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INDUSTRY AND DEVELOPMENT

GLOBAL REPORT 1993/94

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna, 1993

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Preface

A decade ago UNIDO started its series of annual global reports on industry and development analysing major trends in the world industrial economy and its regional and sectoral components. Over that period, the reports addressed a number of special themes, such as South-South trade, the environmental impact of industrialization, energy consumption by industry, financial innovations and privatization, and advanced a consistent view that for most developing countries sustained industrial growth is an essential component in an effective anti-poverty strategy.

At the same time, the Organization lent an active operational dimension to that vision mainly through its technical cooperation projects directed towards industries and industrial institutions and its investment promotion activities.

The decade has seen far-reaching changes. Trade has replaced aid as the major vehicle for industrialization. Private capital in search of profit opportunities flows to open economies willing to adapt and adjust their structures to market forces. Technical assistance is no longer the bottleneck. The crucial factors are managerial decisions about marketing and finance, legal obstacles and government assistance, international commercial barriers and opportunities. Today countries know what they need and where they can get it, and their Governments have assumed an enabling rather than a regulating role in the process of industrialization.

The world industrial economy is shifting its centre of gravity away from Western Europe and North America to East and South-East Asia. The challenges are more economic than technical. Industrial technology is changing rapidly. The vertically integrated, mass-production Fordist technology has yielded to flexible, limited batch production with just-in-time inventory and geographical division of labour. Processes are subdivided and linked by low-cost communication and transport.

Against this backdrop of monumental change UNIDO should reassess its role. How should UNIDO see its role? It must of course continue to promote industrialization wherever and whenever it can, yet the old boundaries between industry and agriculture and between industry and services are fast dissolving. Information is perhaps the most crucial input in all products, and innovation the constant need and challenge.

A complete package of economic advice rather than discrete expertise in engineering, production or project evaluation will be in increasing demand. Not only improved production, but also sound financing, effective marketing and innovative thinking determine the future of factories across the world. Domestic markets can no longer be insulated from external competition, nor can they form the limit of industrial expansion. Countries and companies alike will need advice and guidance on the manifold problems of surviving in a competitive and rapidly changing world.

Chapter I of this year's edition of the *Global Report* shows that 1993 has been a year of industrial decline in Western Europe, faltering revivals in North America and Japan, and continued transitional difficulties in Eastern Europe and the former Union of Soviet Socialist Republics. Moreover, the chapter provides short-term growth forecasts for 136 developed and developing countries. These forecasts are based on UNIDO databases and on various scenarios which reflect current global economic realities; they are current as of mid-July 1993.

The global recession which began in 1990 is still continuing. In global terms it is considerably less severe but more enduring than the recessions of 1975 and 1981. This is due to the broad divergence in the business cycle downturns afflicting the major developed economies. Recovery can be seen to have started in the United States of America, while both Japan and the United Kingdom of Great Britain and Northern Ireland are about to recover, industrial output is still falling in Italy and France, and the downturn is quite steep in Germany.

The combined effect of these asymmetrical business cycles is that global recovery is weak, the overall downturn is non-severe but prolonged, and when the delayed overall upturn does come, it will not be vigorous. This scenario obviously causes global imbalances both in trade and finance, upsetting interest and exchange rates. It has already led to a fracturing of the exchange rate mechanism and cast some doubt on a future European monetary union. Given the nature of this global recession, however, most developing countries have avoided its worst impact. The exceptions are the export-dependent newly industrializing countries of East and South-East Asia. While the African economies have remained stagnant, registering little impact from rising or falling commodity prices, Latin America and the rest of Asia seem set for strong recoveries. This illustrates the important point that through their interdependence with the global economy, developing countries are less vulnerable to changes in output of a cyclical nature in the developed world than to the impact of policy changes in developed countries reflected in short-term interest rates, varying exchange rates and national anti-inflationary policies. The short- and long-term industrial prospects of 10 major regions and subregions in the world are reviewed in chapter II, supported by an analysis of the macroeconomic environment.

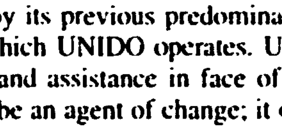
Economists and policy makers have fundamentally changed their way of thinking about the role of trade in industrialization. The more recent key notions seem to be liberalization of trade regimes based on market incentives and export-oriented industrialization. Chapter III of the *Global Report* examines conceptual issues and empirical evidence related to trade as an effective instrument for accelerating industrialization in developing countries. A comparative assessment is provided of the validity and relevance of export-led industrialization strategies in selected developing countries in the Asian and Pacific region and sub-Saharan Africa. A particular focus of the chapter is an examination based on input-output techniques of the implications of greater reliance on market forces and the role of the State in industrialization via trade. The chapter concludes with an assessment of the policy implications of the empirical findings related to developing countries in the Asia and Pacific region and their applicability to sub- Saharan Africa.

As usual in the *Global Report*, the concluding chapter presents surveys of various branches of manufacturing industry. Statistical information is provided on current supply and demand conditions, trade patterns, profits and losses, production cost, capacity utilization and, where possible, employment. Restructuring is examined at the subsector level using measures of overcapacity, shortages, changes in output composition of foreign direct investment and the role of government. Manufacturing capacity in developing countries is accorded special emphasis, with a focus on the build-up of productive capacity, project investment plans, profit potential environmental impact and technological trends. Finally, the short- and medium-term outlook for demand, prices, employment, trade and investment are presented, within the context of the globalization of industrial structure and changing international division of labour. The subsectors examined are: numerically controlled machine tools, power-generating equipment, fork-lift trucks, fertilizer equipment, high-value-added steel products, semiconductors, advanced engineering materials, fine chemicals, petrochemicals, market pulp, copper processing, cocoa processing and seafood processing.

As a global institution, UNIDO has always championed the industrialization of the poorer four fifths of the world, and charted their progress towards that goal in previous *Global Reports*. The task is now even more complex and urgent as the fledgling industries in many of those countries face the harsh winds of competition. To survive and thrive in a dynamic market environment requires access to special skills and knowledge.

It is my intention to ensure that UNIDO continues to be a major source of the advice that developing countries need. It is quite apparent that the Organization no longer will enjoy its previous predominance in this area. The nature of the world has changed, and so has the context in which UNIDO operates. UNIDO must face up to the challenge of winning the market for providing advice and assistance in face of many private as well as some governmental competitors. UNIDO must continue to be an agent of change; it cannot become its victim.

UNIDO is thus reconsidering its role as an international development institution, reassessing its mode of operation and defining the future range of services. The changes now under discussion will revitalize the organization and enhance its performance. They will reflect three main themes: a greater demand-orientation of the Organization's work; a reprioritization of its mandate, and a clear focus on comparative advantages; and the introduction of innovative ideas to increase the effectiveness of its work. The coming year will, I trust, see the organization assuming a new effective role and the world industrial economy taking a turn for the better.



MAURICIO DE MARIA Y CAMPOS
Director-General

تمهيد

قبل عقد من الزمن ، شرعت اليونيدو في اصدار سلسلة تقاريرها العالمية عن الصناعة والتنمية ، التي تحلل فيها الاتجاهات الرئيسية للاقتصاد الصناعي العالمي ومكوناته الاقليمية والقطاعية . وعلى مدى هذه الفترة ، تناولت التقارير عددا من المواضيع الخاصة ، منها التبادل التجاري فيما بين بلدان الجنوب ، والاثر البيئي للتصنيع ، واستهلاك الطاقة في الصناعة ، والابتكارات التمويلية ، والخوصصة : كما دأبت على ترويج وجهة نظر مؤداها أن النمو الصناعي المتواصل يمثل بالنسبة لمعظم البلدان النامية عنصرا أساسيا في أية استراتيجية فعالة لمكافحة الفقر .

وفي الوقت ذاته ، أضفت المنظمة على هذه الرؤية ، بعدا عمليا فعالا وبوجه خاص من خلال ما تضطلع به من مشاريع تعاون تقني موجهة نحو الصناعات والمؤسسات الصناعية وكذلك من خلال أنشطتها لترويج الاستثمار .

وقد شهد العقد المذكور تغيرات بعيدة المدى . فقد حل التبادل التجاري محل المعونة كوسيلة رئيسية للتصنيع . وأخذ رأس المال الخاص ، في بحثه عن فرص الربح ، يتدفق على الاقتصادات المنفتحة الراغبة في تكييف وتعديل هياكلها لتتواءم مع قوى السوق . ولم تعد المساعدة التقنية هي العقدة . وأصبحت العوامل الحاسمة هي القرارات الادارية بشأن التسويق والتمويل ، والعقبات القانونية والمساعدة الحكومية ، والحواجز والفرص التجارية الدولية . ففي الوقت الحاضر ، تعرف البلدان ما تحتاجه وأين يمكنها الحصول عليه . وأصبحت حكوماتها تضطلع بدور تيسيري لا مجرد دور تنظيمي في عملية التصنيع .

وقد أخذ الاقتصاد الصناعي العالمي ينتقل بمركز ثقله بعيدا عن أوروبا الغربية وأمريكا الشمالية في اتجاه شرق آسيا وجنوب شرقها . والتحديات اقتصادية أكثر منها تقنية . والتكنولوجيا الصناعية تتغير بسرعة . كما أن تكنولوجيا الانتاج الكبير المتكاملة رأسيا على نمط شركات فورد تراجعت لتفسح في المجال للانتاج المرن القائم على دفعات محدودة مع توريد المخزون في الوقت المناسب وتقسيم العمل على أساس جغرافي . وأصبحت عمليات الانتاج مقسمة فرعيا وموصولة معا بوسائط اتصال ونقل منخفضة التكاليف .

وازاء هذه الخلفية من التغير الهائل ، ينبغي لليونيدو اعادة تقييم دورها . وكيف ينبغي لليونيدو أن ترى دورها ؟ يجب عليها طبعا أن تمضي في ترويج التصنيع حيثما وكلما أمكنها ذلك . غير أن الحدود القديمة بين الصناعة والزراعة وبين

الصناعة والخدمات آخذة في التلاشي بسرعة . وربما كانت المعلومات هي أهم المدخلات في جميع المنتجات وكان الابتكار هو الحاجة والتحدي الدائمين .

وسوف يتزايد الطلب على حزمة كاملة من المشورة الاقتصادية بدلا من الخبرة الفنية المتحفظة في مجال الهندسة أو الانتاج أو تقييم المشاريع . فمستقبل المصانع في جميع أنحاء العالم لا يقرره تحسين الانتاج وحده . بل يقرره أيضا التمويل السليم والتسويق الفعال والتفكير الابتكاري . فالأسواق المحلية لم يعد ممكنا عزلها عن المنافسة الخارجية . كما لا يمكنها أن تشكل حدود التوسع الصناعي . وستحتاج البلدان والشركات على السواء الى المشورة والارشاد بشأن المشاكل العديدة التي ينطوي عليها البقاء في عالم تنافسي وسريع التغير .

ويبين الفصل الأول من عدد هذه السنة من التقرير العالمي أن سنة ١٩٩٣ هي سنة التراجع الصناعي في أوروبا الغربية ومحاولات النهوض المتعثرة في أمريكا الشمالية واليابان واستمرار الصعوبات الانتقالية في أوروبا الشرقية واتحاد الجمهوريات الاشتراكية السوفياتية سابقا . وفضلا عن ذلك . يقدم الفصل تنبؤات قصيرة المدى بشأن النمو في ١٣٦ بلدا من البلدان النامية والمتقدمة النمو . وتستند هذه التنبؤات الى قواعد بيانات اليونيدو والى سيناريوهات مختلفة تجسد الواقع الاقتصادي العالمي الراهن بمختلف جوانبه : وهي قائمة على المعلومات المتوفرة حتى منتصف تموز/يوليه ١٩٩٣ .

والركود العالمي الذي بدأ في عام ١٩٩٠ لا يزال مستمرا . وهو بشكل عام أقل حدة بكثير من حالتي الركود في عامي ١٩٧٥ و ١٩٨١ ولكنه أطول أمدا . وهذا يرجع الى التباين الواسع في حالات انكماش دورة النشاط الاقتصادي التي أصابت الاقتصادات المتقدمة الرئيسية . ويمكن ملاحظة بداية انتعاش في الولايات المتحدة . بينما اليابان والمملكة المتحدة في سبيلهما الى الانتعاش . ولا يزال الناتج الصناعي في ايطاليا وفرنسا يتراجع والانكماش في ألمانيا بالغ الحدة .

وكانت محصلة هذه الدورات الاقتصادية اللامتناسقة أن الانتعاش العالمي ضعيف . والانكماش العام طويل الأمد وإن لم يكن حادا . وعندما يحصل التحسن العام المنتظر بعد طول تأخر فانه لن يكون تحسنا سريعا . ومن الواضح أن هذا السيناريو يسبب اختلالات في التوازن العالمي في مجالي التجارة والتمويل . مما يحدث اضطرابا في أسعار الفائدة والصرف . وقد أدى بالفعل الى اختلال آلية سعر الصرف وألقى بعض الشكوك على امكانية انشاء اتحاد نقدي أوروبي في المستقبل . ولكن نظرا لطبيعة هذا الركود العالمي تجنب معظم البلدان النامية أسوأ آثاره . وكانت الاستثناءات الوحيدة هي بلدان شرق آسيا وجنوب شرقها الآخذة حديثا بأسباب التصنيع والمعتمدة على التصدير . وبينما ظلت الاقتصادات الافريقية راكدة . مع تأثر قليل بارتفاع أو هبوط أسعار السلع الأولية . تبدو بلدان أمريكا اللاتينية وبقية بلدان آسيا مهيأة لانتعاش قوي . وهذا يؤكد نقطة هامة هي أن البلدان النامية . من خلال ترابطها بالاقتصاد العالمي . أقل تأثرا بتغيرات الناتج ذات الطابع الدوري في العالم المتقدم من تأثرها بتغيرات سياسة البلدان المتقدمة التي تتجسد في أسعار فائدة قصيرة الأجل . وأسعار صرف متغيرة وسياسات وطنية لمكافحة التضخم . ويرد في الفصل الثاني استعراض

للآفاق الصناعية على المديين القصير والطويل في ١٠ من أهم المناطق والمناطق الفرعية في العالم ، مدعما بتحليل للبيئة الاقتصادية على المستوى الكلي .

وقد غير الاقتصاديون ومقررو السياسات طريقة تفكيرهم بشأن دور التجارة في التصنيع تغييرا جوهريا . ويبدو أن أحدث الافكار الرئيسية تتمثل في تحرير الانظمة التجارية بالاستناد الى الحوافز السوقية والتصنيع الموجه نحو التصدير . ويعالج الفصل الثالث من التقرير العالمي المسائل المفاهيمية والشواهد التجريبية ذات الصلة بالتجارة بوصفها أداة فعالة لتعجيل التصنيع في البلدان النامية . وهو يتضمن تقييما مقارنا لمدى صحة وملاءمة استراتيجيات التصنيع القائمة على التصدير في عدد مختار من البلدان النامية في منطقة آسيا والمحيط الهادئ وفي البلدان الأفريقية الواقعة جنوبي الصحراء الكبرى . ويركز الفصل بوجه خاص على دراسة نتائج ازدياد الاعتماد على قوى السوق ودور الدولة في التصنيع من خلال التبادل التجاري ، وذلك بالاستناد الى تقنيات العلاقة بين المدخلات والنواتج . وينتهي الفصل بتقدير للنتائج السياساتية المترتبة على الاستنتاجات التجريبية ذات الصلة بالبلدان النامية في منطقة آسيا والمحيط الهادئ ومدى انطباقها على البلدان الأفريقية الواقعة جنوبي الصحراء الكبرى .

وكما هو معتاد في التقرير العالمي ، يقدم الفصل الختامي استقصاءات لشتى فروع الصناعة التحويلية . وهو يتضمن معلومات احصائية عن ظروف العرض والطلب الراهنة ، وأنماط التبادل التجاري ، والأرباح والخسائر ، وتكلفة الانتاج واستغلال القدرات الانتاجية ، وكذلك العمالة حيثما أمكن . ويدرس هذا الفصل اعادة الهيكلة على مستوى القطاعات الفرعية باستخدام مقاييس فائض الطاقة الانتاجية ، ونقص الموارد ، والتغيرات في تركيبة نواتج الاستثمار الأجنبي المباشر ، ودور الحكومة . ويولي الفصل اهتماما خاصا لقدرات الصناعة التحويلية في البلدان النامية مع التركيز على تحسين القدرة الانتاجية وخطط الاستثمار في المشاريع وفرص الربح والاثر البيئي والاتجاهات التكنولوجية . وأخيرا ، يعرض هذا الفصل الحالة المرتقبة للطلب والأسعار والعمالة والتجارة والاستثمار على المديين القصير والمتوسط ، في سياق عَوْلمة الهيكل الصناعي وتغير التقسيم الدولي للعمل . والقطاعات الفرعية المتناولة هي : العُدد المكنية التي تعمل بأجهزة رقمية ، ومعدات توليد الطاقة الكهربائية ، وشاحنات الرفع الشوكي ، ومعدات الأسمدة ، والمنتجات الفولاذية ذات القيمة المضافة العالية ، وأشباه الموصلات ، والمواد الهندسية الرفيعة ، والكيماويات الدقيقة ، والبتروكيماويات ، والعجينة الورقية التجارية وتجهيز النحاس وتجهيز الكاكاو وتجهيز الأغذية البحرية .

وقد دأبت اليونيدو ، بوصفها مؤسسة عالمية ، على مناصرة تصنيع الجزء الأفقر من العالم والذي يشكل أربعة أخماسه ، وعلى تضمين تقاريرها العالمية السابقة عرضا بيانيا لتقدمها في اتجاه هذا الهدف . وأصبحت المهمة الآن أشد تعقدا والحاحا لأن الصناعات الناشئة في العديد من تلك البلدان تواجه رياح المنافسة الهوجاء . والبقاء والازدهار في بيئة سوقية دينامية يتطلبان تيسر الحصول على مهارات ومعارف خاصة .

واني عازم على ضمان بقاء اليونيدو مصدرا رئيسيا للمشورة التي تحتاجها البلدان النامية . ومن الواضح تماما أن المنظمة لن تحتفظ بهيمنتها السابقة في هذا المجال . فقد تغيرت طبيعة العالم وتغير معها السياق الذي تعمل فيه اليونيدو . ويجب على اليونيدو أن ترتفع الى مصاف التحدي المتمثل في كسب سوق تقديم المشورة والمساعدة في مواجهة العديد من المنافسين في القطاع الخاص وكذلك بعض المنافسين الحكوميين . فاليونيدو يجب أن تظل عاملا فاعلا في التغيير : ولا ينبغي لها أن تصبح ضحية له .

وبناء على ذلك ، تقوم اليونيدو حاليا باعادة النظر في دورها كمؤسسة انمائية دولية ، وباعادة تقييم طريقة عملها وبتحديد نطاق الخدمات التي ستقدمها في المستقبل . والتغييرات الجاري مناقشتها سوف تفضي الى انعاش المنظمة وتحسين أدائها . وسوف تجسد ثلاثة مواضيع رئيسية : جعل عمل المنظمة أكثر توجها نحو الطلب : واعادة تحديد أولويات ولايتها ، مع التركيز بشكل واضح على المزايا النسبية : والأخذ بأفكار ابتكارية لزيادة فعالية عملها . وإني آمل أن تشهد السنة القادمة اضطلاع المنظمة بدور فعال جديد ، وتحولا في الاقتصاد الصناعي العالمي نحو الأحسن .

موريسيو دي ماريا إي كامبوس
المدير العام

序 言

十年前，工发组织创刊了每年一期的《工业与发展全球报告》，主要分析世界工业经济的重要发展趋势，兼而剖析其各区域及各部门的具体情况。 这十年期间，《全球报告》先后探讨了一系列专题，其中包括南南贸易、工业化对环境的影响、工业的能源消耗、创新的筹资手段以及私有化问题等，与此同时，还提出了一个坚持不渝的论点，即对于多数发展中国家而言，持续的工业增长乃是有效的脱贫战略之中必不可少的一个方面。

与此同时，本组织也将这一观点积极贯彻到其业务活动之中，一方面执行着眼于工业和工业机构的技术合作项目，另一方面大力开展投资促进活动。

十年来，出现了一些影响深远的变化。作为推进工业化的主要手段，贸易取代了援助。 寻求获利机会的私人资本大量涌向那些有意进行结构调整、使之适应于市场力量的开放型经济体。技术援助不再是瓶颈障碍。 成为关键性因素的是：管理一级对销售和资金所作的决定，法律障碍和政府支助，国际商业壁垒和机会。今天，各个国家都知道自己需要什么，也知道应向何处求取，在工业化进程中，各国政府起着大力扶助，而不是束缚管卡的作用。

世界工业经济的重心正在发生位移，从西欧北美转向东亚和东南亚。 面临的挑战主要是经济方面而不是技术方面。 工业技术的发展日新月异。 纵向一体化的福特大规模生产技术已经过时，取而代之的是变通灵活的、有限批量的生产，加上及时的清点库存和地理上的合宜分工。加工流程在异地分散进行，而以成本低廉的通信和运输手段将其联成一体。

在这种巨大变革的背景下，工发组织理应对其担负的作用重新作出估价。工发组织到底应起何种作用？毫无疑问，它必须继续尽其所能，大力促进工业化；然而工农业之间、工业与服务业之间原有的界线正在迅速淡化、消失。 信息也许已成为所有各种产品的最关键投入，创新则已成为长期的需要和挑战。

今后，人们将越来越多地需要全面完整的一揽子经济咨询，而不是有关设计、生产或项目评价的单一专门知识。 决定着世界各地工厂企业的前途的不仅仅是生产上的改进，而且还得加上良好的融资，有效的销售和富于创新的头脑。 国内市场再也不能完全避开外部的竞争，工业的发展也不可能以国内市场为限。无论是国家还是公司企业，对于如何在这个充满竞争、日新月异的世界上奋力求存，在许多问题上均将渴望得到中肯的咨询意见和指导。

本年度《全球报告》第一章着重阐明，1993年是西欧工业滑坡，北美和日本复苏乏力，东欧和前苏联在过渡中继续遇到重重困难的一年。除此之外，第一章还对136个国家（包括发达国家和发展中国家）作出了短期增长预测。这些预测数字是根据工发组织的数据库和反映当前全球经济实况的各种设想方案计算出来的；它们是到1993年 7月中旬为止的最新数字。

自1990年开始的全球衰退目前仍在继续。 就全球而言，这场衰退比之1975年和1981年的衰退，不算那么严重，但持续时间较长。 这是由于几个主要发达国家的商业周期下降趋势各不相同所致。 人们看到，美国已经开始复苏，日本和联合王国也即将复苏，但意大利和法国的工业产出仍在下降，德国几乎是急转直下。

商业周期这种不对称现象其后果加到一起，形成了全球复苏的微弱，整个下滑趋势虽不严重但旷日持久，等到全面回升到来之日，回升势头估计也不会猛烈。显然，这一情景会引起全球贸易和金融的失衡，打乱利率和汇率的走向。它已经造成了汇率机制的分崩离析，还给未来的欧洲货币统一蒙上了疑云。但是，在这种全球性的衰退之下，多数发展中国家仍得以免受其最严重打击。少数的例外是东亚和东南亚依赖于出口的那些新兴工业化国家。非洲各国的经济仍处于停滞状态，商品价格的升降似乎对它们并无多大影响，但拉丁美洲及亚洲其他部分看来大有猛烈回升之势。这说明一个重要问题：由于与全球经济的相互依存关系，发展中国家受发达国家周期性产出变化

的影响并不严重，对它们影响较大的是发达国家政策变化所带来的冲击，例如反映在短期利率、汇率升降以及各国反通胀政策方面的变化。第二章主要讨论十大区域及分区域未来短期和长期的工业发展前景，其中还作了宏观经济环境分析。

经济学家和决策者对于贸易在工业化中的作用，从根本上改变了他们的看法。最新提出的两个重要理论概念似乎是：根据市场刺激因素放宽贸易制度和致力于面向出口的工业化。《全球报告》的第三章，就贸易作为加速发展中国家工业化的一项有效手段分析一些有关的理论概念问题和实证材料。以亚太地区和撒哈拉以南非洲地区某些发展中国家为例，对其出口导向型工业化战略的有效性和适切性作了对比评估。第三章的一个特别重点是运用投入产出方法探讨进一步依赖市场力量将产生的影响以及国家在通过贸易促进工业化方面应起的作用。该章的末尾还评估了与亚太地区若干发展中国家有关的经验结论所涉及的政策性问题及其对撒哈拉以南非洲的适用性。

一如既往，《全球报告》最后一章提供了制造业各部门的调查材料。所列统计资料包括：当前的供求状况、贸易格局、获利和亏损、生产成本、生产能力利用率等，可能时还列出就业人数。对于制造业各分部门结构变化的分析，主要着眼于其生产能力的过剩程度、短缺情况、外国直接投资在产出组成中的变化以及政府的作用。对发展中国家制造业的生产能力给予了特别注意，重点是分析其生产能力建设、项目投资计划、利润潜力、环境影响和技术发展趋势。最后，在论述工业结构全球化趋势和国际分工变化情况时，还提出了某些制造业部门在需求、价格、就业、贸易和投资方面的短期和中期前景展望。所论述的分部门是：数控机床、发电设备、叉式装卸车、化肥设备、高增值钢铁产品、半导体、先进工程材料、精细化学品、石油化学产品、市场纸浆、铜加工、可可加工和海鲜加工。

作为一个全球性机构，工发组织一贯致力于推动占全世界五分之四的较穷国家实现工业化，并在先前各期的《全球报告》中记载了它们朝此目标的奋斗历程。这项任务现已变得更为复杂、更为紧迫，因为其中许多国家的尚待成育的工业正面对着竞争的大风大浪。为能在动荡变化的市场环境中站稳脚跟，谋求发展，它们需要得到特别的技能和知识。

我的期望是，工发组织能继续成为发展中国家所需咨询资料的一个主要来源。但人们明显看到，本组织在这方面已经不象过去那样独占鳌头。世界发生了变化，工发组织所处的地位和条件亦已今非昔比。今天，在为数众多的私人竞争者以及一些政府竞争者面前，工发组织必须认真对付在提供咨询和援助这个领域的重大挑战，把这个市场夺过来。工发组织必须继续成为变革的推动者，而绝不能成为其牺牲者。

因此，工发组织正在重新考虑它作为一个国际发展机构的作用，重新审视其工作方式，确定未来的服务项目。当前讨论中的若干改革将使本组织重新焕发活力，提高工作成效。这些改革将体现出三个方面的主题：一．使本组织的工作更大地以需求为导向；二．重新安排工作任务的优先次序，把重点明确地放在相对优势之上；三．吸收创新思想，提高工作效能。我相信，在未来的一年中，人们将看到本组织以崭新的面目出现，发挥新的有效作用，而世界工业经济也将会有一个好转。

总干事

毛里西奥·德玛丽亚一坎波斯

Préface

Voilà dix ans que l'ONUDI a lancé sa série de rapports annuels sur l'industrie et le développement dans le monde dans lesquels sont analysées les principales tendances de l'économie industrielle mondiale et de ses composantes régionales et sectorielles. Au cours de ces dix années, les rapports ont porté sur divers thèmes, dont les échanges Sud-Sud, les effets de l'industrialisation sur l'environnement, la consommation d'énergie dans l'industrie, les innovations financières et la privatisation, mais dans chacun d'entre eux on retrouve le même point de vue, à savoir que pour la plupart des pays en développement une croissance industrielle soutenue constitue un élément essentiel d'une stratégie efficace de lutte contre la pauvreté.

