	36 /e
353 Petroleum refineries	27	25	37 /e
354 Miscellaneous petroleum and coal products	-	2	3 /e
355 Rubber products	2	2	2 /e
356 Plastic products	12	21	19 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	1	7	5 /e
369 Other non-metal mineral products	31	27	14 /e
371 Iron and steel	5	4	1 /e
372 Non-ferrous metals	2	3	2 /e
381 Metal products	19	21	12 /e
382 Non-electrical machinery	1	1	1 /e
383 Electrical machinery	3	4	2 /e
384 Transport equipment	4	13	8 /e
385 Professional and scientific equipment	1	3	2 /e
390 Other manufacturing industries	2	2	3 /e

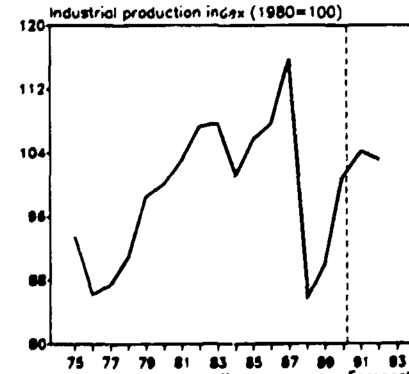
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GDP per capita (1000$)/c

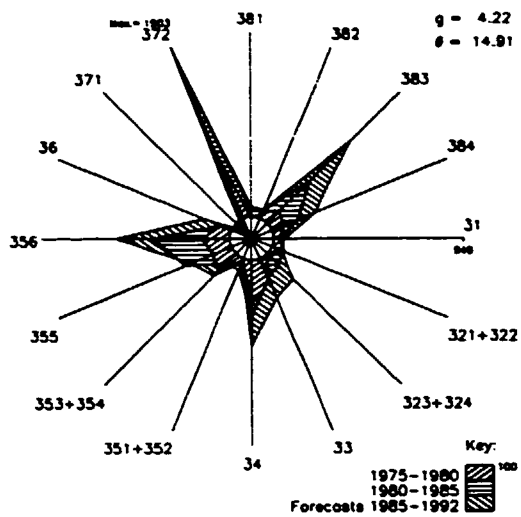


Manufacturing share in GDP current (%)

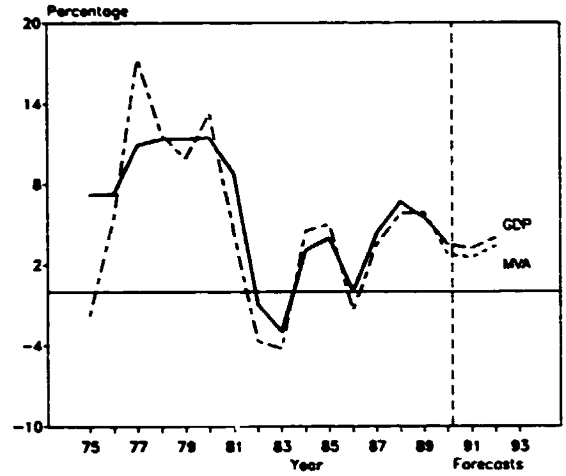
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

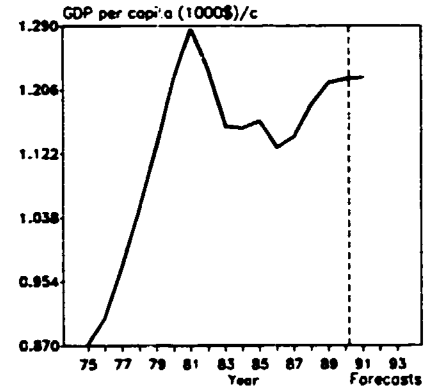


——— Source: National Accounts Statistics from UN/UNSO.
- - - - Estimated by UNIDO/PPD/IPP/GLO.

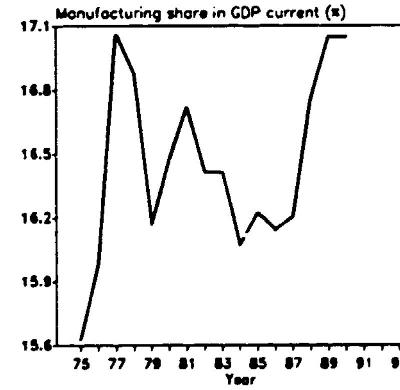
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	3844	4302	5062
Per capita (1980-dollars) /na,c	1222	1164	1215
Manufacturing share (%) /na (current prices)	16.5	16.2	17.0
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	633	669	765
Industrial production index	100	107	124
Value added (millions of dollars)	575	585 /e	490 /e
Gross output (millions of dollars)	1706	.317 /e	1534 /e
Employment (thousands)	68 /e	78 /e	92 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY: (dollars)			
Gross output / worker	25261 /e	23265 /e	16719 /e
Value added / worker	8516 /e	7483 /e	5340 /e
Average wage	...	...	...
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.33	4.82 /e	2.35 /e
as a percentage of average θ in 1970-1975	135	89 /e	43 /e
MVA growth rate / θ	1.19	0.16	1.48
Degree of specialization	31.7	25.5	25.8
-VALUE ADDED: (millions of dollars)			
311 Food products	170	164 /e	132 /e
313 Beverages	43	49 /e	40 /e
314 Tobacco products	6	8 /e	7 /e
321 Textiles	44	40 /e	29 /e
322 Wearing apparel	2	3 /e	2 /e
323 Leather and fur products	7	20 /e	19 /e
324 Footwear	18	24 /e	23 /e
331 Wood and wood products	95	81 /e	75 /e
332 Furniture and fixtures	6	10 /e	9 /e
341 Paper and paper products	-	2 /e	2 /e
342 Printing and publishing	24	27 /e	23 /e
351 Industrial chemicals	4	13 /e	7 /e
352 Other chemical products	10	8 /e	5 /e
353 Petroleum refineries	94	70 /e	62 /e
354 Miscellaneous petroleum and coal products	- /e	- /e	- /e
355 Rubber products	-	- /e	- /e
356 Plastic products	6	11 /e	9 /e
361 Pottery, china and earthenware	-	/e	- /e
362 Glass and glass products	1	3 /e	3 /e
369 Other non-metal mineral products	26	22 /e	21 /e
371 Iron and steel	-	- /e	- /e
372 Non-ferrous metals	1	2 /e	2 /e
381 Metal products	9	12 /e	9 /e
382 Non-electrical machinery	1	1 /e	1 /e
383 Electrical machinery	-	- /e	- /e
384 Transport equipment	5	7 /e	6 /e
385 Professional and scientific equipment	1	1 /e	1 /e
390 Other manufacturing industries	2	3 /e	2 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

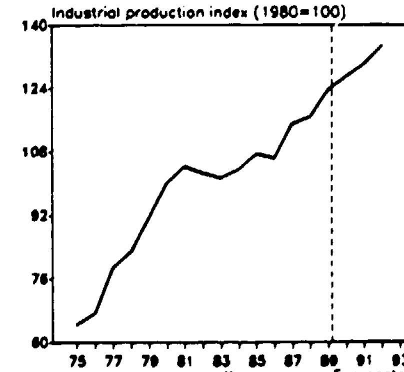
GDP per capita (1000$)/c



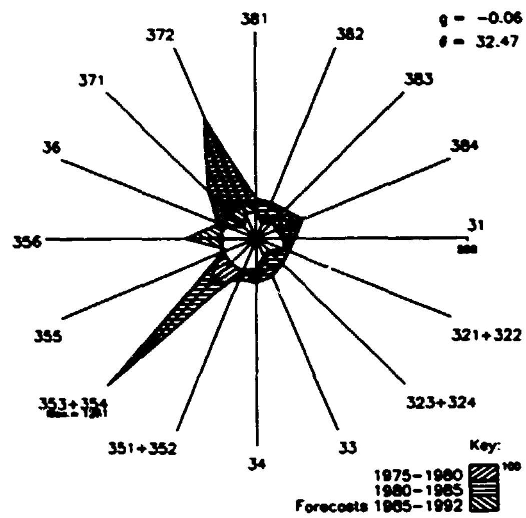
Manufacturing share in GDP current (%)



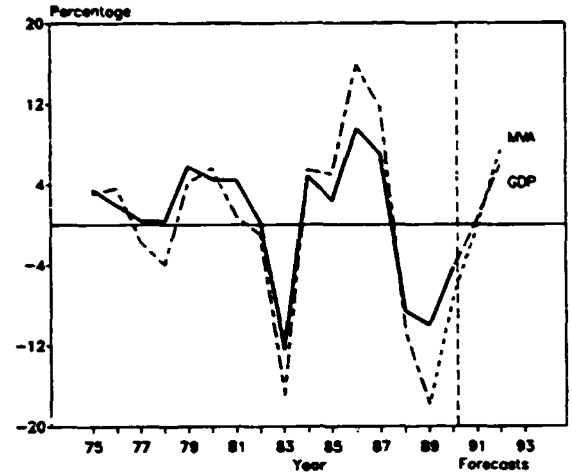
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

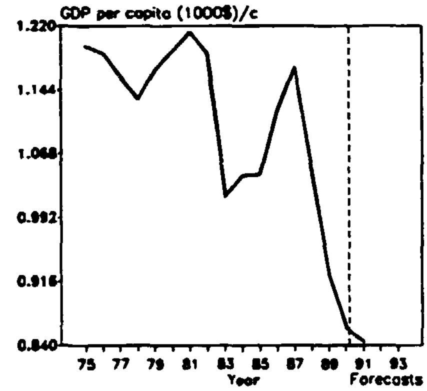


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

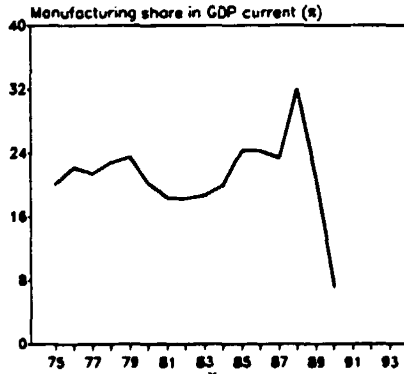
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	20679	20252	19500
Per capita (1980-dollars) /na,c	1190	1043	924
Manufacturing share (%) /na (current prices)	20.2	24.3	20.9
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	4159	3818	3635
Industrial production index	100	86	80
Value added (millions of dollars)	4984	3918	8614 /e
Gross output (millions of dollars)	12977	9573	22625 /e
Employment (thousands)	273	263	300 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	62	59	62 /e
Wages and salaries (%)	6	5	7 /e
Operating surplus (%)	32	36	31 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	47484	36349	75312 /e
Value added / worker	18238	14877	28673 /e
Average wage	2824	1874	5281 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	10.22	16.82	12.48 /e
as a percentage of average θ in 1970-1975	146	240	178 /e
MVA growth rate / θ	0.32	-0.03	0.32
Degree of specialization	12.7	21.3	15.3
-VALUE ADDED: (millions of dollars)			
311 Food products	767	402	1027 /e
313 Beverages	379	303	1061 /e
314 Tobacco products	84	61	154 /e
321 Textiles	466	352	820 /e
322 Wearing apparel	65	52	195 /e
323 Leather and fur products	56	20	51 /e
324 Footwear	41	20	68 /e
331 Wood and wood products	81	32	91 /e
332 Furniture and fixtures	40	19	66 /e
341 Paper and paper products	156	77	210 /e
342 Printing and publishing	100	80	265 /e
351 Industrial chemicals	215	158	248 /e
352 Other chemical products	289	193	471 /e
353 Petroleum refineries	192	1154	1479 /e
354 Miscellaneous petroleum and coal products	6	1	2 /e
355 Rubber products	62	52	109 /e
356 Plastic products	89	90	311 /e
361 Pottery, china and earthenware	16	8	21 /e
362 Glass and glass products	47	15	69 /e
369 Other non-metal mineral products	129	113	274 /e
371 Iron and steel	192	123	111 /e
372 Non-ferrous metals	604	172	238 /e
381 Metal products	188	113	268 /e
382 Non-electrical machinery	156	58	178 /e
383 Electrical machinery	211	111	421 /e
384 Transport equipment	278	106	287 /e
385 Professional and scientific equipment	14	10	38 /e
390 Other manufacturing industries	58	25	104 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

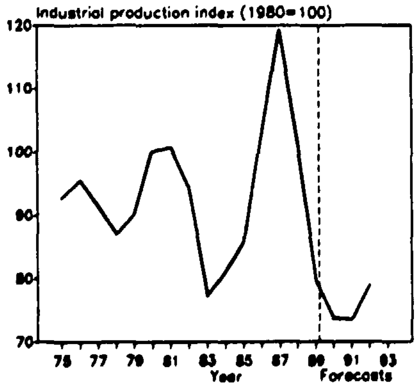
GDP per capita (1000$)/c



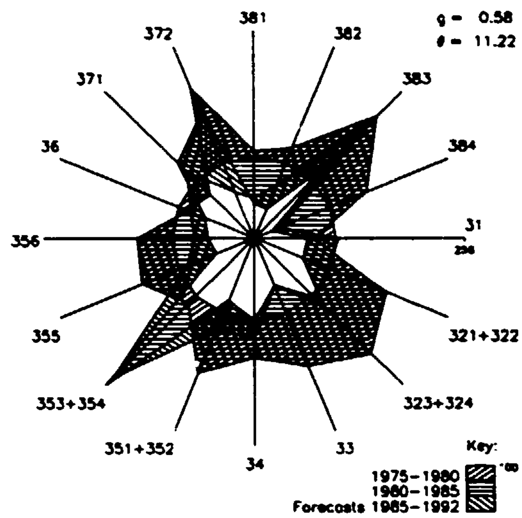
Manufacturing share in GDP current (%)



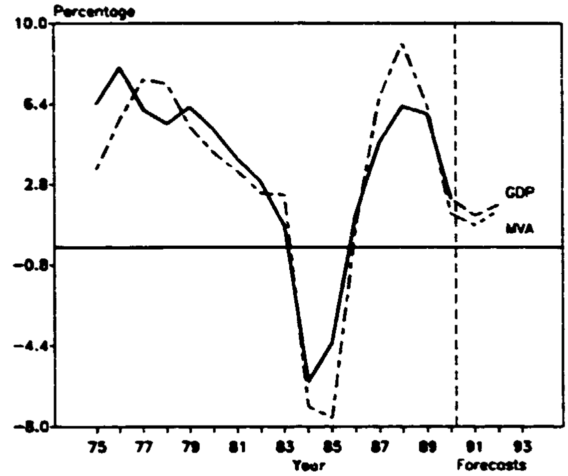
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



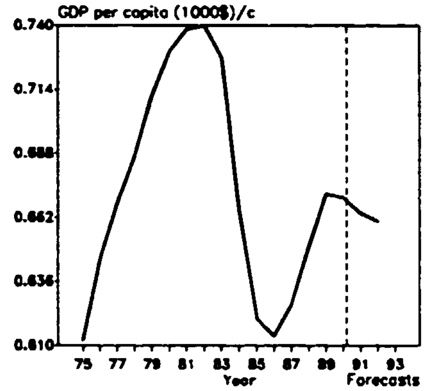
Annual growth rates of GDP and MVA
(Constant 1980 prices)

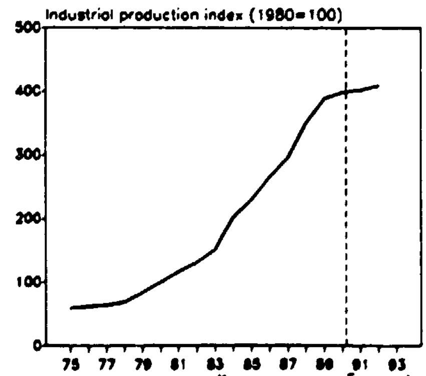


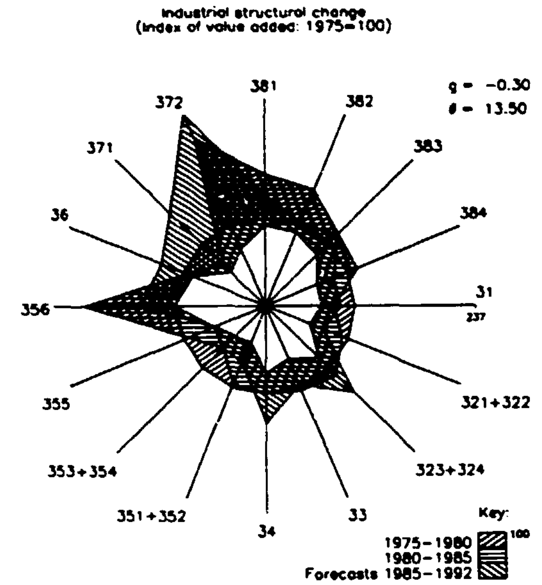
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

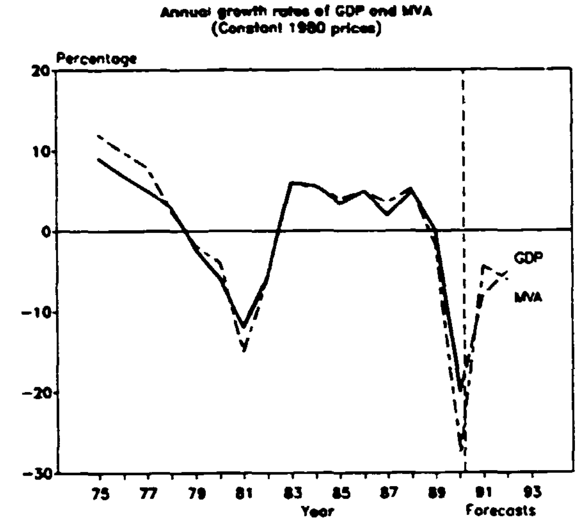
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	35235	34221	40916
Per capita (1980-dollars) /na,c	729	621	672
Manufacturing share (%) /na (current prices)	24.4	24.6	24.6 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	8595	7989	9965
Industrial production index	100	230	389
Value added (millions of dollars)	4861	3448	4787 /e
Gross output (millions of dollars)	17369	12081	18205 /e
Employment (thousands)	949	618	734 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	72	71	74 /e
Wages and salaries (%)	6	6	7 /e
Operating surplus (%)	22	22	19 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	18308	19540	24787 /e
Value added / worker	5124	5576	6518 /e
Average wage	1127	1258	1818 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.12	14.07	9.15 /e
as a percentage of average θ in 1970-1975	122	142	92 /e
MVA growth rate / θ	0.39	-0.27	0.05
Degree of specialization	14.4	22.0	19.2
-VALUE ADDED: (millions of dollars)			
311 Food products	969	658	911 /e
313 Beverages	195	423	563 /e
314 Tobacco products	309	209	472 /e
321 Textiles	395	109	209 /e
322 Wearing apparel	205	105	208 /e
323 Leather and fur products	8	3	4 /e
324 Footwear	13	9	10 /e
331 Wood and wood products	229	86	90 /e
332 Furniture and fixtures	75	22	39 /e
341 Paper and paper products	128	97	141 /e
342 Printing and publishing	89	46	56 /e
351 Industrial chemicals	296	101	176 /e
352 Other chemical products	389	205	313 /e
353 Petroleum refineries	328	715	641 /e
354 Miscellaneous petroleum and coal products	2	3	3 /e
355 Rubber products	103	34	83 /e
356 Plastic products	85	32	50 /e
361 Pottery, china and earthenware	33	9	14 /e
362 Glass and glass products	42	28	44 /e
369 Other non-metal mineral products	63	60	77 /e
371 Iron and steel	98	164	173 /e
372 Non-ferrous metals	36	28	13 /e
381 Metal products	127	49	65 /e
382 Non-electrical machinery	98	31	56 /e
383 Electrical machinery	260	156	256 /e
384 Transport equipment	234	36	74 /e
385 Professional and scientific equipment	5	5	10 /e
390 Other manufacturing industries	49	28	37 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.





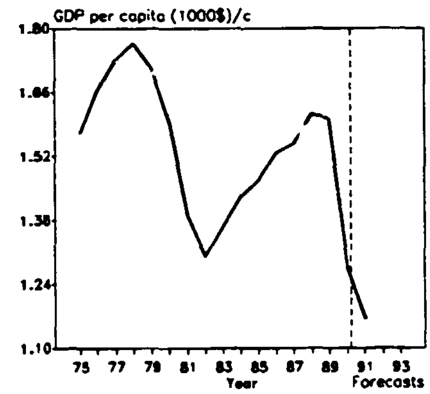


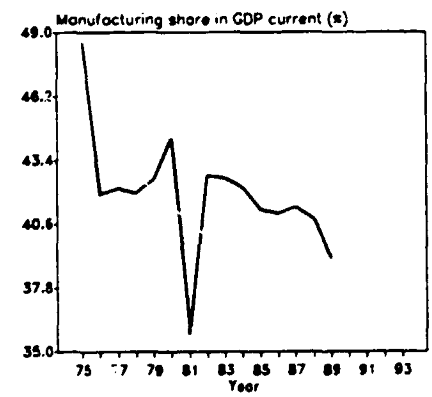


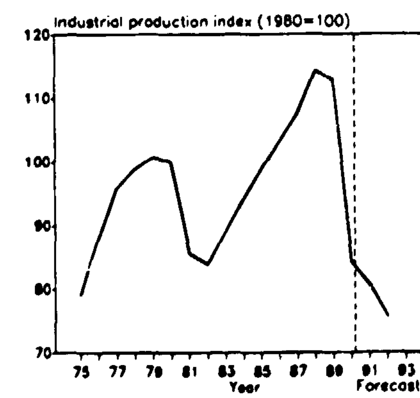
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	56712	54575	61240
Per capita (1980-dollars) /na.c	1594	1467	1603
Manufacturing share (%) /na (current prices)	44.3	41.2	39.1 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	26384	24563	27571
Industrial production index	100	99	113
Value added (millions of dollars)	22833	24432	31740
Gross output (millions of dollars)	...	...	...
Employment (thousands)	4126	3578	3326
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY: (dollars)			
Gross output / worker	...	...	...
Value added / worker	5534	6828	9543
Average wage	1551	1627	1774 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.03	14.02	9.27
as a percentage of average θ in 1970-1975	107	249	165
MVA growth rate / θ	0.06	-0.52	1.28
Degree of specialization	11.7	14.4	10.6
-VALUE ADDED: (millions of dollars)			
311 Food products	-889	144	1978
313 Beverages	3062	3582	2757
314 Tobacco products	636	74	313
321 Textiles	2795	2444	3009
322 Wearing apparel	572	801	1033
323 Leather and fur products	122	221	295
324 Footwear	403	430	641
331 Wood and wood products	423	434	643
332 Furniture and fixtures	491	500	627
341 Paper and paper products	224	269	461
342 Printing and publishing	154	208	217
351 Industrial chemicals	837	734	1164
352 Other chemical products	961	644	853
353 Petroleum refineries	1058	1239	1496
354 Miscellaneous petroleum and coal products	54	60	85
355 Rubber products	317	341	330
356 Plastic products	360	296	338
361 Pottery, china and earthenware	97	146	178
362 Glass and glass products	269	282	340
369 Other non-metal mineral products	335	634	687
371 Iron and steel	868	1161	2110
372 Non-ferrous metals	602	336	1094
381 Metal products	1343	1347	1606
382 Non-electrical machinery	3263	3360	3650
383 Electrical machinery	1558	1801	2334
384 Transport equipment	2436	2255	2739
385 Professional and scientific equipment	244	251	273
390 Other manufacturing industries	237	438	490

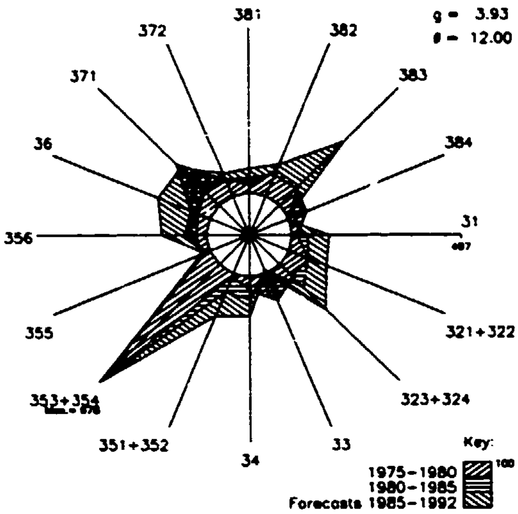
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



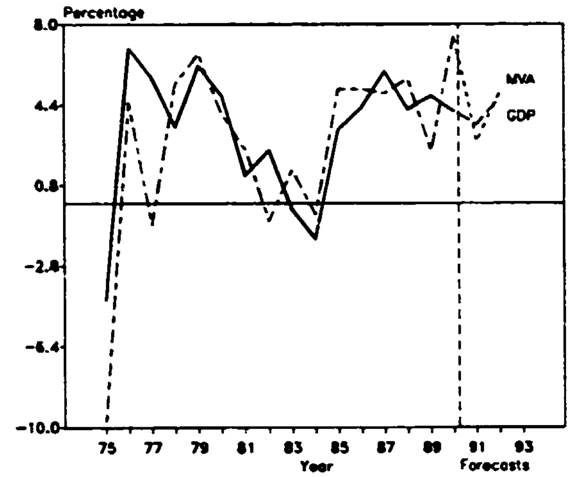




Industrial structural change
(index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

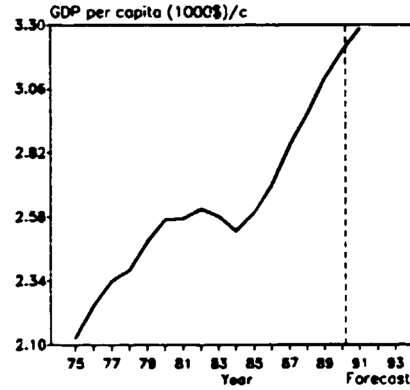


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

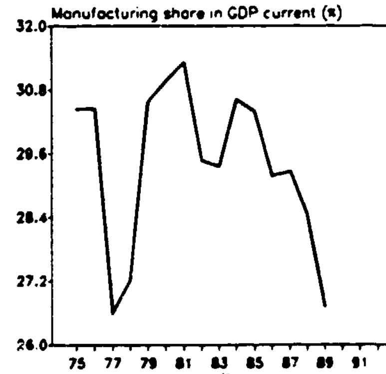
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	25090	26358	31792
Per capita (1980-dollars) /na,c	2569	2595	3097
Manufacturing share (%) /na (current prices)	31.0	30.4	26.7 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	7770	8379	9981
Industrial production index	100	96	108
Value added (millions of dollars)	5602	4141	8784 /e
Gross output (millions of dollars)	17932	15793	28011 /e
Employment (thousands)	680	623	602
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	69	74	69 /e
Wages and salaries (%)	13	10	10 /e
Operating surplus (%)	18	16	21 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	26355	25362	46504 /e
Value added / worker	8233	6650	14583 /e
Average wage	3554	2635	4775 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.30	7.02	5.18
as a percentage of average θ in 1970-1975	79	104	77
MVA growth rate / θ	1.44	-0.16	0.57
Degree of specialization	11.2	10.4	10.5
-VALUE ADDED: (millions of dollars)			
311 Food products	544	490	1011
313 Beverages	135	133	305
314 Tobacco products	64	93	170
321 Textiles	905	679	1291
322 Wearing apparel	186	182	387 /e
323 Leather and fur products	41	41	87
324 Footwear	86	86	193 /e
331 Wood and wood products	325	150	252 /e
332 Furniture and fixtures	106	30	110 /e
341 Paper and paper products	274	276	546 /e
342 Printing and publishing	180	140	261 /e
351 Industrial chemicals	147	215	457
352 Other chemical products	224	190	482
353 Petroleum refineries	219 /e	-17 /e	245 /e
354 Miscellaneous petroleum and coal products	1 /e	- /e	1 /e
355 Rubber products	58	52	108
356 Plastic products	128	82	183
361 Pottery, china and earthenware	80	67	180
362 Glass and glass products	87	53	147
369 Other non-metal mineral products	295	200	511
371 Iron and steel	207	98	247
372 Non-ferrous metals	33	26	38
381 Metal products	323	219	386
382 Non-electrical machinery	170	143	233
383 Electrical machinery	319	263	518
384 Transport equipment	428	222	381
385 Professional and scientific equipment	15	16	32 /e
390 Other manufacturing industries	20	11	21 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

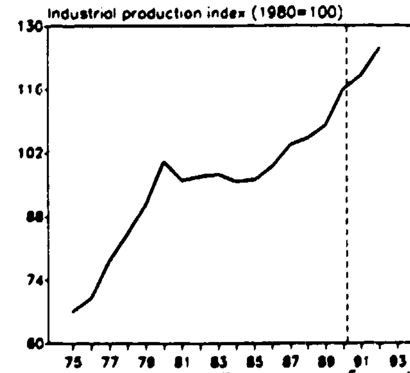
GDP per capita (1000$)/c



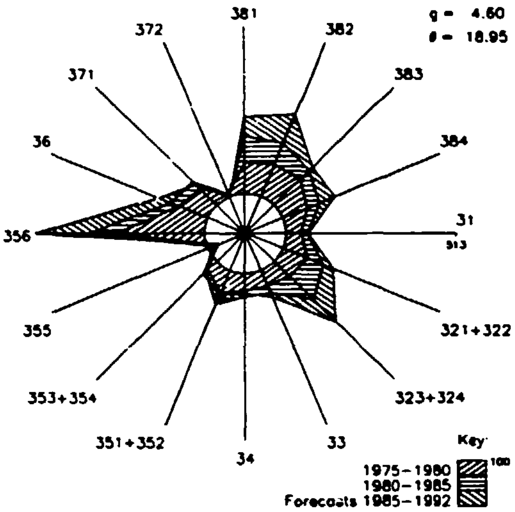
Manufacturing share in GDP current (%)



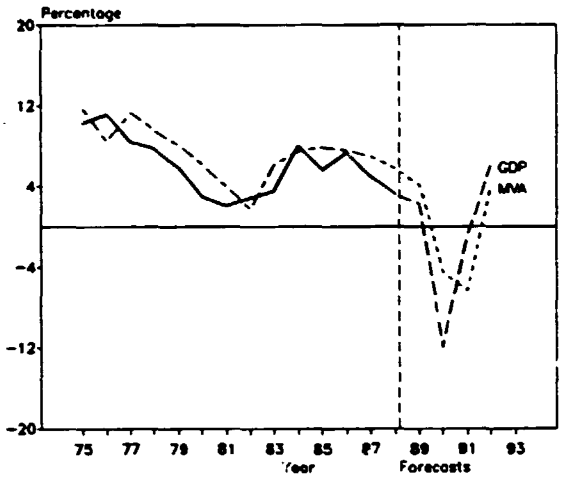
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

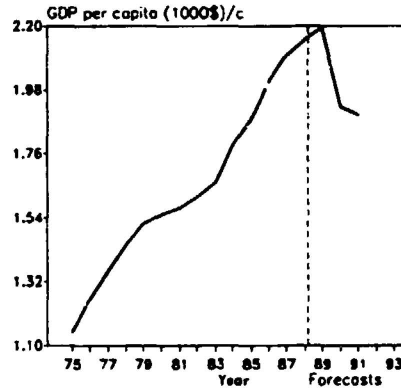


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

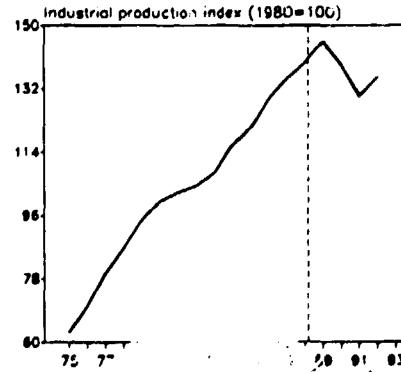
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	34439	42693	50782 /e
Per capita (1980-dollars) /na,c	1551	1879	2193 /e
Manufacturing share (%) /na (current prices)	...	...	...
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	19358	25184	31943 /e
Industrial production index	100	121	145 /e
Value added (millions of dollars)/c	35782	43286	51996 /e
Gross output (millions of dollars)	...	...	...
Employment (thousands)	3221	3437	3630 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY:(dollars)			
Gross output / worker	...	...	...
Value added / worker /c	11109	12594	14324 /e
Average wage	74 /e	95 /e	121 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.02 /e	1.49 /e	1.54 /e
as a percentage of average θ in 1970-1975	67 /e	50 /e	51 /e
MVA growth rate / θ	4.83	2.61	3.06
Degree of specialization	20.5	21.0	20.8
-VALUE ADDED:(millions of dollars)/c			
311 Food products	5073	5681	6852 /e
313 Beverages	786	880	1061 /e
314 Tobacco products	213	238	287 /e
321 Textiles	1899	2203	2680 /e
322 Wearing apparel	580	928	1334 /e
323 Leather and fur products	322	429	558 /e
324 Footwear	228	419	[illegible] /e
331 Wood and wood products	615	701	[illegible]
332 Furniture and fixtures	494	563	[illegible] /e
341 Paper and paper products	518	575	[illegible]3 /e
342 Printing and publishing	70	81	80 /e
351 Industrial chemicals	3618	4377	4941 /e
352 Other chemical products	256	253	289 /e
353 Petroleum refineries	386	394	496 /e
354 Miscellaneous petroleum and coal products	20	29	35 /e
355 Rubber products	85	96	83 /e
356 Plastic products	53	64 /e	87 /e
361 Pottery, china and earthenware	173	217	262 /e
362 Glass and glass products	173	217	262 /e
369 Other non-metal mineral products	1486	1605	2148 /e
371 Iron and steel	2705	3165	3410 /e
372 Non-ferrous metals	1099	1077	[illegible]085 /e
381 Metal products	2143	2936	3945 /e
382 Non-electrical machinery	7564 /e	9929 /e	11694 /e
383 Electrical machinery	2507	2908	3910 /e
384 Transport equipment	2011 /e	2423 /e	2720 /e
385 Professional and scientific equipment	76	93 /e	126 /e
390 Other manufacturing industries	631	806 /e	1093 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

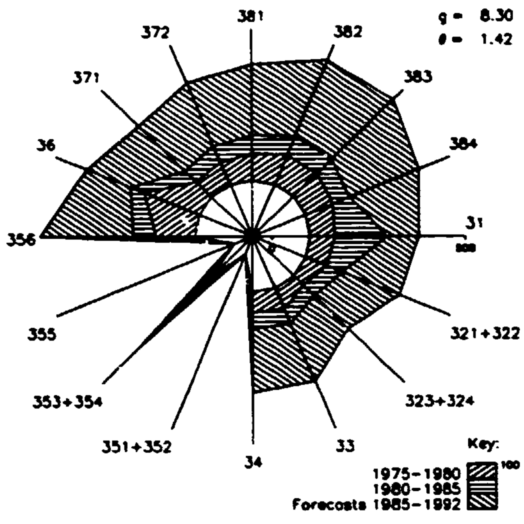
GDP per capita (1000$)/c



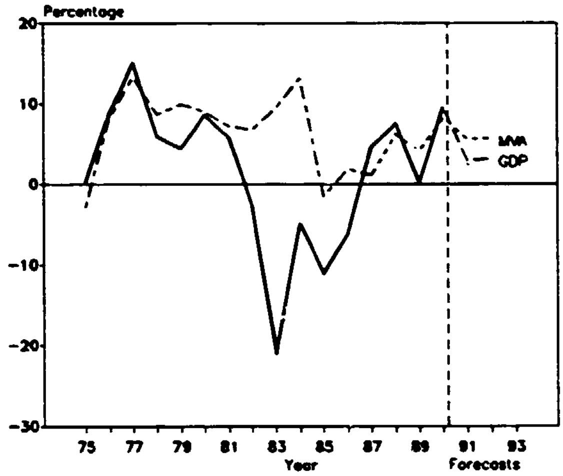
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

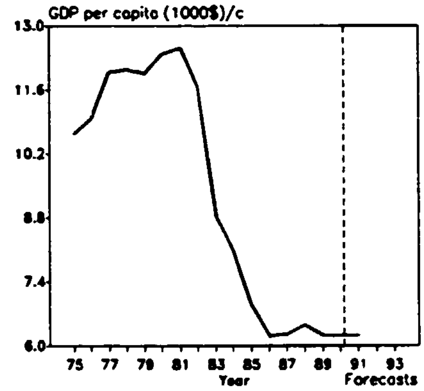


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

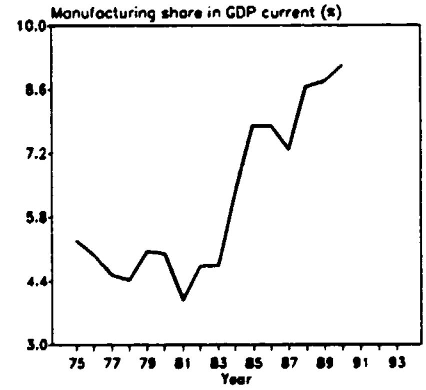
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	115962	79863	84548
Per capita (1980-dollars) /na,c	12372	6887	6219
Manufacturing share (%) /na (current prices)	5.0	7.8	8.8
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	5800	8113	9252 /e
Industrial production index	100	163	227 /e
Value added (millions of dollars)/c	5819 /e	9482 /e	13185 /e
Gross output (millions of dollars)	...	...	...
Employment (thousands)	...	...	...
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY:(dollars)			
Gross output / worker	...	...	...
Value added / worker /c	...	...	...
Average wage	...	...	...
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	1.52 /e	1.73 /e	0.90 /e
as a percentage of average θ in 1970-1975	220 /e	251 /e	131 /e
MVA growth rate / θ	4.81	5.97	11.31
Degree of specialization	47.1	53.1	53.3
-VALUE ADDED:(millions of dollars)/c			
311 Food products	388 /e	732 /e	834 /e
313 Beverages	58 /e	90 /e	104 /e
314 Tobacco products	95 /e	173 /e	175 /e
321 Textiles	8[illegible]	110 /e	170 /e
322 Wearing apparel	103 /e	132 /e	201 /e
323 Leather and fur products	26	34 /e	52 /e
324 Footwear	41 /e	52 /e	80 /e
331 Wood and wood products	62 /e	79 /e	122 /e
332 Furniture and fixtures	37 /e	47 /e	72 /e
341 Paper and paper products	58	75 /e	119 /e
342 Printing and publishing	58	75 /e	115 /e
351 Industrial chemicals	...	...	...
352 Other chemical products	...	...	...
353 Petroleum refineries	3579	6371	8983
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	...	...	...
356 Plastic products	396	511 /e	809 /e
361 Pottery, china and earthenware	-	-	-
362 Glass and glass products	-	-	-
369 Other non-metal mineral products	506	582	692 /e
371 Iron and steel	13 /e	17 /e	26 /e
372 Non-ferrous metals	5 /e	6 /e	9 /e
381 Metal products	87 /e	111 /e	173 /e
382 Non-electrical machinery	57 /e	73 /e	115 /e
383 Electrical machinery	61 /e	79 /e	125 /e
384 Transport equipment	74 /e	96 /e	148 /e
385 Professional and scientific equipment	...	...	...
390 Other manufacturing industries	29	38 /e	61 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

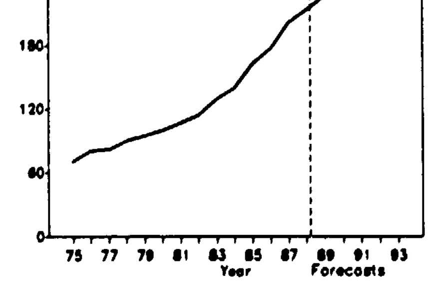
GDP per capita (1000$)/c



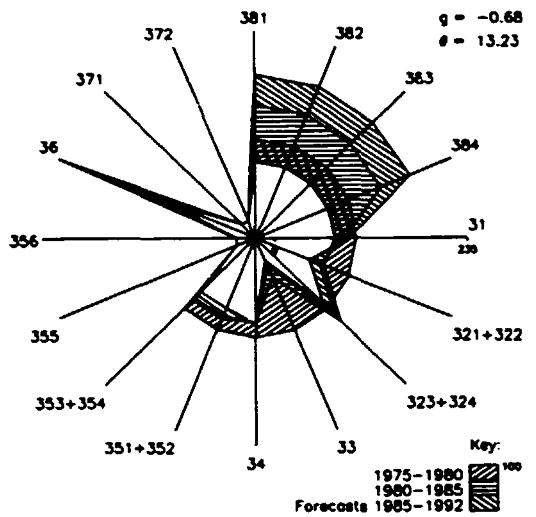
Manufacturing share in GDP current (%)



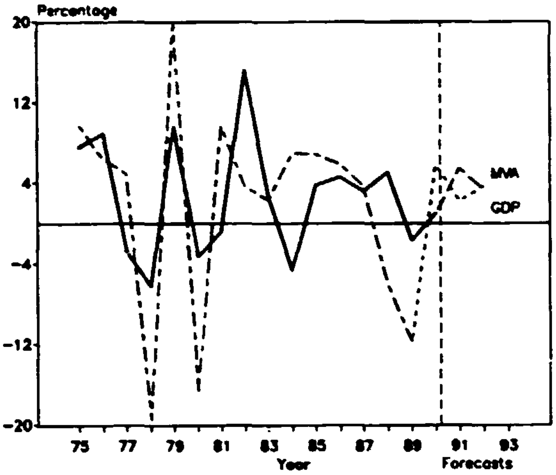
Industrial production inde (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

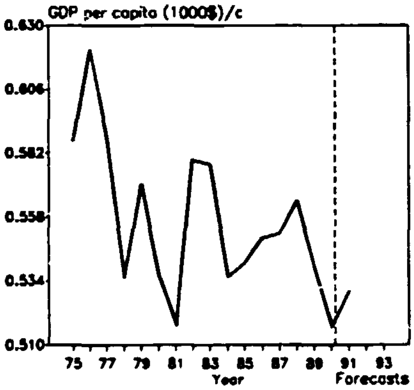


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

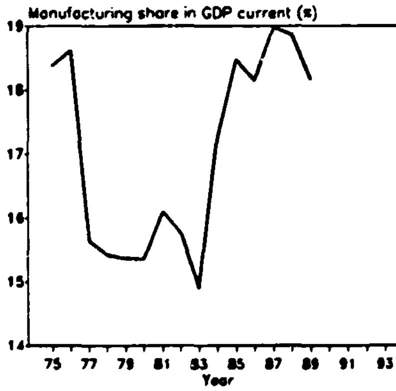
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	2970	3447	3843
Per capita (1980-dollars) /na,c	536	541	539
Manufacturing share (%) /na (current prices)	15.3	18.5	18.2 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	438	582	530
Industrial production index	100	98	104
Value added (millions of dollars)	258	231 /e	292 /e
Gross output (millions of dollars)	1070	1022 /e	1054 /e
Employment (thousands)	32	36 /e	41 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	76	77 /e	72 /e
Wages and salaries (%)	10	10 /e	15 /e
Operating surplus (%)	14	13 /e	12 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	33812	28781 /e	25468 /e
Value added / worker	8164	6510 /e	7069 /e
Average wage	3508	2823 /e	3941 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.47	3.94 /e	1.22 /e
as a percentage of average θ in 1970-1975	194	102 /e	32 /e
MVA growth rate / θ	-0.38	1.00	-1.19
Degree of specialization	25.8	24.7	25.3
-VALUE ADDED: (millions of dollars)			
311 Fond products	106	91 /e	118 /e
313 Beverages	11	9 /e	12 /e
314 Tobacco products	7	9 /e	11 /e
321 Textiles	33	24 /e	26 /e
322 Wearing apparel	13	7 /e	10 /e
323 Leather and fur products	5	4 /e	4 /e
324 Footwear	2	1 /e	1 /e
331 Wood and wood products	2	1 /e	1 /e
332 Furniture and fixtures	2	1 /e	1 /e
341 Paper and paper products	4	2 /e	3 /e
342 Printing and publishing	6	5 /e	7 /e
351 Industrial chemicals	16	12 /e	13 /e
352 Other chemical products	5	4 /e	5 /e
353 Petroleum refineries	18	13 /e	15 /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	-	- /e	- /e
356 Plastic products	-	- /e	- /e
361 Pottery, china and earthenware	-	- /e	- /e
362 Glass and glass products	-	- /e	- /e
369 Other non-metal mineral products	12	18 /e	23 /e
371 Iron and steel	-	- /e	- /e
372 Non-ferrous metals	-	- /e	- /e
381 Metal products	10	16 /e	23 /e
382 Non-electrical machinery	3	5 /e	8 /e
383 Electrical machinery	1	2 /e	2 /e
384 Transport equipment	5	8 /e	11 /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	-	- /e	- /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

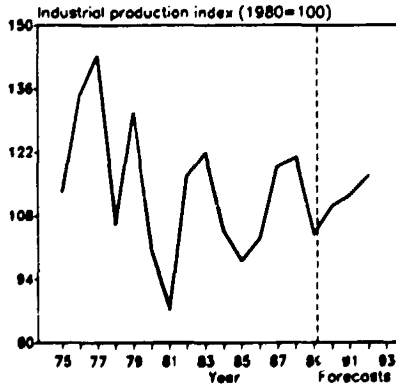
GDP per capita (1000$)/c



Manufacturing share in GDP current (%)

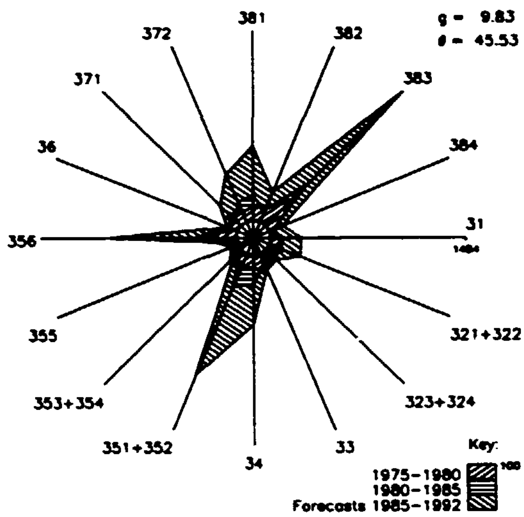


Industrial production index (1980=100)

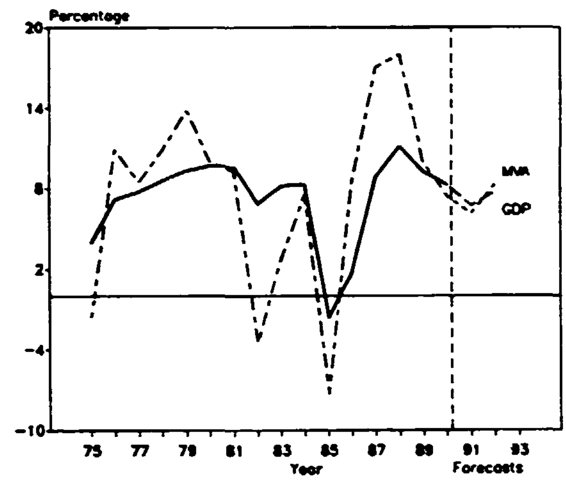


SINGAPORE

Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

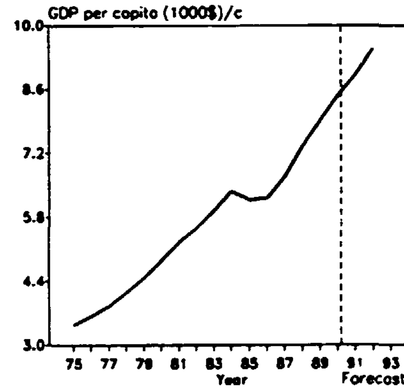


——— Source: National Accounts Statistics from UN/UNSO.
- - - - Estimated by UNIDO/PPD/IPP/GLO.