L'ONUDI a traduit ce point de vue dans les faits par le biais, essentiellement, de ses projets de coopération technique à l'intention des industries et des institutions industrielles et de ses activités de promotion des investissements.

Pendant ces dix années se sont produits des changements profonds. Le commerce a remplacé l'aide comme principal instrument de l'industrialisation. Les investisseurs privés à la recherche d'occasions de profits affluent vers les pays à économie ouverte prêts à s'adapter et à ajuster leurs structures en fonction des forces du marché. L'assistance technique n'est plus l'obstacle à surmonter. Les facteurs fondamentaux sont désormais les suivants : décisions à prendre par les responsables d'entreprises en matière de commercialisation et de financement, difficultés juridiques et aide des pouvoirs publics, obstacles aux échanges et débouchés au niveau international. Aujourd'hui, les pays savent ce dont ils ont besoin et où ils peuvent l'obtenir et les gouvernements interviennent dans le processus d'industrialisation davantage pour faciliter que pour réglementer.

Le centre de gravité de l'industrie mondiale est en train de se déplacer de l'Europe occidentale et de l'Amérique du Nord vers l'Asie de l'Est et du Sud-Est. Les défis sont plus économiques que techniques. La technologie industrielle est en évolution rapide. La technologie fordienne basée sur l'intégration verticale et la production en grande série a laissé la place à une production par lots en flux tendu offrant plus de souplesse et s'accompagnant d'une division géographique du travail. On assiste à un éclatement des opérations, dont la cohésion est néanmoins assurée par des communications et des transports peu coûteux.

Compte tenu de ces changements radicaux, l'ONUDI devrait revoir son rôle. Comment doit-elle le concevoir ? L'Organisation doit bien évidemment continuer de promouvoir l'industrialisation où et quand elle le peut, mais les anciens clivages entre l'industrie et l'agriculture et entre l'industrie et les services disparaissent rapidement. L'information est l'élément peut-être le plus important de tout produit et l'innovation est devenue une nécessité aussi bien qu'un défi permanent.

Au lieu de connaissances spécialisées ponctuelles en matière d'ingénierie, de production ou d'évaluation des projets, ce seront des services consultatifs intégrés dans le domaine économique qui seront de plus en plus demandés. L'avenir des entreprises, dans le monde entier, dépend non seulement d'une amélioration de la production, mais également d'un financement rationnel, d'une commercialisation efficace et d'idées novatrices. Les marchés intérieurs ne peuvent plus être protégés de la concurrence extérieure ni constituer la limite de l'expansion industrielle. Les pays comme les entreprises auront besoin d'avis et d'orientations pour résoudre les très nombreux problèmes que pose la survie dans un monde concurrentiel et en évolution rapide.

Le chapitre premier de la présente édition du *Rapport* montre que l'année 1993 aura été marquée par un déclin industriel en Europe occidentale, une timide reprise en Amérique du Nord et au Japon et la persistance des problèmes de transition en Europe orientale et dans l'ex-Union des Républiques socialistes soviétiques. Il donne en outre, pour 136 pays développés et en développement, des prévisions de croissance à court terme partant de la mi-juillet 1993, qui sont fondées sur les bases de données de l'ONUDI et sur divers scénarios tenant compte des réalités économiques actuelles dans le monde.

La récession mondiale qui a commencé en 1990 se poursuit. Dans l'ensemble, elle est beaucoup moins grave mais beaucoup plus persistante que les récessions de 1975 et de 1981 en raison des grandes différences dans le renversement de la conjoncture économique que subissent les principaux pays développés. On peut considérer que la reprise s'est amorcée aux Etats-Unis et qu'elle commencera bientôt au Japon et au Royaume-Uni, mais la production industrielle diminue encore en Italie et en France et le fléchissement de l'activité est assez marqué en Allemagne.

Ces conjonctures asymétriques produisent la situation suivante : la reprise, à l'échelle mondiale, est faible, la détérioration générale de la conjoncture n'est pas grave, mais elle persiste, et la reprise de l'activité, lorsqu'elle aura effectivement lieu, ne sera pas vigoureuse. Ce scénario engendre de toute évidence des déséquilibres mondiaux à la fois dans les échanges et les finances, en perturbant les taux d'intérêt et les taux de change. Il a déjà entraîné une fracture dans le mécanisme des taux de change et semé quelques doutes quant à l'avenir de l'union monétaire européenne. Etant donné sa nature, cette récession mondiale n'a cependant pas frappé de plein fouet la plupart des pays en développement, à l'exception des nouveaux pays industriels d'Asie de l'Est et du Sud-Est qui sont tributaires des exportations. Si l'économie des pays africains a continué de stagner, peu touchée par les effets de la hausse ou de la baisse des prix des produits de base, l'Amérique latine et le reste de l'Asie, par contre, semblent devoir connaître une forte relance. Cette situation illustre un point important, à savoir que les pays en développement, de par leurs liens d'interdépendance avec l'économie mondiale, sont moins vulnérables aux fluctuations cycliques de la production dans les pays développés qu'aux effets des changements de politique de ces pays qui se reflètent dans les taux d'intérêt à court terme, les variations des taux de change et les mesures anti-inflationnistes. On trouvera au chapitre II un examen des perspectives industrielles à court et à long terme pour 10 grandes régions et sous-régions du monde, appuyé par une analyse de l'environnement macro-économique.

Les économistes et les responsables politiques ont radicalement changé leur manière de concevoir le rôle du commerce dans l'industrialisation. Il semble que, depuis peu, les concepts en faveur soient la libéralisation des régimes des échanges en faisant jouer les stimulants du marché et une industrialisation axée sur l'exportation. Le chapitre III du *Rapport* examine sur le plan théorique et à l'aide d'exemples la manière dont les échanges sont utilisés pour contribuer efficacement à accélérer l'industrialisation des pays en développement. On y trouvera une évaluation comparative de la validité et de la pertinence des stratégies d'industrialisation axée sur l'exportation dans certains pays en développement de la région de l'Asie et du Pacifique et de l'Afrique subsaharienne. Une place particulière y est faite à l'examen par les techniques d'analyse d'entrées-sorties des incidences, dans le cadre d'une industrialisation par le commerce, d'une plus grande sollicitation des mécanismes du marché et du rôle de l'Etat. Le chapitre se termine par une évaluation des implications pour les orientations de politique générale, des conclusions empiriques concernant les pays en développement de la région de l'Asie et du Pacifique et leur applicabilité à l'Afrique subsaharienne.

Comme par le passé, le dernier chapitre du *Rapport* présente des études de diverses branches de l'industrie manufacturière. On y trouvera des informations statistiques sur la situation actuelle de l'offre et de la demande, la structure des échanges, les pertes et les profits, les coûts de production, l'utilisation des capacités et, si possible, l'emploi. Pour examiner la restructuration au niveau sous-sectoriel, on a évalué les surcapacités, les pénuries, la modification de la part des investissements étrangers directs dans la production et le rôle de l'Etat. On a accordé une attention particulière à la capacité de production des pays en développement dans le secteur manufacturier, et plus spécialement au développement de cette capacité, aux plans d'investissement dans des projets, aux perspectives de profit, aux incidences de l'industrialisation sur l'environnement et à l'évolution technologique. Enfin, les perspectives à court et à moyen terme de la demande, des prix, de l'emploi, des échanges et de l'investissement sont présentées dans le contexte de la mondialisation de la structure industrielle et de l'évolution de la division internationale du travail. Les sous-secteurs examinés sont les suivants : machines-outils à commande numérique, équipement de production d'électricité, chariots élévateurs, matériel dans le domaine des engrais, produits en acier à forte valeur ajoutée, semi-conducteurs, matériaux nouveaux, chimie fine, produits pétrochimiques, pâte à papier commerciale, transformation du cuivre, transformation du cacao et transformation des produits de la mer.

En tant qu'organisation internationale, l'ONUDI, dans les précédents rapports sur l'industrie et le développement dans le monde, s'est toujours faite la championne de l'industrialisation des quatre cinquièmes les plus pauvres du monde et a suivi les progrès faits vers la réalisation de cet objectif. Sa tâche est aujourd'hui encore plus complexe et plus urgente dans la mesure où les industries naissantes de nombre de ces pays doivent affronter les dures réalités de la concurrence. Or, pour survivre et prospérer sur des marchés dynamiques, il faut avoir accès à des compétences et à des connaissances spéciales.

J'entends bien veiller à ce que l'ONUDI demeure l'une des principales sources des avis dont ont besoin les pays en développement. De toute évidence, l'Organisation ne pourra plus tenir une place prééminente dans ce domaine. Le monde a changé, de même que le contexte dans lequel elle fonctionne. Elle doit s'employer à conquérir le marché que constituent les services de consultants et l'aide, auquel s'attaquent aujourd'hui de nombreux concurrents privés et quelquefois publics. Elle doit continuer à promouvoir le changement; elle ne peut en devenir la victime.

C'est pourquoi elle repense aujourd'hui son rôle en tant qu'organisation internationale de développement, réévalue son mode de fonctionnement et définit l'éventail futur de ses services. Les changements qui sont actuellement à l'examen permettront de la revitaliser et d'améliorer ses résultats. Ils correspondront à trois thèmes principaux : une meilleure prise en considération de la demande, un recentrage sur son mandat en accordant une importance particulière aux avantages comparatifs, ainsi que l'application d'idées novatrices pour accroître l'efficacité de son action. Je suis persuadé que l'an prochain l'ONUDI jouera un rôle nouveau et efficace et que l'industrie mondiale repartira vers un avenir meilleur.

Le Directeur général

MAURICIO DE MARIA Y CAMPOS

Предисловие

Десять лет назад ЮНИДО приступила к выпуску серии ежегодных глобальных докладов по вопросам промышленности и развития, в которых содержится анализ основных тенденций развития мировой промышленности, а также ее региональных и секторальных компонентов. За этот период ряд докладов был посвящен рассмотрению таких специальных тем, как торговля Юг-Юг, последствия индустриализации для окружающей среды, потребление энергии в промышленности, новые подходы к проблемам финансирования и приватизации. При этом последовательно отстаивалась точка зрения, согласно которой для большинства развивающихся стран устойчивые темпы роста промышленности являются важным компонентом эффективной стратегии борьбы с бедностью.

В то же время Организация, исходя из такого видения, проводила активную оперативную деятельность прежде всего в рамках проектов по техническому сотрудничеству, направленных на развитие предприятий и промышленных учреждений, и в рамках мероприятий по содействию инвестированию.

В ходе десятилетия произошли изменения, которые имеют далеко идущие последствия. На смену помощи как основного механизма индустриализации пришла торговля. Частный капитал, занятый поиском возможностей для получения прибылей, устремляется в страны с открытой экономикой, помогая им адаптировать и перестроить их структуры для деятельности в условиях рынка. В этом процессе техническая помощь более не является основной задачей. Решающую роль приобрели такие факторы, как способность руководства решать вопросы маркетинга и финансирования, юридические препятствия и правительственная помощь, барьеры и возможности в области международной торговли. Сегодня страны знают, в чем заключаются их нужды и где они могут получить все необходимое. Их правительства стали играть не регулирующую, а скорее стимулирующую роль в процессе индустриализации.

Центр тяжести мирового промышленного развития перемещается из Западной Европы и Северной Америки в Восточную и Юго-Восточную Азию. Возникающие при этом проблемы носят не технический, а скорее экономический характер. В промышленной технологии происходят стремительные перемены. Интегрированная по вертикали, рассчитанная на массовое производство технология, которую внедрил Форд, уступила место гибкому мелкосерийному производству с точно рассчитанными по срокам товарно-сырьевыми запасами и географическим разделением труда. Разбивка и соединение производственных процессов определяются минимальным уровнем расходов на средства связи и транспортировку.

На фоне столь разительных перемен ЮНИДО необходимо заново оценить свою роль. Какой видится эта роль ЮНИДО? Она должна, разумеется, и далее, где и когда это возможно, содействовать индустриализации, однако, учитывая при этом, что старые границы между промышленностью и сельским хозяйством, а также между промышленностью и сферой услуг быстро исчезают. Важнейшим фактором всех видов производства является, возможно, информация, а постоянной задачей и потребностью — стремление к новшеству.

Спрос будет расти не на отдельные услуги специалистов в области проектно-конструкторских работ, производства или оценки проектов, а скорее на комплекс услуг по экономическому консультированию. Будущее предприятий во всем мире зависит не только от повышения уровня производства, но и от того, насколько обоснованным является финансирование, насколько эффективным является маркетинг, а также от состояния творческой мысли. Внутренние рынки не могут оставаться далее изолированными от внешней конкуренции и не могут определять пределы расширения масштабов промышленного производства. Как страны, так и компании будут нуждаться в услугах в области консультирования и ориентации по различным проблемам выживания в условиях конкуренции и быстрых перемен, происходящих во всем мире.

В главе I настоящего Глобального доклада отмечается, что в 1993 году в Западной Европе наблюдался спад промышленного производства, в Северной Америке и Японии наметились неуверенные признаки оживления экономики, в Восточной Европе и бывшем Союзе Советских Социалистических Республик продолжались трудности переходного периода. Кроме того, в этой главе представлены краткосрочные прогнозы в отношении темпов роста экономики 136 развитых и развивающихся стран. Эти прогнозы подготовлены на основе баз данных ЮНИДО и различных сценариев, отражающих существовавшие по состоянию на середину июля 1993 года глобальные экономические реалии.

Начавшийся в 1990 году спад в мировой экономике все еще продолжается. В глобальных масштабах он значительно уступает по остроте, но превосходит по степени устойчивости кризисы 1975 и 1981 годов. Это обусловлено большой разницей во времени периодов спада деловой активности в основных экономически развитых странах. Соединенные Штаты вступили в фазу начала подъема, Япония и Соединенное Королевство приблизились к этой фазе, Италия и Франция все еще переживают спад промышленного производства, а в Германии наблюдается весьма резкое снижение деловой активности.

Вследствие такой асимметрии деловых циклов оживление экономической деятельности в глобальных масштабах происходит вялыми темпами, общий спад является неглубоким, но затяжным. Когда наконец наступит задержавшийся рост деловой активности, его темпы не будут столь динамичными. Такой сценарий, несомненно, ведет к глобальным диспропорциям как в сфере торговли, так и в сфере финансов, расстраивая системы процентых ставок и обменных курсов. Он уже привел к нарушению механизма обменных курсов валют и посеял некоторые сомнения в отношении будущего европейского валютного союза. Учитывая характер этого глобального спада, большинству развивающихся стран, тем не менее, удалось избежать его наиболее тяжелых последствий. Исключение составляют зависящие от экспортных поступлений новые индустриальные страны Восточной и Юго-Восточной Азии. Экономика африканских стран по-прежнему находится в состоянии застоя и на нее практически не повлияло повышение или падение цен на сырьевые товары, в то время как в странах Латинской Америки и остальных регионах Азии, по-видимому, происходит активное оживление экономики. Это является важным свидетельством того, что благодаря своим взаимосвязям с мировой экономикой развивающиеся страны в меньшей степени подвержены воздействию циклических изменений в объеме производства в развитых странах, чем воздействию происходящих в политике развитых стран изменений, нашедших свое отражение в уровне краткосрочных процентных ставок, изменении обменных курсов валют и проведении национальной антиинфляционной политики. В главе II представлены прогнозы в отношении краткосрочных и долгосрочных перспектив промышленного развития в десяти крупнейших регионах и субрегионах мира, а также анализ макроэкономических условий.

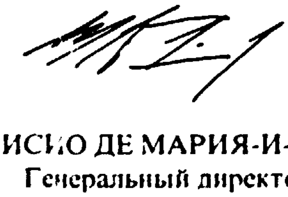
Экономисты и политики кардинально изменили свои взгляды на роль торговли в процессе индустриализации. В последнее время ключевое значение придается, по-видимому, либерализации режимов торговли на основе рыночных стимулов, а также индустриализации, ориентированной на экспорт. В главе III Глобального доклада представлен анализ концептуальных вопросов и практического опыта, касающегося торговли как эффективного механизма ускорения процесса индустриализации в развивающихся странах. В этой главе содержится также сравнительная оценка обоснованности и приемлемости ориентированных на экспорт стратегий индустриализации в отдельных развивающихся странах в регионе Азии и Тихого океана, а также в странах Африки, расположенных к югу от Сахары. При этом особое внимание уделяется построенному на оценке затрат и результатов анализу последствий более широкого использования рыночных сил, а также роли государства в процессе индустриализации через развитие торговли. В конце главы предлагается оценка последствий для политики эмпирических выводов, сделанных в отношении развивающихся стран в регионе Азии и Тихого океана, а также их применимости к странам Африки, расположенным к югу от Сахары.

Как обычно, в заключительной главе Глобального доклада представлен обзор различных отраслей обрабатывающей промышленности. В ней содержатся статистические данные о сложившейся в настоящее время конъюнктуре в области спроса и предложения, о структуре торговли, о доходах и убытках, об издержках производства, об использовании производственных мощностей и, по возможности, о занятости. Структурная перестройка исследуется на подсекторальном уровне с помощью таких показателей, как излишки производственных мощностей, дефицит, качественные изменения в направленности прямых иностранных инвестиций и роль правительства. Особое внимание уделяется возможностям обрабатывающей промышленности в развивающихся странах и прежде всего наращиванию производственных мощностей, планам инвестирования проектов, возможностям получения прибыли, экологическим последствиям и тенденциям в области развития технологии. И наконец, в этой главе излагаются взгляды на краткосрочные и среднесрочные перспективы в отношении спроса, цен, занятости, торговли и инвестирования в контексте глобализации промышленной структуры и изменений в международном разделении труда. Исследуются следующие подсекторы: изготовление станков с числовым программным управлением, энергетического оборудования, вилочных погрузчиков, оборудования для производства удобрений, продукции из стали с высокой добавленной стоимостью, полупроводников, улучшенных конструкционных материалов, химических продуктов тонкого органического синтеза, нефтехимических продуктов, товарной целлюлозы, а также переработка меди, какао и морских продуктов.

Как международное учреждение, ЮНИДО всегда выступала за индустриализацию более бедных стран, составляющих четыре пятых всех стран мира, и в предыдущих Глобальных докладах уделяла особое внимание их прогрессу на пути к этой цели. В настоящее время эта задача становится еще более сложной и неотложной, поскольку не имеющим достаточного опыта предприятиям во многих из этих стран приходится противостоять суровым ветрам конкуренции. Для выживания и процветания в динамичных условиях рынка необходим доступ к специальным знаниям и опыту.

Я хочу заверить, что ЮНИДО остается важным источником необходимого для развивающихся стран опыта. Совершенно очевидно, что Организация более не будет занимать прежнего господствующего положения в этой области. Мир изменился, и вместе с ним изменились условия, в которых ЮНИДО осуществляет свою деятельность. ЮНИДО необходимо решить задачу завоевания рынка в области оказания консультативных услуг и помощи, конкурируя с множеством частных, а также с некоторыми правительственными организациями. ЮНИДО должна по-прежнему выступать в качестве проводника перемен; она не может стать их жертвой.

Поэтому ЮНИДО пересматривает свою роль как международной организации развития, заново оценивает методы своей деятельности и определяет сферу своих услуг на перспективу. Обсуждаемые в настоящее время изменения позволят активизировать деятельность Организации и повысить ее эффективность. В них будут отражены три основные задачи: строить работу Организации с учетом спроса; пересмотреть очередность задач в рамках ее мандата и четко ориентироваться на использование сравнительных преимуществ, а также внедрять новые идеи с целью повышения эффективности ее деятельности. Я надеюсь, что в предстоящем году Организация будет играть новую эффективную роль и что положение в мировой промышленности изменится к лучшему.



МАУРИСИО ДЕ МАРИЯ-И-КАМПОС
Генеральный директор

Prefacio

Hace un decenio, la ONUDI inició la publicación de una serie de informes mundiales anuales sobre industria y desarrollo, en los que se analizaban las principales tendencias de la economía industrial en todo el mundo, así como sus componentes regionales y sectoriales. A lo largo de ese período, en los informes se han abordado diversos temas especiales, como el comercio Sur-Sur, el impacto ambiental de la industrialización, el consumo de energía en la industria, las innovaciones financieras y la privatización, sustentándose siempre la opinión de que, para la mayoría de los países en desarrollo, el crecimiento industrial sostenido es un componente esencial de una estrategia eficaz de lucha contra la pobreza.

Al mismo tiempo, la Organización dio una activa dimensión operacional a esa perspectiva, principalmente a través de sus proyectos de cooperación técnica destinados a industrias e instituciones industriales y a sus actividades de fomento de las inversiones.

En el transcurso del decenio se han producido cambios de largo alcance. El comercio ha reemplazado a la ayuda como principal vehículo de la industrialización. Los capitales privados que buscan la oportunidad de obtener ganancias afluyen hacia unas economías abiertas que están dispuestas a adaptar y ajustar sus estructuras a las fuerzas del mercado. La dificultad ya no radica en la asistencia técnica. Los factores esenciales son las decisiones empresariales en materia de comercialización y financiamiento, los obstáculos jurídicos y las ayudas gubernamentales, las barreras y oportunidades comerciales internacionales. En la actualidad, los países saben lo que necesitan y dónde obtenerlo, y sus gobiernos han asumido una función más permisiva que reguladora en el proceso de industrialización.