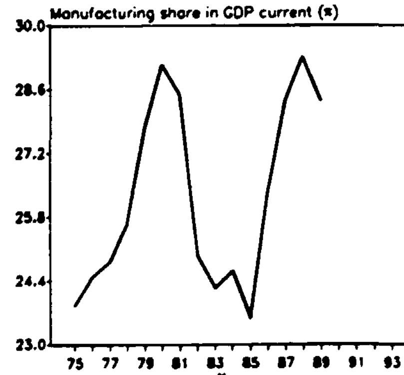
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	11719	15821	21264
Per capita (1980-dollars) /na,c	4853	6182	7902
Manufacturing share (%) /na (current prices)	29.1	23.6	28.4 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	3415	3689	6070
Industrial production index	100	103	159
Value added (millions of dollars)	4074	4970	10279
Gross output (millions of dollars)	15482	17845	33255
Employment (thousands)	294	263	348
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	74	72	69
Wages and salaries (%)	8	11	9
Operating surplus (%)	19	17	22
-PRODUCTIVITY: (dollars)			
Gross output / worker	52575	67966	95460
Value added / worker	13833	18930	29507
Average wage	4103	7162	8931
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.89	7.36	3.74
as a percentage of average θ in 1970-1975	50	62	31
MVA growth rate / θ	2.70	0.21	3.13
Degree of specialization	19.2	22.4	28.1
-VALUE ADDED: (millions of dollars)			
311 Food products	129	190	308
313 Beverages	51	76	127
314 Tobacco products	25	35	50
321 Textiles	75	29	64
322 Wearing apparel	132	170	302
323 Leather and fur products	7	6	15
324 Footwear	11	7	10
331 Wood and wood products	87	45	59
332 Furniture and fixtures	44	69	96
341 Paper and paper products	45	83	153
342 Printing and publishing	136	246	423
351 Industrial chemicals	51	138	607
352 Other chemical products	143	270	493
353 Petroleum refineries	444 /e	230 /e	377 /e
354 Miscellaneous petroleum and coal products	243 /e	167 /e	263 /e
355 Rubber products	44	21	42
356 Plastic products	84	106	254
361 Pottery, china and earthenware	1	-	1
362 Glass and glass products	11	5	11
369 Other non-metal mineral products	82	141	119
371 Iron and steel	62	48	97
372 Non-ferrous metals	11	18	30
381 Metal products	202	310	655
382 Non-electrical machinery	360	385	610
383 Electrical machinery	949	1545	4054
384 Transport equipment	501	478	742
385 Professional and scientific equipment	61	90	176
390 Other manufacturing industries	66	61	144

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

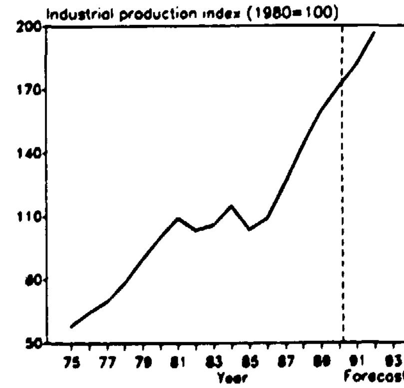
GDP per capita (1000$)/c



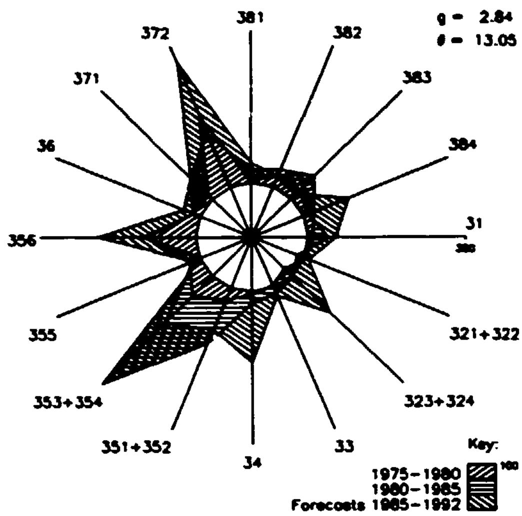
Manufacturing share in GDP current (%)



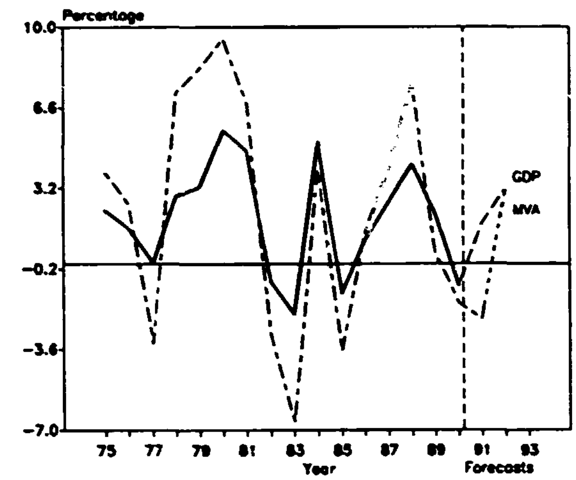
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



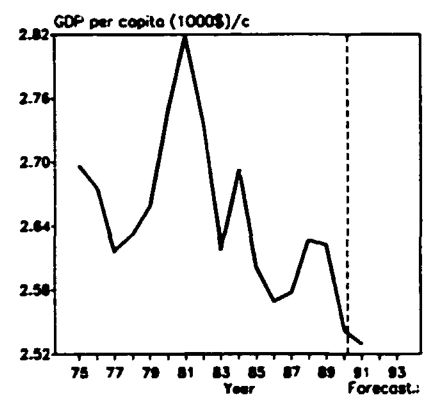
Annual growth rates of GDP and MVA
(Constant 1980 prices)

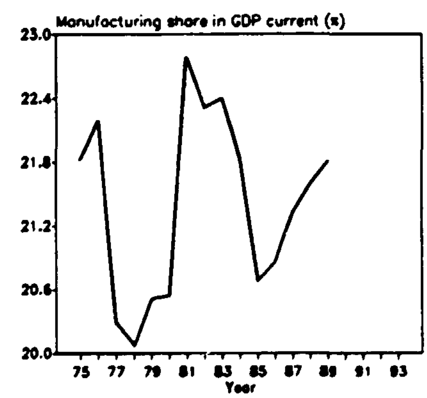


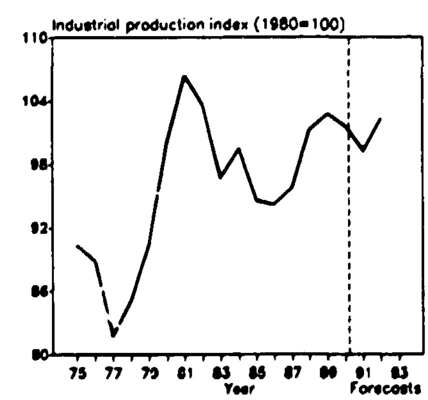
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

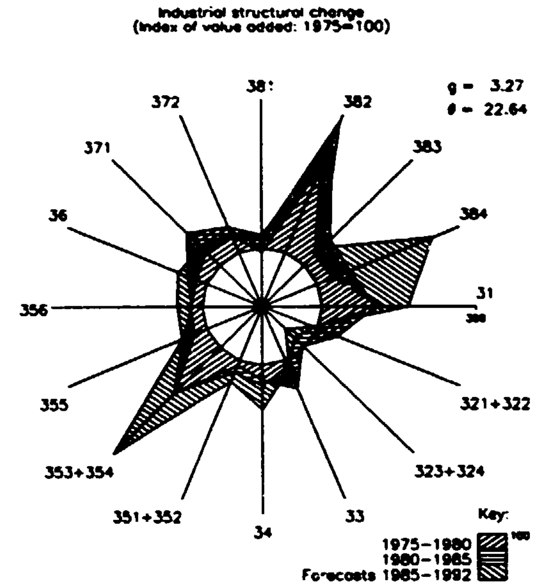
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	77693	82103	90496
Per capita (1980-dollars) /na.c	2748	2601	2622
Manufacturing share (%) /na (current prices)	20.5	20.7	21.8 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	16125	15611	17747
Industrial production index	100	95	103
Value added (millions of dollars)	17866	12584	20673
Gross output (millions of dollars)	61206 /e	36062	57822
Employment (thousands)	1392	1423	1459
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	71 /e	65	64
Wages and salaries (%)	14 /e	17	17
Operating surplus (%)	15 /e	17	19
-PRODUCTIVITY: (dollars)			
Gross output / worker	43970 /e	25342	39631
Value added / worker	12835	8843	14169
Average wage	6118	4419	6636
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.32 /e	6.23	6.25
as a percentage of average θ in 1970-1975	144 /e	207	208
MVA growth rate / θ	1.19	0.29	0.33
Degree of specialization	10.7	9.2	8.7
-VALUE ADDED: (millions of dollars)			
311 Food products	1626	1277	1757
313 Beverages	458	418	883
314 Tobacco products	111	108	118
321 Textiles	886	408	742
322 Wearing apparel	477	334	559
323 Leather and fur products	40	44	91
324 Footwear	152	113	272
331 Wood and wood products	213	190	272
332 Furniture and fixtures	219	138	199
341 Paper and paper products	591	471	1325
342 Printing and publishing	549	392	601
351 Industrial chemicals	1006	717	1206
352 Other chemical products	639	1047	1064
353 Petroleum refineries	634	1038	1045
354 Miscellaneous petroleum and coal products	111	182	182
355 Rubber products	297	157	276
356 Plastic products	365	225	396
361 Pottery, china and earthenware	28	24	33
362 Glass and glass products	154	102	227
369 Other non-metal mineral products	754	481	779
371 Iron and steel	2136	966	2068
372 Non-ferrous metals	565	418	746
381 Metal products	1576	860	1401
382 Non-electrical machinery	1361	806	1168
383 Electrical machinery	1229	607	866
384 Transport equipment	1268	741	1755
385 Professional and scientific equipment	49	54	148
390 Other manufacturing industries	415	246	501

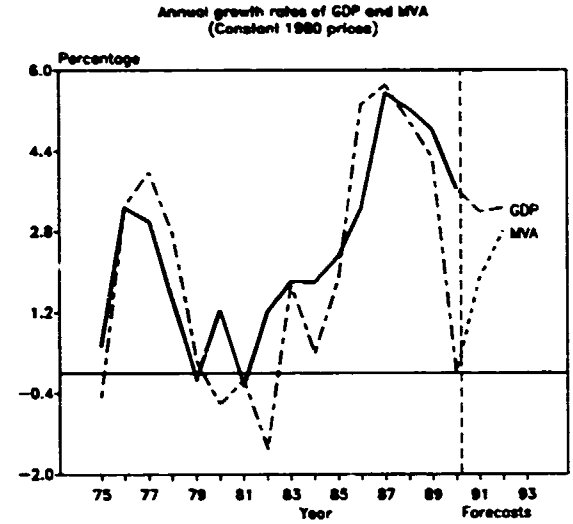
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.







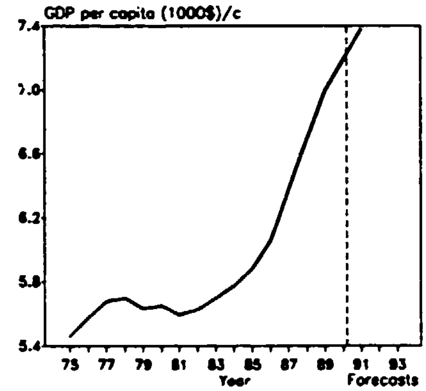


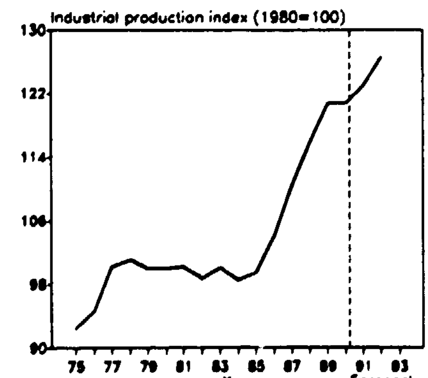


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

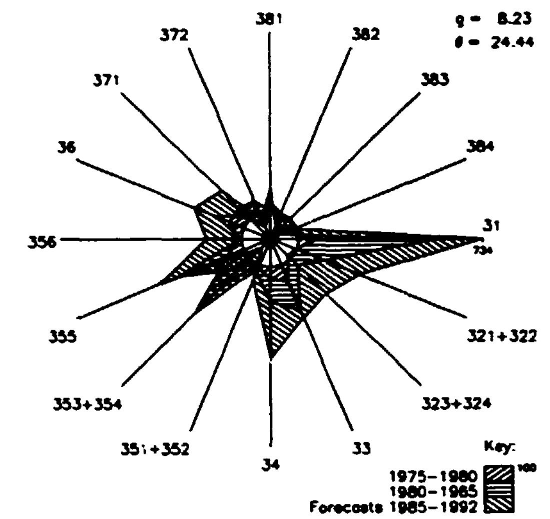
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	212115	227090	273044
Per capita (1980-dollars) /na,c	5650	5883	6988
Manufacturing share (%) /na (current prices)	27.2	26.4	25.8
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	59751	61143	74522
Industrial production index	100	99	121
Value added (millions of dollars)	51944	33140	72070
Gross output (millions of dollars)	149786	104581	199859
Employment (thousands)	2383	1792	1809 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	65	68	64
Wages and salaries (%)	16	13	14 /e
Operating surplus (%)	19	19	22 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	62856	58360	110477 /e
Value added / worker	21798	18494	39838 /e
Average wage	9795	7362	15307 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.46	3.43	4.94
as a percentage of average θ in 1970-1975	87	55	79
MVA growth rate / θ	1.78	-0.70	0.57
Degree of specialization	8.4	8.5	9.8
-VALUE ADDED:(millions of dollars)			
311 Food products	5665	4193	8816 /e
313 Beverages	1932	1576	3122 /e
314 Tobacco products	649	471	691
321 Textiles	3289	1613	2900
322 Wearing apparel	1502	753	1500
323 Leather and fur products	375	269	492
324 Footwear	810	415	458
331 Wood and wood products	1258	707	1582 /e
332 Furniture and fixtures	1262	617	1068 /e
341 Paper and paper products	1278	947	1899
342 Printing and publishing	1506	1198	3016
351 Industrial chemicals	2006	1737	3371 /e
352 Other chemical products	2506	1922	4011 /e
353 Petroleum refineries	1409	969	2642
354 Miscellaneous petroleum and coal products	229	191	562
355 Rubber products	955	597	1316 /e
356 Plastic products	1098	814	1719 /e
361 Pottery, china and earthenware	346	174	351
362 Glass and glass products	640	442	893
369 Other non-metal mineral products	2522	1617	3719
371 Iron and steel	3255	1756	3497
372 Non-ferrous metals	948	616	1136
381 Metal products	3720	2044	4620
382 Non-electrical machinery	3595	2225	4912
383 Electrical machinery	3669	2064	4478
384 Transport equipment	4743	2776	8333
385 Professional and scientific equipment	205	122	333
390 Other manufacturing industries	573	316	632 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

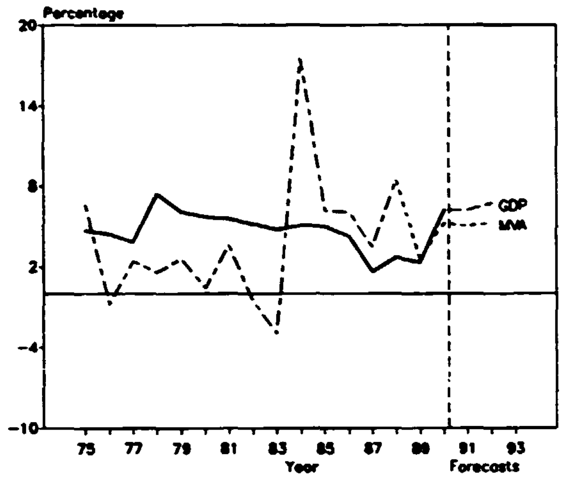




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

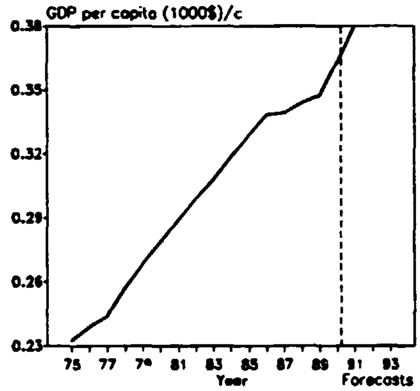


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

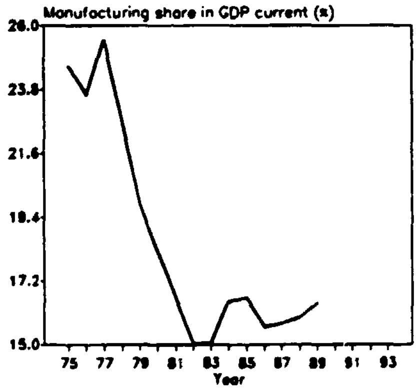
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	4133	5303	5903
Per capita (1980-dollars) /na,c	279	329	347
Manufacturing share (%) /na (current prices)	18.2	16.6	16.4 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	751	936	1143 /e
Industrial production index	100	111	132
Value added (millions of dollars)	307	636 /e	809 /e
Gross output (millions of dollars)	1129	1815	1923 /e
Employment (thousands)	163	211	225 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	73	65 /e	58 /e
Wages and salaries (%)	7	6	7 /e
Operating surplus (%)	20	29 /e	35 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	6934	8599	8535 /e
Value added / worker	1887	3010 /e	3590 /e
Average wage	486	529	599 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.56 /e	12.34 /e	5.94 /e
as a percentage of average θ in 1970-1975	103 /e	168 /e	81 /e
MVA growth rate / θ	1.12	1.91	0.72
Degree of specialization	20.4	29.2	25.5
-VALUE ADDED: (millions of dollars)			
311 Food products	28	186 /e	169 /e
313 Beverages	8	37 /e	73 /e
314 Tobacco products	63	139 /e	177 /e
321 Textiles	27	51 /e	68 /e
322 Wearing apparel	12	36 /e	84 /e
323 Leather and fur products	1	2 /e	2 /e
324 Footwear	2	4 /e	12 /e
331 Wood and wood products	5	9 /e	9 /e
332 Furniture and fixtures	1	2 /e	1 /e
341 Paper and paper products	8	10 /e	18 /e
342 Printing and publishing	4	9 /e	13 /e
351 Industrial chemicals	6	5 /e	3 /e
352 Other chemical products	12	18 /e	26 /e
353 Petroleum refineries	55	25 /e	10 /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	14	31 /e	32 /e
356 Plastic products	4	4 /e	9 /e
361 Pottery, china and earthenware	4	6 /e	14 /e
362 Glass and glass products	2	2 /e	3 /e
369 Other non-metal mineral products	21	30 /e	32 /e
371 Iron and steel	3	2 /e	5 /e
372 Non-ferrous metals	2	1 /e	1 /e
381 Metal products	7	9 /e	11 /e
382 Non-electrical machinery	4	6 /e	3 /e
383 Electrical machinery	10	5 /e	6 /e
384 Transport equipment	4	2 /e	6 /e
385 Professional and scientific equipment	1	- /e	- /e
390 Other manufacturing industries	1	6 /e	22 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

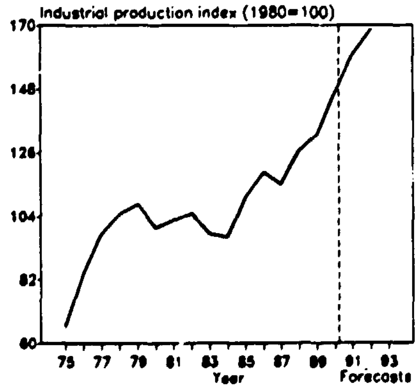
GDP per capita (1000$)/c



Manufacturing share in GDP current (%)

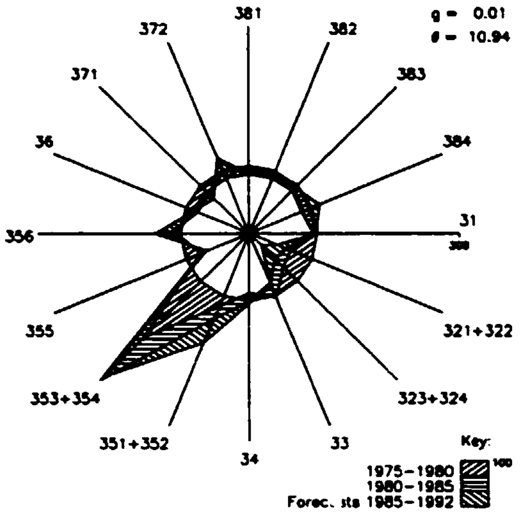


Industrial production index (1980=100)

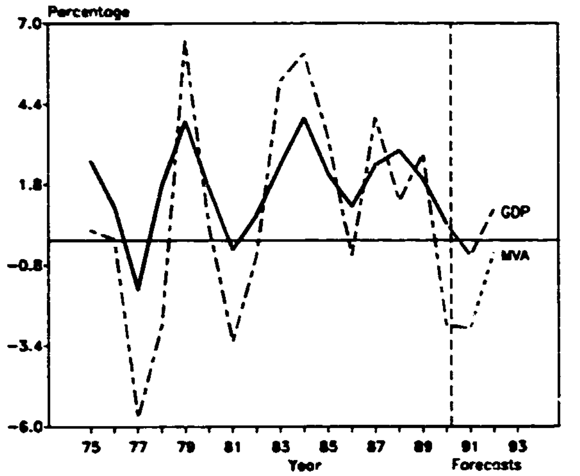


SWEDEN

Industrial structural change
(Index of value added: 1975=100)



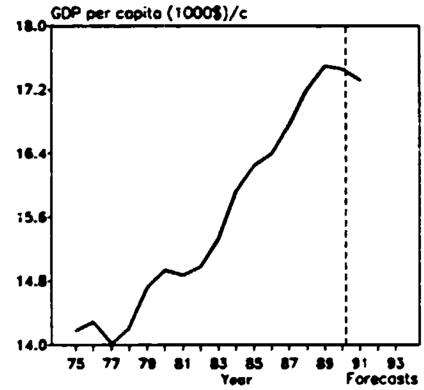
Annual growth rates of GDP nd MVA
(Constant 1980 prices)

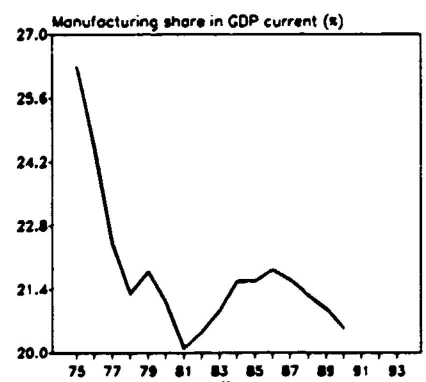


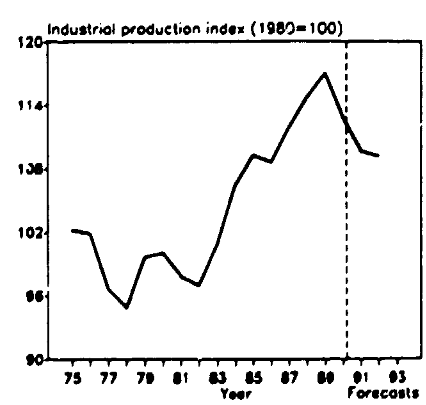
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

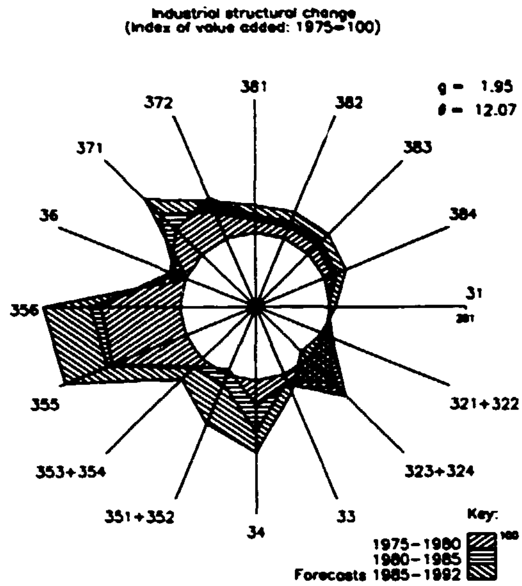
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	124137	135673	147391
Per capita (1980-dollars) /na,c	14936	16246	17492
Manufacturing share (%) /na (current prices)	21.1	21.6	21.0
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	26245	29096	31329
Industrial production index	100	109	117
Value added (millions of dollars)	30905	24486	45863
Gross output (millions of dollars)	73194	59391	103106
Employment (thousands)	853	769	769
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	58	59	56
Wages and salaries (%)	18	15	15 /e
Operating surplus (%)	24	26	29 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	85808	77252	134067
Value added / worker	36231	31850	59635
Average wage	15835	11676	20139 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.84	4.04	3.41
as a percentage of average θ in 1970-1975	73	76	65
MVA growth rate / θ	-0.45	0.37	0.65
Degree of specialization	15.4	16.1	16.7
-VALUE ADDED: (millions of dollars)			
311 Food products	2719	2107	3627
313 Beverages	338	250	531
314 Tobacco products	104	108	194
321 Textiles	534	379	586
322 Wearing apparel	274	157	215
323 Leather and fur products	54	40	41
324 Footwear	61	24	29
331 Wood and wood products	2102	1154	2308 /e
332 Furniture and fixtures	452	285	498 /e
341 Paper and paper products	2596	2230	4509
342 Printing and publishing	1842	1517	2671
351 Industrial chemicals	986	841	1899 /e
352 Other chemical products	1246	1090	2100 /e
353 Petroleum refineries	359	396	538
354 Miscellaneous petroleum and coal products	137	122	208 /e
355 Rubber products	314	225	367 /e
356 Plastic products	402	334	660 /e
361 Pottery, china and earthenware	87	71	101
362 Glass and glass products	175	124	241
369 Other non-metal mineral products	801	510	1029
371 Iron and steel	1650	1185	2027
372 Non-ferrous metals	390	331	709
381 Metal products	2598	2048	3829
382 Non-electrical machinery	3936	3185	5360
383 Electrical machinery	2570	2'32	3564
384 Transport equipment	3652	3153	7053
385 Professional and scientific equipment	371	400	806
390 Other manufacturing industries	154	87	175 /e

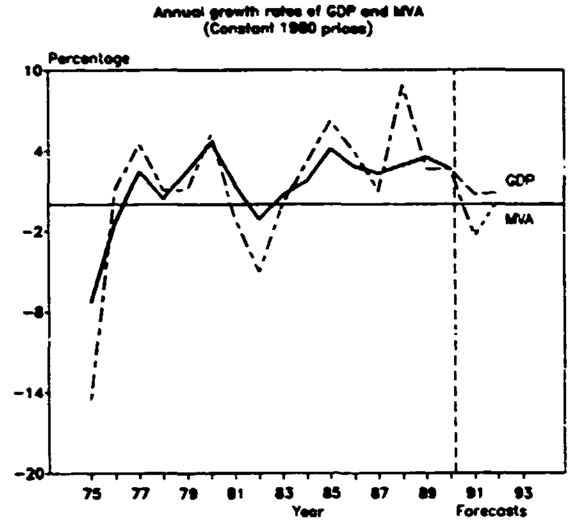
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.









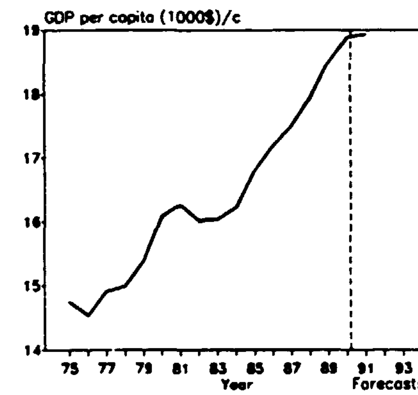


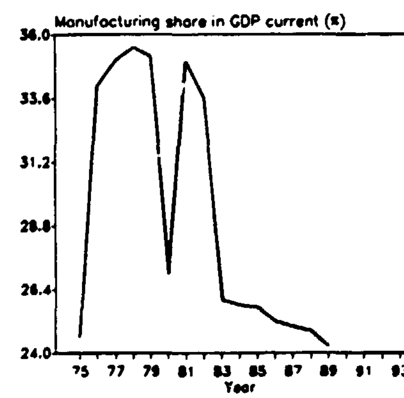
Source: National Accounts Statistics from UN/UNSO.