El centro de gravedad de la economía industrial en todo el mundo se desvía, pasando de Europa occidental y América del Norte a Asia oriental y sudoriental. Las dificultades son más de índole económica que técnica. La tecnología industrial está cambiando rápidamente. La tecnología de integración vertical y producción en serie al estilo de Ford ha cedido el paso a una producción especializada limitada y flexible, con las existencias indispensables y una división geográfica del trabajo. Los procesos se subdividen y se eslabonan mediante comunicaciones y transportes de bajo costo.

Ante cambios de tal magnitud, la ONUDI debe examinar de nuevo su función. ¿Cuál debe ser esa función a juicio de la Organización? Como es natural, debe continuar promoviendo la industrialización siempre y cuando pueda y no obstante el hecho de que los antiguos límites entre industria y agricultura y entre industria y servicios vayan desapareciendo rápidamente. La información es quizá el insumo más importante en todos los productos, y la innovación un reto y una necesidad constante.

Será cada vez mayor la demanda de programas completos de asesoramiento económico, en lugar de los distintos conocimientos especializados en materia de ingeniería, producción o evaluación de proyectos. Lo que determina el futuro de las fábricas en todo el mundo no es únicamente el aumento de la producción, sino también un financiamiento sólido, una comercialización eficaz y un pensamiento innovador. Los mercados nacionales ya no pueden permanecer a salvo de la competencia externa, ni pueden constituir el límite de la expansión industrial. Tanto los países como las empresas necesitarán asesoramiento y orientación respecto de los múltiples problemas de supervivencia en un mundo competitivo y en rápida evolución.

El capítulo I de la presente edición del *Informe Mundial* indica que 1993 ha sido un año de decadencia industrial en Europa occidental, de reactivación vacilante en América del Norte y el Japón y de continuas dificultades en la transición en que se hallan los países de Europa oriental y de la antigua Unión de Repúblicas Socialistas Soviéticas. Además, el capítulo presenta pronósticos de crecimiento a corto plazo para 136 países desarrollados y en desarrollo. Estos pronósticos se fundan en las bases de datos de la ONUDI y en diversos argumentos que reflejan las actuales realidades económicas mundiales; se trata de pronósticos que corresponden a mediados de julio de 1993.

La recesión mundial que se inició en 1990 continúa su curso. En términos generales, es mucho menos grave, aunque de mayor duración que las recesiones de 1975 y 1981. Esto se debe a la amplia divergencia de las fases descendentes de los ciclos económicos que afectan a las principales economías desarrolladas. Es posible observar un principio de recuperación en los Estados Unidos, mientras que tanto el Japón como el Reino Unido están a punto de recuperarse, y la producción industrial sigue descendiendo en Italia y Francia, y la contracción de la actividad económica es muy pronunciada en Alemania.

Debido al efecto combinado de estos ciclos económicos asimétricos, la recuperación mundial es débil, la contracción de la actividad económica mundial no es grave pero sí prolongada, y cuando se produzca la demorada reactivación de la economía en su conjunto, ésta no será vigorosa. Como es obvio, este pronóstico causa desequilibrios mundiales tanto en lo que se refiere al comercio como en las finanzas y perturba las tasas de interés y los tipos de cambio. Ha ya provocado una fractura en el mecanismo del tipo de cambio y ha puesto en entredicho la futura unidad monetaria europea. No obstante, dada la naturaleza de esta recesión mundial, la mayoría de los países en desarrollo han evitado sus peores repercusiones. Las excepciones son los países dependientes de las exportaciones y de reciente industrialización de Asia oriental y sudoriental. Mientras que las economías africanas han permanecido estancadas, habiendo repercutido muy poco en ellas el aumento o la disminución del precio de los productos básicos, América Latina y el resto de Asia parecen dirigirse hacia una reactivación enérgica. Esto ilustra un hecho importante, y es que los países en desarrollo, debido a su interdependencia con la economía mundial, son menos vulnerables a los cambios de carácter cíclico de la producción del mundo desarrollado que a las repercusiones de los cambios de política en los países desarrollados que se reflejan en las tasas de interés a corto plazo, unos tipos de cambio variables y unas políticas nacionales antiinflacionistas. En el capítulo II se examinan las perspectivas industriales a corto y largo plazo de diez importantes regiones y subregiones del mundo, apoyadas en un análisis del entorno macroeconómico.

Los economistas y los encargados de la formulación de políticas han cambiado fundamentalmente su forma de pensar con respecto al papel del comercio en la industrialización. Las nociones clave más recientes parecen relacionarse con la liberalización de los regímenes de intercambio basada en los incentivos del mercado y la industrialización orientada hacia la exportación. En el capítulo III del *Informe Mundial* se examinan cuestiones conceptuales y pruebas empíricas relativas al comercio como instrumento eficaz para acelerar la industrialización de los países en desarrollo. Se proporciona una evaluación comparativa de la validez y pertinencia de las estrategias de una industrialización orientada hacia la exportación en determinados países en desarrollo de la región de Asia y el Pacífico y el África subsahariana. El capítulo se centra especialmente en el examen, basado en técnicas de insumo-producción, de las consecuencias que se derivan de una mayor dependencia de las fuerzas del mercado y del papel del Estado en la industrialización a través del comercio. El capítulo termina con una evaluación de las consecuencias de índole política de las conclusiones empíricas relativas a los países en desarrollo de la región de Asia y el Pacífico y su aplicabilidad al África subsahariana.

Como es habitual en el *Informe Mundial*, el último capítulo presenta estudios de diversas ramas de la industria manufacturera. Se proporciona información estadística sobre las actuales condiciones de la oferta y la demanda, las modalidades del intercambio, las pérdidas y ganancias, los costos de producción, la utilización de la capacidad y, siempre que es posible, el empleo. La reestructuración se examina a nivel de los subsectores utilizando medidas de capacidad excesiva, insuficiencias, cambios en la composición del rendimiento de las inversiones extranjeras directas y el papel de los gobiernos. Se hace especial hincapié en la capacidad manufacturera de los países en desarrollo, con un enfoque basado en la creación de capacidad productiva, planes de inversiones en proyectos, posibilidades de obtener ganancias, impacto ambiental y tendencias tecnológicas. Finalmente, se presentan las perspectivas a corto y mediano plazo de la demanda, los precios, el empleo, el comercio y la inversión, en el contexto de la mundialización de la estructura industrial y de la evolución de la división internacional del trabajo. Los subsectores examinados son: máquinas herramienta numéricas, equipo generador de energía, carretillas de horquilla elevadora, equipo para fertilizantes, productos siderúrgicos de alto valor agregado, semiconductores, materiales de ingeniería avanzada, productos químicos muy puros, productos petroquímicos, pasta de madera para uso en el mercado, procesamiento del cobre, elaboración del cacao y elaboración de pescados y mariscos.

Como institución mundial, la ONUDI ha propiciado siempre la industrialización de las cuatro quintas partes más pobres del mundo, habiendo proyectado y reflejado su marcha hacia este objetivo en ediciones anteriores del *Informe Mundial*. En la actualidad, la tarea es aún más compleja y urgente, dado que las industrias nacientes de muchos de esos países tienen que capear los ásperos vientos de la competencia. Para sobrevivir y prosperar en un entorno de mercado dinámico, es necesario tener acceso a conocimientos y aptitudes especiales.

El propósito que me anima es garantizar que la ONUDI siga siendo la importante fuente de asesoramiento que necesitan los países en desarrollo. Es harto evidente que la Organización ya no podrá conservar su antiguo predominio en esta esfera. La naturaleza del mundo ha cambiado y también el contexto en el que funciona la ONUDI. La Organización debe enfrentar el reto de conquistar el mercado para proporcionar asesoramiento y asistencia, superando a muchos competidores privados y también a algunos competidores gubernamentales. La ONUDI debe seguir siendo un agente del cambio; no puede convertirse en su víctima.

Por consiguiente, la ONUDI está examinando nuevamente su papel de institución de desarrollo internacional, evaluando una vez más su modalidad de funcionamiento y definiendo la serie de servicios que habrá de ofrecer en el futuro. Los cambios que se analizan actualmente revitalizarán a la Organización y mejorarán su actuación. Reflejarán tres temas principales: una mayor orientación hacia la demanda en las actividades de la Organización; una nueva prioridad en el desempeño de su mandato, y un claro enfoque de las ventajas comparativas; y la introducción de ideas innovadoras para aumentar la eficacia de su labor. Confío en que el año próximo la Organización asumirá una función nueva y eficaz y que la economía industrial dará un giro positivo en todo el mundo.

MAURICIO DE MARIA Y CAMPOS
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 tons, unless otherwise specified.

A slash (1980/81) 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, requires 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 IV.

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
BiCMOS	bipolar complementary metal-oxide conductor
CAD	computer-aided design
CIS	Commonwealth of Independent States
CMEA	Council for Mutual Economic Assistance
CMOS	complementary metal-oxide semiconductor
DRAM	dynamic random access memory
EC	European Community
ECOWAS	European Community of West African States
EEC	European Economic Community
EOI	export oriented industrialization
EFTA	European Free Trade Association
ERM	exchange rate mechanism
ESCWA	Economic and Social Commission for Western Asia
FDI	foreign direct investment
GATT	General Agreement on Tariffs and Trade
GCC	Gulf Co-operation Council
GDP	gross domestic product
GNP	gross national product
GSP	generalized system of preferences
IC	integrated circuit
IMF	International Monetary Fund
ISI	import substitution industrialization
ISIC	International Standard Industrial Classification of all Economic Activities
JESSI	Joint European Submicronic Silicon Initiative
MITI	Ministry of International Trade and Industry
MOS	metal oxide semiconductor
MVA	manufacturing value added
NAFTA	North American Free Trade Agreement

NC	numerically controlled
NIC	newly industrializing country
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
R and D	research and development
SABIC	Saudi Basic Industries Corporation
SRAM	static random access memory
TVA	Tennessee Valley Authority
VLSI	very large-scale integration
ULSI	ultra-large-scale integration

This report is based on information available as of March 1993.

I. Global economy: short- and medium-term outlook

A. UNIDO projections for 1993 and 1994

After registering near zero growth in 1991, world output failed to rebound strongly in 1992. According to UNIDO estimates, the growth rate in world gross domestic product (GDP) in 1992 was barely more than 1 per cent. World manufacturing suffered even more, registering negative growth for two consecutive years, and the outlook for 1993 does not seem much better. As it stands, growth in world output is likely to stay at around 1.3 per cent during 1993, with manufacturing growing at a meagre 0.4 per cent. Although it could be expected that growth momentum will return by 1994, the continuing sluggishness of many cyclical indicators in the more advanced developed countries makes it difficult to project the precise timing for this worldwide economic upturn. The 3.1 per cent growth projected in 1994 for world GDP is therefore the most tentative one UNIDO has offered in the last 10 years of its projection exercises. Tentative though they might be, the forecasts for 1993 and 1994 are summarized in tables I.1 and I.2, in which some 140 countries are organized in 10 regions.

The difficulty associated with the 1993 projection exercise stems from the output behaviour in the more advanced developed countries, which has so far failed to conform to the established norm. By past standards, the economy of the United States should have had a much stronger recovery in 1992 than the actual 2.1 per cent growth, and it appears that the United States is headed for another lacklustre year in 1993. The year 1993 marks year one of the vaunted single market of the European Community (EC). The hopes and threats of an economically unified Europe, often translated and transcribed in the economic calculations for the growth of the world as a whole, seem to have disappeared amid the continent's worst recession for two decades. Germany is now in deep recession, with its manufacturing output in the western part of the country projected to decline by 6 per cent in 1993. France, Italy, Netherlands and Spain are all quite suddenly in recession, and will effectively cancel the output gains expected in a few European countries during the year. At this stage, the economic slump in Europe is shaking the very foundations of European integration. A new set of projections based on some intermediate politico-economic arrangement might produce a completely different picture. Even the UNIDO projection involving Japanese output performance is no exception. Japan, which once seemed invulnerable to economic recession, is undergoing a rapid economic deceleration in spite of the pump-priming efforts of the Government—the tested and proven remedy in the past.

The uncertainty surrounding the growth performance involving the more advanced developed countries obviously has a direct bearing on the overall exercise determining the growth prospects of developing countries. UNIDO is, however, convinced that the growth rate for developing countries as a whole (excluding China) will improve by a nearly a half percentage point to 4.4 per cent in 1994 (see figures I.1 and I.2 and the industrial sector shares in figure I.3). The impact of prolonged recession in developed countries would, however, be felt in 1994 by a number of countries in the different regions. As pointed out in previous issues of the UNIDO *Global Report*, however, developing countries have learned to insulate their economies more effectively from adverse external forces, and to rely more on their internal resources and domestic or intraregional markets. This means that the economic relationship between developed and developing countries is no longer strictly quantitative. What concerns developing countries most nowadays is the macroeconomic environment under which the global economy functions. It is the qualitative changes in the global financial and trading regimes which affect developing countries the most, and to a large extent, these changes are brought about by policies of major developed countries. In this context, UNIDO paid particular attention in preparing its medium-term projections to the probable impact of the new United States economic initiative, especially relating to its fiscal and trade policies.

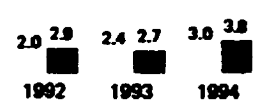
B. Economic leadership of the United States

One of the changes which will affect the world economy in the 1990s is the would-be strong United States economic leadership. For the first time in decades, the United States is focusing its international policy not on global security, but on global economic growth. The immediate concern of the United States is, for sure, its domestic economy, specifically the problem of job creation. However, the effort to revitalize the United States economy would not only eliminate some of the basic global economic imbalances, but will bring with it new United States policy initiatives on international economic dealings and trade arrangements. A new global economic order based on *realpolitik* of national economic self-interest might sound ominous. Yet, after a decade of directionless expansion based on an equally disoriented international competition, the world might welcome strong leadership – this time around, in international economics as was the case in geopolitics.

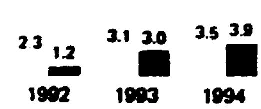
Table I.1. Regional and country estimates of GDP and MVA

Region, country or area	GDP growth rates (percentage) 1992	1993	1994	MVA growth rates (percentage) 1992	1993	1994
World	1.3	1.2	3.1	-0.9	0.4	3.6
Developing countries (excluding China)	3.5	4.0	4.4	3.0	5.0	6.0
Developed market economies	1.4	1.0	2.5	-0.8	-0.5	2.2
China	12.8	10.0	8.2	21.7	15.0	10.0
Eastern Europe and former USSR (excluding former Yugoslavia)	-12.1	-10.7	1.1	-18.9	-13.6	1.7
North America	2.0	2.4	3.0	2.9	2.7	3.8
Bermuda	1.9	2.0	2.5	2.3	2.4	2.5
Canada	0.9	3.0	3.3	0.5	5.2	3.0
United States	2.1	2.3	3.0	3.1	2.5	3.8
Western Europe	1.2	-0.3	1.9	-1.0	-2.8	1.1
Austria	1.5	-0.9	1.1	—	-2.8	1.1
Belgium	1.3	—	1.2	-2.4	-1.0	0.9
Denmark	1.1	1.1	2.1	1.9	2.4	1.3
Finland	-3.6	—	2.0	1.5	4.4	2.6
France	2.0	-0.8	1.9	-1.4	-3.6	0.6
Germany, eastern part	6.0	3.0	4.2	8.4	4.6	6.1
Germany, western part	1.5	-1.7	1.3	-2.1	-6.3	-0.6
Greece	1.4	1.5	2.0	-0.9	-0.1	0.7
Iceland	-4.3	-0.7	1.2	-8.5	0.1	-0.1
Ireland	2.1	1.2	1.8	9.8	2.8	4.7
Israel	6.4	3.8	6.0	8.5	4.1	6.2
Italy	1.0	-0.8	1.8	-1.8	-3.8	1.3
Luxembourg	1.7	3.5	3.3	-0.8	3.4	3.1
Malta	5.3	3.4	4.7	4.9	2.8	4.3
Netherlands	1.8	-0.7	1.5	0.2	-0.3	1.5
Norway	3.3	0.5	2.1	1.5	-1.3	0.0
Portugal	2.7	0.8	2.2	-4.0	0.1	1.9
Spain	2.0	-0.4	2.0	-2.0	-3.7	0.4
Sweden	-0.9	-1.6	1.4	-3.9	-6.3	0.2
Switzerland	-0.7	-0.5	1.0	-0.7	-1.3	1.1
United Kingdom	-0.6	2.0	3.1	-0.6	1.4	2.8
Eastern Europe and former USSR (including former Yugoslavia)	-12.3	-10.7	1.0	-19.1	-13.9	1.4
Albania	-16.0	-5.0	3.1	-20.0	-12.0	-3.2
Bulgaria	-15.0	-9.0	2.5	..	..	..
Former Czechoslovakia	-9.0	-3.0	1.0	-12.4	-4.5	-0.7
Hungary	-3.0	—	2.0	-8.5	-1.6	1.9
Poland	0.5	1.5	3.3	3.4	1.5	4.0
Romania	-15.0	-9.0	—	-22.0	-14.0	-10.0
Former USSR	-12.8	-12.0	1.0	-20.0	-15.0	2.0
Former Yugoslavia	-17.0	-11.0	-2.0	-24.3	-21.3	-10.2
Japan	0.8	1.1	2.5	-6.2	-0.8	1.8
Other developed countries	1.4	2.3	2.7	-1.3	0.9	1.7
Australia	2.2	3.0	3.4	-1.3	1.2	2.1
New Zealand	2.5	3.2	3.2	5.9	3.9	3.9
South Africa	-0.9	0.5	1.0	-3.4	-0.6	0.2
Latin America and the Caribbean	2.3	3.1	3.5	1.1	3.0	3.8
Argentina	8.7	6.0	6.5	13.9	9.1	10.1
Bahamas	-1.1	2.3	3.9	..	..	..
Barbados	-3.0	0.8	4.4	-7.1	0.4	2.8
Belize	-0.3	3.7	4.3	1.4	1.3	2.8
Bolivia	3.8	4.1	4.2	4.5	4.9	5.0
Brazil	-0.9	3.0	3.0	-3.4	2.0	2.0
Chile	10.4	5.0	4.3	17.6	7.0	6.0
Colombia	2.7	3.4	3.8	1.5	2.6	3.3
Costa Rica	7.3	4.5	4.7	8.6	5.1	5.4
Cuba	-10.0	-3.0	—	-11.0	-7.0	-2.0
Dominican Republic	7.7	5.3	3.0	9.5	5.8	2.1
Ecuador	3.7	3.2	3.9	2.8	3.2	3.4
El Salvador	4.6	4.2	4.4	5.3	4.9	5.2
French Guiana	1.4	—	0.6	2.3	1.9	2.1
Guadeloupe	1.8	4.1	2.7	1.4	1.5	2.0
Guatemala	4.6	3.5	4.0	4.6	3.4	4.0
Guyana	7.8	5.0	5.0	11.8	10.8	8.2
Haiti*	-10.0	-8.5	-5.5	-19.3	-16.5	-10.7
Honduras	4.3	3.9	3.9	4.4	4.3	4.8
Jamaica	2.0	1.7	2.0	1.7	1.5	1.8
Martinique	6.1	6.5	5.0	1.9	1.8	2.1
Mexico	2.8	2.5	4.0	1.8	2.9	5.1
Montserrat	0.3	2.9	4.0	6.3	4.4	5.7
Netherlands Antilles and Aruba	-1.0	1.3	-0.7	2.7	2.4	2.7
Nicaragua	-0.6	1.9	3.0	0.0	3.0	5.0
Panama	7.6	3.0	2.8	7.2	2.4	2.1
Paraguay	1.7	1.9	2.0	0.8	0.9	1.1
Peru	-2.8	2.5	1.5	-6.2	2.6	1.4
Puerto Rico	1.0	2.5	4.0	1.7	3.3	4.9
Suriname	1.4	2.4	1.4	1.0	1.5	0.5
Trinidad and Tobago	0.0	1.0	1.3	-1.3	1.7	0.6
Uruguay	7.4	3.0	3.8	8.3	2.6	3.6
Venezuela	7.3	4.0	2.0	8.3	5.1	3.2
Tropical Africa (sub-Sahara)	0.5	2.0	2.4	-0.1	2.7	3.3
Benin*	2.8	1.1	1.6	5.0	4.2	3.3
Botswana*	4.0	7.0	8.1	..	..	..

NORTH AMERICA



LATIN AMERICA AND THE CARIBBEAN



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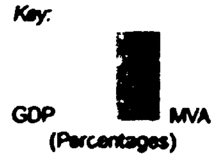


growth for 1992 and projections for 1993 and 1994

Region, country or area	GDP growth rates (percentage) 1992	1993	1994	MVA growth rates (percentage) 1992	1993	1994
Burkina Faso*	4.0	2.4	2.4	3.0	2.6	2.1
Burundi*	2.4	1.0	3.6	1.0	4.2	3.5
Cameroon	−4.0	−3.6	−2.9	−4.8	−4.1	−3.0
Cape Verde*	5.0	3.8	4.3	6.5	6.6	6.5
Central African Republic*	0.2	−0.1	0.7	1.9	1.8	2.0
Chad*	3.0	0.7	−0.3	2.6	0.2	−1.1
Congo	3.2	5.0	5.2	8.7	4.2	6.3
Côte d'Ivoire	0.7	1.0	2.5	2.0	1.7	3.6
Djibouti*	2.9	2.7	2.4	4.0	3.8	3.7
Equatorial Guinea*	−4.3	−4.5	−2.4	−4.9	−6.3	−3.9
Ethiopia and Eritrea*	1.0	—	1.5	−3.7	0.2	0.6
Gabon	1.5	2.5	3.0	. .	. .	. .
Gambia*	8.4	5.7	4.0	4.9	3.4	2.4
Ghana	3.9	4.6	6.1	5.8	7.5	11.0
Guinea*	2.1	0.6	1.9	2.5	2.1	2.4
Guinea-Bissau*	2.2	2.4	2.9	−0.1	−0.3	—
Kenya	1.0	2.1	3.8	2.5	3.0	6.0
Lesotho*	3.4	6.9	5.0	. .	. .	. .
Liberia*	−1.2	−3.7	−2.5	0.3	−4.6	−2.8
Madagascar*	−2.0	−0.9	−1.4	−5.3	−3.4	−3.1
Malawi*	−7.9	0.9	0.1	1.2	4.0	4.1
Mali*	0.3	3.2	2.3	3.3	4.2	4.6
Mauritania*	1.4	1.1	2.8	6.3	6.4	6.3
Mauritius	5.8	6.9	6.4	8.8	9.9	9.4
Mozambique*	—	0.5	−2.3	−0.2	−0.9	−3.4
Namibia	1.0	1.9	2.0	. .	. .	. .
Niger*	1.6	1.4	2.2	1.3	1.3	1.5
Nigeria	4.3	4.0	3.5	5.7	7.5	4.5
Reunion	4.7	4.2	5.0	4.1	4.3	3.7
Rwanda*	−19.0	−2.0	−5.0	. .	. .	. .
Sao Tome and Principe*	0.8	−2.5	−2.5	1.3	−1.3	−1.3
Senegal	3.3	2.1	3.1	3.1	4.0	3.6
Seychelles	1.9	2.9	3.6	7.9	8.4	8.8
Sierra Leone*	3.5	1.1	−0.6	0.8	0.1	−1.6
Somalia*	−7.0	—	−4.3	. .	. .	. .
Swaziland	4.1	3.4	4.3	6.0	4.5	6.0
Togo*	−1.5	1.3	2.2	−0.9	1.7	2.5
Uganda*	3.5	3.2	3.8	5.7	4.6	6.2
United Republic of Tanzania*	2.2	2.6	2.9	2.9	2.6	3.5
Zaire*	−6.1	−3.0	−2.1	−8.4	−4.7	−3.7
Zambia*	−2.2	0.1	−0.6	−2.6	0.3	0.5
Zimbabwe	−11.0	3.5	4.5	−10.1	4.3	5.0
North Africa	1.3	1.4	2.9	4.1	3.5	4.4
Algeria	−1.8	−0.4	1.1	−2.2	−3.4	1.5
Egypt	2.8	3.3	3.9	6.0	7.0	3.1
Libyan Arab Jamahiriya	0.9	0.1	3.5	9.7	9.9	10.2
Morocco	3.3	3.1	3.5	4.4	3.9	4.1
Sudan*	2.0	2.5	1.9	1.0	1.4	1.0

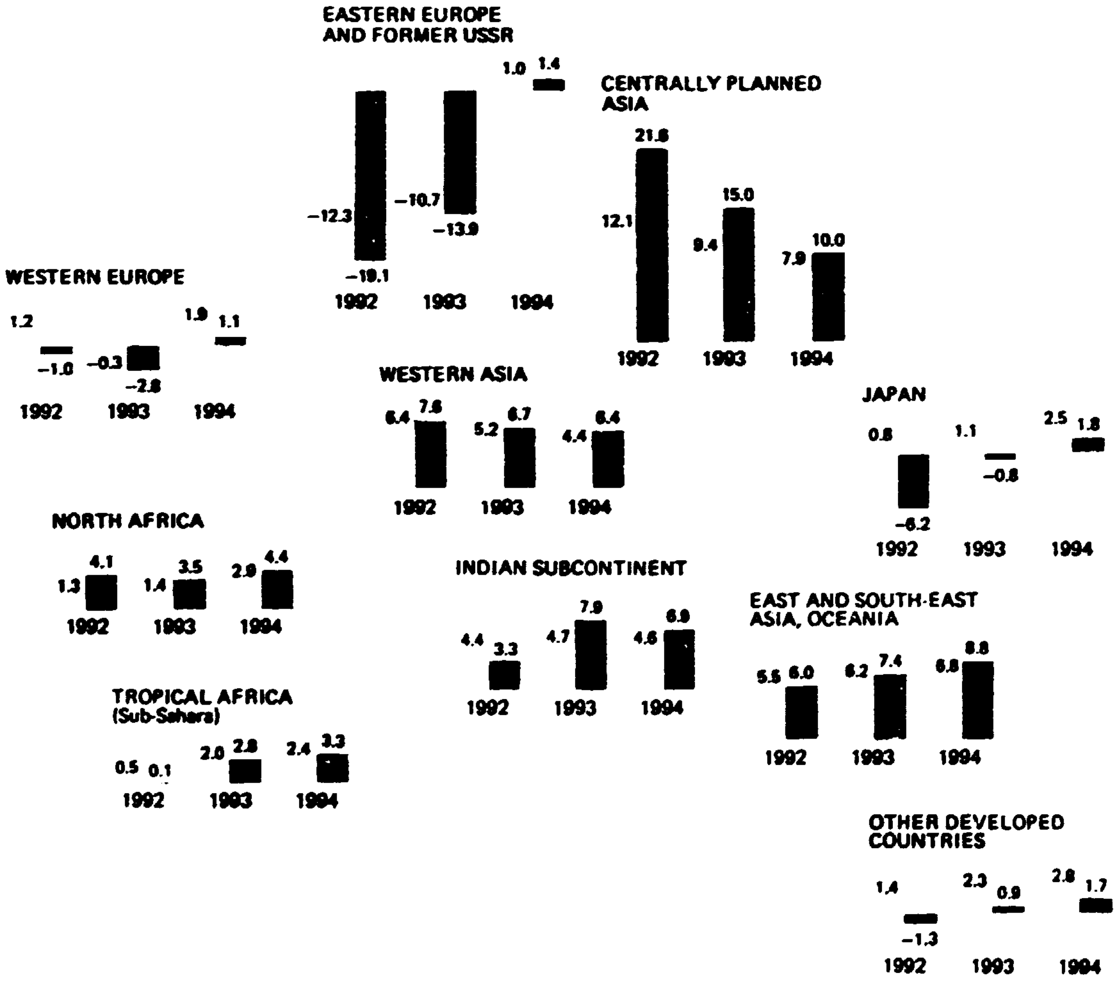


Table I.1. Regional and country estimates of GDP and MVA growth for 1992 and projections for 1993 and 1994

(continued)

Region, country or area	GDP growth rates (percentage)			MVA growth rates (percentage)		
	1992	1993	1994	1992	1993	1994
Tunisia	8.0	4.0	5.8	12.0	6.9	9.1
Western Asia	6.4	5.2	4.4	7.6	6.7	6.4
Bahrain	1.3	2.3	3.1	1.6	2.1	2.6
Cyprus	1.4	2.0	3.1	2.0	3.4	4.4
Iran (Islamic Republic of)	9.0	3.5	2.9	8.6	4.6	4.2
Iraq	-2.0	2.0	2.8	-1.1	8.0	5.3
Jordan	11.0	8.7	9.3	7.8	7.0	6.8
Kuwait	20.0	. .	8.0	20.7	. .	7.5
Oman	7.0	7,8	6.1	. .	. .	. .
Qatar	4.0	5.0	4.5	9.7	9.8	9.7
Saudi Arabia	5.0	5.0	4.5	7.7	7.7	7.7
Syrian Arab Republic	7.0	5.0	5.7	. .	. .	. .
Turkey	5.3	4.8	5.0	6.6	6.0	6.2
United Arab Emirates	3.5	4.0	4.5	10.4	8.4	7.6
Yemen*	3.5	6.5	8.1	8.5	8.6	8.5
Indian Subcontinent	4.4	4.7	4.6	3.3	7.9	6.9
Afghanistan*	3.0	3.0	4.0	4.0	3.4	3.7
Bangladesh*	3.9	4.6	4.0	10.1	. .	. .
Bhutan*	5.0	7.8	6.0	6.0	8.0	12.9
India	4.2	4.5	4.5	2.2	8.0	7.0
Myanmar*	1.2	1.5	0.8	1.1	6.0	1.3
Nepal*	3.1	3.7	5.2	1.5	3.0	1.4
Pakistan	6.4	6.3	6.0	7.7	6.0	6.9
Sri Lanka	4.3	4.4	4.1	7.5	8.0	7.2
East and South-East Asia, Oceania	5.5	6.2	5.8	6.0	7.4	8.8
Brunei Darussalam	2.0	0.4	3.3	2.4	0.6	3.9
Fiji	4.2	1.0	0.5	7.4	4.3	-2.2
French Polynesia	4.0	5.7	5.4	5.2	4.7	7.1
Hong Kong	6.0	5.5	5.1	4.6	4.3	4.4
Indonesia	5.7	6.1	6.5	8.9	7.0	8.4
Macao	. .	. .	. .	. .	. .	. .
Malaysia	8.1	7.8	8.0	9.2	10.8	11.5
New Caledonia	9.0	7.7	8.6	6.7	5.8	6.9
Papua New Guinea	9.0	9.0	8.0	15.1	14.6	13.9
Philippines	0.0	4.1	5.1	3.0	5.1	5.8
Republic of Korea	4.8	6.0	7.5	5.1	8.0	11.5
Samoa*	-5.0	3.0	1.1	-0.6	0.2	-0.6
Singapore	5.8	5.8	6.5	6.0	5.9	7.1
Taiwan Province	6.1	6.7	6.4	3.1	5.9	5.1
Thailand	7.4	7.6	8.1	9.0	9.2	9.8
Tonga	1.9	1.2	2.8	6.3	2.9	7.9
Tuvalu*	. .	. .	. .	. .	. .	. .
Vanuatu*	—	3.8	4.5	13.7	13.4	13.3
Centrally planned Asia	12.1	9.4	7.9			
China	12.8	10.0	8.2	21.7	15.0	10.0
Democratic People's Republic of Korea	-5.0	-6.2	-5.0	. .	. .	. .
Lao People's Democratic Republic*	7.3	5.9	5.8	8.0	8.1	8.5
Mongolia	-7.6	-10.0	—	-14.2	-5.0	—
Viet Nam	8.1	7.5	8.0	. .	. .	. .

*Least developed country.

Note: Calculations are based on 1980 United States dollars.

Table I.2. Share of manufacturing value added of developing countries in world total in 1975, projected shares for 1990 and 1994 and growth rates for 1975-1993

(Percentage)

ISIC	Industry	Share of developing countries in world total (excluding China)[a] 1975[a]	Projected 1990	Projected 1994	Average annual growth rates: Developed market economies 1975-1985	Developed market economies 1985-1993	Developing market economies 1975-1985	Developing market economies 1985-1993
3	Manufacturing	11.7	14.5	17.8	2.0	1.4	4.8	2.8
311	Food manufacturing	14.8	16.5	19.0	1.7	1.8	3.3	0.7
313	Beverages	19.8	23.9	27.6	0.8	1.6	2.8	2.8
314	Tobacco manufactures	32.9	35.0	37.2	1.5	3.5	3.6	3.4
321	Textiles	18.9	27.8	33.8	-0.4	-0.5	2.9	1.1
322	Wearing apparel	11.9	21.7	27.0	-0.4	-0.3	4.7	3.1
323	Leather and fur products	18.2	36.9	47.7	-1.2	-1.8	4.5	4.2
324	Footwear, excluding rubber or plastic	18.8	28.4	32.8	-0.5	-3.6	4.5	-1.5
331	Wood and cork products	12.6	12.5	15.1	-0.1	0.5	1.4	0.8
332	Furniture and fixtures	10.2	10.1	12.0	0.8	2.0	2.9	2.6
341	Paper and paper products	10.2	11.5	13.4	1.6	2.3	4.8	2.8
342	Printing and publishing	8.8	6.9	8.2	3.7	2.4	2.3	4.2
351	Industrial chemicals	9.6	12.6	16.2	1.4	2.7	6.9	2.5
352	Other chemical products	15.9	15.1	16.9	3.7	3.5	5.9	1.7
353	Petroleum refineries	24.7	38.5	45.1	0.9	0.6	6.8	3.3
354	Miscellaneous petroleum and coal products	5.8	15.3	21.2	1.0	2.2	11.8	0.9
355	Rubber products	13.4	21.2	26.8	1.0	0.3	5.7	3.7
356	Plastic products n.e.c.	13.7	13.4	15.1	5.6	3.9	7.3	3.7
361	Pottery, china and earthenware	14.1	20.5	27.5	-0.6	-0.1	5.9	1.6
362	Glass and glass products	11.5	14.2	17.9	1.5	1.2	3.5	3.9
369	Other non-metallic mineral products	14.2	20.4	27.4	0.5	0.9	3.4	4.4
371	Iron and steel	10.1	19.5	26.2	-1.8	-0.8	5.9	2.9
372	Non-ferrous metals	10.0	16.8	22.3	1.0	1.2	6.8	4.6
381	Metal products excluding machinery	9.8	10.8	13.8	1.2	1.4	3.8	3.2
382	Non-electrical machinery	5.1	5.8	7.6	2.7	0.8	4.9	2.2
383	Electrical machinery	8.2	12.4	15.5	4.8	0.6	7.3	5.9
384	Transport equipment	7.7	9.6	12.2	2.9	0.9	5.3	3.8
385	Professional and scientific goods	2.7	4.9	6.3	2.9	3.9	8.8	6.3
390	Other manufactures	9.8	17.4	22.9	1.0	1.3	6.2	4.5

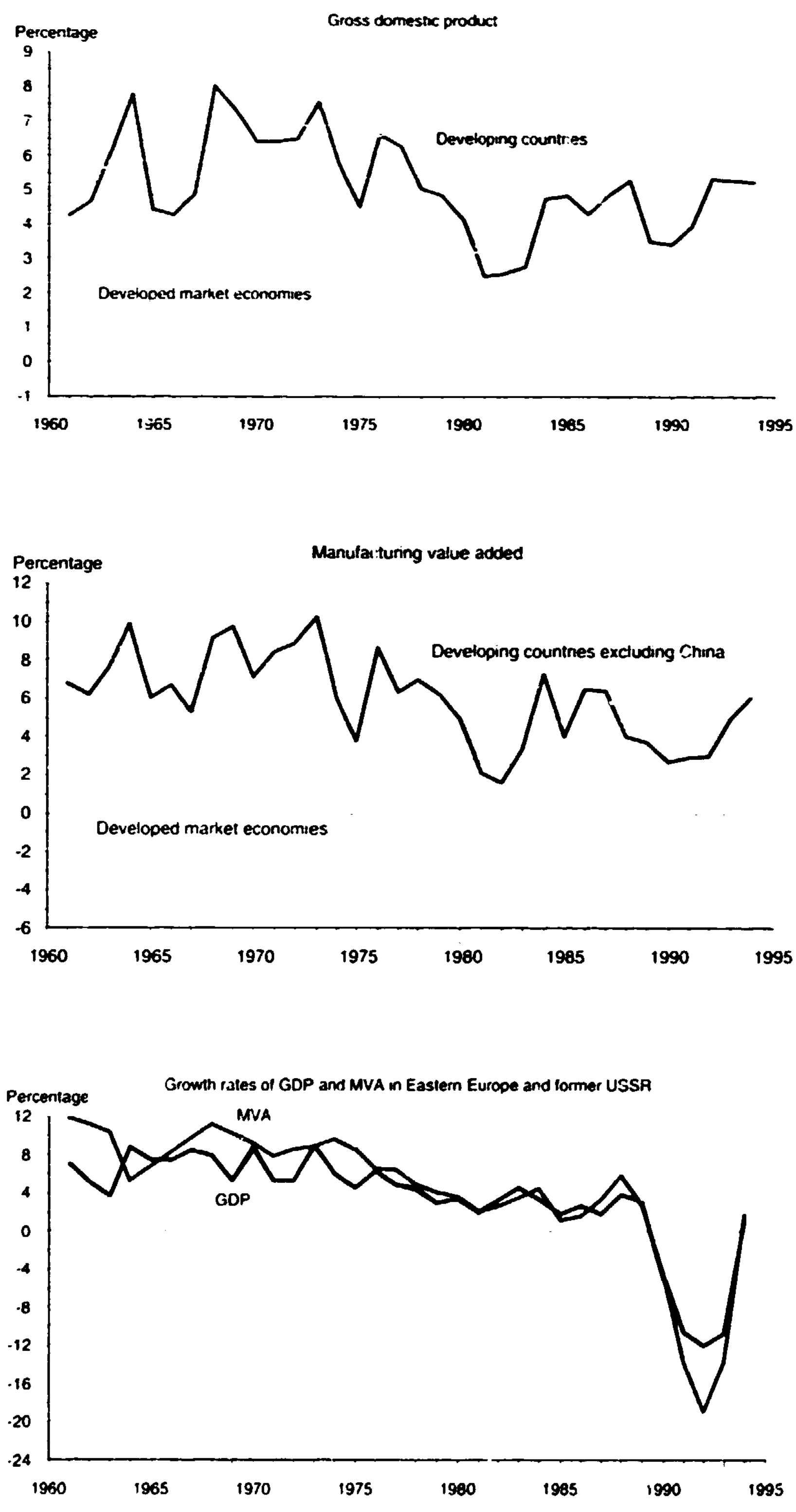
Source: UNIDO.

Notes: MVA growth rates are based on deflated national currencies converted to 1990 United States dollars. Growth rates are derived from 113 sample countries — 25 developed and 88 developing (industrial statistics consolidated by UNIDO).

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

[a]This share calculation is based on 1975 prices and exchange rates, other years are in 1980 dollars. China and other Asian centrally planned economies are not included in the sample (their share in the world total is estimated to have amounted to 2.2 per cent in 1990 for total manufacturing).

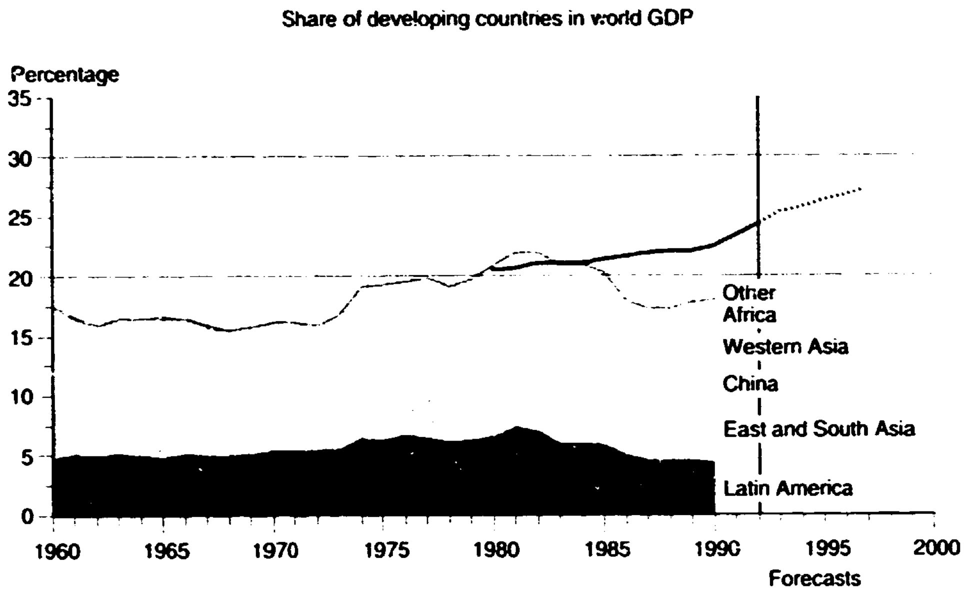
Figure I.1. Growth rates of GDP and MVA in developed and developing regions, 1961-1994

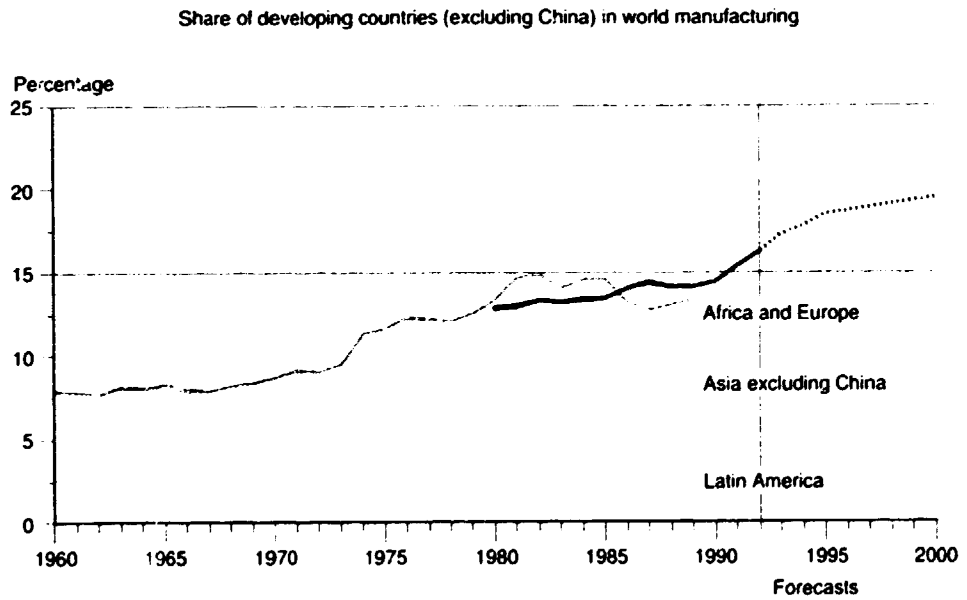


Note: Growth rates are computed using GDP and MVA data expressed in national currencies at 1980 prices and aggregated in terms of 1980 United States dollar exchange rates. The dashed lines show the long-term historical trend.

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

Figure I.2. Share of developing countries in world GDP and world manufacturing, 1960-2000

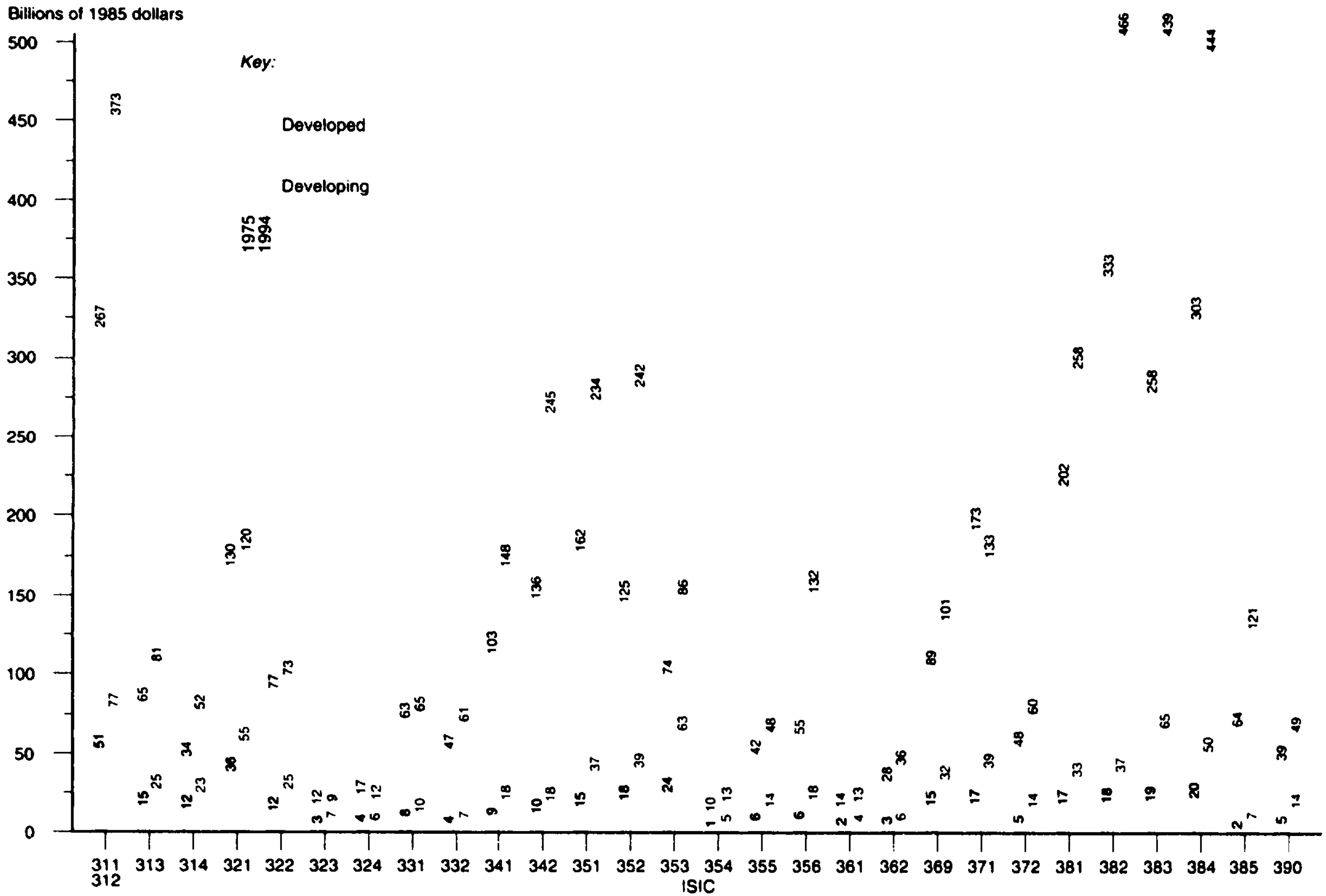




Note: Regional GDP and MVA shares are computed using national currency figures, which are aggregated in terms of United States dollars at current prices and exchange rates. The single dashed lines show the historical and projected world share of all developing countries for GDP and of all developing countries except China for MVA. They are computed using national currency figures expressed in 1980 prices and aggregated in terms of 1980 United States dollar exchange rates.

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

Figure I.3. Manufacturing value added of North and South, 1975 and 1994



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

Already the direction of United States policy is quite plain to see. It actually intends to reduce its fiscal deficit, which has become a burden to the world as well as to the United States. Narrow though his victories were in the House of Representatives and the Senate, the President succeeded in getting legislative approval for a deficit reduction package—tax increases and expenditure reductions—of $496 billion over the next five years. The deficit reduction will lower interest rates, domestically and internationally, and encourage investment which is essential for growth. The United States will urge the European countries to lower interest rates in favour of their own economic recovery, and to open markets to the former East bloc countries. The United States has asked for and received a pledge from Japan both to reflate its economy with another huge expenditure of public money to encourage imports, and to revalue its currency to discourage exports, especially to the United States. The yen appreciated by up to 25 per cent *vis-à-vis* the dollar in the year to August 1993. The multibillion-dollar international financial package to aid the Russian Federation would not have been possible without the United States initiative. What is required now is a strong and convincing United States economic recovery. Will this occur?