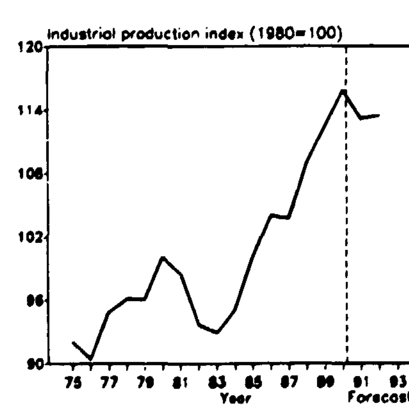
Estimated by UNIDO/PPD/IPP/GLO.

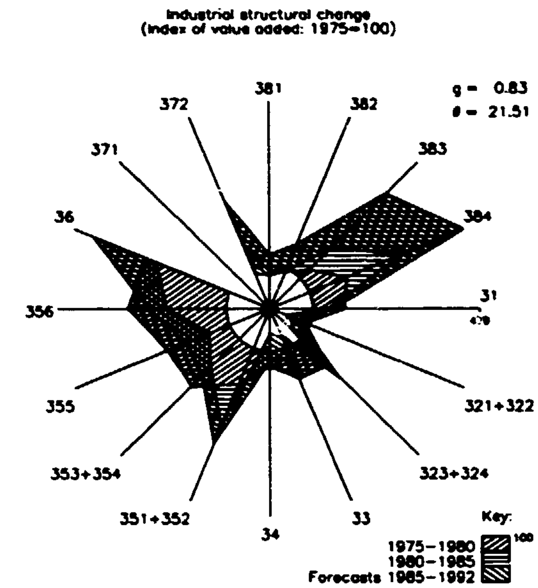
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	101629	108700	121786
Per capita (1980-dollars) /na,c	16081	16798	18489
Manufacturing share (%) /na (current prices)	27.0 /e	25.7	24.2 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	26569	27366	32068
Industrial production index	100	100	112
Value added (millions of dollars)	27450	23366	44792
Gross output (millions of dollars)	...	...	...
Employment (thousands)	686	656	676 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY: (dollars)			
Gross output / worker	...	...	...
Value added / worker	40026	35598	66225 /e
Average wage	...	...	...
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.84 /e	2.57 /e	2.25 /e
as a percentage of average θ in 1970-1975	76 /e	51 /e	44 /e
MVA growth rate / θ	0.98	0.00	1.66
Degree of specialization	11.6	11.8	12.7
-VALUE ADDED: (millions of dollars)			
311 Food products	2905	2584 /e	4729 /e
313 Beverages	499	455 /e	794 /e
314 Tobacco products	292	157 /e	246 /e
321 Textiles	972	878	1440
322 Wearing apparel	864	633	888
323 Leather and fur products	124	67 /e	85 /e
324 Footwear	324	255	326
331 Wood and wood products	1079	873 /e	1698 /e
332 Furniture and fixtures	707	572 /e	1113 /e
341 Paper and paper products	624	558	1129
342 Printing and publishing	1471	1703	3361
351 Industrial chemicals	1530	1660 /e	3328 /e
352 Other chemical products	1332	1330 /e	3621 /e
353 Petroleum refineries	585	496 /e	981 /e
354 Miscellaneous petroleum and coal products	95	100 /e	102 /e
355 Rubber products	226	198 /e	402 /e
356 Plastic products	625	572 /e	1156 /e
361 Pottery, china and earthenware	137	148 /e	223 /e
362 Glass and glass products	187	203 /e	306 /e
369 Other non-metal mineral products	661	433 /e	770 /e
371 Iron and steel	455	468 /e	940 /e
372 Non-ferrous metals	584	428 /e	798 /e
381 Metal products	1922	1545 /e	2933 /e
382 Non-electrical machinery	3777	3037 /e	5764 /e
383 Electrical machinery	2960	2300 /e	4365 /e
384 Transport equipment	508	408 /e	775 /e
385 Professional and scientific equipment	1977	1217 /e	2277 /e
390 Other manufacturing industries	138	86	159

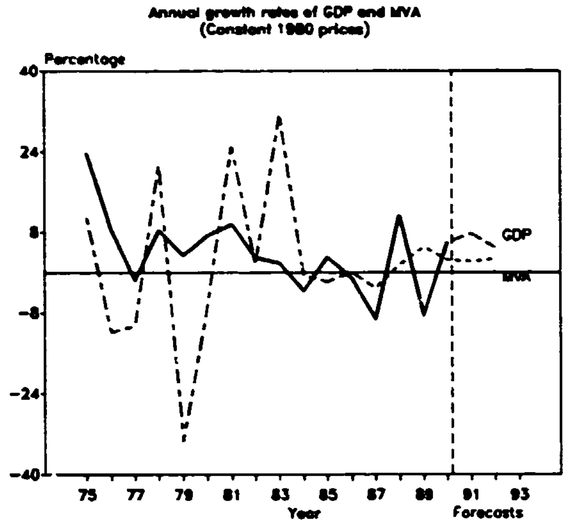
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.







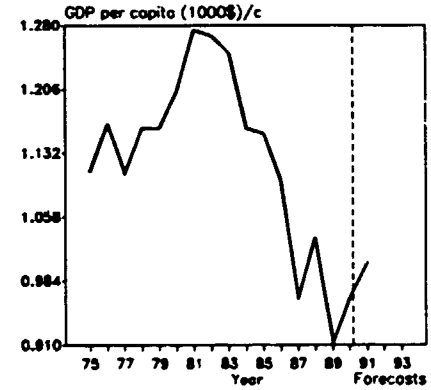


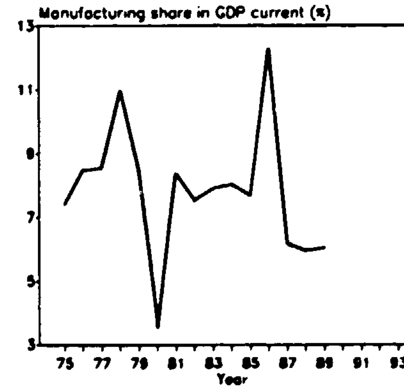


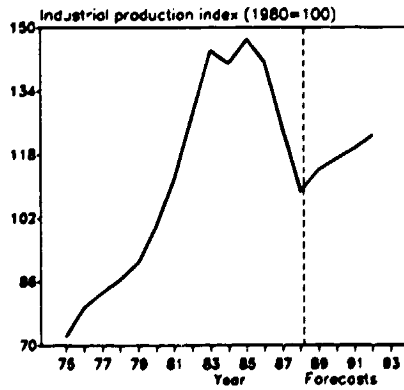
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP:/na,c (millions of 1980-dollars)	10593	12071	11019
Per capita (1980-dollars) /na,c	1204	1154	912
Manufacturing share (%) /na (current prices)	3.6	7.7	6.0 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	377	615	...
Industrial production index	100	147	114 /e
Value added (millions of dollars)	1256	1435	1461 /e
Gross output (millions of dollars)	3362	5914	6349 /e
Employment (thousands)	195	182	130
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	63	76	77 /e
Wages and salaries (%)	10 /e	8 /e	6 /e
Operating surplus (%)	27 /e	16 /e	17 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	17278	32511	48853 /e
Value added / worker	6452	7892	11243 /e
Average wage	1788 /e	2738 /e	3043
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.56	12.60	9.60 /e
as a percentage of average θ in 1970-1975	132	253	193 /e
MVA growth rate / θ	1.17	-0.17	-0.54
Degree of specialization	20.0	14.7	19.9
-VALUE ADDED:(millions of dollars)			
311 Food products	214	235	235 /e
313 Beverages	37	42	40 /e
314 Tobacco products	146	163	168 /e
321 Textiles	273	154	326 /e
322 Wearing apparel	14	9	18 /e
323 Leather and fur products	26	19	41 /e
324 Footwear	43	28	61 /e
331 Wood and wood products	29	27	18 /e
332 Furniture and fixtures	74	69	45 /e
341 Paper and paper products	6	8	4 /e
342 Printing and publishing	14	16	9 /e
351 Industrial chemicals	3	7	6 /e
352 Other chemical products	31	73	64 /e
353 Petroleum refineries	100	112	104 /e
354 Miscellaneous petroleum and coal products	4	4	4 /e
355 Rubber products	15	16	13 /e
356 Plastic products	13	14	12 /e
361 Pottery, china and earthenware	7	13	10 /e
362 Glass and glass products	13	24	15 /e
369 Other non-metal mineral products	72	135	98 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	13	28	10 /e
381 Metal products	53	100	66 /e
382 Non-electrical machinery	18	42	28 /e
383 Electrical machinery	16	62	41 /e
384 Transport equipment	3	11	8 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	19	23	20 /e

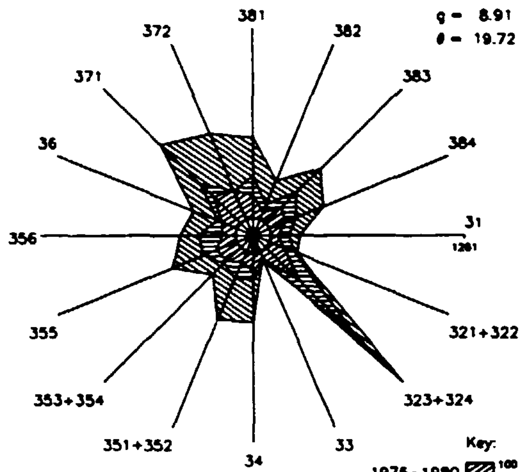
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



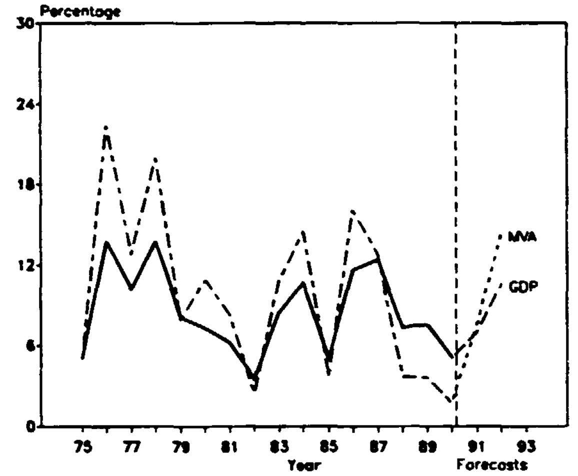




Industrial structural change
(Index of value added: 1975=100)



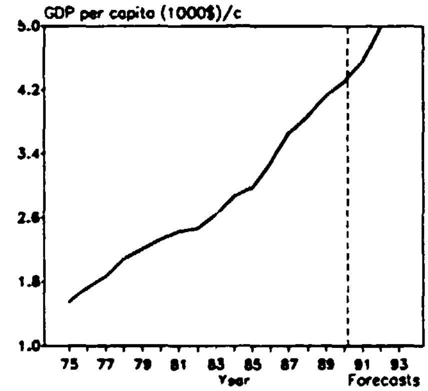
Annual growth rates of GDP and MVA
(Constant 1980 prices)

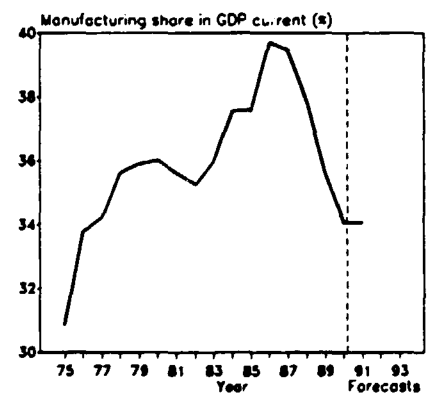


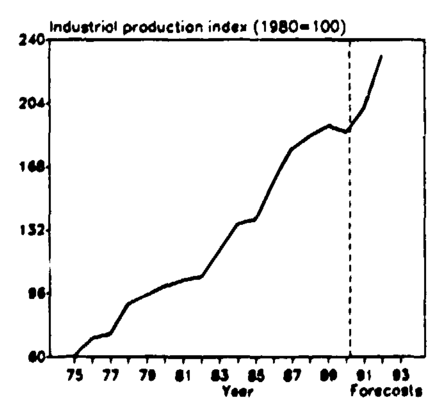
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	41384	57275	82933
Per capita (1980-dollars) /na,c	2324	2974	4125
Manufacturing share (%) /na (current prices)	36.0	37.6	35.6
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	14907	21734	30544
Industrial production index	100	138	191
Value added (millions of dollars)	14907	23557	48995
Gross output (millions of dollars)	55343	69508	132678
Employment (thousands)	1997	2459	2453
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	73	66	63
Wages and salaries (%)	10	14	15
Operating surplus (%)	17	20	22
-PRODUCTIVITY:(dollars)			
Gross output / worker	27719	28267	54097
Value added / worker	7466	9580	19977
Average wage	2678	3862	8323
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.14	3.18	3.72
as a percentage of average θ in 1970-1975	70	43	51
MVA growth rate / θ	2.83	2.37	2.21
Degree of specialization	11.0	11.8	11.2
-VALUE ADDED:(millions of dollars)			
311 Food products	1542	2541	4320
313 Beverages	173	313	717
314 Tobacco products	123	125	237
321 Textiles	1885	2687	4198
322 Wearing apparel	337	720	1021
323 Leather and fur products	176	431	797
324 Footwear	46	119	212
331 Wood and wood products	316	394	695
332 Furniture and fixtures	119	146	258
341 Paper and paper products	424	647	1662
342 Printing and publishing	263	294	733
351 Industrial chemicals	622	1125	2557
352 Other chemical products	502	941	2326
353 Petroleum refineries	719	946	2142
354 Miscellaneous petroleum and coal products	157	116	196
355 Rubber products	223	336	691
356 Plastic products	917	1793	3605
361 Pottery, china and earthenware	158	229	504
362 Glass and glass products	85	120	255
369 Other non-metal mineral products	439	535	1128
371 Iron and steel	828	1242	3074
372 Non-ferrous metals	139	146	349
381 Metal products	637	1069	2346
382 Non-electrical machinery	475	703	1659
383 Electrical machinery	1676	2866	6027
384 Transport equipment	766	1136	2411
385 Professional and scientific equipment	129	234	518
390 Other manufacturing industries	1028	1604	4357

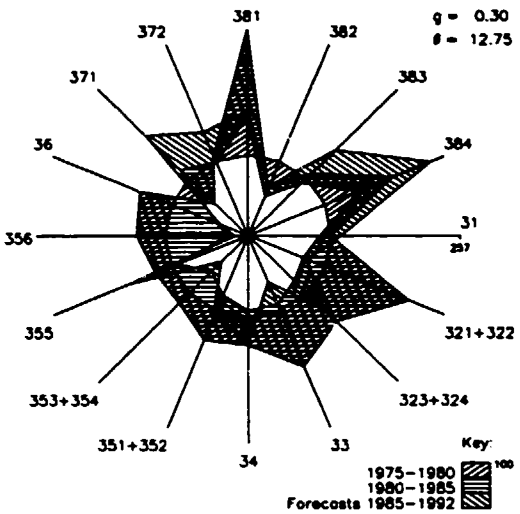
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



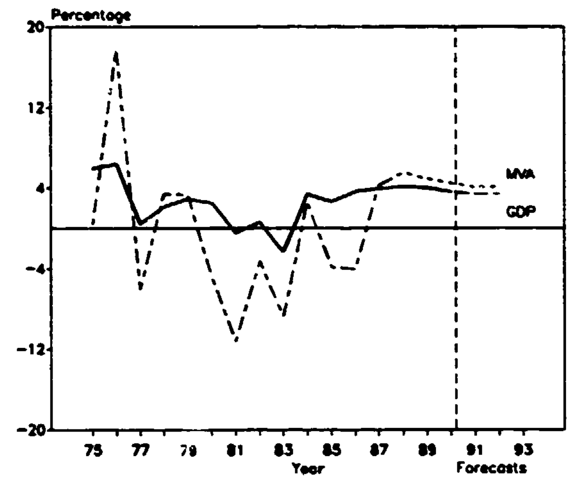




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

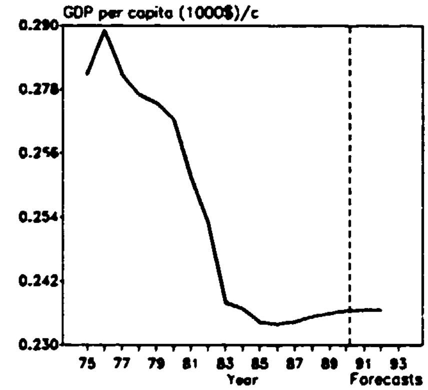


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

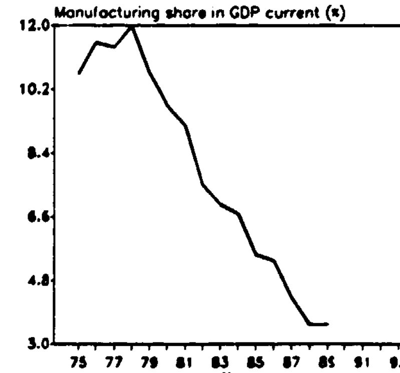
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	5138	5327	6210
Per capita (1980-dollars) /na,c	272	234	236
Manufacturing share (%) /na (current prices)	9.7	5.5	3.5 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	500	387	428 /e
Industrial production index	100	81	101 /e
Value added (millions of dollars)	361	278	111 /e
Gross output (millions of dollars)	1266	1145	464 /e
Employment (thousands)	101	94	110 /e
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	71	76	76 /e
Wages and salaries (%)	9	9	9 /e
Operating surplus (%)	19	16	15 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	12537	12217	4206 /e
Value added / worker	3577	2970	1008 /e
Average wage	1174	1041	358 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.71 /e	9.82	3.13 /e
as a percentage of average θ in 1970-1975	83 /e	142	45 /e
MVA growth rate / θ	1.31	-1.00	-0.14
Degree of specialization	17.0	14.7	15.5
-VALUE ADDED:(millions of dollars)			
311 Food products	58	58	23 /e
313 Beverages	14	21	9 /e
314 Tobacco products	12	16	7 /e
321 Textiles	95	43	17 /e
322 Wearing apparel	10	4	1 /e
323 Leather and fur products	7	4	2 /e
324 Footwear	8	6	3 /e
331 Wood and wood products	7	6	2 /e
332 Furniture and fixtures	6	3	1 /e
341 Paper and paper products	8	7	4 /e
342 Printing and publishing	14	12	5 /e
351 Industrial chemicals	11	9	4 /e
352 Other chemical products	10	7	2 /e
353 Petroleum refineries	15	10	3 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	11	11	5 /e
356 Plastic products	8	2	- /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	-	-	- /e
369 Other non-metal mineral products	11	4	1 /e
371 Iron and steel	2 /e	6 /e	3 /e
372 Non-ferrous metals	4 /e	4 /e	2 /e
381 Metal products	20	15	5 /e
382 Non-electrical machinery	3	4	1 /e
383 Electrical machinery	6	6	3 /e
384 Transport equipment	19	19	8 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	2	2	- /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

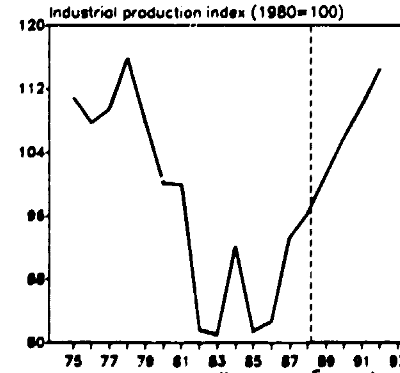
GDP per capita (1000$)/c



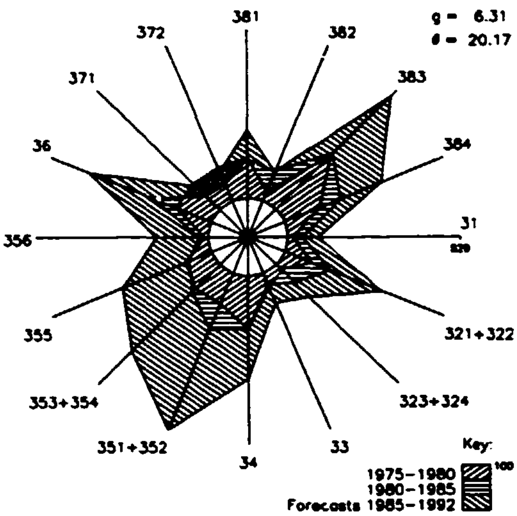
Manufacturing share in GDP current (%)



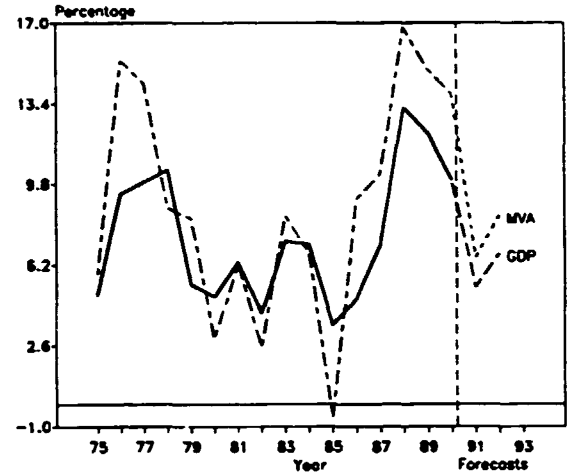
Industrial production index (1980=100)



Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

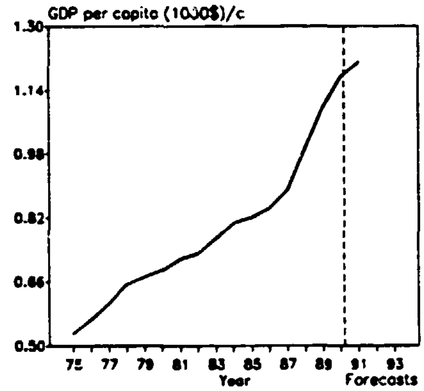


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

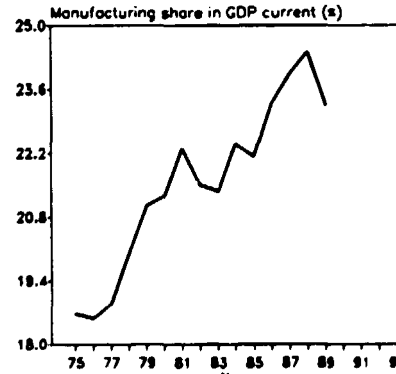
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	32160	42323	60195
Per capita (1980-dollars) /na.c	688	820	1096
Manufacturing share (%) /na (current prices)	21.3	22.1	23.2 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	6834	8567	13828
Industrial production index	100	116	184
Value added (millions of dollars)	9341	10752	16677 /e
Gross output (millions of dollars)	29255	33165	50688 /e
Employment (thousands)	1549	1341 /e	1413 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	68	68	67 /e
Wages and salaries (%)	7	8	8 /e
Operating surplus (%)	25	25	25 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	18890	24723 /e	35880 /e
Value added / worker	6032	8015 /e	11805 /e
Average wage	1401	1894 /e	2709 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.13	4.08	2.59 /e
as a percentage of average θ in 1970-1975	68	67	43 /e
MVA growth rate / θ	2.14	0.93	2.30
Degree of specialization	13.4	14.1	13.4
-VALUE ADDED: (millions of dollars)			
311 Food products	1763	2022	2677 /e
313 Beverages	698	824	1192 /e
314 Tobacco products	361	436	569 /e
321 Textiles	1021	1143	1770 /e
322 Wearing apparel	489	703	1163 /e
323 Leather and fur products	24	33	38 /e
324 Footwear	53	69	105 /e
331 Wood and wood products	267	215	309 /e
332 Furniture and fixtures	113	128	184 /e
341 Paper and paper products	357	334	497 /e
342 Printing and publishing	80	86	122 /e
351 Industrial chemicals	171	211	426 /e
352 Other chemical products	347	475	948 /e
353 Petroleum refineries	561	569	1134 /e
354 Miscellaneous petroleum and coal products	35	35	70 /e
355 Rubber products	301	272	548 /e
356 Plastic products	108	116	224 /e
361 Pottery, china and earthenware	33	42	66 /e
362 Glass and glass products	97	122	193 /e
369 Other non-metal mineral products	212	268	422 /e
371 Iron and steel	312	230	266 /e
372 Non-ferrous metals	138	102	118 /e
381 Metal products	230	217	332 /e
382 Non-electrical machinery	158	217	259 /e
383 Electrical machinery	319	315	487 /e
384 Transport equipment	661	820	1249 /e
385 Professional and scientific equipment	20	34	51 /e
390 Other manufacturing industries	412	716	1257 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