Paradoxically, the economic prospects for developing countries seem much brighter in the 1990s than during the 1980s. The World Bank is forecasting a surge in the growth rates of developing countries over the next 10 years. It projected annual growth rates of 4.7 per cent for the coming decade for developing countries as a whole, compared with the rate of 2.7 per cent achieved between 1982 and 1992. On the assumption that GDP per capita will grow at a slower pace, but still at 2.9 per cent per year, the Bank is confidently predicting the elimination of mass poverty in developing countries by the year 2002. UNIDO projections, which are essentially of a short- to medium-term nature, bear out this general optimism. The five-year UNIDO projection puts the growth rate for developing countries, excluding China, at 4.4 per cent per year. China, which is always treated separately in the UNIDO projection exercises, is however expected to grow at 8 per cent per year for the next five years.

There are basic reasons for this optimism. In the past three years, when the major developed countries were taking turns going through one of the worst economic recessions, developing countries remained largely unscathed, maintaining an average 3.2 per cent overall growth rate. Such a feat is all the more impressive when it is considered that the EC countries, working together, were scarcely able to achieve such a high joint growth rate even during the most prosperous years of the 1980s. Investors were quick enough to notice and exploit such a disparity in performance. The past three years have witnessed an unprecedented increase in private investment flows to developing countries. This sudden transformation of investor confidence reflects the often painful economic reforms undertaken by developing countries in recent years, under which trade and financial rules have been liberalized, public finances brought under control, unprofitable State enterprises sold off, and State control in industry and commerce has been generally reduced. But, as will be noted shortly, the "push" effect of the low interest rates in the United States has helped a great deal as well. The success by the new United States administration in lowering long-term interest rates provides a genuine opportunity for growth in the United States and for the rest of the world.

The most significant change for developing countries in recent years has been, however, their willingness to experiment with an open economy. Developing countries, with their fragile industrial bases and fear of foreign economic influences, have always felt infinitely more comfortable with an insulated and closed economy. Decisions to eliminate tariff barriers to expose domestic industries to international competition and to allow free capital movements across borders to encourage foreign direct investment signal the end of a self-imposed isolation by these countries. It is particularly ironical, therefore, to find that developed countries have in the meantime decided to move along in an opposite direction—in the direction of managed trade. One prediction that can be made is that, under the new United States economic leadership, free trade as such will undergo careful scrutiny as a functioning system not only for facilitating the exchange of goods among countries, but also to balance conflicting national economic interests of trade partners, including the secondary impact on domestic industries. The immediate hope for developing countries is, therefore, a strong United States economic recovery that will reduce the immediate trade pressures on the United States administration even as it provides a stimulus to developing-country growth. This will give the United States and the rest of the world time to resolve trade-associated problems gradually and rationally.

C. Prolongation of the ecomomic downturn

Although growth has picked up in the United States, the outlook for Japan and Europe has deteriorated, making economic recovery in the United States much weaker. A generalized economic recovery in the more advanced developed countries, and thus for the world as a whole, therefore remains even more elusive, and fears of the global economy sliding backwards into an even longer recession is prompting many international organizations to revise downward their original growth forecasts. The prolongation of the global economic downturn after 1991 is evidently due to the staggered nature of the current recession—each major developed country undergoing recession within a staggered time-frame. There are, however, indications that the current recessions will require much more than a quick restoration of consumer confidence in each country. For one thing, growth in real income in most major developed countries has been so low and for so long (see figure I.1), that both the national savings and investment ratios have been sliding down, undermining the strength of recovery and future growth prospects. But, more importantly, the long slow growth has deprived these countries of the essential ability to implement structural adjustments without inviting in turn a major economic downturn. In the meantime, Governments in many of the countries have been effectively deprived of the use of fiscal and monetary policies to counter these recessions. Today, for instance, no major developed country, excluding Japan, is in a position to raise the aggregate level of demand through public spending. In a capitalist economy, an occasional recession is unavoidable, with the public being accustomed to government action to steer the economy out of recession. The public would surely become extremely wary if it realized that the economy was rudderless, or even steered with the wrong rudder, in the midst of recession: witness the recently sweeping phenomenon of corporate "downsizing" or "re-engineering" in the more advanced developed countries, which promised to create millions of job redundancies in the name of enhancing international corporate competitiveness.

The prolongation of the current recession is therefore due to a generally lowered expectation for future growth held by both consumers and businesses in the more advanced developed countries, and to the fact that the same consumers and businesses are left to seek a "market solution" for their own problems as well as the global recession. The consequence of this is that not only is the resumption of growth uncertain, but the profile of future growth remains largely undecided: the overall shape of growth achieved through atomistic competition and spontaneous decision-making in the market place is bound to differ from growth obtainable through a joint strategy involving the Governments of a few major industrialized countries in command of their own macroeconomic policies.

D. Lower interest rates and economic growth

In the name of controlling inflation, the world in the 1980s paid a steep price in growth and development. Not only did the average growth rate for the world as a whole drop, but the strain of having to cope with various problems of structural adjustment internally and between countries in a slow-paced global economy became quite unbearable. In many countries, the combination of slow growth and high real interest rates effectively discouraged investment in the real production sectors and production-related infrastructure, and encouraged financial speculation. Real-estate prices soared, and the prices for manufactured goods and primary products kept easing domestically and externally. In both developed and developing countries, real wages generally failed to improve. Employment in developing countries increased steadily, but real wages declined continuously. In developed countries, however, the progress in productivity led to unemployment rather than to higher wages and income as capital share increased. With real income stagnant, developed countries have become increasingly protectionist, not only against cheap imports from low-wage developing countries, but against imports from one another. Foreign direct investment, used as a newly discovered instrument to circumvent actual and imagined trade barriers, inevitably resulted in duplicated production facilities all over the world, and caused excess world capacity, especially in the steel, automobile and electronics industries. In the meantime, more and more Governments kept becoming large debtors themselves, and by the time recession commenced, they were powerless and could not contain it.

Currently, inflation in the major developed countries remains at a modest 2 to 4 per cent per year. By August 1993, lower inflation expectations in the United States and the deficit reduction plan had pushed the yield on a 30-year United States Treasury bond to 6.53 per cent, down from 8.6 per cent in 1990, and 7.69 per cent in early November 1992. Given the 3.1 per cent consumer price increase observed in the second quarter of 1993, real interest rates in the United States have finally dropped below 3.5 per cent, and closer to the GDP growth of 2.3 per cent forecast by UNIDO for the United States in 1993. Thus for the first time in more than a decade, interest rate premiums on long-term industrial investment need not be double or triple the rates of return which the economy as a whole is capable of producing. Furthermore, the immediate impact on businesses is in their cash flow. Thus, lower interest rates are expected to save United States business some $30 billion, homeowners some $22 billion, and Government some $30 billion a year. Over $100 billion could be made available for spending on housing and on new plants and equipment by 1994.

The successful lowering of long-term interest rates in the United States broke the international log-jam which has kept global interest rates so high for so long. It might have been genuinely the case that a belated realization by Germany of the seriousness of its own economic recession prompted its interest rate cuts. However, the decision to lower the German interest rate would have been impossible in the absence of the precedent set by the United States, especially without endangering the international standing of the deutsche mark. Most EC countries saw the need to lower their interest rates in the face of the worst recession since the 1930s but were constrained from doing so by the parity provisions of the exchange rate mechanism (ERM) of the European Monetary System. However, in September 1992 Italy and the United Kingdom were forced by the international financial markets to exit from ERM; consequently, their currencies were devalued and their interest rates significantly lowered. As a result, signs of an end to recession and an economic turnaround, had by mid-1993 become clear in the United Kingdom. The financial markets continued pressure on the remaining members of ERM, with the result that by the end of July 1993 this pressure became almost unbearable, and ERM itself all but collapsed. It had become increasingly clear to the international financial markets during July 1993 that attempts to maintain some currencies, such as the French franc, within the prescribed parities of the unreformed ERM, were reminiscent of the linking of various major currencies in the 1930s to the Gold Standard, and similar economic damage was occurring. At the beginning of August 1993, the consensus in the markets was that almost all remaining countries of the ERM will reduce interest rates in a matter of weeks. As and when this occurs, EC countries will see their recessions coming to an end and a gradual return to growth.

Lower interest rates in the key currency countries, including Japan, would directly reduce the external debt service charges for developing countries, and assist these countries in lowering their own domestic interest rates. It is hoped that the era of high interest rates has finally come to an end, giving developing countries a chance of getting growth restarted. The benefits of lower interest rates to indebted developing countries are obvious. The aggregate external debt of developing countries, most of which are in various stages of debt restructuring, is still estimated to exceed $1,200 billion, of which, the interest-rate-sensitive portion amounted to $698 billion as of

June 1992.* A 100-bases points reduction in interest rates would therefore save these countries some $7 billion a year in hard currency. That these are significant sums to developing countries can be seen from the fact that the net transfer of financial resources to developing countries amounted to $28 billion in 1991 and $25 billion in 1992.

Of the $134 billion in aggregate resource inflows to developing countries which took place in 1992, more than half originated from the private sector (especially from the non-bank private sector), reflecting a reassessment by investors of the performance and prospects of developing countries. The multilateral financial institutions usually credit this change of perception to the painful reforms undertaken by developing countries, especially their financial and trade liberalization measures. Only a few years ago, the idea of New York institutional investors voluntarily purchasing Mexican Treasury bills denominated in new pesos would have been unthinkable. Since 1991, foreign investors have reportedly purchased $9 billion in Mexican Treasury bills (which currently earn 17 per cent per annum), and some $20 billion in Mexican bank certificates of deposit (which earn as much as 22 per cent annually). The main deterrent, the currency risk associated with these investments, proved to be minimal—devaluation of less than 5 per cent of the new peso per year so far (compared with the one-time devaluations of 20 to 30 per cent of some key European currencies during the same period).

This explosive growth in portfolio investment flows to developing countries was assisted by a steep fall in short-term interest rates in the United States, starting in mid-1990. Between mid-1990 and mid-1993, short-term bank rates declined from over 8 per cent to 3 per cent per annum, bringing the rate down to the lowest level since 1964. Huge amounts of savings hitherto held in certificates of deposit and money-market funds sought outlets in stock markets, often through mutual funds. However, with economic recovery taking more time than expected in the United States, high price-to-earning ratios have made the yields from stocks generally less attractive. In contrast, many so-called "emerging markets" have shown much better performances. The annual foreign equity investment in these newly established stock markets in developing countries increased from $0.4 billion in 1989 to over $6.0 billion in 1991, and to an estimated $5.2 billion in 1992. Including international bond financing by developing countries, the total private portfolio investment flows to developing countries jumped from $7.6 billion in 1989 to $20.3 billion in 1991, and are estimated to have reached over $27 billion in 1992.

During the same period, the share of United States dollar-based international lending soared from 60 per cent of all lending in 1990 to 86 per cent in 1991, and well over 90 per cent in 1992. The share of European currencies with relatively high interest rates fell sharply: the pound sterling, which made up 17 per cent of loans in 1990, contracted to a tiny 3 per cent, and deutschemark-based lending, which constituted 4 per cent of international loans in 1990, almost disappeared by 1991. Yen-based loans, which made up 7 per cent of international lending in 1987, disappeared almost completely by 1991, however, for different reasons. Lower interest rates in the United States, therefore, had the effect both of halting finally and reversing the past trend of international interest rate hikes, and of providing the international community with a much-needed, single reference currency with a single reference interest rate. Since exchange rate risks are an important component of the overall cost of international capital, this was also a positive development for capital-importing developing countries. Many economists believe that declining interest rates could add 0.5 to 1 percentage point to United States economic growth in 1993. The impact on developing countries, especially to those with high external debts, could be considerably greater.

*This consists of the total external claims of banks in the reporting area of the Bank for International Settlements and the official and officially guaranteed or insured trade-related claims of banks and non-banks in 20 countries of the Organisation for Economic Cooperation and Development (OECD) against developing countries, excluding such financial centres as Bahrain, Singapore and Vanuatu.

E. The halving of Japan's trade surplus

During 1992, world trade expanded by 4.5 per cent—an unusually high rate, given the depressed status of world output. One of the reasons for this is undoubtedly the staggered nature of the current world recession, which is causing rising and falling economic activity levels in different countries at different times. The low growth in world output and its uneven distribution among the major trading countries brought about an unexpected result, that of concentrating the world trade surplus in a very few countries. Specifically, in the fiscal year ending 31 March 1993, Japan achieved a record trade surplus of $111 billion (on a customs-cleared basis) which amounted to 47 per cent of the total world trade surplus—the sum total achieved by all surplus countries in 1992. The fact that Japan started slowing down precisely when its trade partners were all poised for expansion, even at the risk of incurring larger trade deficits, has had its impact. During 1992, therefore, the trade surplus of Japan with the United States widened from $38.46 billion to $46.11 billion, with the EC countries from $28 billion to $31 billion, and with the developing Asian countries from $35 billion to $44.8 billion. In the meantime, the Japanese trade deficit *vis-à-vis* the rest of the world, including the oil-exporting countries of Western Asia, decreased to $30 billion, producing the record surplus.

Soon after Japan's announcement of the 1992 trade surplus, the United States proposed to Japan that it should reduce its surplus, not only with the United States, but with the entire world, by as much as 50 per cent over the next three years. Although prompted by the chronic Japanese trade surplus, this proposal could considerably alter the level of future world trade, as well as the size of international capital flow. This is because, whether concentrated or not, the overall size of the world trade surplus (which is equal to the combined sum of deficits of all trade deficit countries) bears a close relationship with the overall level of world trade, as well as constituting the direct source of international investment capital. The level of world trade, in turn, frequently affects and determines the level of world output. The interdependent relationship between output, trade and trade imbalance is not a static one, as was argued in *Global Report 1985* ([1], chapter I) the first in the series.

However, it has shown enough historical consistency to warrant closer scrutiny, as is briefly reflected below.

First, regarding the trade and output relationship, since 1981 the world as a whole has been setting aside on an average a little more than 18 per cent of the goods and services it has produced annually for international trade. The ratio between world trade (measured here by exports) and world GDP actually ranged from 17.7 per cent (1986) to 21.1 per cent (1981). Even within this narrow range, the ratio varied in strict conformity (an inverse relation) to the general level of world economic activity—with a clear tendency to increase during periods of economic recession, and to decrease during the expansionary phase. This observation simply confirms the fact that trade mimics the behaviour of output, but moves at a much quicker and exaggerated tempo.

Since international trade is carried out by individuals, if such trade was free, the attempt to balance exports of a country against its import at a particular time would be neither feasible nor desirable. Furthermore, countries exporting more than their imports are in fact transferring resources to others requiring external financing. Given the wide scope for international resource flows, the world trade imbalance (measured here either by the sum total of trade deficits incurred by all individual deficit countries, or by its counterpart — the sum total of surpluses) has remained extremely modest since 1974, when 1.88 per cent of world output was transferred from surplus to deficit countries. The current ratio of world trade imbalance against world GDP is estimated to be less than 1.20 per cent. The year 1974 was admittedly an exceptional year, when the quadrupling oil price produced many sudden surplus (and deficit) countries. The ratio dropped to 1.13 per cent in 1982 in the wake of the so-called third-world debt crisis, but recovered soon after (1.49 per cent in 1984, 1.67 per cent in 1985, and 1.70 per cent in 1986) with a liberalized and increasing capital transfer, mainly among developed countries. It has, however, been steadily declining since 1986 with a gradual diminution in the number of capital-exporting countries both traditional (such as Germany) and upstart (such as the Republic of Korea). Indeed, the ratio dropped to 1.12 per cent in 1990, when Germany switched its status to a deficit country, and Japan became practically the only major developed country carrying a sizeable trade surplus. As mentioned earlier, by 1992 Japan's trade surplus of $111 billion had become the source for almost half the total global resource transfer.*

The gradual shift of emphasis from macroeconomic to micro-economic decision-making in the 1980s has altered the very precept of international division of labour, and changed the course of global industrialization significantly. Under the post Second World War Bretton Woods system, countries tried to match exports with their import requirements, or to import as little as their export earnings could afford, setting a limit to international specialization. The focus of the Bretton Woods system was on trade among countries. However, the new system of trade involving individuals, lacking the constraint of a national discipline, has allowed international specialization to proceed more or less unchecked. At the same time, the new trade regime has exposed all domestic producers, not only those engaged in export industries, to international price competition, creating a genuine probability that a country could lose a whole spectrum of industries in one sweep. A managed trade system, in the context of establishing an overall ceiling on national imports (compared to the more rigid sector-by-sector adjustment targeting) remains, therefore, a real possibility for a country such as the United States, concerned about "deindustrialization".

F. Prospect of trade diversion and global industrial realignment

Managed trade, in one version or another, looms large on the global scene. One reason why free trade had a rough ride in recent years stems from the persistently high unemployment figures observed in the more advanced developed countries. When the global economy is poised for an upswing, protectionist sentiment subsides and trade expands. This time around, however, some countries are determined to keep whatever fragile growth stimulus they have found or generated for themselves—to expand domestic output, and not to disperse it on imports. The United States, which bailed out the world economy in 1981 by opening the floodgate to foreign imports, is far less inclined this time to play the same locomotive role. Unlike in 1981/82, the United States economic recovery starts with a large trade deficit and high unemployment. A fall in United States unemployment to 7.1 per cent in January 1993 indicated that the 4.8 per cent economic growth rate of the fourth quarter of 1992 was beginning to dent the high unemployment figures. The 106,000 newly created non-farm jobs constituted, however, only a third to a half of the monthly increase registered in previous recoveries. Manufacturing employment increased by 50,000 in the fourth quarter of 1992 to 1.75 million. But this was in pale comparison to the 200,000 manufacturing job losses registered in the third quarter of 1992 alone. On the other hand, the strong United States showing in the fourth quarter of 1992 has brought about a surge of imports.

If the United States is to create growing job opportunities, a steady 4.5 to 5.0 per cent rate of growth has to be maintained without a further deterioration in its trade balance. Such growth rates for the United States were common in the 1960s and 1970s. In the 1980s, however, the United States achieved the necessary growth rate only once—in the second year of recovery after the 1982 recession, and before its dependence on imports became a structural rather than cyclical problem. The employment gains in manufacturing achieved in 1984 have also long since disappeared under the flood of imports. This unsatisfactory job-creation record prompted the new United States administration to pronounce an "aggressive and targeted" approach to create "the high-wage

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*Another way of looking at the overall world trade imbalance is to regard it as the necessary cost for conducting world trade. As any business person knows, at any given time, a proportion of sales has to be outstanding on credit — otherwise sales would decline. In 1974, the total combined trade deficit of all deficit countries amounted to about $89 billion, or 9.2 per cent of total world exports —a historical high. It used to be around 4 per cent in the 1960s, and increased to 8 to 9 per cent during the two oil crises. In the mid-1980s, the ratio climbed back to 8 per cent because of the massive credit sales to the United States. Otherwise the ratio stays within the range of 6 to 7.5 per cent. This means that if all the exporters gave a rebate of 6 to 7.5 per cent on their sales at the end of any fiscal year, world trade would be in complete balance, including all bilateral trade.

jobs of the future".* Under the circumstances, the United States is bound to take a searching look at its traditional trade policy, seen as an extension of its new industrial policy. Implicit in this change of policy is the need for the overall structure of United States imports to undergo a sector-by-sector scrutiny which will inevitably lead to a large-scale modification in its existing bilateral trade relationships, forcing another global restructuring in terms of output and employment. Notwithstanding the diplomatic success of President Clinton at the Tokyo summit, held in July 1993, of the Group of Seven major industrialized countries and the optimism generated for a not-unsatisfactory completion of the Uruguay Round of talks under the General Agreement on Tariffs and Trade (GATT), the very significant change of Government in Japan in August 1993 adds a new element of uncertainty. The uncertainty may arise out of new differences of policy *vis-à-vis* Japan's major partners regarding development cooperation, trade and interest and exchange rates.

An examination of the relationship between output and employment in the United States shows that every $1 billion in extra manufactured imports in 1990 would have cost the United States economy 17,650 jobs, of which 7,060 would have been in those manufacturing industries directly affected. Similarly, an additional $1 billion in manufactured exports in 1990 would have created 15,100 new jobs in the economy as a whole, and 6,040 in the industries experiencing the export boom. The difference in the impact of imports and exports on employment figures stems from the fact that the composition of United States exports differs from its import composition. Not surprisingly, United States exports generally contain less labour inputs than its imports.** This relationship holds true even for trade with Japan. In terms of those manufacturing industries directly affected, United States exports to Japan in 1990 contained, on an average, 5.76 man-years of labour per $1 million in sales, which compared with 6.57 man-year units contained in the equivalent sum of imports. This means that the United States can create more jobs more quickly by cutting imports rather than pushing exports to reduce its massive bilateral trade deficit. In 1990, the United States exported $33.7 billion worth of manufactured goods to Japan, and imported $89.8 billion worth of manufactured products from that country.

In 1990, the United States exported to EC countries some $80 billion worth of manufactured products, containing on an average 6.0 man-years of labour input per $1 million. The United States, in turn, imported $81 billion worth of manufactured goods from Europe, which would have required 6.33 man-years per $1 million to produce domestically. The recent row between the United States and the EC over telecommunications and heavy electrical equipment contracts in Europe involves the surprisingly labour-intensive electrical machinery industry in both the United States and Europe. The number of employees per $1 million of gross output in the electrical machinery industry in the United States was 9.72 in 1980 and 7.54 in 1990, representing a 23 per cent improvement in labour productivity in a decade. However, the industry remained relatively labour-intensive, the comparative figures for the United States manufacturing sector as a whole being 6.87 in 1980 and 6.12 in 1990. For exactly the same reason, the industry remains important for EC countries, where the comparative labour content figures for the industry were 11.69 in 1980 and 8.53 in 1990.

The United States currently runs a healthy trade surplus with EC countries, postponing the need for a detailed sector-by-sector examination of United States trade with the EC for the time being. The consequence of this surplus is that the main focus of the new United States trade policy has been directed towards Japan, China and other East and South-East Asian countries. The huge United States trade deficit with Japan has become a perennial problem for both countries and even for the world economy as a whole. In principle, bilateral trade imbalances, no matter how serious they might be, would be accepted by countries if their combined aim was to create a genuinely free multilateral trade system for the whole world. Japan has been underlining its traditional stand for a globally integrated, against a regionally based, trade system, and "rule-based", against "results-oriented", trade policies—the approach the United States intends to use to pry open Japanese markets. Japan's advocacy of adherence to free market and free trade principles is based on more than just pure ideology. Japan imports raw materials and exports finished products, which requires a multilateral global system of trade balances as a basic precondition. With only a difference in degree, the situation is common to all countries, including the United States. However, for the time being, the world is definitely heading for a heterogeneous trade balance and multilayer clearance system, in which the trade surplus of Japan *vis-à-vis* the United States in particular is expected to decline.

In 1993, China is expected to become one of the "top 10" exporting countries in the world. The extraordinary export growth of China, especially *vis-à-vis* the United States, has placed the China-United States trade relationship in a much similar situation to the Japan-United States trade relationship. While the United States is demanding trade liberalization from China and improved access to its markets, China still sees early GATT membership as one way of dealing with bilateral pressures from its main trade partners including the United States. In sharp contrast, most of the East and South-East Asian countries, long accused of trade malpractices, have gone ahead by diverting their trade from the United States and focusing increasingly on their own geographic region. Intraregional trade among the Asian countries has been growing since the mid-1980s. The pace has, however, accelerated since 1989, when the United States growth rate started declining, and with it began the build-up of pressure by the United States on these countries to reduce their bilateral trade surpluses. In 1992, of the $487.7 billion combined export figure of nine Asian developing economies,* $144.5 billion or fully 30 per cent of it consisted of exports to each other, while $105.3 billion or less than 22 per cent of their combined exports

*As stated by President Clinton in his State of the Union message to Congress.

**This conclusion contradicts the so-called Leontief paradox. However, no direct comparison is possible due both to the long period of time which has passed since those original calculations, and to differences in the valuation methods used [2].

*Including China, Hong Kong, Indonesia, Republic of Korea, Malaysia, Philippines, Singapore, Taiwan Province and Thailand.

went to the United States. In contrast, the United States used to provide 31 to 33 per cent of the total export market share for these Asian countries at a crucial stage of their export-driven industrial development during the 1980s. The need for growing South-South trade argued in *Global Report 1985* ([1], chapters III and IV) seems to have been recognized in practice at last.

Nevertheless, one consequence has been that the United States has been running declining, but persistent, bilateral trade deficits with most of the East and South-East Asian developing economies. These deficits combined stood at $31 billion or almost 47 per cent of total United States global trade deficits in 1991. With the exception of China, these economies have been running deficits with Japan, amounting to $32.5 billion in 1991 and equal to just under a third of the global trade surpluses of Japan in that year. Quite clearly industrialization in the developing Pacific Rim countries has changed the pattern of trade and investment flows among countries in the region. Figure I.4 is a simplified sketch of how the pattern of trade and investment among some of the Pacific Rim countries has changed from around 1980 to the present, and how it seems likely to evolve during the rest of the decade. Figure I.4 shows the strategic role that Asian countries have been assigned and have come to play so effectively in the triangular industrial relationship of production, specialization and trade with the United States and Japan. This industrial relationship, inasmuch as it has been mostly uni-directional in product flow, has been aberrational. It also had its ultimate limit in the willingness of the United States to accommodate it. The message is now clear, or has been for some time, that the limit has indeed been breached.

Even when the United States trade balance becomes lopsidedly favourable, overconcern for domestic employment persists. United States exports to Mexico have grown from $12 billion in 1986, when Mexico began reducing tariffs, to $44 billion in 1992. The North American Free Trade Agreement (NAFTA) will eliminate tariffs on most trade between the United States, Canada and Mexico, creating the world's biggest trading bloc. With a host of young, well-trained workers willing to work for $60 a week, Mexico provides the United States and Canada with a practicable alternative to the triangular industrial relationship and the production arrangement involving the South-East Asian countries as shown in figure I.4. Access to cheaper labour is, however, not a priority goal of the United States for the time being. All the same, there is the danger of repeating the mistakes made by Germany in its transition after reunification, where wages in the eastern portion were artificially increased and the environmental and labour standards drastically raised before the pool of relatively cheap labour could effectively be absorbed and utilized for the benefit of all. This being said, it is still no more than a question of time before NAFTA, in one version or another, or even in its expanded version including other Latin American countries, is expected to come to pass.

In 1990, the United States exported to Africa $6.14 billion in merchandise (mainly to Egypt and Algeria). This amounted to no more than 1.6 per cent of its total exports to the world. Although the figure represents a 12 per cent improvement since 1985 (a low point), it shows absolutely no improvement from the $6.18 billion observed a decade ago in 1980. As a source of imports, African countries are a little more significant to the United States. The United States imported from African countries a combined sum of $30 billion in 1980, $10.30 billion in 1985 and $15.13 billion in 1990 (all in nominal current dollars)—70 to 75 per cent constituting imports from three or four oil-producing African countries. The rest of United States imports were apportioned thinly among 48 to 49 countries whose primary export earnings depend on two or three export commodities each. The impact of change in United States trade policy, therefore, would not be a direct one as far as African countries are concerned. A United-States-initiated world economic recovery might, however, lead to increased demand and improved prices for their export commodities.

G. Income gap between developed and developing countries

Many developing countries possess an absolute advantage in cheap labour; and with increasing mobility of capital, the cost of capital tends to converge worldwide. If prices of traded goods were equal everywhere, then wages and income in each country should converge. Thus, the idea that poorer countries with low wage labour should catch up to richer ones through trade is as old as the theory of international trade itself. That convergence in income has somehow failed to take place between developed and developing countries—having mainly occurred among developed countries up to now—is usually taken as an indictment against the existing system of global trade. If this were indeed the case, there are several possible explanations for it. For instance, either the developing countries do not really possess cheap labour or the prices of traded goods are not equal everywhere, or perhaps such convergence takes much longer than the economic theorists have foreseen.

Table I.3 compares the wage levels in the manufacturing sector observed in 1990 in some 110 countries, converted into dollars at current exchange rates. Apparently, German manufacturing workers were paid the highest and workers in the United Republic of Tanzania the lowest wages in terms of annual remuneration. As expected, there was an enormous difference in productivity between workers in these two countries—the gross output of German workers being 48 times greater than that of their counterparts in the United Republic of Tanzania. The wage differential between the two countries was, however, 189 times in favour of German workers, making the United Republic of Tanzania a much cheaper place to locate in terms of labour cost per unit of output. Even so, the labour cost advantage enjoyed by manufacturers in the United Republic of Tanzania was more than ruled out because of the much higher material cost which they had to bear. The actual breakdown of production costs in 1990 involving these two extreme-case countries were: per $100 worth of manufacturing output, direct labour costs of $6.32 in the United Republic of Tanzania and $24.98 in Germany, and material costs of, respectively $78.06 and $50.37, leaving $15.63 and $24.65 as gross manufacturing profits in each country.

Figure I.4. Changing partners and changing roles in the Pacific Rim trade and investment triangle: 1980-2000

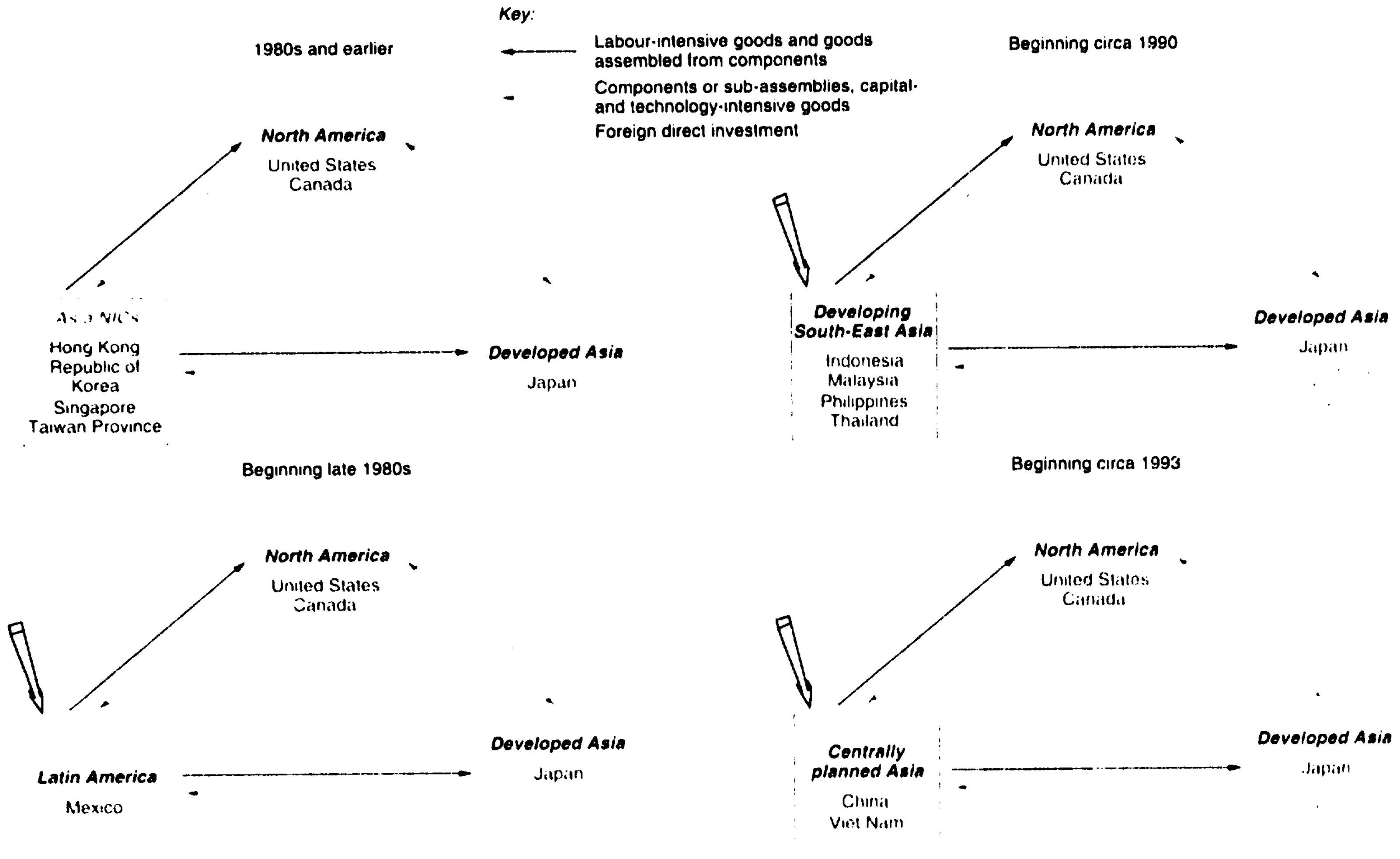

Table 1.3. International competitiveness in manufacturing: labour productivity and unit costs in 1990 with average annual growth rates, 1980-1990

Country or area	Wage per employee 1990 (dollars)	Wage per employee Average annual growth	Gross output per person engaged 1990 (dollars)	Gross output per person engaged Average annual growth	Unit costs of production per $100 of output: Labour Percentage	Labour Average annual growth	Intermediate input Percentage	Intermediate input Average annual growth	Gross output Percentage	Gross output Average annual growth
Germany, western part	38 440	1.33	153 881	1.68	24.98	-0.34	50.37	-1.40	24.65	4.31
Finland	37 654	2.91	171 322	1.81	21.98	1.08	64.48	-0.06	14.24	-1.17
France	36 111	1.52	151 193	2.23	22.65	-0.72	62.05	-0.37	15.29	3.10
Norway	35 540	1.22	184 350	2.25	19.23	-0.97	72.03	0.18	8.75	0.84
Netherlands	35 414	1.10	185 446	2.04	19.10	-0.42	69.76	-0.52	11.14	5.37
Luxembourg	34 311	0.61	176 968	4.09	21.11	-2.49	62.29	-0.31	16.60	6.83
United States	33 573	1.07	163 521	1.17	20.53	-0.10	53.79	-0.84	25.67	1.17
Denmark	33 093	0.45	144 754	0.91	22.79	-0.43	56.63	-0.49	20.57	2.10
Italy	31 954	0.64	170 796	1.82	18.56	-1.13	67.26	0.93	14.19	-2.29
Austria	30 941	1.74	162 351	2.32	22.70	-0.40	64.93	-0.33	12.37	2.93
Canada	28 410	1.18	167 278	1.19	16.97	0.01	62.14	-0.33	20.89	1.05
Japan	26 828	2.37	200 997	2.12	13.12	0.75	60.29	-0.76	26.59	1.56
Iran (Islamic Republic of)	26 415	-4.44	113 449	-2.44	23.92	-1.79	45.49	-0.62	30.59	2.92
United Kingdom	25 318	1.95	118 945	3.06	21.00	-1.12	56.03	-0.54	22.97	2.84
Sweden	24 885	0.44	160 525	2.21	15.50	-1.73	55.46	-0.41	29.04	2.02
Spain	24 115	0.89	126 977	2.28	17.73	-1.42	66.34	0.15	15.94	1.14
Ireland	23 879	2.16	170 261	4.13	13.97	-1.83	55.44	-1.45	30.59	4.86
Belgium	22 774	0.53	199 636	4.97	11.41	-3.65	71.11	0.63	17.49	0.48
Iceland	21 878	0.78	110 295	0.67	19.83	0.10	68.24	1.11	11.93	-4.66
Israel	21 499	-2.73	93 942	0.14	21.46	-3.37	64.30	1.63	14.24	-0.56
Australia	20 456	0.27	120 803	2.17	16.75	-1.83	62.74	0.23	20.51	1.04
New Zealand	17 676	-0.81	97 492	1.06	16.88	-2.55	69.27	0.21	13.85	3.00
Kuwait	16 259	2.89	89 144	-6.85	16.65	9.45	48.66	-3.82	34.69	4.94
Libyan Arab Jamahiriya	16 120	-0.44	144 723	1.10	11.60	-1.08	68.37	-0.18	20.03	1.37
Greece	12 941	2.33	107 392	1.18	15.28	1.25	68.68	-0.23	16.04	-0.13
Singapore	10 790	5.40	112 015	3.25	9.59	2.12	69.75	-0.56	20.66	1.15
Saudi Arabia							70.07	-0.82		
Portugal	10 367	2.21	63 816	3.00	16.04	-0.71	68.68	-0.01	15.28	0.87
Gabon	10 333	1.90	54 258	0.34	18.85	1.45	68.18	0.09	12.96	-2.13

Table I.3 *(continued)*

Country or area	Wage per employee: 1990 (dollars)	Wage per employee: Average annual growth	Gross output per person engaged: 1990 (dollars)	Gross output per person engaged: Average annual growth	Unit costs of production per $100 of output — Labour: Percentage	Labour: Average annual growth	Intermediate input: Percentage	Intermediate input: Average annual growth	Gross output: Percentage	Gross output: Average annual growth
Taiwan Province	10 168	7.59	63 575	2.30	15.99	5.17	61.43	-1.72	22.58	2.71
Germany, eastern part	10 054	1.83	114 296	7.26	8.75	-5.10	81.41	4.32	9.83	-11.09
Trinidad and Tobago	9 906	-0.28	56 168	-1.64	16.61	0.78	75.04	0.79	8.35	-5.86
Cyprus	9 738	4.47	46 057	2.34	19.21	2.37	63.94	-0.04	16.85	-1.98
Barbados	9 449	2.28	62 042	1.32	15.14	0.94	77.44	0.09	7.42	-0.88
Republic of Korea	9 353	7.98	82 955	6.39	11.04	1.44	60.00	-1.14	28.96	2.28
Malta	9 238	1.87	51 038	4.91	17.89	-2.50	61.01	0.64	21.09	0.69
Hong Kong	9 182	4.13	54 430	4.75	16.87	-0.59	71.02	0.60	12.11	-2.25
United Arab Emirates	9 065	0.38	73 933	3.54	17.31	-0.55	68.88	2.97	13.81	-7.56
Turkey	9 013	1.51	74 807	4.83	12.03	-3.07	60.37	-0.45	27.60	3.07
Cote d'Ivoire	7 997	0.91	106 615	3.46	7.33	-2.69	73.94	0.81	18.73	-1.66
South Africa	7 817		43 590	0.50	17.93		64.22	-0.38	17.85	
Algeria	7 377	0.41	27 723	-1.35	26.18	1.61	56.65	-0.58	17.18	-0.26
Cameroon	7 281	-1.47	51 631	-1.30	14.10	-0.16	68.32	1.54	17.58	-4.22
Senegal	7 074	4.62	37 210	-1.53	12.46	1.85	56.68	-2.87	30.86	8.40
Argentina	6 767	-2.67	83 878	-0.21	8.07	-2.46	60.56	0.75	31.37	-0.65
Nicaragua	6 440	-7.83	55 173	-7.94	10.87	-0.59	34.82	-5.36	54.30	6.83
Panama (excluding Canal Zone)	6 184	1.99	43 810	-2.43	14.04	4.46	63.60	-0.61	22.36	-0.43
Central African Republic	6 047	5.55	33 904	4.59	17.01	0.44	68.22	0.60	14.77	-2.71
El Salvador	6 024	-2.53	47 460	-0.77	12.42	-1.99	52.65	-1.36	34.92	3.65
Papua New Guinea	5 587	-1.58	34 036	-2.23	16.68	0.93	56.32	-0.49	27.00	0.52
Congo	5 428	-1.03	35 352	4.65	15.33	1.95	62.51	-	22.16	-1.14
Iraq	5 390	2.12	41 491	1.48	12.89	0.55	46.05	-2.88	41.06	4.62
Mexico	5 373	-1.48	61 903	3.23	8.68	-4.56	56.71	-0.19	34.61	2.02
Burkina Faso	5 115	1.39	64 304	2.06	7.94	-0.68	65.39	0.36	26.67	-0.63
Sudan	5 074	-1.69	63 239	0.52	8.30	-1.42	71.68	0.70	20.02	-1.62
Chile	4 861	1.36	70 919	3.62	6.83	-2.16	58.72	0.89	34.45	-0.91

	Wage per employee		Gross output per person engaged		Unit costs of production per $100 of output					
					Labour		Intermediate input		Gross output	
Country or area	1990 (dollars)	Average annual growth	1990 (dollars)	Average annual growth	Percentage	Average annual growth	Percentage	Average annual growth	Percentage	Average annual growth
Venezuela	4 651	-4.91	51 776	0.96	8.95	-4.78	49.54	-0.51	41.51	2.24
Uruguay	4 625	1.54	42 801	3.32	10.83	-1.64	55.95	-0.87	33.21	2.42
Peru	4 619	-3.77	48 216	-7.16	9.55	3.62	49.07	-2.25	41.38	2.69
Togo	..	..	49 168	0.69	..	..	61.84	-1.32	..	..
Niger	4 501	-3.40	29 335	-3.54	15.82	0.49	65.31	0.02	18.88	-0.32
Former Yugoslavia	4 488	1.12	24 252	-1.34	18.32	2.39	55.49	-2.30	26.19	5.40
Jamaica	4 484	-0.06	39 263	0.57	11.42	-0.62	70.60	-0.44	17.98	2.47
Brazil	4 334	1.54	56 015	0.54	7.74	1.00	74.90	2.36	17.36	-6.41
Zimbabwe	4 099	0.99	25 098	1.56	16.34	-0.56	53.02	-1.01	30.64	2.45
Macao	4 098	3.13	22 185	1.26	16.21	0.70	71.36	0.30	12.43	-2.28
Syrian Arab Republic	3 843	1.45	72 252	7.43	5.32	-6.44	79.77	2.44	14.91	-5.76
Tunisia	3 834	0.84	27 195	-0.61	14.74	1.93	70.93	-0.39	14.33	0.18
Swaziland	3 504	-2.13	35 895	-1.25	9.84	-0.81	57.71	-2.41	32.44	7.54
Fiji	3 253	-2.92	30 433	-2.58	10.51	-0.16	77.88	0.36	11.61	-1.97
Malaysia	3 226	1.88	42 489	1.91	7.57	-0.32	74.40	0.30	18.04	-1.03
Cuba	3 198	2.25	20 911	0.94	14.50	0.77	61.71	2.17	23.80	-4.26
Morocco	3 183	-2.74	34 094	0.43	9.34	-3.15	70.22	-0.67	20.44	5.42
Jordan	3 175	-2.30	32 641	3.03	7.62	-4.35	68.44	2.07	23.94	-2.97
Ecuador	3 106	-2.20	35 083	3.83	8.82	-5.74	78.15	2.03	13.03	-4.27
Burundi	3 007	2.66	28 110	0.36	9.83	1.43	38.79	-0.50	51.39	0.14
Costa Rica	2 711	-4.91	23 827	-3.32	11.38	-0.15	70.92	-0.05	17.70	0.30
Thailand	2 611	5.12	28 286	2.90	9.19	2.10	63.86	-0.29	26.96	0.06
Rwanda	2 574	-2.44	47 579	-4.05	7.04	2.71	26.76	-4.55	66.20	2.45
Hungary	2 495	2.03	22 454	-1.29	11.11	3.36	68.75	-1.03	20.14	2.50
Colombia	2 432	1.81	42 509	5.42	5.64	-3.41	61.17	0.77	33.19	-0.63
Honduras	2 411	0.82	20 836	0.88	11.57	-0.06	70.97	-0.23	17.45	1.03
Former Czechoslovakia	2 396	0.41	18 348	1.70	13.06	-1.26	72.23	2.13	14.71	-5.78
Benin	2 282	-4.27	36 481	-2.74	6.69	-0.91	71.60	0.17	21.71	-0.25
Former USSR	2 159	2.27	18 687	2.87	11.63	-0.52	11.64	-4.37	76.73	0.99
Botswana	2 150	-6.64	22 813	-2.99	9.42	-3.54	73.30	0.10	17.28	2.16

Table I.3 *(continued)*

Country or area	Wage per employee: 1990 (dollars)	Wage per employee: Average annual growth	Gross output per person engaged: 1990 (dollars)	Gross output per person engaged: Average annual growth	Unit costs of production per $100 of output — Labour: Percentage	Labour: Average annual growth	Intermediate input: Percentage	Intermediate input: Average annual growth	Gross output: Percentage	Gross output: Average annual growth
Zaire	2 092	0.17	..	..	..	..	..	..	..	..
Kenya	2 046	-0.89	40 907	6.26	5.00	-5.58	88.14	1.02	6.86	-5.01
Egypt	1 940	-1.05	14 598	1.43	13.19	-2.44	68.48	-0.86	18.33	8.07
Philippines	1 913	4.60	23 413	2.89	8.11	2.79	66.02	-0.87	25.87	1.71
Mauritius	1 904	0.12	15 077	-1.06	12.63	1.19	72.27	-0.83	15.10	3.96
Mali	1 900	0.40	18 347	-0.79	10.38	1.23	63.73	-0.47	25.89	0.75
Guatemala	1 785	-1.86	19 487	-0.41	8.45	-2.17	59.32	-0.05	32.22	0.77
Romania	1 728	0.15	11 919	-1.08	14.09	0.95	63.88	1.95	22.03	-4.39
Pakistan	1 693	5.00	23 710	5.77	7.12	0.04	67.11	0.15	25.76	-0.40
Bulgaria	1 666	2.61	13 808	-0.71	12.56	3.39	20.25	-5.25	67.19	1.79
Gambia	1 628	-0.33	17 388	0.04	7.50	-2.41	75.67	1.98	16.83	-5.05
Ethiopia and Eritrea	1 555	1.35	17 076	0.19	9.08	1.10	51.81	-0.56	39.11	0.54
India	1 487	3.67	17 611	6.11	8.48	-2.26	82.54	0.11	8.98	1.58
Bolivia	1 423	-8.27	69 607	7.57	12.36	2.08	54.16	-1.90	33.02	3.33
Nigeria	1 390	-2.84	14 235	-0.94	9.60	-1.51	50.71	0.37	39.69	-0.06
Dominican Republic	1 348	-3.75	21 914	2.43	6.16	-6.03	57.23	-0.03	36.61	1.63
Lesotho	1 309	-0.08	10 899	-8.16	11.25	5.68	68.00	-1.01	20.75	1.31
Poland	1 257	-4.54	..	..	..	..	..	..	..	..
Malawi	1 244	-0.15	13 370	2.35	9.74	-1.99	77.25	1.92	13.00	-6.03
Bangladesh	1 036	3.19	5 416	-1.77	17.87	4.33	63.41	0.07	18.72	-2.98
Madagascar	1 018	-3.77	7 769	-2.54	13.09	-1.25	58.45	-0.45	18.47	1.72
Ghana	970	3.24	13 728	6.49	7.07	-3.04	52.64	0.16	40.29	0.32
Indonesia	941	4.72	16 500	4.26	5.67	0.45	68.92	0.29	25.41	0.84
Sri Lanka	642	0.10	8 846	-0.25	7.27	0.37	58.13	-2.22	34.60	5.52
China	501	3.70	10 298	5.45	4.86	-1.66	74.18	1.83	20.96	-4.25
Albania	424	..	..	..	..	..	..	..	..	..
Nepal	361	1.80	3 116	-7.80	11.27	11.28	57.76	-3.51	30.97	8.61
Somalia	287	-13.93	7 355	-4.08	5.99	-6.32	71.29	1.09	22.72	-0.75
United Republic of Tanzania	203	-8.09	3 224	-4.32	6.32	-3.86	78.06	0.89	15.63	-2.02
Total	11 820	-8.09	70 324	-4.32	16.78	-3.86	57.92	0.89	25.31	-2.02

Source: UNIDO, consolidated industrial statistics.

The above example illustrates one of the basic problems encountered by developing countries in general. Although low wages in developing countries hold down their unit cost of labour, high cost of intermediate inputs to manufacturers in these countries often nullifies this basic production cost advantage. The overall cost of intermediate inputs is more in developing countries because they invariably include imports, especially for those engaged in manufacturing, in the form of processed or semi-processed industrial raw materials, and parts and components for finished products. The prices of imported intermediate goods, supplied frequently by developed countries, becomes higher in developing countries partly because they have to go through the arduous process of international trading, involving specialized trading agents and commission brokers. And the margins charged by various international trading agents often become exhorbitant compared with the original prices of products and materials involved.