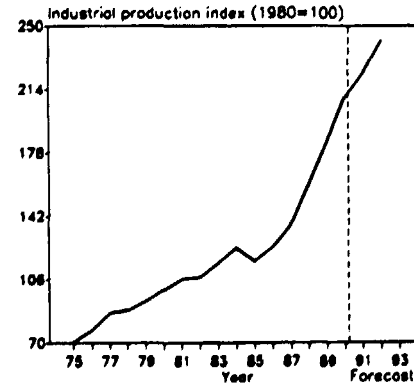
GDP per capita (1000$)/c

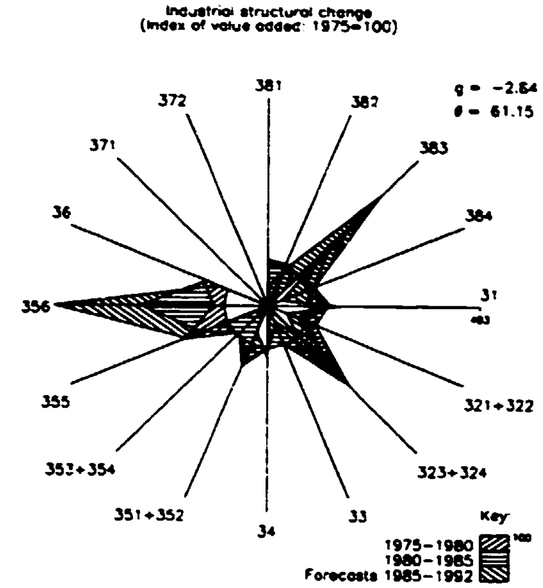


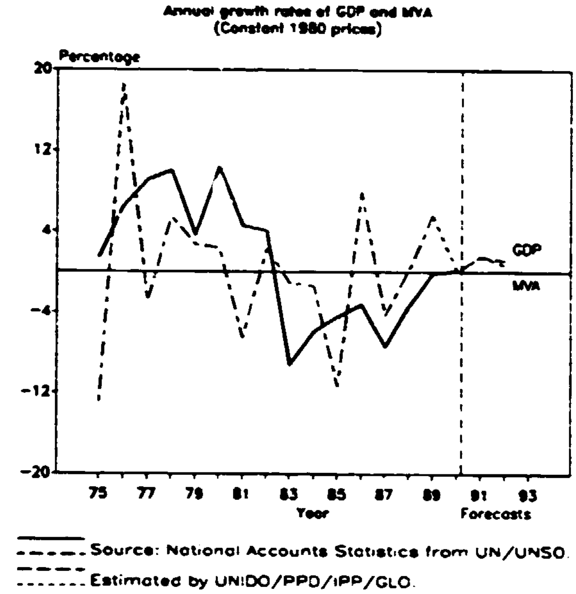
Manufacturing share in GDP current (%)



Industrial production index (1980=100)

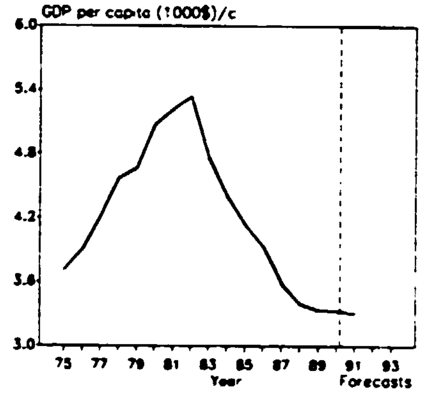


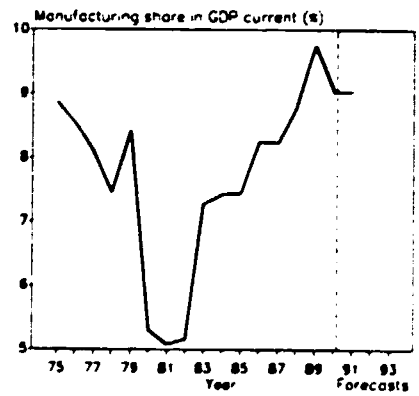


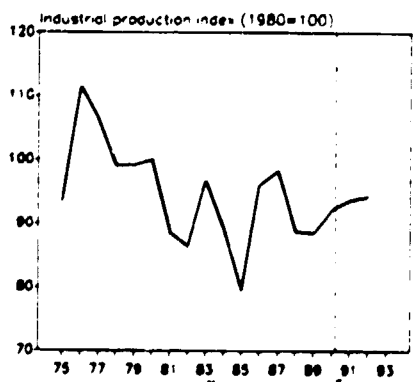


	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	5486	4874	4207
Per capita (1980-dollars) /na.c	5070	4134	3334
Manufacturing share (%) /na (current prices)	5.3	7.4	3.8
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	490	405	442
Industrial production index	100	80	88
Value added (millions of dollars)	492	387	413 /e
Gross output (millions of dollars)	1559 /e	1765	1645 /e
Employment (thousands)	44	34	31 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	68 /e	78	75 /e
Wages and salaries (%)	17 /e	18 /e	16 /e
Operating surplus (%)	14 /e	4 /e	9 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	35202 /e	52667	52877 /e
Value added / worker	11099	11544	13267 /e
Average wage	6085 /e	9488 /e	8718 /e
-STRUCTURAL INDICES:			
Structural change θ (5 year average in degrees)	2.62 /e	20.14	12.27 /e
as a percentage of average θ in 1970-1975	112 /e	862	525 /e
MVA growth rate / θ	0.74	-0.52	-0.51
Degree of specialization	28.3	18.0	21.2
-VALUE ADDED: (millions of dollars)			
311 Food products	67	95	123 /e
313 Beverages	27	34	36 /e
314 Tobacco products	14	35	33 /e
321 Textiles	1	2	1 /e
322 Wearing apparel	16	13	10 /e
323 Leather and fur products	-	-	- /e
324 Footwear	4	5	2 /e
331 Wood and wood products	6	4	3 /e
332 Furniture and fixtures	9	7	1 /e
341 Paper and paper products	9	14	22 /e
342 Printing and publishing	13	19	17 /e
351 Industrial chemicals	5	6	4 /e
352 Other chemical products	12	10	8 /e
353 Petroleum refineries	190 /e	17 /e	34 /e
354 Miscellaneous petroleum and coal products	2 /e	- /e	- /e
355 Rubber products	9	10	11 /e
356 Plastic products	2	8	12 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	3	4	3 /e
369 Other non-metal mineral products	23	31	24 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	26	11	17 /e
382 Non-electrical machinery	13	-	16 /e
383 Electrical machinery	3	13	13 /e
384 Transport equipment	18	43	17 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	8	6	6 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex







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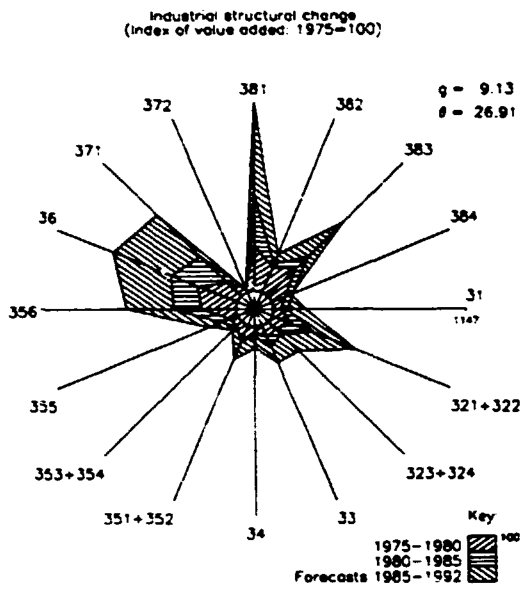
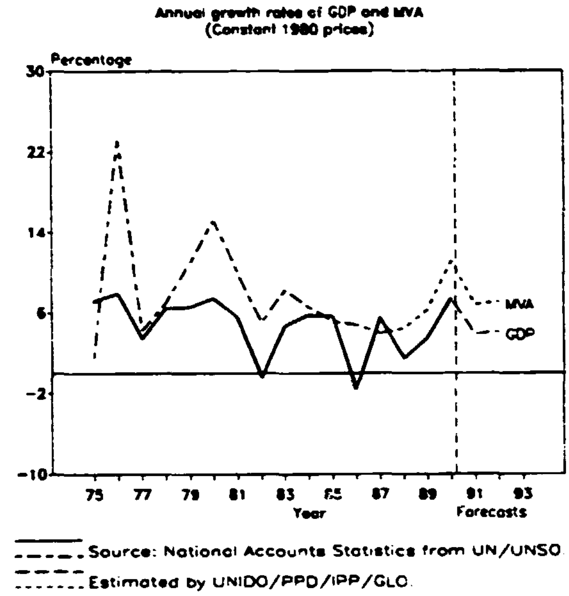
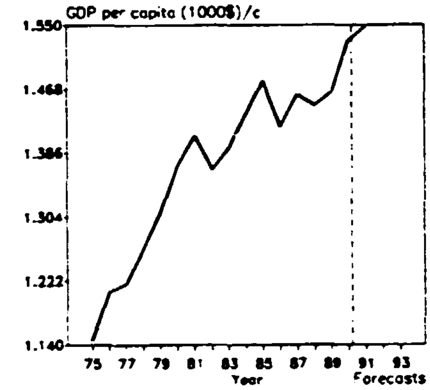
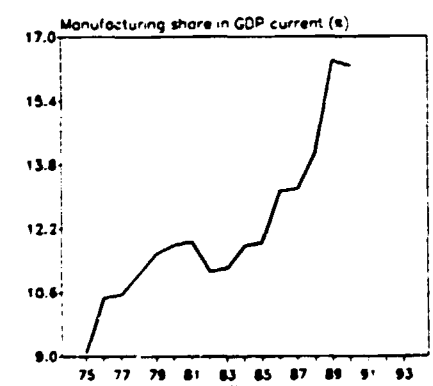


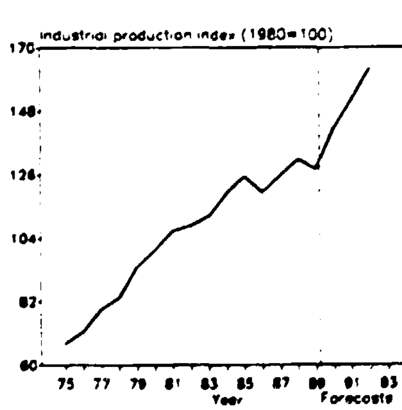


	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	8742	10733	11599
Per capita (1980-dollars) /na,c	1369	1478	1463
Manufacturing share (%) /na (current prices)	11.8	11.8	16.4
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	1030	1443	1744 /e
Industrial production index	100	125	128
Value added (millions of dollars)	939 /e	989 /e	1469 /e
Gross output (millions of dollars)	3579	3449 /e	5039 /e
Employment (thousands)	125	162 /e	195 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	74 /e	71 /e	71 /e
Wages and salaries (%)	12	14 /e	15 /e
Operating surplus (%)	14 /e	15 /e	15 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	28737	21294 /e	25899 /e
Value added / worker	7542 /e	6105 /e	7550 /e
Average wage	3499	3005 /e	3784 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	9.45 /e	3.34 /e	0.98 /e
as a percentage of average θ in 1970-1975	90 /e	32 /e	9 /e
MVA growth rate / θ	1.58	1.97	6.98
Degree of specialization	13.9	15.5	17.0
-VALUE ADDED: (millions of dollars)			
311 Food products	96	80 /e	112 /e
313 Beverages	49	57 /e	87 /e
314 Tobacco products	22	24 /e	37 /e
321 Textiles	55	71 /e	104 /e
322 Wearing apparel	92	106 /e	171 /e
323 Leather and fur products	6	6 /e	8 /e
324 Footwear	21	21 /e	33 /e
331 Wood and wood products	12	12 /e	15 /e
332 Furniture and fixtures	13	14 /e	20 /e
341 Paper and paper products	24	19 /e	30 /e
342 Printing and publishing	17	17 /e	20 /e
351 Industrial chemicals	42 /e	23 /e	29 /e
352 Other chemical products	96 /e	80 /e	122 /e
353 Petroleum refineries	13	11 /e	13 /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	8	8 /e	10 /e
356 Plastic products	18	21 /e	30 /e
361 Pottery, china and earthenware	11	8 /e	12 /e
362 Glass and glass products	7	6 /e	9 /e
369 Other non-metal mineral products	156	182 /e	280 /e
371 Iron and steel	45	71 /e	111 /e
372 Non-ferrous metals	8	6 /e	6 /e
381 Metal products	53	75 /e	120 /e
382 Non-electrical machinery	2	2 /e	2 /e
383 Electrical machinery	35	34 /e	52 /e
384 Transport equipment	30	28 /e	26 /e
385 Professional and scientific equipment	1	1 /e	2 /e
390 Other manufacturing industries	5	5 /e	7 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

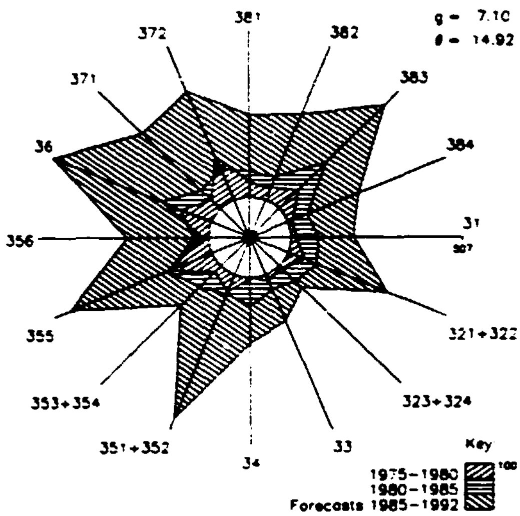




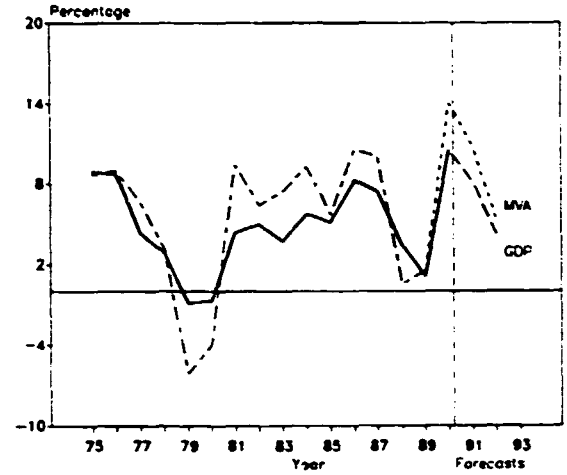


TURKEY

Industrial structural change
(Index of value added 1975=100)



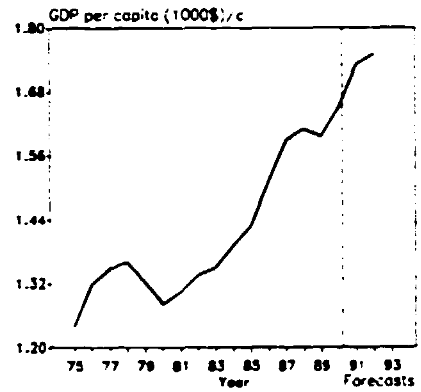
Annual growth rates of GDP and MVA
(Constant 1980 prices)

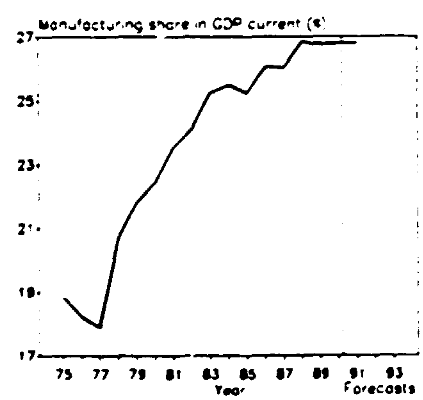


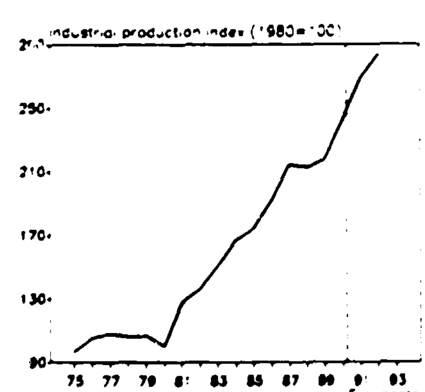
Source: National Accounts Statistics from UN/UNSC
Estimated by UNIDO/PPD/IPP/GLO

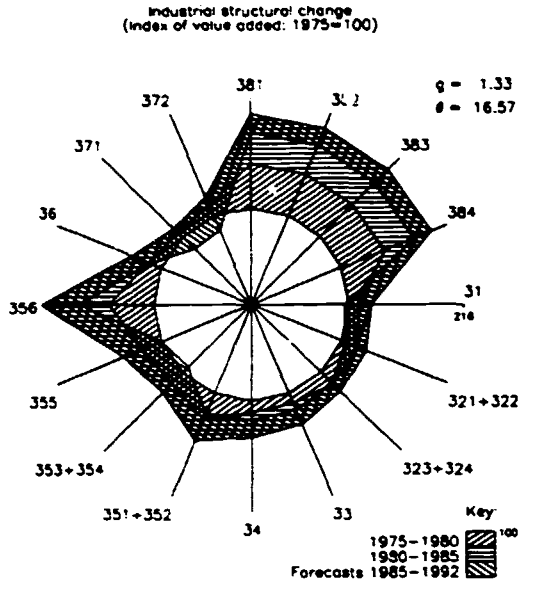
	1980	1985	1989	
GDP: (nat.c millions of 1980-dollars)	56918	71886	87353	
Per capita (1980-dollars) (nat.c	1281	1428	1595	
Manufacturing share (%) (nat. current prices)	22.4	25.2	26.8	
MANUFACTURING:				
Value added (nat.c millions of 1980-dollars)	12770	18457	22928	
Industrial production index	100	174	218	
Value added (millions of dollars)	10837	10449	22211	e
Gross output (millions of dollars)	29413	32471	56991	e
Employment (thousands)	787	844	962	
-PROFITABILITY: (in percent of gross output)				
Intermediate input (%)	63	68	61	e
Wages and salaries (%)	11	7	6	e
Operating surplus (%)	26	25	33	e
-PRODUCTIVITY: dollars				
Gross output / worker	37374	38478	59255	e
Value added / worker	13770	12382	23094	e
Average wage	4231	2618	3359	e
-STRUCTURAL INDICES:				
Structural change θ (5-year average in degrees)	14.36	11.39	11.01	e
as a percentage of average θ in 1970-1975	154	127	118	e
MVA growth rate / θ	0.38	0.54	1.05	
Degree of specialization	14.3	13.8	12.8	
-VALUE ADDED: millions of dollars				
311 Food products	1185	973	1382	e
313 Beverages	335	331	581	e
314 Tobacco products	457	577	1213	e
321 Textiles	1535	1289	2582	e
322 Wearing apparel	50	146	665	e
323 Leather and fur products	25	37	38	e
324 Footwear	33	22	39	e
331 Wood and wood products	118	64	149	e
332 Furniture and fixtures	16	55	63	e
341 Paper and paper products	205	241	376	e
342 Printing and publishing	97	133	271	e
351 Industrial chemicals	719	457	2029	e
352 Other chemical products	387	394	835	e
353 Petroleum refineries	1352	1514	2706	e
354 Miscellaneous petroleum and coal products	222	152	294	e
355 Rubber products	201	151	393	e
356 Plastic products	125	76	217	e
361 Pottery, china and earthenware	93	102	276	e
362 Glass and glass products	110	167	416	e
369 Other non-metal mineral products	535	428	1039	e
371 Iron and steel	783	734	1759	e
372 Non-ferrous metals	292	181	491	e
381 Metal products	395	344	709	e
382 Non-electrical machinery	506	456	1001	e
383 Electrical machinery	463	531	1002	e
384 Transport equipment	541	534	1100	e
385 Professional and scientific equipment	8	9	43	e
390 Other manufacturing industries	28	49	42	e

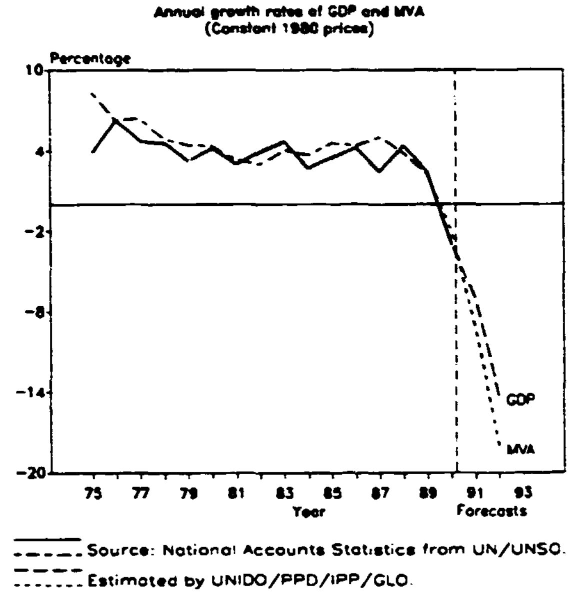
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





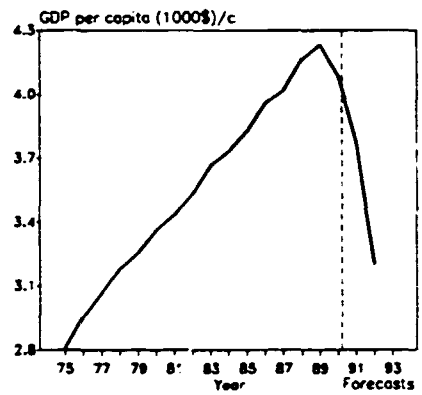


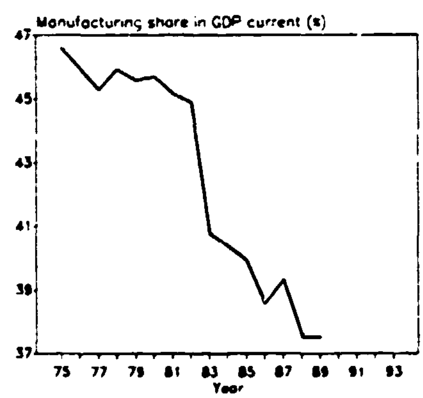


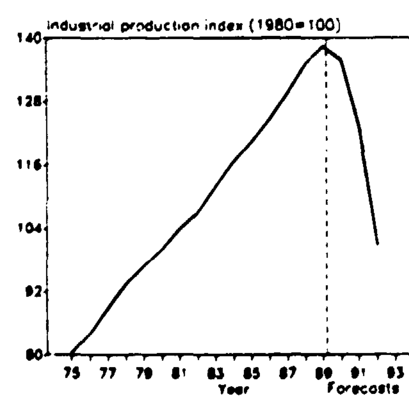


	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	892879	1062526	1212263
Per capita (1980-dollars) /na.c	3362	3828	4232
Manufacturing share (%) /na (current prices)	45.7	39.9	37.5 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	404805	485530	564471
Industrial production index	100	120	138
Value added (millions of dollars)/c	362425	436247	501622
Gross output (millions of dollars)	834090	867603	1295101
Employment (thousands)	31464	32794	31207
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	...	...	...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	...
-PRODUCTIVITY: (dollars)			
Gross output / worker	26509	25456	41500
Value added / worker /c	11519	13303	16074
Average wage	3247	3002	4836
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	1.77	1.21	1.10
as a percentage of average θ in 1970-1975	103	70	64
MVA growth rate / θ	2.51	3.11	3.20
Degree of specialization	18.1	18.9	19.5
-VALUE ADDED: (millions of dollars)/c			
311 Food products	66053	75960	85208
313 Beverages	10336	9303	8889
314 Tobacco products	2032	2866	2398
321 Textiles	32553	34506	38086
322 Wearing apparel	19633	21792	23559
323 Leather and fur products	2443	2345	2345
324 Footwear	3892	4593	5371
331 Wood and wood products	4932	5771	6560
332 Furniture and fixtures	3457	4459	5427
341 Paper and paper products	2784	3424	3981
342 Printing and publishing	2613	3214	3736
351 Industrial chemicals	14704	17939	20144
352 Other chemical products	7584	8419	9632
353 Petroleum refineries	5490	6093	6972
354 Miscellaneous petroleum and coal products	11003	12214	13974
355 Rubber products	4154	4861	5401
356 Plastic products	1546	2273	2969
361 Pottery, china and earthenware	2014	2457	2860
362 Glass and glass products	1204	1517	1878
369 Other non-metal mineral products	13769	15696	18037
371 Iron and steel	14418	15283	15860
372 Non-ferrous metals	7716	8333	8256
381 Metal products	7130	9625	11693
382 Non-electrical machinery	79367	107146	130162
383 Electrical machinery	9105	12292	14932
384 Transport equipment	11574	15625	18982
385 Professional and scientific equipment	9711	13110	15927
390 Other manufacturing industries	11210	15133	18384

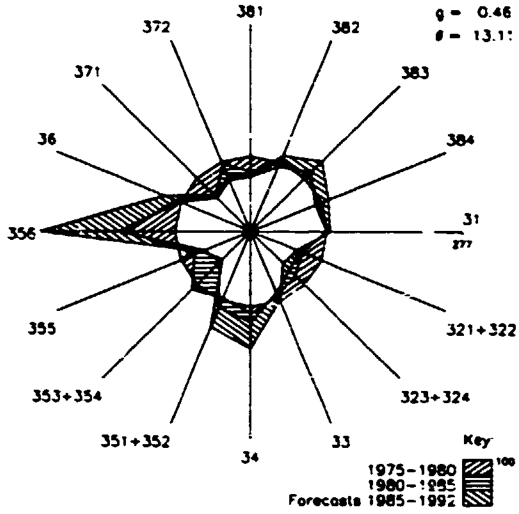
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



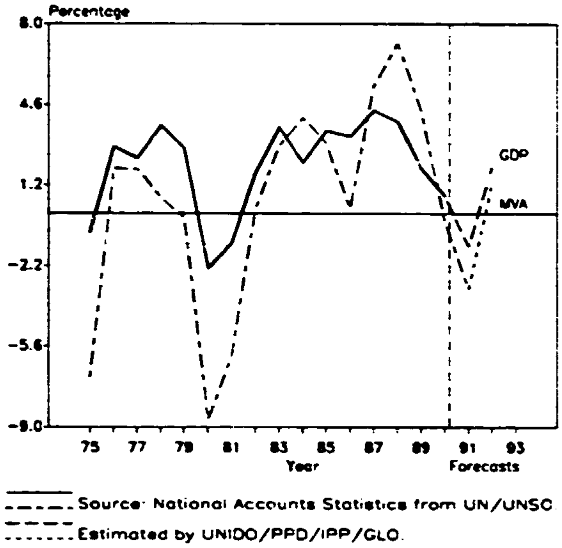




Industrial structural change
(index of value added: 1975=100)