In the traditional theory, production costs determine the price of a product. In reality, however, costs of production determine only a part of the final price, and that part has been shrinking to the extent that it is now becoming completely overshadowed by distributional and marketing costs. Again in theory, the price of an internationally traded good deviates from its original factory-gate price by customs duties and international transport costs. That these two cost items combined have come to occupy a very insignificant portion of the final imported price in the country of destination owes much to the continuous rounds of tariff reduction in developed and developing countries in recent years and to the competitive price structure maintained by the world freight-carrying industry. However, a pair of running shoes with an internationally distinct brand name, sold at a retail price of $82 in New York, costs no more than $6.50, after being loaded on to a container ship ready for shipment by its original producer in the Republic of Korea. Similarly, a paricular brand of men's shirts retailed in Germany at $42 would have cost the German importer-distributor between $1.25 and $1.85, depending on the identity of its contract producer in Sri Lanka, Poland or the territory of the former Yugoslavia. Indeed, a random survey by UNIDO involving typical original, brand-name product-processing establishments located in three specific export-processing zones in Sri Lanka and China, discloses that the ratio between the actual factory-gate price and the retail price at destination is roughly 1 to 12.*

Needless to say, if production cost weighs only 8 per cent in the final product price of a globally traded manufactured good, the traditional efforts for productivity gains and other cost-saving measures to reduce cost at production site misses a much larger picture determining international competition. Today, international competition prevails at two distinct levels—one at the production and the other at the distribution level. At the production level, wage differentials have already forced many export product manufacturers in the Republic of Korea and Taiwan Province to relocate initially to Indonesia, Malaysia, Philippines, Sri Lanka and Thailand, and then on to China and Viet Nam. Although the wage difference between countries in South-East Asia constitutes no more than a tiny fraction, in terms of final product price, and can hardly influence this price, the search for cheaper wage location has become an integral part of international price competition at the production level. But the competition is among the producers, that is, among developing-country producers, and involves "producer prices".

One of the distinguishing features of the Asian NICs is that they are not only adept in producing goods cheaply, but they excel in marketing them abroad. Some of these countries have large trading companies of their own with a worldwide sales network, which perform a multiple task of selling, buying, brokering, financing, insuring and shipping. A few Asian countries benefit from the so-called Chinese diaspora, which functions as a giant trading network. Many electronics products produced in these countries even bear their own brand names which are promoted worldwide through active advertising campaigns. Professional market research firms are being created. Up to now, these traders handled only those products made in or sold to their own countries. With the rapid expansion in regional trade, however, they are becoming multilateral and international traders. International trading and marketing, the traditional preserve of the more advanced developed countries, have therefore been successfully encroached upon by a few developing countries for the first time. And products marketed by these Asian traders abroad carry less imposing prices because the trade margins charged by them are less forbidding, introducing a completely different dimension to the traditional international competition over product prices.

Returning to the subject of the persisting income gap between developed and developing countries, one possible explantion relates, therefore, to the two-layer structure of price determination involving developing-country exports. Producers in developing countries compete essentially among themselves within a narrow margin assigned by the vertical chain of price determination dominated by distribution and marketing costs. The pursuit of high-value-added content through production has its ultimate limit in factory-gate prices. Developing countries should realize sooner rather than later that industrialization under globally linked production and trade entails expertise not only in production but also in finance, marketing, shipping and trading. In a way, the existing income gap between developed and developing countries is more apparent than real. In a recent issue of its *World Economic Outlook*, the International Monetary Fund (IMF) used purchasing-power parities, rather than market exchange rates, to recompute GDPs [3].* The result is a sharp increase in the developing-country share of world GDP from 18 to 34 per cent. By contrast, the share of developed countries dropped from 73 to 54 per cent. This is clearly due to the enormous price spread

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*This is not a surprising finding, especially to European or Japanese travellers who can purchase brand-name clothing items at one fifth the price at Bangkok, or electronics products at a 50-per-cent discount in Hong Kong. Nor to any North American who is used to a pervasive discount pricing system.

*The use of purchasing-power parities to compare living standards in different countries has drawbacks as serious as the use of exchange rates. Living standards or even the level of income should be measured by the availability of choices in, as well as the affordability of, a vast range of goods and services. A pound of beef in a supermarket displaying 3,000 other well-packaged food items is different from the same offered by a street vendor. Income measured by price differentials on a few strictly selected items available to all countries including the poorest necessarily ignores the choice aspect which is after all the main ingredient of high income (see *Global Report 1990/91* for a more detailed discussion on this subject [4]).

between developed and developing countries—a spread reflecting the value added in the service industries, including trading. Moreover, there is also overwhelming evidence that those developing economies which climbed the income ladder rather quickly happened to be all active traders (two of them, Hong Kong and Singapore, incidentally joined the exclusive club of developed countries in 1993, according to the World Bank). In contrast, many African countries do not trade extensively, and whatever is traded is mainly through international trading agents.

Up to half a century ago, industrialization provided the base for trade expansion. In modern days, however, industrialization has always been preceded by the opening up of new trading opportunities. The Asian NICs clearly provide an example of a rapid take-off in the mid-1950s based on export-led industrialization, as did China in the 1980s. "Trade rather than aid" is the urgent appeal from the countries of Eastern Europe and the former USSR, anxious to restart their interrupted industrialization process. The importance attached to trade by these countries clearly reflects the fact that the essence of industrialization for developing countries today consists as much in an enhanced production capability of traditional and domestic goods, as in the acquisition of know-how in technology, design, manufacture and marketing at all levels of distribution for new products which are demanded by the world at large.

II. Industrial performance and prospects in the major regions

Several general factors are driving overall change in the global industrial economy. One is that technological change has perhaps never been greater than at present; advances in computers and electronics in particular are rapidly lowering costs of communication, information and control. Liberal, market-based economic policies have spread to all corners of the globe, allowing greater scope for the private sector. Industrial enterprises are being forced to restructure in terms of production platforms, management, employment, finance and linkages among themselves, merely to remain competitive in a world where large profits one day can vanish the next.

But short-term regional differences seem as great as the common factors. The current performance of both Western Europe and Eastern Europe, including the new States that emerged from the breakup of the former USSR, is disappointing. In the latter region, the introduction of market-based economic structures has proved much more difficult than had originally been hoped for. Although great changes are under way and much has been achieved, industrial decline continues in 1993 for all but a few countries in this region. In Western Europe, prospects have been sharply downgraded since about the third quarter of 1992, when doubts arose about approval of the Treaty on European Union (the Maastricht Treaty), the exchange-rate mechanism (ERM) partly broke down, and the high costs of German reunification, especially in terms of inflation and the budget, became apparent. In August 1993 continued uncertainties brought about effective discontinuance of ERM, at least temporarily. The expected positive impact of the introduction of the single European market in January 1993 seems hardly noticed.

In early 1993 it seemed that North America was emerging from recession and would be able to take over as "world locomotive" as Western Europe, and Germany in particular, went into decline. But recovery in North America has remained weak, as the new United States administration attempts to implement new policies. A compromise budget package was passed by Congress in the third quarter, but its impact is still not clear. Recovery in Japan, which was expected to be fuelled by fiscal stimulus, has so far also remained weak, especially since recent strengthening of the yen has reduced export competitiveness. Thus none of the major economic actors has been able to provide much push for the global economy.

Short-term prospects for the developing regions are far better, particularly for the East and South-East Asian region, which continues to benefit greatly from a strong nexus of industrial trade and investment ties within the region and between the region and Japan, and now including China. Low-cost labour only partly explains this growth phenomenon. Sound macroeconomic policies have encouraged investment, rapid technological change and expansion of manufactured exports. Similar policies were adopted in the 1980s in much of Latin America and the Caribbean in the wake of the debt crisis, and more recently in India, and manufacturing output and exports are responding. Even in Tropical Africa, subject to so many disadvantages, the small manufacturing sector is expected to grow at about 4 per cent annually in 1993/94.

Regional shares in world MVA in 1993 and changes since 1975 are shown in table II.1. By far the biggest changes are the increase in the share of Japan to 16.6 per cent (up by 8.9 percentage points) and the sharp drop (down by 12.9 percentage points) of Eastern Europe and the former USSR to 7 per cent (somewhat ahead of East and South-East Asia). The share of North America increased slightly (to 28.3 per cent) and that of Western Europe remained unchanged, at 31.3 per cent. Thus despite rapid growth in East and South-East Asia, the three most developed regions continue to account for more than three quarters of world MVA.

This is partly explained by the dominance of the three most developed regions in the capital- and technology-intensive sectors such as machinery, electronics, transport equipment and chemicals, which form the bulk of world manufacturing; ISIC 38 (fabricated metal products, machinery etc.) accounted for 39.7 per cent of 1990 world MVA, and ISIC 35 (chemicals, petroleum etc.) for 17.5 per cent (see table II.2, which summarizes comparable tables at regional level shown in the following sections). Plastic products, for example, has been one of the highest-growth sectors (the share of the three developed regions being over 80 per cent). Among the developing regions, only East and South-East Asia has shown large gains in share in the capital- and technology-intensive industries. In ISIC 32 (wearing apparel, textiles etc.), where developing countries have gained in market share, growth rates have been well below those in most other industries.

Table II.1. Regional shares in world MVA by industry, 1993, and change in shares, 1975-1993

ISIC	Industry	North America		Japan		Western Europe		Eastern Europe and former USSR		Latin America and the Caribbean		Tropical Africa		North Africa and Western Asia		Indian Subcontinent		East and South-East Asia		China [a]
311	Food	27.4	(5.2)	14.0	(7.8)	29.4	(5.1)	11.5	(-21.1)	6.3	(-1.5)	0.6	(0.1)	2.4	(1.4)	0.7	(0.2)	4.3	(2.5)	1.3
313	Beverages	21.7	(4.0)	8.5	(2.2)	36.5	(5.8)	7.1	(-19.3)	9.6	(-0.6)	1.9	(0.6)	3.0	(2.0)	0.4	(0.3)	5.6	(2.9)	3.2
314	Tobacco manufactures	28.5	(11.2)	3.0	(-0.6)	30.3	(-6.2)	2.7	(-9.3)	7.4	(-5.9)	0.7	(-0.4)	8.4	(4.2)	1.7	(-)	8.4	(4.3)	8.5
321	Textiles	19.6	(5.3)	12.2	(4.4)	24.3	(-0.1)	12.9	(-18.0)	6.3	(-0.4)	0.7	(0.1)	5.9	(4.0)	1.9	(0.1)	9.5	(6.9)	5.2
322	Wearing apparel	24.8	(0.4)	11.0	(6.0)	24.9	(-2.4)	15.3	(-17.1)	4.5	(-1.4)	0.4	(0.1)	2.5	(2.0)	0.5	(0.4)	11.6	(9.3)	2.6
323	Leather and fur products	12.9	(-1.2)	8.5	(3.7)	26.1	(-7.1)	10.5	(-17.7)	8.2	(-1.3)	0.9	(0.6)	4.0	(2.9)	0.9	(0.4)	19.6	(18.1)	6.8
324	Footwear, excluding rubber or plastic	10.3	(-5.6)	6.4	(4.1)	35.2	(2.1)	21.2	(-11.5)	10.4	(-1.1)	1.0	(0.3)	5.2	(4.2)	0.7	(0.5)	6.8	(6.1)	-
331	Wood and cork products	32.5	(6.5)	14.6	(1.7)	31.5	(2.2)	6.6	(-11.4)	3.6	(-2.3)	0.4	(-0.1)	1.7	(1.1)	0.2	(0.1)	5.1	(3.0)	0.8
332	Furniture and fixtures	26.4	(2.9)	13.1	(5.8)	42.5	(-0.3)	7.5	(-3.3)	2.8	(2.5)	0.3	(-)	1.0	(0.5)	-	(-)	3.6	(2.9)	0.7
341	Paper and paper products	42.3	(0.5)	12.8	(3.2)	29.5	(-0.5)	2.1	(-4.6)	4.5	(-0.8)	0.2	(-)	1.1	(0.4)	0.3	(-0.2)	3.8	(2.9)	1.4
342	Printing and publishing	41.4	(-0.3)	18.4	(5.9)	30.2	(-0.7)	1.2	(-3.6)	2.5	(-2.3)	0.1	(-0.2)	0.6	(0.2)	0.2	(-0.1)	2.7	(1.9)	0.5
351	Industrial chemicals	29.4	(1.8)	11.0	(3.3)	38.0	(0.6)	5.0	(-9.7)	4.5	(0.2)	0.1	(-0.1)	2.4	(1.4)	0.8	(0.1)	3.9	(3.0)	3.8
352	Other chemical products	32.0	(-0.7)	19.1	(8.8)	30.6	(1.6)	2.9	(-8.6)	5.2	(-3.2)	0.3	(-0.1)	1.9	(0.8)	0.9	(-0.1)	4.3	(2.9)	1.5
353	Petroleum refineries	15.9	(-2.7)	5.1	(1.2)	33.4	(-4.0)	3.9	(-9.5)	16.7	(3.1)	0.5	(-)	11.6	(8.2)	0.9	(0.5)	8.4	(5.3)	2.6
354	Miscellaneous petroleum and coal products	20.3	(8.8)	7.7	(3.8)	19.1	(7.4)	34.4	(-33.1)	6.9	(4.2)	0.1	(-)	5.1	(4.5)	1.3	(0.8)	3.0	(3.6)	1.1
355	Rubber products	21.2	(-4.2)	15.5	(8.2)	33.5	(-0.5)	6.0	(-10.2)	5.5	(-0.6)	0.3	(0.1)	2.5	(1.8)	1.2	(0.5)	10.1	(8.0)	2.8
356	Plastic products n.e.c.	29.4	(0.9)	22.2	(7.4)	32.2	(-3.3)	1.7	(-4.0)	3.4	(-3.6)	0.2	(-)	1.2	(0.5)	0.2	(-)	6.5	(4.1)	1.6
361	Pottery, china and earthenware	8.9	(-0.6)	14.2	(3.7)	42.0	(-2.5)	10.7	(-10.1)	8.4	(-)	0.1	(-)	4.6	(3.7)	0.6	(0.3)	6.2	(5.4)	3.7
362	Glass and glass products	24.3	(-6.5)	17.3	(8.3)	37.2	(1.2)	4.3	(-5.8)	4.7	(-1.3)	0.1	(-)	3.3	(2.2)	0.4	(0.1)	4.5	(3.5)	2.1
369	Other non-metallic mineral products	17.4	(-1.2)	16.4	(6.7)	32.1	(2.2)	8.2	(-16.2)	4.1	(-2.4)	0.4	(0.1)	8.7	(7.9)	1.0	(0.5)	5.7	(4.5)	4.3
371	Iron and steel	18.3	(-5.4)	21.3	(10.8)	28.1	(-6.3)	6.9	(-10.6)	6.6	(1.9)	0.2	(-)	3.0	(2.1)	1.7	(0.7)	7.3	(6.5)	4.6
372	Non-ferrous metals	26.2	(-1.3)	13.1	(4.3)	28.9	(4.4)	8.6	(-17.1)	8.6	(3.3)	0.3	(-)	2.7	(2.2)	0.7	(0.3)	3.2	(2.7)	3.2
381	Metal products, excluding machinery	24.9	(-8.7)	21.8	(11.0)	36.7	(1.7)	3.3	(-4.7)	3.2	(-1.5)	0.2	(-0.1)	1.7	(0.9)	0.3	(-)	4.8	(4.0)	1.3
382	Non-electrical machinery	28.0	(2.6)	18.3	(9.7)	30.6	(2.0)	14.6	(-13.4)	1.5	(-1.4)	-	(-)	0.9	(0.7)	0.3	(-)	2.6	(2.3)	2.2
383	Electrical machinery	25.4	(-5.0)	24.7	(13.2)	33.1	(-8.5)	2.7	(-5.2)	2.2	(-1.5)	0.1	(-)	0.9	(0.4)	0.5	(-)	7.7	(6.3)	2.0
384	Transport equipment	33.2	(-[illegible].6)	19.2	(8.7)	33.3	(-3.0)	3.2	(-6.6)	3.1	(-0.9)	0.2	(0.1)	0.9	(0.4)	0.4	(-)	4.3	(3.6)	1.2
385	Professional and scientific goods	56.9	(18.2)	10.8	(4.4)	18.3	(-11.1)	7.8	(-13.7)	1.5	(0.2)	-	(-)	0.2	(0.1)	0.2	(0.1)	2.9	(2.4)	0.9
390	Other manufactures	25.9	(0.4)	17.2	(8.5)	18.8	(0.4)	16.6	(-18.8)	4.9	(-)	0.2	(-0.1)	0.7	(0.5)	0.2	(-)	10.9	(8.9)	3.7
	All manufacturing	28.3	(1.7)	16.6	(8.9)	31.3	(-)	7.0	(-12.9)	4.5	(-1.2)	0.3	(-)	2.4	(1.5)	0.6	(0.1)	5.4	(4.1)	2.2

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Notes: Figures in parentheses are changes in shares from 1975 to 1993. In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

[a] Change in share for China is not shown, because reliable sectoral share estimates for China in 1975 do not exist.

Table II.2. World growth rates of MVA in individual regions and in 28 industries, 1970-1992, and 1990 region and industry shares
(Percentage)

Region or industry (ISIC) and total		Average annual growth rates			Share in total MVA[a]
		1970-1980	1980-1990	1990-1992	1990
A. Regional breakdown					
North America		2.8	1.3	-	26.5
Japan		3.3	3.6	-0.9	16.4
Western Europe		1.9	1.2	-1.5	31.7
Eastern Europe and former USSR		5.6	2.7	-16.1	11.1
Latin America and the Caribbean		6.4	-1.1	2.2	4.0
Tropical Africa		6.2	1.1	1.9	0.3
North Africa and Western Asia		5.9	4.3	4.7	2.0
Indian Subcontinent		3.4	6.1	3.3	0.5
East and South-East Asia		11.5	8.8	6.2	4.3
China		..	..	9.7	1.7
B. Industry breakdown					
311	Food	3.2	2.1	-1.7	9.7
313	Beverages	2.2	1.3	0.1	2.1
314	Tobacco manufactures	1.5	4.1	0.9	1.5
321	Textiles	1.4	-	-3.1	4.2
322	Wearing apparel	2.4	0.3	-3.4	2.3
323	Leather and fur products	1.7	0.5	-3.7	0.4
324	Footwear, excluding rubber or plastic	1.8	-1.1	-6.6	0.5
331	Wood and cork products	2.7	-0.5	-3.6	1.6
332	Furniture and fixtures	4.1	1.0	-0.7	1.4
341	Paper and paper products	2.7	2.3	-	3.1
342	Printing and publishing	3.2	3.7	-1.7	4.8
351	Industrial chemicals	2.6	3.2	-0.3	5.4
352	Other chemical products	2.5	4.3	1.1	5.0
353	Petroleum refineries	6.3	-0.8	3.4	2.6
354	Miscellaneous petroleum and coal products	4.5	1.6	-4.1	0.6
355	Rubber products	2.0	1.7	-2.4	1.3
356	Plastic products n.e.c.	6.3	5.0	1.5	2.6
361	Pottery, china and earthenware	3.9	0.7	-4.4	0.4
362	Glass and glass products	2.3	1.6	-1.8	0.8
369	Other non-metallic mineral products	3.4	1.0	-2.5	2.9
371	Iron and steel	1.8	-1.0	-3.1	3.9
372	Non-ferrous metals	2.6	0.5	-2.5	1.6
381	Metal products, excluding machinery	2.5	1.4	-1.4	5.6
382	Non-electrical machinery	4.0	2.4	-5.1	12.5
383	Electrical machinery	3.6	3.0	-0.1	9.5
384	Transport equipment	3.4	2.6	-1.6	9.5
385	Professional and scientific goods	4.6	3.6	-2.8	2.6
390	Other manufactures	3.4	2.2	-4.4	1.6
Total[b]		3.1	2.0	-1.7	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

[a] Total MVA for the world in 1990 was $5,423,022 million.

[b] For both regional and industry breakdown.

A. North America

1. Short-run outlook

In North America GDP grew by 2.0 per cent in 1992, following a 1.2 per cent decline in 1991. According to the UNIDO forecast, the recovery will continue through 1994, with GDP growth of 2.4 and 3.0 per cent in 1993 and 1994 respectively (see table I.1). The recovery has been less robust than that following most other recessions since the Second World War. In part this is due to the fact that the recession itself was mild, and the size of the gap between actual and potential GDP did not become as large as in the recession of 1982, for example. The need to raise taxes and check spending to trim the federal deficit has also taken some of the steam out of the recovery. The new United States administration has succeeded in gaining approval of a budget plan that is expected to significantly reduce the budget deficit, by an estimated $100 billion per year over the next five years. Canada too has put in place a combination of spending cuts and tax increases to reduce its budget deficit.

The progress of recovery in the United States has been uneven. The recession ended in a technical sense when GDP growth turned positive in the second quarter of 1991. But growth during the remainder of 1991 remained low, and the result for the year was a 1.2 decline in GDP. Growth remained low in the first half of 1992, before rising to 3.4 per cent in the third quarter and 4.8 per cent in the final quarter. It then fell to 0.7 per cent in the first quarter of 1993. While growth appears to have recovered somewhat at mid-year, it is clear that the recession in Europe and low growth in Japan will affect the recovery in the United States. In the recovery from the last recession the United States could ignore the rapid rise in its budget and the current-account deficits. It was possible at that time for the United States to act as the locomotive that pulled the world economy out of recession. This is not possible in 1993.

MVA growth in the United States improved from -2.2 per cent in 1991 to 3.1 per cent in 1992. In Canada it increased from -6.6 per cent in 1991 to 0.5 per cent in 1992. The distribution of regional MVA growth by three-digit ISIC category for the decades of the 1970s and 1980s and for 1990 to 1992 is shown in table II.3 (also see figure II.1 for GDP and MVA growth in recent years and also for the pattern of structural change in industry). The annual average growth rate of manufacturing as a whole declined from 2.8 per cent during the 1970s to 1.3 per cent during the 1980s. Among the industries experiencing the greatest decline during the 1980s, petroleum refining (ISIC 353) declined by 34 per cent after having more than doubled during the 1970s. MVA in the iron and steel industry (ISIC 371) fell by nearly 30 per cent in the 1980s, after expanding by 13 per cent during the 1970s. The steel industry in the United States showed real signs of life in 1992, however, with an increase in MVA of nearly 5 per cent. The restructuring that began in the 1970s and continued through the 1980s has resulted in a considerably more efficient industry. While overall growth has declined, the mini-mills and specialty steel producers have continued to grow, accounting for nearly all the gain in 1992. The lower value of the dollar has also made the industry more competitive internationally. Despite the improvement in the outlook for the industry, in early 1993 the United States moved toward imposing heavy tariffs on steel imports from several countries in retaliation for trade practices judged to be unfair.

Two problems that the manufacturing sector in the United States will have to overcome in 1993 and for the next few years are cut-backs in defence spending and a slow-down in the growth of exports. Export growth will slow as a result of the slow-down in growth in the rest of the world in 1993. Exports of manufactured goods make up a little over half of total merchandise exports. Some 60 per cent of defence industry workers are engaged in manufacturing [1]. Between 1992 and 1995, the United States Office of Technology Assessment estimates that defence cuts will result in some 250,000 net jobs lost per year [2]. During 1993, the fall-off in exports may be the more serious problem. If, for example, export growth were to cease, while imports continued to grow at current trends, the net job loss would be roughly twice that of the yearly loss associated with the defence build-down.