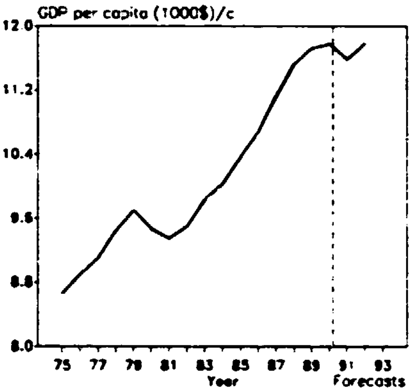
Annual growth rates of GDP and MVA
(Constant 1980 prices)



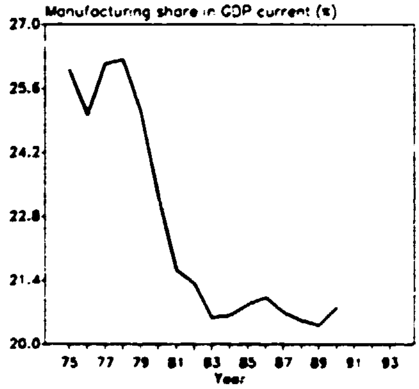
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	535256	588356	671543
Per capita (1980-dollars) /na,c	9470	10366	11719
Manufacturing share (%) /na (current prices)	23.2	20.9	20.4 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	124379	129105	152418
Industrial production index	100	103	122
Value added (millions of dollars)	163790	124409	231549
Gross output (millions of dollars)	400929	306225	523446
Employment (thousands)	6462	4932	4869 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	59	56
Wages and salaries (%)	20	18	18 /e
Operating surplus (%)	21	23	27 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	62044	62089	107497 /e
Value added / worker	25347	25225	47552 /e
Average wage	12371	10916	18998 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.83	2.57	1.98
as a percentage of average θ in 1970-1975	105	71	54
MVA growth rate / ∂	-0.20	-0.15	[illegible]
Degree of specialization	11.1	11.9	12.1
-VALUE ADDED: (millions of dollars)			
311 Food products	14744	12179	20696
313 Beverages	5419	3554	6072
314 Tobacco products	1814	1479	1885
321 Textiles	5419	3917	6636
322 Wearing apparel	3395	2633	4235
323 Leather and fur products	558	363	522
324 Footwear	1093	752	1150
331 Wood and wood products	2349	1556	3281 /e
332 Furniture and fixtures	2558	2101	3960 /e
341 Paper and paper products	4860	3800	7434
342 Printing and publishing	9814	8807	17726
351 Industrial chemicals	8233	7328	14403 /e
352 Other chemical products	7512	6641	13410 /e
353 Petroleum refineries	4512	1712	2707
354 Miscellaneous petroleum and coal products	721	428	746 /e
355 Rubber products	2349	1505	2757 /e
356 Plastic products	3898	3087	6891 /e
361 Pottery, china and earthenware	977	765	1396
362 Glass and glass products	1442	960	2046
369 Other non-metal mineral products	5698	4215	8845
371 Iron and steel	5860	4345	8431
372 Non-ferrous metals	2581	1505	2978
381 Metal products	10140	7211	12381
382 Non-electrical machinery	21320	15110	27198
383 Electrical machinery	15209	12399	22600
384 Transport equipment	17512	12944	25339
385 Professional and scientific equipment	2209	1803	3323
390 Other manufacturing industries	1791	1310	2501 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

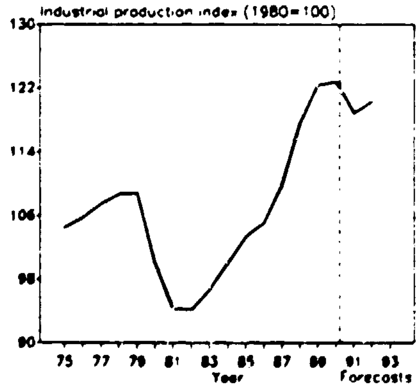
GDP per capita (1000$)/c

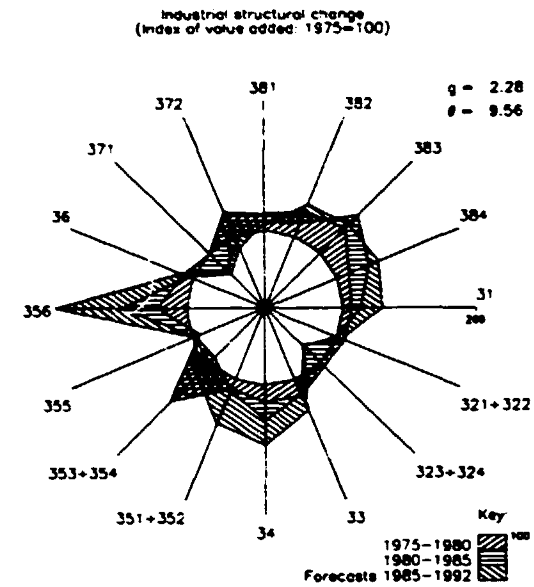


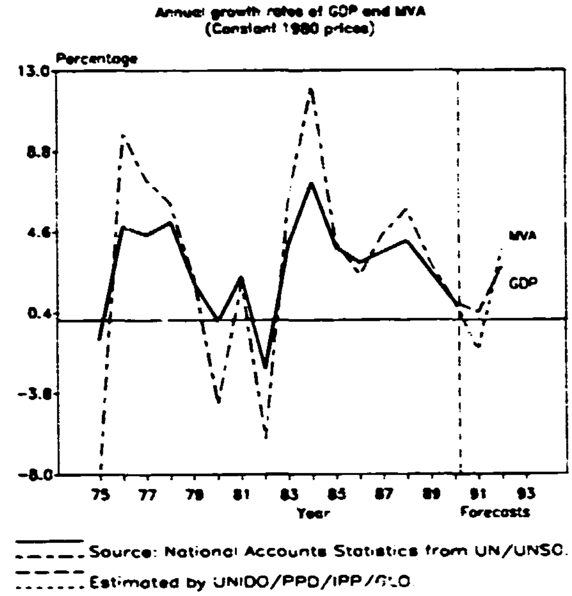
Manufacturing share in GDP current (%)



Industrial production index (1980=100)

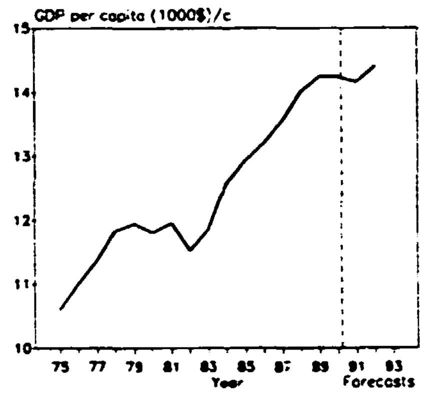


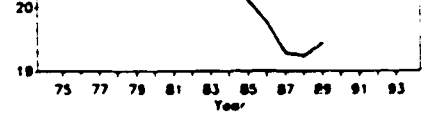


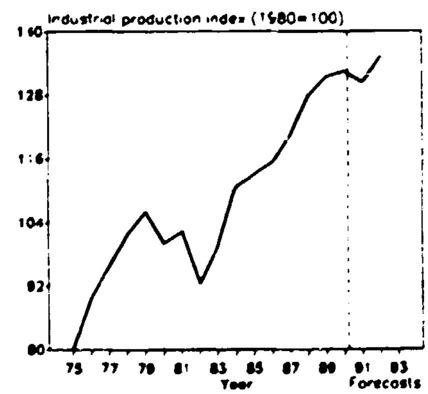


	1980	1985	1989
GDP./na.c (millions of 1980-dollars)	2688470	3095560	3522430
Per capita (1980-dollars) na.c	11804	12937	14242
Manufacturing share (%) (na current prices)	21 8	20.1	19.4 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	586438	694514	808640
Industrial production index	100	113	131
Value added (millions of dollars)	769899	996380	1345892
Gross output (millions of dollars)	1857092	2267000	2874815
Employment (thousands)	19210	17422	17820
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	56	53
Wages and salaries (%)	17	17	16 /e
Operating surplus (%)	24	27	30 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	96673	130123	161325
Value added / worker	40078	57191	75527
Average wage	16406	22583	26356 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2 90	3 35	3 14
as a percentage of average θ in 1970-1975	79	91	85
MVA growth rate / θ	1 45	0 10	0 96
Degree of specialization	11 9	13 5	12.4
-VALUE ADDED: (millions of dollars)			
311 Food products	63460	87960	116264
313 Beverages	11810	16160	22154
314 Tobacco products	6160	11890	[illegible]
321 Textiles	23030	26910	36379
322 Wearing apparel	19780	22150	27371
323 Leather and fur products	1850	1570	2483
324 Footwear	2950	2470	2414
331 Wood and wood products	12970	15390	21758 /e
332 Furniture and fixtures	9840	13250	17382 /e
341 Paper and paper products	29790	40390	58011
342 Printing and publishing	44390	73050	92665
351 Industrial chemicals	38920	43360	73209 /e
352 Other chemical products	35530	54280	77988 /e
353 Petroleum refineries	23010	13890	21759
354 Miscellaneous petroleum and coal products	2670	3450	5134 /e
355 Rubber products	8030	10970	13365 /e
356 Plastic products	14540	24740	37445 /e
361 Pottery, china and earthenware	1210	1300	1813 /e
362 Glass and glass products	6470	7660	10876 /e
369 Other non-metal mineral products	16300	19880	25507 /e
371 Iron and steel	30780	24070	33832
372 Non-ferrous metals	14340	11440	20064
381 Metal products	53180	51810	73822
382 Non-electrical machinery	102760	115550	159978
383 Electrical machinery	74850	111220	115619
384 Transport equipment	81280	128230	161828
385 Professional and scientific equipment	27940	40280	80399
390 Other manufacturing industries	12060	13060	18655 /e

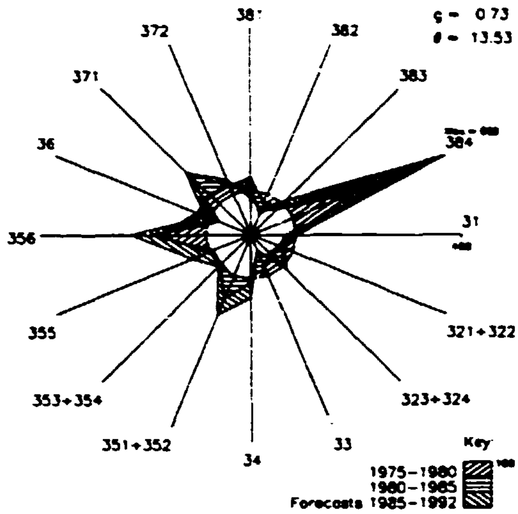
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex



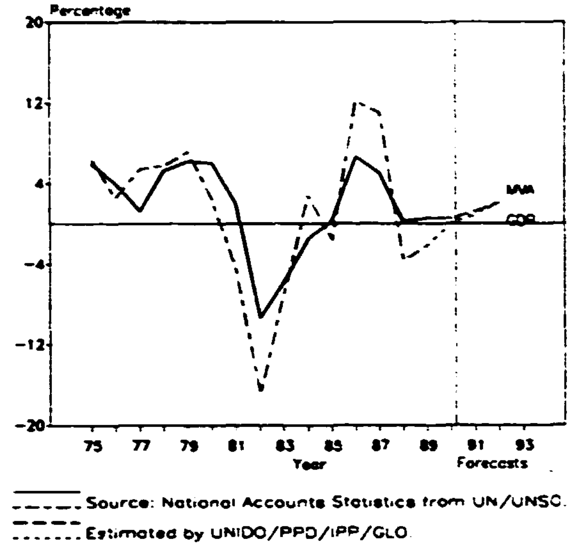




Industrial structural change
(Index of value added: 1975=100)



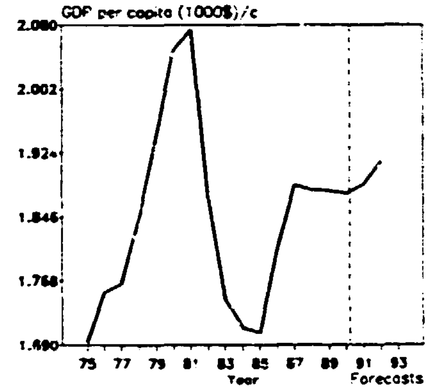
Annual growth rates of GDP and MVA
(Constant 1980 prices)



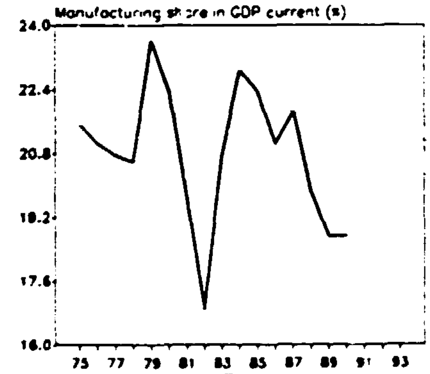
	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	5970	5129	5778
Per capita (1980-dollars) /na.c	2049	1705	1878
Manufacturing share (%) /na (current prices)	22.3	22.4	18.7
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1334	995	1167
Industrial production index	100	74	89
Value added (millions of dollars)	1286	1344	2106 /e
Gross output (millions of dollars)	3302	3189	4761 /e
Employment (thousands)	150 /e	123	124 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	58	56 /e
Wages and salaries (%)	13 /e	9	11 /e
Operating surplus (%)	26 /e	33	33 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	20615 /e	26012	38479 /e
Value added / worker	8028 /e	10965	17018 /e
Average wage	2635 /e	2448	4263 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.10	14.61	5.95 /e
as a percentage of average θ in 1970-1975	116	139	57 /e
MVA growth rate / θ	-0.08	0.14	0.67
Degree of specialization	13.9	18.7	16.2
-VALUE ADDED: (millions of dollars)			
311 Food products	165	266	379 /e
313 Beverages	104	92	163 /e
314 Tobacco products	90	68	101 /e
321 Textiles	109	137	203 /e
322 Wearing apparel	59	43	67 /e
323 Leather and fur products	31	75	100 /e
324 Footwear	18	8	19 /e
331 Wood and wood products	14 /e	8	11 /e
332 Furniture and fixtures	7 /e	2	4 /e
341 Paper and paper products	30	47	75 /e
342 Printing and publishing	37	27	43 /e
351 Industrial chemicals	20	26	41 /e
352 Other chemical products	75	112	173 /e
353 Petroleum refineries	192	194	239 /e
354 Miscellaneous petroleum and coal products	2	4	5 /e
355 Rubber products	40	34	65 /e
356 Plastic products	24	25	42 /e
361 Pottery, china and earthenware	13	7	17 /e
362 Glass and glass products	14	7	28 /e
369 Other non-metal mineral products	41	24	34 /e
371 Iron and steel	10	14	18 /e
372 Non-ferrous metals	3	3	4 /e
381 Metal products	53 /e	32	61 /e
382 Non-electrical machinery	16 /e	12	15 /e
383 Electrical machinery	33	31	59 /e
384 Transport equipment	78	38	131 /e
385 Professional and scientific equipment	1	1	2 /e
390 Other manufacturing industries	8	6	7 /e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex.

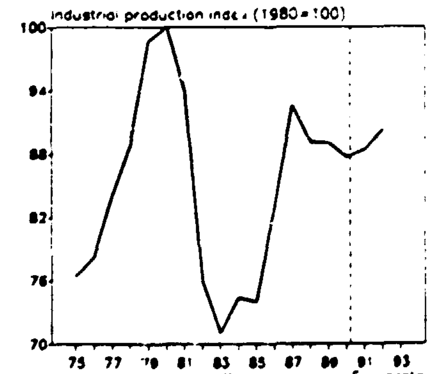
GDP per capita (1000$)/c



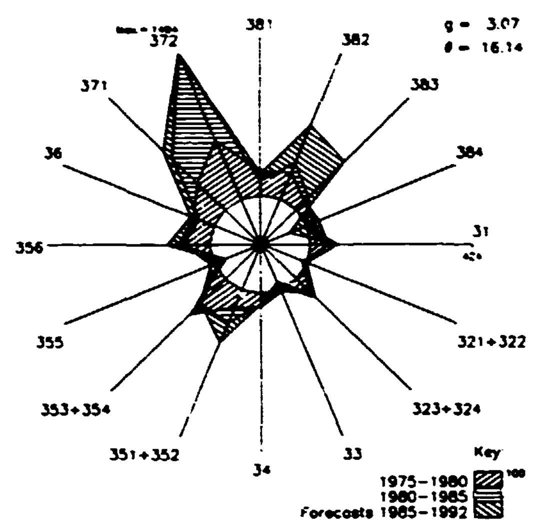
Manufacturing share in GDP current (%)



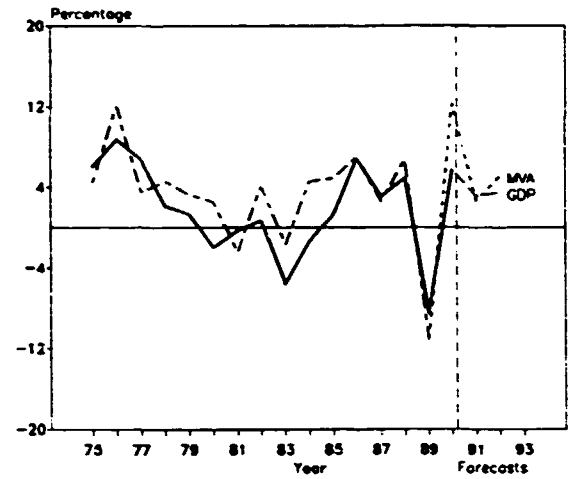
Industrial production index (1980=100)



Industrial structural change
(index of value added 1975=100)



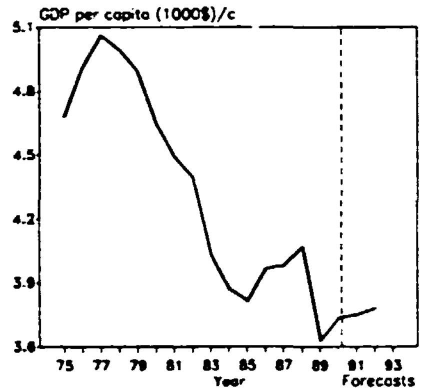
Annual growth rates of GDP and MVA
(Constant 1980 prices)

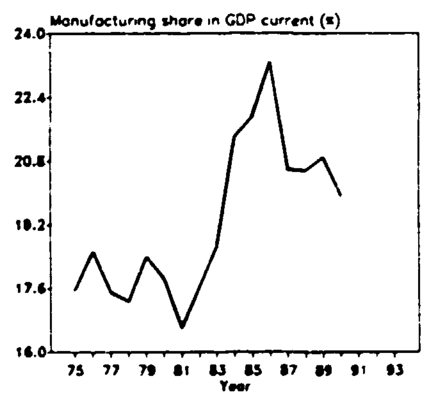


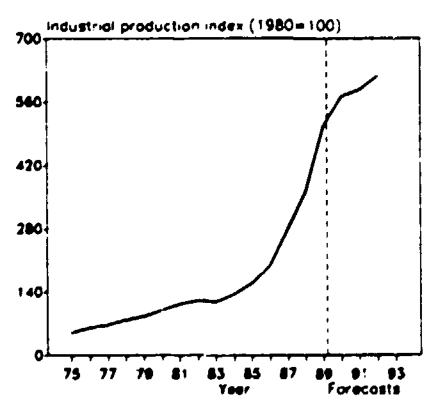
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	69769	66043	59778
Per capita (1980-dollars) /na,c	4644	3814	3626
Manufacturing share (%) /na (current prices)	17.8	21.9	20.9
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	11307	12373	12868
Industrial production index	100	159	506
Value added (millions of dollars)	14172	14071	9965
Gross output (millions of dollars)	29407	30305	21843
Employment (thousands)	477	426	469
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	52	54	54
Wages and salaries (%)	13	12	9
Operating surplus (%)	35	35	36
-PRODUCTIVITY: (dollars)			
Gross output / worker	61640	71155	46614
Value added / worker	29705	33038	21265
Average wage	7932	8436	4382
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.50	10.25	14.17
as a percentage of average θ in 1970-1975	74	101	139
MVA growth rate / θ	1.18	0.07	-0.01
Degree of specialization	20.6	17.3	17.6
-VALUE ADDED: (millions of dollars)			
311 Food products	1410	1597	1052
313 Beverages	992	836	551
314 Tobacco products	331	597	310
321 Textiles	483	505	346
322 Wearing apparel	330	359	178
323 Leather and fur products	55	58	34
324 Footwear	147	158	86
331 Wood and wood products	88	80	50
332 Furniture and fixtures	167	142	72
341 Paper and paper products	355	357	254
342 Printing and publishing	364	299	213
351 Industrial chemicals	275	498	418
352 Other chemical products	881	890	607
353 Petroleum refineries	4417	3634	2563
354 Miscellaneous petroleum and coal products	24	30	17
355 Rubber products	141	188	101
356 Plastic products	379	348	240
361 Pottery, china and earthenware	44	39	28
362 Glass and glass products	136	132	96
369 Other non-metal mineral products	441	378	272
371 Iron and steel	632	855	557
372 Non-ferrous metals	198	447	730
381 Metal products	601	503	378
382 Non-electrical machinery	217	241	219
383 Electrical machinery	291	307	314
384 Transport equipment	652	486	190
385 Professional and scientific equipment	34	26	32
390 Other manufacturing industries	88	81	56

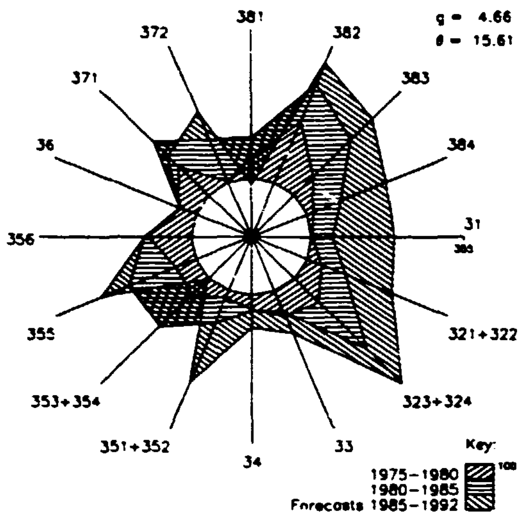
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



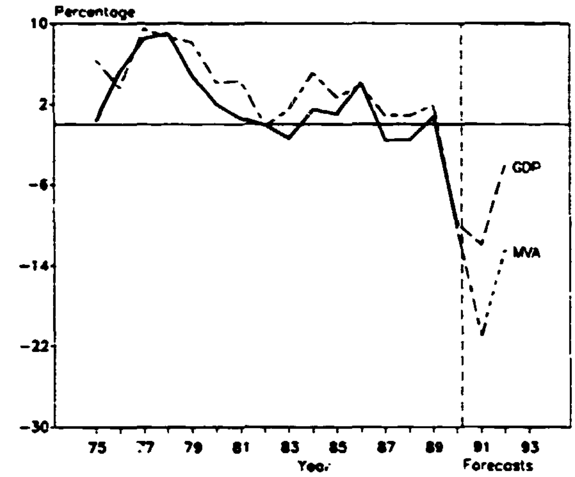




Industrial structural change
(index of value added: 1975=100)



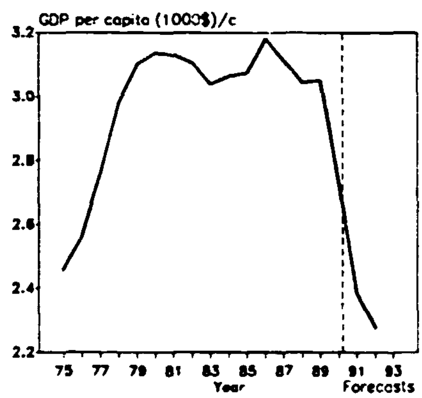
Annual growth rates of GDP and MVA
(Constant 1980 prices)

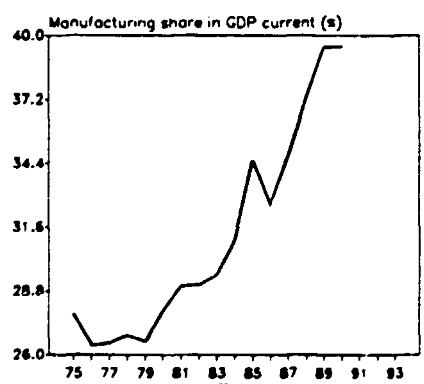


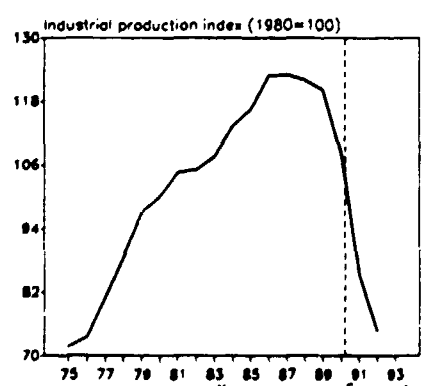
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	69958	71058	72234
Per capita (1980-dollars) /na,c	3136	3073	3050
Manufacturing share (%) /na (current prices)	27.9	34.5	39.5
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	19526	22283	24021
Industrial production index	100	116	120
Value added (millions of dollars)	21750	17171	30245
Gross output (millions of dollars)	72629	57020	65078
Employment (thousands)	2106	2467	2658
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	70	70	54
Wages and salaries (%)	10	9	12 /e
Operating surplus (%)	20	21	3. /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	34486	23113	24484
Value added / worker	10328	6960	11379
Average wage	3546	2024	2986 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.08	4.66	6.61
as a percentage of average θ in 1970-1975	75	69	97
MVA growth rate / θ	1.13	1.20	1.16
Degree of specialization	8.8	9.0	10.4
-VALUE ADDED:(millions of dollars)			
311 Food products	1897	1458	3916
313 Beverages	458	353	663
314 Tobacco products	184	221	344
321 Textiles	1759	1428	2881
322 Wearing apparel	903	718	1593
323 Leather and fur products	226	231	383
324 Footwear	482	503	1022
331 Wood and wood products	977	530	794
332 Furniture and fixtures	730	438	1030
341 Paper and paper products	529	394	759
342 Printing and publishing	876	462	761
351 Industrial chemicals	694	631	1107
352 Other chemical products	681	525	1419
353 Petroleum refineries	454	415	260
354 Miscellaneous petroleum and coal products	101	101	104
355 Rubber products	276	269	479
356 Plastic products	413	258	397
361 Pottery, china and earthenware	128	72	162
362 Glass and glass products	163	113	224
369 Other non-metal mineral products	906	513	683
371 Iron and steel	1221	1000	1343
372 Non-ferrous metals	480	509	944
381 Metal products	2105	1577	1293
382 Non-electrical machinery	1828	1463	2372
383 Electrical machinery	1600	1544	2640
384 Transport equipment	1441	1263	2389
385 Professional and scientific equipment	101	93	154
390 Other manufacturing industries	134	88	128

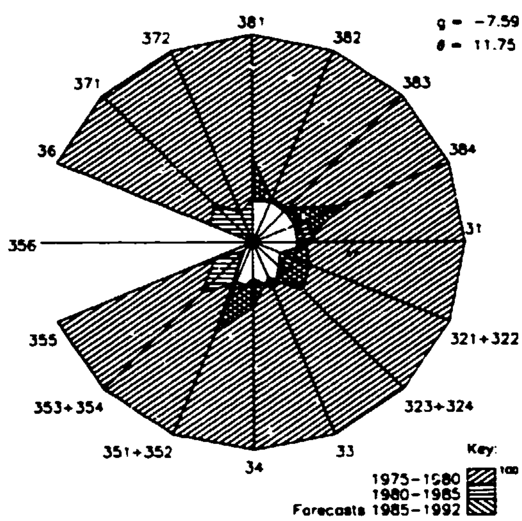
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



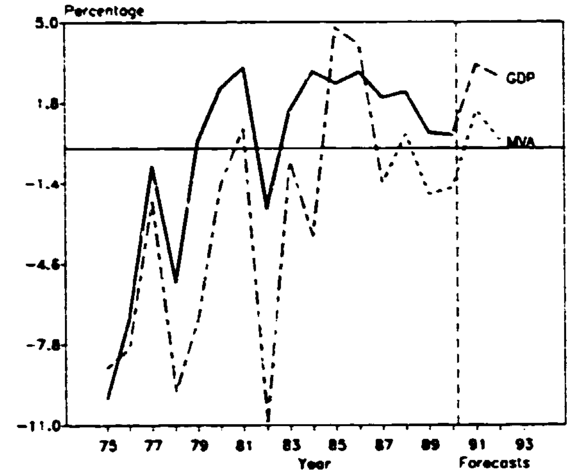




Industrial structural change
(Index of value added: 1975=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

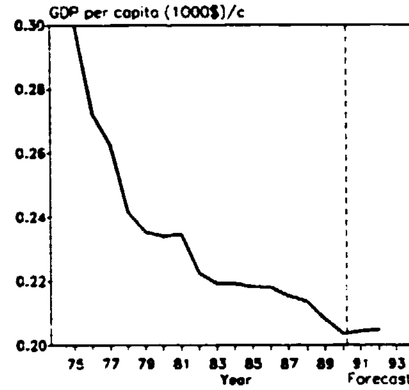


Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

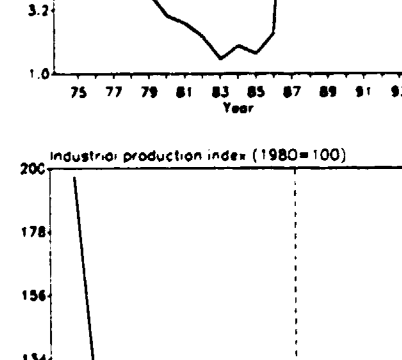
	1980	1985	1989
GDP: /na,c (millions of 1980-dollars)	6137	6630	7164
Per capita (1980-dollars) /na,c	234	218	208
Manufacturing share (%) /na (current prices)	3.0	1.7	11.4 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	184	166	169 /e
Industrial production index	100	118	119 /e
Value added (millions of dollars)	170	63 /e	93 /e
Gross output (millions of dollars)	...	...	...
Employment (thousands)	44 /e	35 /e	31 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	...		...
Wages and salaries (%)	...	...	...
Operating surplus (%)	...	...	
-PRODUCTIVITY: (dollars)			
Gross output / worker	...		...
Value added / worker	3677 /e	1794 /e	2956 /e
Average wage	6310 /e	2738 /e	3947 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.94 /e	15.01 /e	7.18 /e
as a percentage of average θ in 1970-1975	81 /e	246 /e	118 /e
MVA growth rate / θ	-4.91	0.13	0.73
Degree of specialization	19.1	22.4	19.5
-VALUE ADDED: (millions of dollars)			
311 Food products	20	7 /e	11 /e
313 Beverages	35	18 /e	19 /e
314 Tobacco products	9	7 /e	11 /e
321 Textiles	10	3 /e	5 /e
322 Wearing apparel	7	1 /e	2 /e
323 Leather and fur products	-	- /e	1 /e
324 Footwear	8	2 /e	4 /e
331 Wood and wood products	4	2 /e	1 /e
332 Furniture and fixtures	1	- /e	1 /e
341 Paper and paper products	-	- /e	- /e
342 Printing and publishing	2	1 /e	1 /e
351 Industrial chemicals	12	6 /e	12 /e
352 Other chemical products	-	- /e	- /e
353 Petroleum refineries	14	1 /e	1 /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	-	- /e	- /e
356 Plastic products	-	- /e	- /e
361 Pottery, china and earthenware	-	- /e	- /e
362 Glass and gl... products	1	- /e	- /e
369 Other non-metal mineral products	4	2 /e	1 /e
371 Iron and steel	4		
372 Non-ferrous metals	2		
381 Metal products	5	2 /e	3 /e
382 Non-electrical machinery	5	2 /e	3 /e
383 Electrical machinery	3	1 /e	1 /e
384 Transport equipment	5	2 /e	5 /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	15	6 /e	9 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

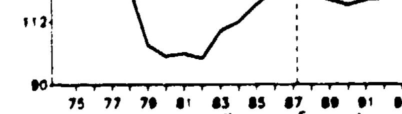
GDP per capita (1000$)/c



Manufacturing share in GDP current (%)

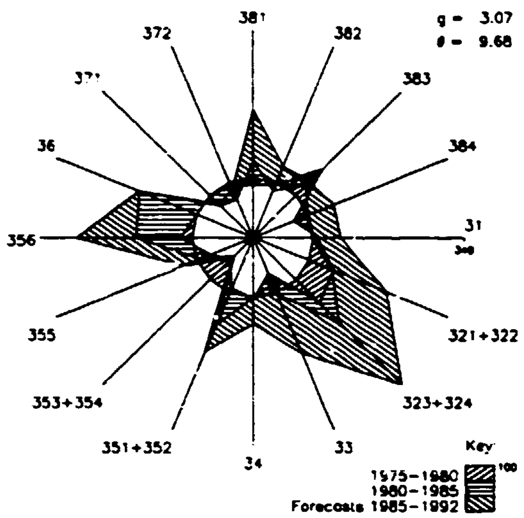


Industrial production index (1980=100)

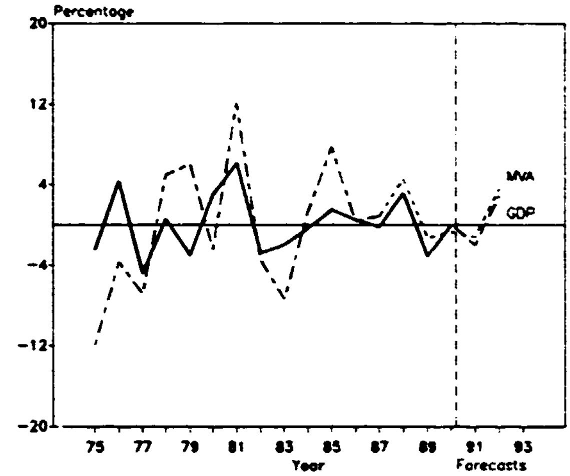


ZAMBIA

Industrial structural change
(Index of value added: 1975=100)



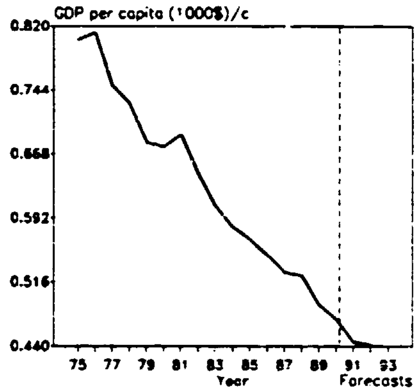
Annual growth rates of GDP and MVA
(Constant 1980 prices)

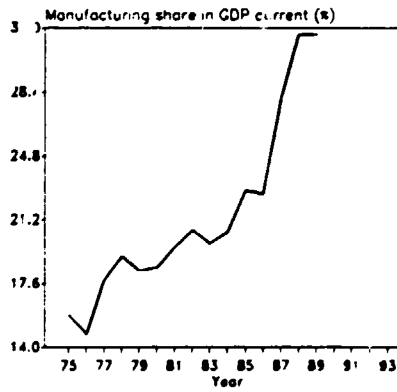


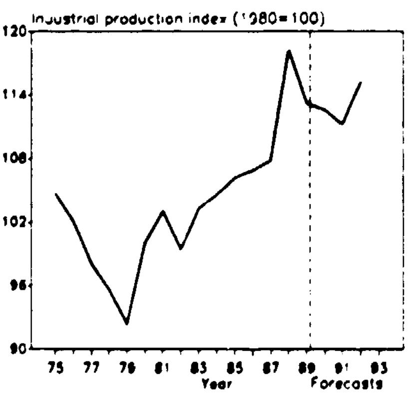
Source: National Accounts Statistics from UN/UNSO.
Estimated by UNIDO/PPD/IPP/GLO.

	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	3883	3972	3981
Per capita (1980-dollars) /na.c	677	567	489
Manufacturing share (%) /na (current prices)	18.5	22.9	31.6 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	717	785	821 /e
Industrial production index	100	106	113
Value added (millions of dollars)	780	575	1133
Gross output (millions of dollars)	1671	1378	2668
Employment (thousands)	59	62	61
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	53	58	58
Wages and salaries (%)	11	11	11
Operating surplus (%)	35	30	31
-PRODUCTIVITY: (dollars)			
Gross output / worker	28286	22254	43950
Value added / worker	13199	9280	18661
Average wage	3245	2542	4980
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.91 /e	5.05	5.71
as a percentage of average θ in 1970-1975	46 /e	80	91
MVA growth rate / θ	0.15	0.52	1.46
Degree of specialization	17.9	15.4	17.2
-VALUE ADDED: (millions of dollars)			
311 Food products	92	62	100
313 Beverages	193	104	243
314 Tobacco products	58	39	111
321 Textiles	51	32	69
322 Wearing apparel	34	23	47
323 Leather and fur products	4	3	6
324 Footwear	15	13	28
331 Wood and wood products	8	11	29
332 Furniture and fixtures	12	10	24
341 Paper and paper products	15	8	13
342 Printing and publishing	17	13	24
351 Industrial chemicals	22	26	43
352 Other chemical products	47	51	84
353 Petroleum refineries	9	5	7
354 Miscellaneous petroleum and coal products	3	2	3
355 Rubber products	20	16	27
356 Plastic products	7	7	13
361 Pottery, china and earthenware	1	1	1
362 Glass and glass products	3	3	4
369 Other non-metal mineral products	33	45	60
371 Iron and steel	10	5	8
372 Non-ferrous metals	2	1	1
381 Metal products	50	47	39
382 Non-electrical machinery	18	11	20
383 Electrical machinery	26	13	21
384 Transport equipment	28	24	45
385 Professional and scientific equipment	-	-	-
390 Other manufacturing industries	2	1	1

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

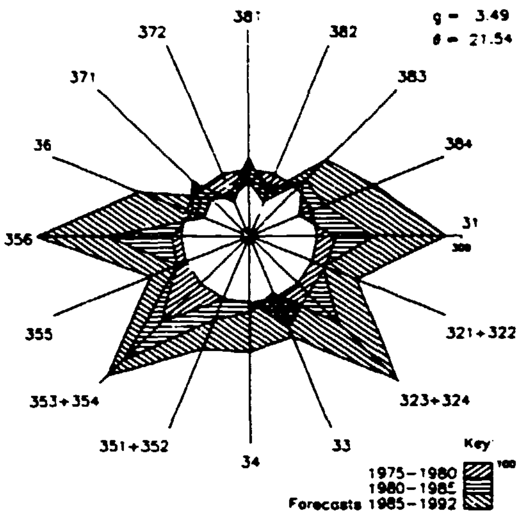




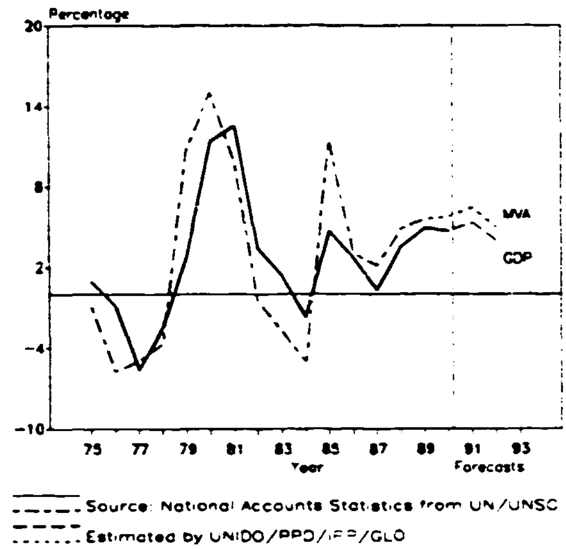


ZIMBABWE

Industrial structural change
(index of value added: 1975=100)

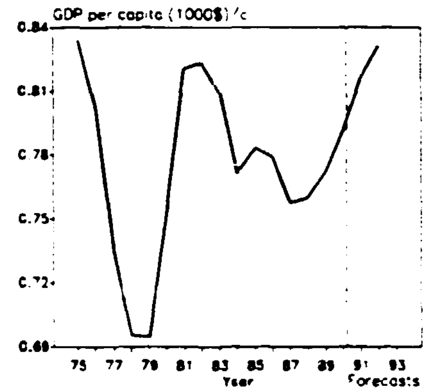


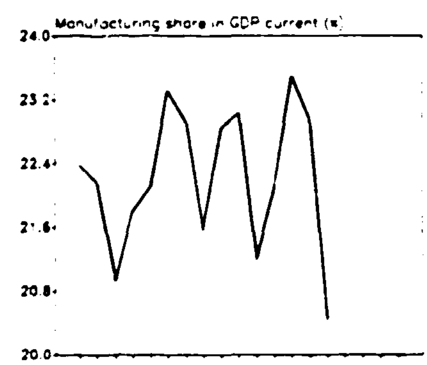
Annual growth rates of GDP and MVA
(Constant 1980 prices)

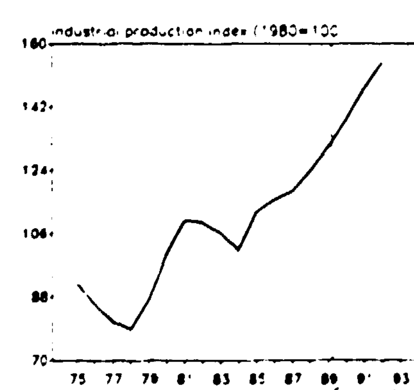


	1980	1985	1989
GDP: /na.c (millions of 1980-dollars)	5351	6495	7264
Per capita (1980-dollars) /na.c	751	783	772
Manufacturing share (%. /na (current prices)	23.3	21.2	20.4 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1247	1403	1634
Industrial production index	100	112	131
Value added (millions of dollars)	1480	1278	1567 /e
Gross output (millions of dollars)	3579	3020	4543 /e
Employment (thousands)	161	163	186 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	58	59 /e
Wages and salaries (%)	17	18	15 /e
Operating surplus (%)	24	25	25 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	22265	18472	24481 /e
Value added / worker	9205	7818	10062 /e
Average wage	3848	3241	3751 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.17	12.05	6.71 /e
as a percentage of average θ in 1970-1975	136	266	148 /e
MVA growth rate / θ	0.49	0.14	0.63
Degree of specialization	13.4	13.3	13.2
-VALUE ADDED: (millions of dollars)			
311 Food products	193	130	217 /e
313 Beverages	92	189	281 /e
314 Tobacco products	55	72	108 /e
321 Textiles	147	114	152 /e
322 Wearing apparel	70	55	86 /e
323 Leather and fur products	4	4	8 /e
324 Footwear	34	42	64 /e
331 Wood and wood products	38	17	33 /e
332 Furniture and fixtures	26	15	23 /e
341 Paper and paper products	30	37	58 /e
342 Printing and publishing	59	45	66 /e
351 Industrial chemicals	58	67	70 /e
352 Other chemical products	80	78	121 /e
353 Petroleum refineries	-	1	1 /e
354 Miscellaneous petroleum and coal products	7	8	9 /e
355 Rubber products	30	24	35 /e
356 Plastic products	25	37	56 /e
361 Pottery, china and earthenware	3	2	3 /e
362 Glass and glass products	9	5	7 /e
369 Other non-metal mineral products	44	28	71 /e
371 Iron and steel	194	105	110 /e
372 Non-ferrous metals	10	9	10 /e
381 Metal products	132	78	113 /e
382 Non-electrical machinery	39	22	27 /e
383 Electrical machinery	44	36	50 /e
384 Transport equipment	38	48	73 /e
385 Professional and scientific equipment	2	1	2 /e
390 Other manufacturing industries	17	9	13 /e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex







AFGHANISTAN	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	3852	4450	4732 /e	4783 /e	4964 /e
Growth rate (%) /na.c	-3.72	3.53	2.52 /e	1.06 /e	3.80 /e
Per capita (in 1980-dollars) /na.c	239.8	306.5	313.6 /e	304.6 /e	308.4 /e
MVA: /na.c (in million 1980-dollars)	272	258	279 /e	283 /e	291 /e
Growth rate (%) /na.c	-6.06	0.63	2.26 /e	1.22 /e	2.82 /e
Manufacturing share (%) /na.current prices	...	...	...	...	...

ALBANIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	2373	2711	3164 /e	3132 /e	3217 /e
Growth rate (%) /na.c	6.29	1.48	7.17 /e	-1.00 /e	2.70 /e
Per capita (in 1980-dollars) /na.c	888.1	914.9	1009.5 /e	981.9 /e	987.7 /e
MVA: /na.c (in million 1980-dollars)	912	1111	1351 /e	1410 /e	1436 /e
Growth rate (%) /na.c	6.08	1.57	6.09 /e	4.40 /e	1.85 /e
Manufacturing share (%) /na.current prices	...	...	...	...	...

BAHAMAS	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1323	1778	1639	1704	1738
Growth rate (%) /na.c	-3.56	0.69	2.00	4.00	2.00
Per capita (in 1980-dollars) /na.c	6269.2	7632.1	6689.1	6817.5	6844.4 /e
MVA: /na.c (in million 1980-dollars)	...	...	...	...	...
Growth rate (%) /na.c	...	...	...	...	...
Manufacturing share (%) /na.current prices	...	...	...	...	...

BARBADOS	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	861	827	1003	1033	1002
Growth rate (%) /na.c	3.53	0.68	3.00	3.00	-3.00
Per capita (in 1980-dollars) /na.c	3442.1	3267.8	3932.6	4050.5	3929.0 /e
MVA: /na.c (in million 1980-dollars)	91	79	82	87	83
Growth rate (%) /na.c	2.16	-9.51	6.70	5.44	-5.05
Manufacturing share (%) /na.current prices	10.6	9.6	7.7	6.9	...

BELIZE	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	171	183	214	231	238 /e
Growth rate (%) /na.c	4.39	2.25	7.60	8.00	3.20 /e
Per capita (in 1980-dollars) /na.c	1172.6	1093.2	1193.6	1254.0	1301.2 /e
MVA: /na.c (in million 1980-dollars)	22	21	23 /e	25 /e	26 /e
Growth rate (%) /na.c	14.91	-1.09	5.01 /e	6.21 /e	4.44 /e
Manufacturing share (%) /na.current prices	14.6	9.7	10.3 /e	10.6 /e	...

BENIN	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1163	1206	1330	1348	1376
Growth rate (%) /na.c	10.16	-2.90	1.80	1.30	2.10
Per capita (in 1980-dollars) /na.c	336.1	302.7	305.3	300.1	297.1 /e
MVA: /na.c (in million 1980-dollars)	78	89	109 /e	111 /e	114 /e
Growth rate (%) /na.c	7.43	-3.55	1.94 /e	2.05 /e	2.75 /e
Manufacturing share (%) /na.current prices	4.5	4.2	5.7 /e	...	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

BERMUDA	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	624	606	606	615	623 /e
Growth rate (%) /na,c	4.95	-2.31	1.30	1.50	1.30 /e
Per capita (in 1980-dollars) /na,c	11350.9	10530.8	10443.1	10599.7	10737.5 /e
MVA: /na,c (in million 1980-dollars)	84	82	91 /e	94 /e	96 /e
Growth rate (%) /na,c	4.43	2.97	2.57 /e	2.75 /e	2.80 /e
Manufacturing share (%) /na,current prices					

BHUTAN	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	142	196	263	280 /e	299 /e
Growth rate (%) /na,c	17.63	3.69	3.30	6.21 /e	7.00 /e
Per capita (in 1980-dollars) /na,c	113.6	144.1	181.6	188.7 /e	198.1 /e
MVA: /na,c (in million 1980-dollars)	5	10	15 /e	17 /e	18 /e
Growth rate (%) /na,c	-9.05	12.20	11.57 /e	11.58 /e	10.39 /e
Manufacturing share (%) /na,current prices	3.2	5.4	5.7		

BOTSWANA	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	1017	1820	2247	2551	2592
Growth rate (%) /na,c	8.72	13.96	8.98	13.54	1.60
Per capita (in 1980-dollars) /na,c	1127.5	1679.1	1853.7	2027.7	1982.7 /e
MVA: /na,c (in million 1980-dollars)	63	78			
Growth rate (%) /na,c	26.71	26.82			
Manufacturing share (%) /na,current prices	4.1	5.3	4.8		

BRUNEI DARUSSALAM	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	4848	4115	3729	3823	3952 /e
Growth rate (%) /na,c	-7.00	0.73	2.20	2.50	3.39 /e
Per capita (in 1980-dollars) /na,c	26063.3	18287.7	14917.9	14816.7	15318.7 /e
MVA: /na,c (in million 1980-dollars)	573	321	258 /e	259 /e	262 /e
Growth rate (%) /na,c	-8.35	-8.40	0.36 /e	0.27 /e	1.21 /e
Manufacturing share (%) /na,current prices	11.8	10.1	9.3		

CAPE VERDE	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	104	151	187	197	206
Growth rate (%) /na,c	3.32	8.28	7.67	5.50	4.50
Per capita (in 1980-dollars) /na,c	359.5	467.2	534.1	549.3	560.6 /e
MVA: /na,c (in million 1980-dollars)	6	8			
Growth rate (%) /na,c	7.16	6.38			
Manufacturing share (%) /na,current prices	5.1	6.1	5.6		

CHAD	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	1005	804	964	1005	1036
Growth rate (%) /na,c	-7.40	6.86	11.90	4.30	3.00
Per capita (in 1980-dollars) /na,c	224.5	160.2	178.5	181.6	182.4 /e
MVA: /na,c (in million 1980-dollars)	92	69	81 /e	85 /e	87 /e
Growth rate (%) /na,c	-12.00	5.39	11.38 /e	4.15 /e	2.91 /e
Manufacturing share (%) /na,current prices	10.7	13.8	9.7 /e		

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

CHINA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	286716	459012	606663	630323	661839
Growth rate (%) /na.c	6.44	13.13	10.80	3.90	5.00
Per capita (in 1980-dollars) /na.c	293.0	441.2	559.6	571.8	592.1 /e
MVA: /na.c (in million 1980-dollars)					
Growth rate (%) /na.c					
Manufacturing share (%) /na.current prices	48.9	44.9	46.2		

COMOROS	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	139	170	182	181	184
Growth rate (%) /na.c	7.27	2.71	0.70	-0.40	1.50
Per capita (in 1980-dollars) /na.c	353.5	367.5	354.5	340.5	354.2 /e
MVA: /na.c (in million 1980-dollars)	5	6	7 /e	7 /e	7 /e
Growth rate (%) /na.c	5.78	3.52	2.87 /e	0.09 /e	0.61 /e
Manufacturing share (%) /na.current prices	3.6	3.9	3.8 /e		

DJIBOUTI	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	339	362	379	376	380
Growth rate (%) /na.c	4.72	0.60	0.90	-0.80	1.10
Per capita (in 1980-dollars) /na.c	1116.3	1020.3	981.3	944.1	917.2 /e
MVA: /na.c (in million 1980-dollars)	34	36	17 /e	16 /e	15 /e
Growth rate (%) /na.c	2.98	0.92	-17.12 /e	-8.66 /e	-5.24 /e
Manufacturing share (%) /na.current prices	8.4	8.3	8.1 /e		

EQUATORIAL GUINEA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	55	63	71	74	77
Growth rate (%) /na.c	-9.14	7.31	3.70	4.10	3.90
Per capita (in 1980-dollars) /na.c	253.7	200.5	209.2	214.6	174.1 /e
MVA: /na.c (in million 1980-dollars)	3	3	4 /e	4 /e	4 /e
Growth rate (%) /na.c	-9.24	4.19	4.60 /e	5.53 /e	4.60 /e
Manufacturing share (%) /na.current prices	0.9	1.5	1.9 /e	...	

FRENCH GUIANA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	183	189	179 /e	177 /e	175 /e
Growth rate (%) /na.c	0.00	-0.35	-4.41 /e	-1.40 /e	-0.80 /e
Per capita (in 1980-dollars) /na.c	2649.6	2280.0	1949.0 /e	1861.1 /e	1808.1 /e
MVA: /na.c (in million 1980-dollars)	11	11	12 /e	12 /e	12 /e
Growth rate (%) /na.c	4.43	2.98	3.22 /e	2.52 /e	2.77 /e
Manufacturing share (%) /na.current prices	...	...	...		

FRENCH POLYNESIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1265	1774	2187 /e	2311 /e	2488 /e
Growth rate (%) /na.c	-2.93	5.35	6.17 /e	5.66 /e	7.66 /e
Per capita (in 1980-dollars) /na.c	8488.8	10078.1	11274.7 /e	11555.5 /e	13670.5 /e
MVA: /na.c (in million 1980-dollars)	83	128	164 /e	179 /e	196 /e
Growth rate (%) /na.c	1.78	-1.09	10.56 /e	9.08 /e	9.48 /e
Manufacturing share (%) /na.current prices	6.6	8.3	8.3 /e		

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

GAMBIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	239	242	284	298	314
Growth rate (%) /na.c	2.10	5.56	5.50	4.90	5.40
Per capita (in 1980-dollars) /na.c	373.6	324.7	348.5	355.6	365.1 /e
MVA: /na.c (in million 1980-dollars)	16	16	19 /e	19 /e	19 /e
Growth rate (%) /na.c	19.40	3.93	0.75 /e	0.84 /e	0.85 /e
Manufacturing share (%) /na.current prices	3.7	4.2	3.7		

GUADELOUPE	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1387	1412	1605 /e	1587 /e	1624 /e
Growth rate (%) /na.c	-4.66	-0.76	2.78 /e	-1.10 /e	2.29 /e
Per capita (in 1980-dollars) /na.c	4240.7	4226.4	4734.2 /e	4654.7 /e	4817.7 /e
MVA: /na.c (in million 1980-dollars)	85	82	94 /e	95 /e	96 /e
Growth rate (%) /na.c	4.44	2.97	4.69 /e	1.36 /e	1.16 /e
Manufacturing share (%) /na.current prices					

GUINEA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1595	1316	1447	1507	1567
Growth rate (%) /na.c	5.60	-10.58	5.20	4.10	4.00
Per capita (in 1980-dollars) /na.c	357.6	263.9	266.8	269.7	292.1 /e
MVA: /na.c (in million 1980-dollars)	51	40	40 /e	42 /e	43 /e
Growth rate (%) /na.c	2.70	-19.43	5.04 /e	3.84 /e	3.73 /e
Manufacturing share (%) /na.current prices	2.9	2.0	5.7 /e		

GUINEA-BISSAU	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	227	252	294	318	334
Growth rate (%) /na.c	-4.19	-2.30	6.00	8.00	5.00
Per capita (in 1980-dollars) /na.c	285.7	288.8	318.3	336.5	343.2 /e
MVA: /na.c (in million 1980-dollars)	4	4	3 /e	3 /e	3 /e
Growth rate (%) /na.c	-5.10	-5.95	0.67 /e	1.13 /e	0.94 /e
Manufacturing share (%) /na.current prices	1.6	1.6	6.8		

GUYANA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	591	494	438	429	402
Growth rate (%) /na.c	1.66	1.02	-3.00	-2.00	-6.23
Per capita (in 1980-dollars) /na.c	778.2	624.3	551.5	540.5	494.8 /e
MVA: /na.c (in million 1980-dollars)	64	45	39	34	32 /e
Growth rate (%) /na.c	0.76	-3.13	-5.19	-13.67	-6.76 /e
Manufacturing share (%) /na.current prices	10.7	11.6	11.0	13.5	

HAITI	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1437	1365	1378	1385	1384
Growth rate (%) /na.c	7.34	0.26	-0.20	0.50	-0.10
Per capita (in 1980-dollars) /na.c	267.5	231.8	220.4	217.0	213.6 /e
MVA: /na.c (in million 1980-dollars)	274	228	214	210	207 /e
Growth rate (%) /na.c	14.69	-2.87	-2.55	-2.10	-1.54 /e
Manufacturing share (%) /na.current prices	18.3	16.0	15.2		

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

KOREA, DEMOCRATIC PEOPLE'S REPUBLIC	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	12730	20368	23975 /e	25150 /e	26332 /e
Growth rate (%) /na.c	9.89	9.59	6.41 /e	4.90 /e	4.70 /e
Per capita (in 1980-dollars) /na.c	697.2	1024.1	1142.9 /e	1177.0 /e	1203.2 /e
MVA: /na.c (in million 1980-dollars)					
Growth rate (%) /na.c					
Manufacturing share (%) /na,current prices					

LAO PEOPLE'S DEMOCRATIC REPUBLIC	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	462	661	753	783	809 /e
Growth rate (%) /na.c	-1.35	9.33	2.00	4.00	3.30 /e
Per capita (in 1980-dollars) /na.c	144.1	183.8	192.8	194.8	199.1 /e
MVA: /na.c (in million 1980-dollars)	22	29	30 /e	31 /e	33 /e
Growth rate (%) /na.c	7.94	1.99	-1.12 /e	3.71 /e	6.89 /e
Manufacturing share (%) /na,current prices					

LESOTHO	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	382	400	476	495	526
Growth rate (%) /na.c	8.35	1.63	5.70	4.00	6.20
Per capita (in 1980-dollars) /na.c	285.2	259.9	284.4	287.3	292.9 /e
MVA: /na.c (in million 1980-dollars)	18	31			
Growth rate (%) /na.c	16.00	-1.23			
Manufacturing share (%) /na,current prices	5.6	9.1	11.5		

LIBERIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	917	843	792	795	779
Growth rate (%) /na.c	-6.29	-2.02	-1.00	0.40	-2.30
Per capita (in 1980-dollars) /na.c	488.3	383.4	327.7	318.9	284.7 /e
MVA: /na.c (in million 1980-dollars)	77	75	65 /e	66 /e	65 /e
Growth rate (%) /na.c	-21.21	-1.61	-0.81 /e	1.89 /e	-1.82 /e
Manufacturing share (%) /na,current prices	8.4	6.1	5.9 /e		

MALI	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1670	1708	1985	2182	2230
Growth rate (%) /na.c	4.01	-0.11	-0.80	9.90	2.20
Per capita (in 1980-dollars) /na.c	243.3	215.7	229.1	244.2	242.7 /e
MVA: /na.c (in million 1980-dollars)	73	108	113 /e	118 /e	121 /e
Growth rate (%) /na.c	1.58	-0.47	5.76 /e	4.69 /e	2.45 /e
Manufacturing share (%) /na,current prices	4.3	8.5	6.4 /e		

MARTINIQUE	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1444	1797	2027 /e	2058 /e	2128 /e
Growth rate (%) /na.c	2.80	4.50	0.58 /e	2.00 /e	2.92 /e
Per capita (in 1980-dollars) /na.c	4415.4	5413.0	6015.5 /e	6099.6 /e	6449.0 /e
MVA: /na.c (in million 1980-dollars)	72	70	78 /e	80 /e	83 /e
Growth rate (%) /na.c	4.44	2.97	3.01 /e	2.95 /e	2.90 /e
Manufacturing share (%) /na,current prices	5.0		6.0 /e		

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

MAURITANIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	829	874	943	976	1016
Growth rate (%) /na.c	3.93	3.11	2.60	3.60	4.00
Per capita (in 1980-dollars) /na.c	534.6	494.4	491.9	495.9	500.5 /e
MVA: /na.c (in million 1980-dollars)	43	66	82 /e	87 /e	93 /e
Growth rate (%) /na.c	-1.39	8.01	7.38 /e	6.33 /e	6.63 /e
Manufacturing share (%) /na.current prices	3.3	4.3	3.6	...	...

MONGOLIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1389	1911	2249 /e	2393 /e	2501 /e
Growth rate (%) /na.c	3.43	5.51	7.72 /e	6.39 /e	4.50 /e
Per capita (in 1980-dollars) /na.c	835.0	1000.8	1084.5 /e	1123.0 /e	1140.2 /e
MVA: /na.c (in million 1980-dollars)	347	512	560 /e	609 /e	650 /e
Growth rate (%) /na.c	8.03	3.13	6.56 /e	8.86 /e	6.71 /e
Manufacturing share (%) /na.current prices	...	...	...	...	...

MONTSERRAT	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	24	27	34 /e	35 /e	36 /e
Growth rate (%) /na.c	10.22	4.73	9.04 /e	2.10 /e	1.27 /e
Per capita (in 1980-dollars) /na.c	2018.5	2241.1	2647.7 /e	2703.3 /e	2737.6 /e
MVA: /na.c (in million 1980-dollars)	1	1	2 /e	2 /e	2 /e
Growth rate (%) /na.c	10.73	0.00	11.33 /e	7.82 /e	4.94 /e
Manufacturing share (%) /na.current prices	5.2	5.1	4.8 /e	...	...

MOZAMBIQUE	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	2414	1513	1733	1789	1846
Growth rate (%) /na.c	2.46	-7.22	5.60	3.20	3.20
Per capita (in 1980-dollars) /na.c	199.5	110.3	116.8	117.4	117.4 /e
MVA: /na.c (in million 1980-dollars)	762	336	403 /e	427 /e	452 /e
Growth rate (%) /na.c	3.25	-11.98	9.90 /e	5.88 /e	5.88 /e
Manufacturing share (%) /na.current prices	33.1	14.9	8.2 /e	...	...

MYANMAR	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	5851	7473	6829	7332	6892 /e
Growth rate (%) /na.c	7.94	3.20	-11.44	7.36	-6.00 /e
Per capita (in 1980-dollars) /na.c	173.0	199.1	170.9	179.6	165.4 /e
MVA: /na.c (in million 1980-dollars)	558	722	630 /e	675 /e	629 /e
Growth rate (%) /na.c	7.46	2.14	-12.41 /e	7.10 /e	-6.83 /e
Manufacturing share (%) /na.current prices	9.5	9.9	9.1	...	...

NAMIBIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	2007	1878	2026	2031	2037 /e
Growth rate (%) /na.c	-2.24	0.37	1.70	0.20	0.32 /e
Per capita (in 1980-dollars) /na.c	1535.7	1236.7	1212.7	1176.4	1086.4 /e
MVA: /na.c (in million 1980-dollars)	79	83			
Growth rate (%) /na.c	-14.65	-3.54	...		
Manufacturing share (%) /na.current prices	4.0	4.3	4.8 /e	...	...

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

NEPAL	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1946	2511	2867	2978	3085
Growth rate (%) /na.c	-2.32	7.86	7.25	3.86	3.59
Per capita (in 1980-dollars) /na.c	131.0	148.5	157.2	159.4	160.9 /e
MVA: /na.c (in million 1980-dollars)	78	101	107 /e	104 /e	110 /e
Growth rate (%) /na.c	-4.52	-9.86	4.10 /e	-2.48 /e	5.90 /e
Manufacturing share (%) /na.current prices	4.0	4.5	5.8		

NETHERLANDS ANTILLES AND ARUBA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1152	1103	1252 /e	1236 /e	1361 /e
Growth rate (%) /na.c	4.06	-2.07	9.43 /e	3.50 /e	5.00 /e
Per capita (in 1980-dollars) /na.c	6584.1	6062.3	6733.1 /e	6931.5 /e	6979.5 /e
MVA: /na.c (in million 1980-dollars)	89	86	96 /e	99 /e	101 /e
Growth rate (%) /na.c	4.43	2.97	2.30 /e	2.65 /e	2.64 /e
Manufacturing share (%) /na.current prices	...	...	...		

NEW CALEDONIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1182	1172	1223 /e	1227 /e	1240 /e
Growth rate (%) /na.c	-0.40	4.51	-0.33 /e	0.38 /e	1.00 /e
Per capita (in 1980-dollars) /na.c	8446.1	7663.3	7547.0 /e	7438.2 /e	7467.4 /e
MVA: /na.c (in million 1980-dollars)	68	71	77 /e	78 /e	78 /e
Growth rate (%) /na.c	2.02	3.92	3.36 /e	1.45 /e	-0.35 /e
Manufacturing share (%) /na.current prices	5.8	4.7	5.6 /e		

NIGER	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	2538	2473	2673	2580	2644
Growth rate (%) /na.c	4.90	5.70	7.50	-3.50	2.50
Per capita (in 1980-dollars) /na.c	454.3	374.1	368.1	344.4	372.4 /e
MVA: /na.c (in million 1980-dollars)	94	100	101 /e	103 /e	103 /e
Growth rate (%) /na.c	4.68	8.25	1.72 /e	2.02 /e	0.11 /e
Manufacturing share (%) /na.current prices	3.7	7.1	8.9 /e		

OMAN	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	5896	11343	12503	13853	14504
Growth rate (%) /na.c	12.15	8.89	5.70	10.80	4.70
Per capita (in 1980-dollars) /na.c	5991.6	9125.4	8962.6	9567.1	9826.7 /e
MVA: /na.c (in million 1980-dollars)	45	240	...	...	
Growth rate (%) /na.c	19.05	20.39	...	...	...
Manufacturing share (%) /na.current prices	0.8	2.4	4.2		

PAPUA NEW GUINEA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	2549	2807	3190	3235	3299 /e
Growth rate (%) /na.c	-2.29	4.62	3.13	1.39	2.00 /e
Per capita (in 1980-dollars) /na.c	825.9	811.0	861.6	853.9	851.4 /e
MVA: /na.c (in million 1980-dollars)	242	245	264 /e	268 /e	273 /e
Growth rate (%) /na.c	2.62	-7.23	3.15 /e	1.59 /e	2.04 /e
Manufacturing share (%) /na.current prices	10.4	10.9	10.0	...	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

PUERTO RICO	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	15823	17843	20134	20859	21339
Growth rate (%) /na.c	0.60	6.96	4.90	3.60	2.30
Per capita (in 1980-dollars) /na.c	4933.9	5436.8	5930.5	5065.4	6204.9 /e
MVA: /na.c (in million 1980-dollars)	5786	7659	9055 /e	9673 /e	10145 /e
Growth rate (%) /na.c	0.14	8.77	6.16 /e	6.78 /e	4.88 /e
Manufacturing share (%) /na,current prices	36.8	39.0	39.7	39.2	

QATAR	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	7836	6342	6745	7403	7823
Growth rate (%) /na.c	7.10	-3.91	0.09	9.76	5.66
Per capita (in 1980-dollars) /na.c	34077.6	21211.1	19779.9	20913.8	22350.0 /e
MVA: /na.c (in million 1980-dollars)	258	389	483 /e	528 /e	579 /e
Growth rate (%) /na.c	13.11	3.54	10.31 /e	9.51 /e	9.49 /e
Manufacturing share (%) /na,current prices	3.3	7.9	11.8		

REUNION	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1999	2455	2827 /e	2912 /e	3016 /e
Growth rate (%) /na.c	4.20	3.49	5.02 /e	3.00 /e	3.60 /e
Per capita (in 1980-dollars) /na.c	3927.7	4488.9	4890.8 /e	4943.4 /e	5151.1 /e
MVA: /na.c (in million 1980-dollars)	190	217	237 /e	242 /e	248 /e
Growth rate (%) /na.c	0.86	3.36	2.51 /e	2.36 /e	2.40 /e
Manufacturing share (%) /na,current prices	9.5	9.2	8.2 /e		

RWANDA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1163	1347	1334	1250	1261
Growth rate (%) /na.c	6.01	4.41	-3.20	-6.30	0.90
Per capita (in 1980-dollars) /na.c	225.2	220.7	197.4	178.7	174.6 /e
MVA: /na.c (in million 1980-dollars)	178	202			
Growth rate (%) /na.c	12.30	6.96			
Manufacturing share (%) /na,current prices	15.3	13.7	14.6		

SAMOA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	112	107	107	108	107 /e
Growth rate (%) /na.c	3.00	1.13	-1.90	1.00	-0.81 /e
Per capita (in 1980-dollars) /na.c	718.4	657.6	640.5	643.1	
MVA: /na.c (in million 1980-dollars)	16	18	17 /e	18 /e	18 /e
Growth rate (%) /na.c	0.97	4.54	-0.05 /e	1.62 /e	0.35 /e
Manufacturing share (%) /na,current prices	4.8				

SAO TOME AND PRINCIPE	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	47	33	41	43	45
Growth rate (%) /na.c	2.59	-5.01	5.20	5.90	4.60
Per capita (in 1980-dollars) /na.c	497.2	311.0	351.1	365.5	372.9 /e
MVA: /na.c (in million 1980-dollars)	4	3	4 /e	4 /e	4 /e
Growth rate (%) /na.c	0.00	-8.74	3.99 /e	4.50 /e	3.56 /e
Manufacturing share (%) /na,current prices	7.3	7.2	1.6		

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

SEYCHELLES	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	147	154	177	191	195
Growth rate (%) /na.c	-2.55	9.50	7.40	7.50	2.50
Per capita (in 1980-dollars) /na.c	2302.4	2336.7	2607.9	2767.8	
MVA: /na.c (in million 1980-dollars)	11	11	13 /e	14 /e	10 /e
Growth rate (%) /na.c	27.33	5.68	10.48 /e	10.52 /e	5.35 /e
Manufacturing share (%) /na.current prices	[illegible].4	9.7	10.4		

SIERRA LEONE	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	847	832	769	765	784
Growth rate (%) /na.c	6.19	-2.49	0.12	-0.60	2.50
Per capita (in 1980-dollars) /na.c	259.6	227.1	195.0	189.0	188.9 /e
MVA: /na.c (in million 1980-dollars)	61	52	42 /e	41 /e	42 /e
Growth rate (%) /na.c	7.44	-7.05	-1.92 /e	-2.75 /e	1.76 /e
Manufacturing share (%) /na.current prices	7.3	4.8	5.9		

SOMALIA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	2755	3400	3538	3782	3858 /e
Growth rate (%) /na.c	-2.25	9.53	-3.40	6.90	2.00 /e
Per capita (in 1980-dollars) /na.c	515.3	533.6	501.2	519.1	505.9 /e
MVA: /na.c (in million 1980-dollars)	123	103			
Growth rate (%) /na.c	9.17	7.55			
Manufacturing share (%) /na.current prices	4.5	4.7	5.1		

SUDAN	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	10172	10022	10277	11140	10360
Growth rate (%) /na.c	0.21	-1.71	-2.70	8.40	-7.00
Per capita (in 1980-dollars) /na.c	544.5	459.3	431.7	454.9	410.6 /e
MVA: /na.c (in million 1980-dollars)	789	839	846 /e	899 /e	857 /e
Growth rate (%) /na.c	12.50	4.03	-1.62 /e	6.34 /e	-4.71 /e
Manufacturing share (%) /na.current prices	8.1	8.0	8.4	7.9 /e	

SURINAME	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	898	886	828	844	853
Growth rate (%) /na.c	-7.72	1.07	0.50	2.00	1.00
Per capita (in 1980-dollars) /na.c	2542.9	2312.6	2038.3	2038.9	2129.2 /e
MVA: /na.c (in million 1980-dollars)	140	112	108	112	111 /e
Growth rate (%) /na.c	-10.52	6.45	14.78	3.83	-1.61 /e
Manufacturing share (%) /na.current prices	15.5	11.9	11.0 /e		

SWAZILAND	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	543	605	709	743	767
Growth rate (%) /na.c	3.28	2.04	9.00	4.80	3.20
Per capita (in 1980-dollars) /na.c	963.7	911.7	963.2	975.0	967.2 /e
MVA: /na.c (in million 1980-dollars)	119	138	162 /e	170 /e	178 /e
Growth rate (%) /na.c	11.17	-1.28	4.88 /e	5.04 /e	4.89 /e
Manufacturing share (%) /na.current prices	18.9	14.3	22.6		

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

TOGO	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	1131	1109	1217	1265	1298
Growth rate (%) /na.c	-4.53	7.04	4.70	4.00	2.60
Per capita (in 1980-dollars) /na.c	432.2	366.0	366.7	369.7	375.4 /e
MVA: /na.c (in million 1980-dollars)	79	74	80 /e	83 /e	85 /e
Growth rate (%) /na.c	-3.19	4.80	3.99 /e	3.38 /e	2.17 /e
Manufacturing share (%) /na.current prices	7.0	6.7	8.0	...	...

TONGA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	60	90	90	92	98 /e
Growth rate (%) /na.c	15.81	5.37	-2.00	2.50	5.84 /e
Per capita (in 1980-dollars) /na.c	614.8	938.4	947.1	970.8	...
MVA: /na.c (in million 1980-dollars)	3	3	5 /e	5 /e	6 /e
Growth rate (%) /na.c	21.44	6.26	16.14 /e	10.41 /e	18.44 /e
Manufacturing share (%) /na.current prices	6.1	8.2	8.4 /e	...	...

UGANDA	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	2638	2781	3037	3236	3366
Growth rate (%) /na.c	-3.40	-5.50	7.18	6.57	4.00
Per capita (in 1980-dollars) /na.c	201.0	177.7	174.0	178.7	182.6 /e
MVA: /na.c (in million 1980-dollars)	109	110	119 /e	130 /e	136 /e
Growth rate (%) /na.c	6.10	-12.70	9.13 /e	9.46 /e	4.06 /e
Manufacturing share (%) /na.current prices	4.2	3.6	5.4	...	...

UNITED ARAB EMIRATES	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	29629	27036	21700	24009	25690
Growth rate (%) /na.c	26.42	-2.39	-0.12	10.64	7.00
Per capita (in 1980-dollars) /na.c	29162.0	20026.8	14447.1	15519.9	15988.2 /e
MVA: /na.c (in million 1980-dollars)	1131	2547	2140 /e	2352 /e	2550 /e
Growth rate (%) /na.c	64.87	-2.20	2.87 /e	9.88 /e	8.43 /e
Manufacturing share (%) /na.current prices	3.8	9.3	9.4	...	...

VANUATU	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	113	149	148	151	156 /e
Growth rate (%) /na.c	-11.46	4.01	1.00	2.00	3.16 /e
Per capita (in 1980-dollars) /na.c	961.3	1084.0	986.8	980.4	1011.4 /e
MVA: /na.c (in million 1980-dollars)	3	10	21 /e	26 /e	32 /e
Growth rate (%) /na.c	24.99	9.95	25.36 /e	25.09 /e	25.28 /e
Manufacturing share (%) /na.current prices	4.2	3.8	...	...	...

VIET NAM	1980	1985	1988	1989	1990
GDP: /na.c (in million 1980-dollars)	5630	7791	8865	8977	8777 /e
Growth rate (%) /na.c	-4.81	6.20	8.25	1.27	-2.23 /e
Per capita (in 1980-dollars) /na.c	104.8	130.1	138.8	137.6	130.7 /e
MVA: /na.c (in million 1980-dollars)	...	...	...	...	...
Growth rate (%) /na.c	...	...	...	...	...
Manufacturing share (%) /na.current prices	...	...	...	...	...

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

YEMEN, NORTHERN PART	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	2779	3692	4878	5087	5494
Growth rate (%) /na,c	5.04	10.31	13.90	4.30	8.00
Per capita (in 1980-dollars) /na,c	437.1	484.4	571.8	574.4	602.2 /e
MVA: /na,c (in million 1980-dollars)	185	341	395	408	451 /e
Growth rate (%) /na,c	7.70	1.45	4.30	3.19	10.68 /e
Manufacturing share (%) /na,current prices	7.6	11.2	11.6	...	...

YEMEN, SOUTHERN PART	1980	1985	1988	1989	1990
GDP: /na,c (in million 1980-dollars)	668	892	809	825	846 /e
Growth rate (%) /na,c	14.78	-2.97	0.30	2.00	2.52 /e
Per capita (in 1980-dollars) /na,c	359.0	417.2	345.6	341.7	317.6 /e
MVA: /na,c (in million 1980-dollars)	34	62	62 /e	64 /e	67 /e
Growth rate (%) /na,c	-41.12	22.41	4.08 /e	4.11 /e	4.12 /e
Manufacturing share (%) /na,current prices	5.3	7.6	7.3	...	...

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.