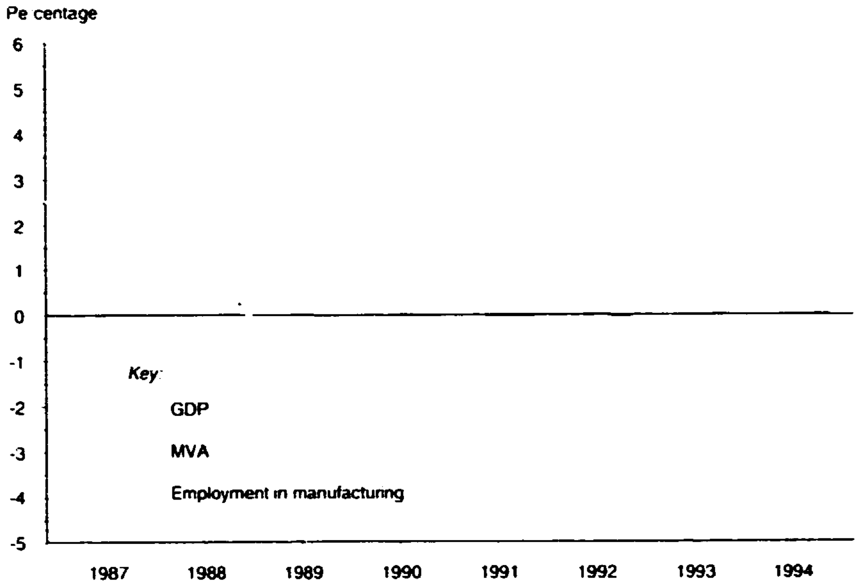
2. Longer-term prospects

(a) Cutbacks in defence spending

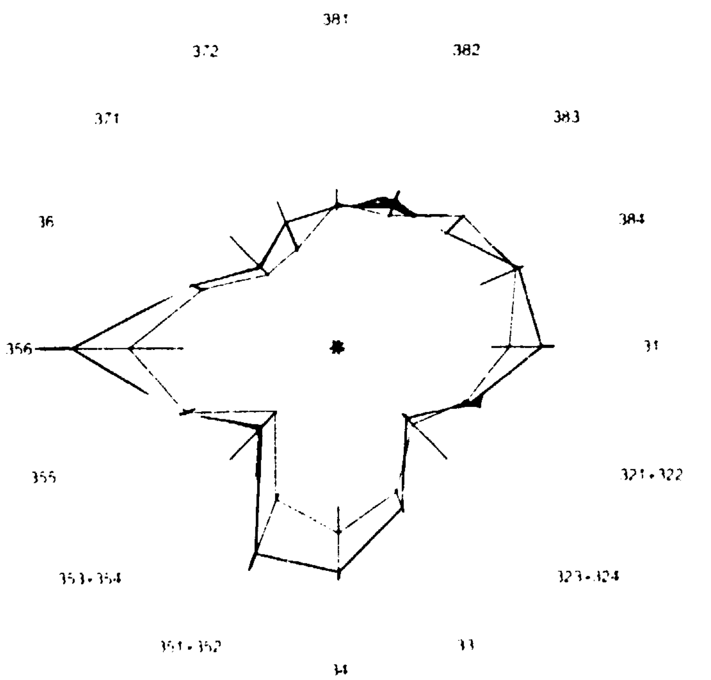
Cuts in defence spending will result in dislocations in the United States economy for the next five years. Defence spending cuts are like any other structural adjustment, which requires time and a certain amount of economic resilience for resources to be transferred to other productive activities. Adjustment is apt to be slow, however, because of the magnitude of the decline and the fact that some of the resources used in the defence industry are specialized and not so easy to relocate to the civilian sector. The last column of table II.4 shows the impact of the defence build-down in terms of the increase in the number of workers in selected occupations that will be seeking civilian jobs. Over the 10 years from 1986 to 1996, defence cuts will increase the supply of civilian aircraft assemblers by over 50 per cent and the supply of aeronautical and astronautical engineers by nearly a third. Some occupations are not limited to defence industries, and the effects of defence cut-backs may not have much impact. One example is that of engineering technicians, with a supply increase due to defence cuts of about 0.6 per cent per year, and with defence industry employment only accounting for 10 per cent of the total. In the specialized occupations of aircraft assemblers and aeronautical and astronautical engineers the impact will be severe. Unless the non-defence aerospace industry greatly expands, workers who lose defence jobs in these occupations will have to embark on new careers. The losses run up by United States airlines over the past few years and the increased share of the civil aircraft market held by European builders do not bode well for an offsetting expansion of the United States aircraft industry.

While defence cuts will have a negative effect on employment growth over the medium-term, a more positive aspect of defence cut-backs, the peace dividend, should have both short- and long-term positive effects. The peace dividend is a net gain because the level of spending required to purchase the same amount of national defence has fallen as a result of the end of the cold war. In the case of both Canada and the United States the peace dividend has made it much easier to implement

Figure II.1. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: North America



Industrial structural change
(Index of value added 1980=100)



g = 1.27, θ = 10.33

Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

Source: UNIDO database, estimates and forecasts by UNIDO/PPD/IPP/GLO deficit reduction programmes, and will make it easier to implement budget targets over the next five years. This in turn should help to lower long-term interest rates and increase investment.

(b) *Productivity and manufacturing wages*

During the 1970s and 1980s growth of business productivity in the United States lagged behind that in most other industrial countries, and well below the long-term trend for the United States. The service sector was particularly hard hit by the slow-down in productivity growth. But in the 1980s not only was productivity growth slow, but wages grew more slowly than productivity [3]. Various theories have been put forth to account for the decline in productivity growth, including lower business investment levels, lack of investment in public infrastructure and declining educational achievement. One factor that has lowered productivity growth is the decline in the share of output accounted for by manufacturing, which has consistently had a higher rate of productivity growth than the rest of the business sector. Accompanying the slow-down in productivity growth was an increase in wage dispersion (as measured by the difference in wage earnings at the upper and lower ends of the wage scale). This occurred in the economy as a

Table II.3. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: North America
(Percentage)

Country or industry (ISIC) and total		Average annual growth rates			Share in total MVA[a]
		1970-1980	1980-1990	1990-1992	1990
		A. Country breakdown			
United States		2.7	1.3	0.2	91.9
Canada		4.2	1.6	-3.0	8.0
		B. Industry breakdown			
311	Food	2.0	2.3	0.9	9.2
313	Beverages	1.2	1.7	0.3	1.7
314	Tobacco manufactures	2.3	8.8	-0.9	1.6
321	Textiles	0.5	-0.1	3.3	2.6
322	Wearing apparel	0.5	-1.4	0.7	2.0
323	Leather and fur products	0.7	-2.4	-0.7	0.2
324	Footwear, excluding rubber or plastic	-1.8	-6.0	-4.8	0.2
331	Wood and cork products	3.3	0.6	-1.0	1.8
332	Furniture and fixtures	3.0	1.3	-0.6	1.3
341	Paper and paper products	3.2	2.2	0.9	4.7
342	Printing and publishing	2.9	4.4	-3.2	7.7
351	Industrial chemicals	3.4	2.5	2.1	5.5
352	Other chemical products	1.0	4.3	0.4	6.1
353	Petroleum refineries	9.7	-4.2	-0.1	1.7
354	Miscellaneous petroleum and coal products	4.6	1.1	5.9	0.3
355	Rubber products	-0.7	0.9	-4.0	1.0
356	Plastic products n.e.c.	6.5	5.5	2.4	2.8
361	Pottery, china and earthenware	2.7	0.1	-5.4	0.1
362	Glass and glass products	1.4	0.4	-2.0	0.8
369	Other non-metallic mineral products	2.7	-	-3.3	1.9
371	Iron and steel	1.2	-3.4	-2.7	2.5
372	Non-ferrous metals	3.1	-1.6	-1.5	1.5
381	Metal products, excluding machinery	2.0	-1.3	-2.5	5.3
382	Non-electrical machinery	4.2	-0.5	2.7	10.6
383	Electrical machinery	3.4	0.1	3.3	8.3
384	Transport equipment	3.3	2.5	-2.0	11.7
385	Professional and scientific goods	4.9	6.0	-2.9	5.4
390	Other manufactures	2.1	0.3	-2.2	1.4
Total[b]		2.8	1.3	.	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

[a] Total MVA for the region in 1990 was $1,437,881 million.

[b] For both country and industry breakdown.

Table II.4. Selected military-related occupational dependencies, 1986

Occupation	Military-related jobs (thousands)	Total employment (thousands)	Military share (percentage)	Supply increase from cuts (percentage)
Aircraft assemblers	12.2	24.0	50.83	56.86
Aeronautical and astronautical engineers	18.9	51.6	36.63	31.80
Tool programmes, numerical control	1.6	8.8	18.18	12.22
Electrical and electronic assemblers	30.0	170.1	17.64	11.78
Metallurgical and materials engineers	2.9	17.8	16.29	10.74
Electrical and electronic engineers	57.2	391.5	14.56	9.37
Mechanical and industrial engineers	44.2	345.1	12.81	8.08
Procurement, planning, expediting clerks	27.2	251.5	10.82	6.67
Machinists, metalworkers, ship-fitters	94.8	900.0	10.53	6.48
Aircraft mechanics, engine specialists	10.8	105.1	10.28	6.30
Welders, cutters, solderers, brazers	29.1	283.5	10.26	6.29
Nuclear technicians	65.1	682.9	9.53	5.80
Inspectors, testers, graders	65.7	689.9	9.52	5.79

Sources: Ann Markusen and Joel Yudken, *Dismantling the Cold War Economy* (New York, Basic Books, 1992), tables 6.1 and 6.2, pp. 141-142; last column based on UNIDO calculations. "Supply increase from cuts" means percentage increase in the civilian labour force attributable to projected 55-per cent military spending cuts between 1986 and 1996 (see Jurgen Brauer and John Tepper Malin, "Converting resources from military to non-military uses", *Journal of Economic Perspectives*, vol. 6, No. 4 (Fall 1992), p. 157.

whole, in part because workers moved from manufacturing to the generally lower-wage service sector, but it also occurred within manufacturing. Apparently the trend toward higher wage disparity has being going on for a long time in the United States [4]. One study examines wage trends between 1940 and 1985, and finds that there was a very large compression of wage differentials during the 1940s, but that during the years since 1950 wage differentials have gradually widened back to their 1940 levels [4]. Another study of wage differentials shows that over the period from 1963 to 1987 the wage rate of male high-school graduates with 1 to 5 years of experience fell by 1.6 per cent, while that of male college graduates with 1 to 5 years of experience increased by 18.4 per cent, or 20 per cent relative to the former group [5]. Table II.5 shows wages trends for a number of different experience and skill levels, and confirms the general long-term tendency for the wages of more experienced and better educated workers to increase in relative terms. The phenomenon of growing wage inequality is clearly not new, but it accelerated over the last decade and economists have begun to give it much more attention and to try to explain its causes. Several explanations have been offered, among which are the relative decline in the share of manufacturing in GDP, but as the next section shows, manufacturing has also exhibited a declining demand for lower-skilled labour over the last three decades.

(c) *Decline of blue-collar labour in manufacturing*

In the United States manufacturing sector there has been a steady decline in the ratio of production workers to non-production workers over the past 30 years. For the period from 1959 to 1989, figure II.2 shows the percentage increase in United States manufacturing outputs and inputs classified by materials, capital and production and non-production workers. Capital has increased approximately in line with output. Labour and materials have grown less rapidly, and while the trend for production workers did show periods of growth over the 30-year period, corresponding to upswings in economic activity, it always retreated toward its 1959 level during downturns. After falling to slightly below its 1959 level during the severe downturn from 1979 to 1982, the level of employment of production workers rose only slightly, back to its 1959 level, and remained there as the economy underwent expansion following the recession. Thus while manufacturing output and capital input in 1989 were twice their 1959 levels, materials input increased by about two thirds, non-production labour by about 40 per cent, and production labour remained at the same level as in 1959.

(d) *Effect of trade in manufactures on blue-collar employment*

Dividing the period from 1959 to 1989 into three intervals, whose end-points correspond roughly to peak years in the business cycle, it is evident from figure II.2 that the overall rate of growth in skill upgrading* accelerated period by period. In the first period, from 1957 to 1973, the ratio of white-collar to blue-collar workers grew slowly at an annual rate of 0.069 per cent. In the next period, from 1973 to 1979, it grew at 0.299 per cent as white-collar employment increased sharply, while blue-collar employment stagnated. Finally, from 1979 to 1989 its growth increased to 0.599 per cent, when white-collar employment remained almost unchanged and blue-collar employment plummeted. A recent paper of the National Bureau for Economic Research undertakes to explain some of the factors responsible for these trends in the United States manufacturing sector [6]. Skill upgrading in each of the three periods is decomposed into

*The term skill upgrading means an increase in the ratio of non-production to production employees, and the terms production and non-production workers are synonymous with blue-collar and white-collar workers.

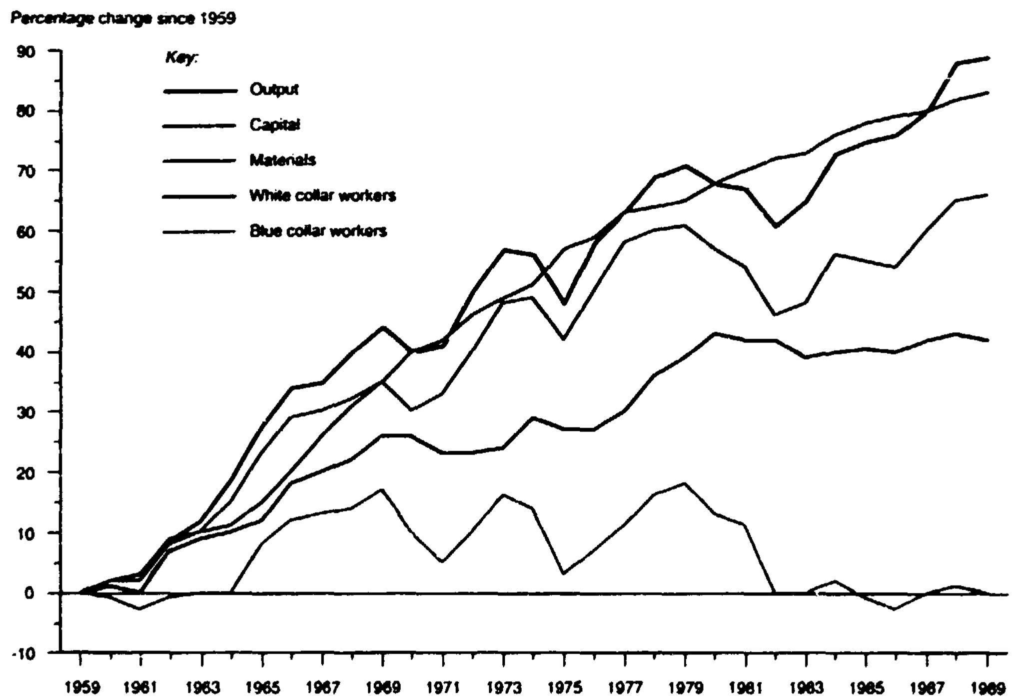
Table II.5. United States weekly wage changes for full-time workers, 1963-1987[a/]

Item	Percentage change in average real weekly wage			
	1963-1971	1971-1979	1979-1987	1963-1987
Gender				
Men	19.7	-3.4	-2.4	13.9
Women	17.6	-0.8	6.1	22.9
Years of education				
8-11	17.1	0.3	-6.6	10.9
12	16.7	1.4	-4.0	14.1
13-15	16.4	-3.4	1.5	14.4
16+	25.5	-10.1	7.7	23.1
Years of experience (men)				
1-5	17.1	-3.5	-6.7	6.8
26-35	19.4	-0.6	-	16.8
Years of education and experience (men)				
Education, 8-11				
Experience, 1-5	20.5	1.5	-15.8	6.2
Experience, 26-35	19.3	-0.4	-1.9	17.0
Education, 12				
Experience, 1-5	17.4	0.8	-19.8	-1.6
Experience, 26-35	14.3	3.2	-2.8	14.7
Education, 16+				
Experience, 1-5	18.9	-11.3	10.8	18.4
Experience, 26-35	28.1	-4.0	1.8	25.9
Total	19.2	-2.8	-0.3	16.1

Source: Lawrence F. Katz and Kevin M. Murphy, "Changes in relative wages, 1963-1987: supply and demand factors", *Quarterly Journal of Economics*, vol. CVII, No. 1 (February 1992), table 1.

a/ The numbers in the table represent percentage changes in mean weekly wages.

Figure II.2. United States manufacturing: outputs and inputs, 1959-1989 (Percentage change)



Source: Eli Berman, John Bound and Zvi Griliches, "Changes in the demand for skilled labour within United States manufacturing industries: evidence from the annual survey of manufacturing" (Cambridge, Massachusetts, National Bureau of Economic Research, Inc., January 1993), figure 3.

that caused by employment shifting between high- and low-skill industries, and that due to changes in the skill composition of labour within industries. In searching for explanations for the increase in the use of white-collar labour relative to blue-collar labour, the study considers the growth of international trade in manufactures, the defence build-up of the 1980s, other changes in the composition of domestic demand for manufactures, and technological change.

In the United States, increases in imports and exports exert their effect on the ratio of blue-collar to white-collar employment in part because imports tend to be concentrated in the more blue-collar-intensive industries, while exports tend to be concentrated in the white-collar-intensive industries. An increase in imports will tend to displace employment in the traditional lower-technology industries, while an increase in exports will increase employment in the modern higher-technology industries. Using a 450-industry disaggregation of trade and production, it is possible to trace the amount of employment that was shifted between industries as a result of international trade in each of the three periods. In terms of the percentages of the overall skill upgrading that occurred in manufacturing in each of the three periods, the amount due to trade operating through these "between-industry" effects was 25.6 per cent from 1959 to 1973, 7.3 per cent from 1973 to 1979 and 8.7 per cent from 1979 to 1987. In the 1979 to 1987 period it was also possible to evaluate the effects of defence purchases on the ratio of white-collar to blue-collar workers. The defence build-up of the 1980s was found to account for 13 per cent of the increase in the ratio. In addition, changes in composition of domestic demand for manufactures other than defence also tended to result in a shift in employment to more white-collar-intensive industries, accounting for another 8 per cent of the skill upgrading that occurred in the last period.

Together, the effects of international trade, the defence build-up and shifts in non-defence domestic demand account for less than a third of the increase in the ratio of white-collar to blue-collar manufacturing employment from 1979 to 1987. The rest of the relative decline in blue-collar manufacturing employment in the United States was due to other factors, or could not be captured in the statistical framework and used in the study.* Changes in management organization or differences in the classification of employees may explain some of the residual change, but most observers assign the bulk of the change in the structure of manufacturing employment to technological change. A number of observers have pointed to the computer revolution. For example, one study shows that the share of production workers in total employment was 2.5 percentage points lower in plants using three or more advanced technologies (computer-aided manufacturing, engineering, design etc.) than in plants using no such technologies. In addition to process innovation, in many cases product innovation has tended to be production-labour-saving. The replacement of electromechanical devices by micro- electronic devices in the telecommunications industry is one example.

While over the past 30 years there has been a fall in the demand for unskilled relative to skilled labour, there is some preliminary evidence that the trend may be shifting in the other direction. The most obvious evidence is the apparent tendency for enterprise restructuring in the past few years to shed white-collar workers to a much greater extent than in previous recessions. Another indicator is related to the sharp increase in general business productivity in the United States economy in 1992. The gain of 3 per cent in 1992 was the largest increase in 20 years. The large investment in computer equipment and software and the reorganization of firms may be beginning to pay off in higher productivity. In many cases computer technology can replace white-collar staff in the activity of processing and distilling information for management and communicating the results back to production workers. One aspect of the restructuring of manufacturing firms in the United States has been to give greater responsibility to production workers. Whether it is called lean production, the Toyota manufacturing system, the just-in-time inventory system or the re-engineered firm, new types of firm organization have emerged which require fewer white collar workers per unit of output. It is much too early, however, to say how far this trend will go, or whether it will eventually reverse the effects of the past 30 years of technological change that tended to displace blue-collar workers. Yet, it does seem likely that these changes will have their main impact on better-educated and more highly skilled blue-collar workers. This emphasis on enhancing the responsibilities of production workers has sometimes been called the "white collarization" of the blue-collar labour force, by which is meant something quite different than the type of white collarization discussed above.

(e) North American Free Trade Agreement

Despite some popular opposition in all three countries, Canada, Mexico and the United States signed the North American Free Trade Agreement (NAFTA) in December of 1992. NAFTA expands the free trade area consisting of Canada and the United States to include Mexico. If it is ratified by the legislatures of the three countries, it will take effect on 1 January 1994.

At that time the three countries will remove most quantitative restrictions, such as quotas or import licensing requirements, on imports from the other NAFTA members. Some quantitative restrictions will be simply abandoned, while others will be converted to tariffs. Tariffs will be eliminated over a period of 5 to 10 years in most cases, but up to 15 years in a few cases. Since trade-weighted tariffs are already low between Mexico and the United States, the removal of non-tariff barriers will give trade an immediate boost. Mexican tariffs on goods imported from the United States are approximately 10 per cent on a trade-weighted basis, and the corresponding figure for the United States is about 4 per cent. Sectors where full implementation will stretch out over 10 to 15 years include some agricultural products, textiles, steel and financial services.

While NAFTA establishes a trade block that is only slightly smaller than the European Community (EC) and

*One significant factor escaping the 450-industry disaggregation used in the study is intra-industry trade. The authors address this issue with some ad hoc observations on intra-industry trade and outsourcing of components to foreign suppliers. Exact figures on the effect of such imports on skill upgrading cannot be established because ratios of non-production to production employment are not available for industries disaggregated below the 4-digit (450 industry) level. It is however possible to establish some upper bounds for the contributions that such imports could make to skill upgrading. On this basis, the authors report that the total effects of trade on skill upgrading could be somewhat higher than the figures reported in the text, but not enough higher to alter their conclusions.

the European Free Trade Association (EFTA), economic integration will be more limited under NAFTA, and political union is not a goal. In particular, while the NAFTA agreement allows for a substantially free flow of capital between the three countries, it does not provide for the free flow of labour. Furthermore, NAFTA does not constrain the external tariff policies of the three members.

NAFTA will increase already substantial trade flows among the three countries. The flow of goods and services between Canada and the United States is the largest bilateral trade flow in the world, and that between the United States and Mexico is the ninth largest. Mexico is the third largest United States export market, behind Canada and Japan. In 1992, following a surge of 27 per cent in imports from the United States, Mexico accounted for some 9 per cent of United States exports. Canada and Mexico combined account for some 30 per cent of United States merchandise exports, and the United States accounts for between 60 and 75 per cent of Canadian and Mexican exports and imports. The United States and Canada have long sent investment funds in both directions, although United States nationals and corporations own a much larger share of Canadian business than the other way around. In the case of Mexico, the flow of direct investment has been from the United States to Mexico, and Mexican investment law had until recently taken a very restrictive stance toward investment outside the *maquiladora* programme.

A typical view of NAFTA proponents in the United States is illustrated by a quote from a monograph on the effect of NAFTA on the economy of the State of Texas:

> "Global production works only if trade barriers are kept low to minimize the costs of final production. Without the low barriers, United States industry would lose ground to European and Japanese producers. United States strategy cannot be otherwise if the nation is to maintain income levels." [7].

A large share of Mexican *maquiladora* manufactures has been in intermediate goods that are used in producing final products for the United States domestic and export markets. And much of the trade between Mexico and the United States takes place on an intra-firm basis, with parent firm and its subsidiary shipping parts and products between their own corporate units. Production costs for products with a significant proportion of *maquiladora* inputs, or other imported inputs, can be significantly reduced with the use of such imported inputs. The automobile and semi-conductor industries are probably the largest users of imported inputs in the United States.

Another view of NAFTA as a strategic alliance notes that members will face tariffs with one another that are lower than tariffs that non-members will face. *Business Week* reports:

> "Caterpillar Inc, which in 1983 sold only 12 pieces of equipment in Mexico, shipped 1,200 there [in 1991]. NAFTA will remove tariffs of 15 to 20 per cent on North American equipment sold in Mexico, while maintaining duties against Japanese rival Komatsu, Ltd".

On the other hand, the difficulties facing *maquiladora* firms may increase. Again *Business Week* reports:

> "Because of NAFTA, Mexicans assembling televisions, stereos, and computers from mostly Asian components will find themselves at a disadvantage. They will pay a 15% tariff on imported Asian gear, while not qualifying for duty-free entry into the United States." [8].

The concept of "Fortress North America" may be a latent threat, but without a common external tariff policy it is unlikely to materialize. While some external discrimination will result, the economics works against it. Consider, for example, the case of 15 to 20 per cent tariffs on Komatsu equipment versus Caterpillar equipment mentioned in the quotation from *Business Week* cited above. If Mexico retains the tariff on Komatsu equipment, it enables Caterpillar to charge its Mexican customers up to 15 or 20 per cent over what it could charge them if it faced competition at a zero tariff rate with its Japanese competitor. Logic would dictate that, in such cases, Mexico would exercise its right under NAFTA to lower tariffs against products coming from outside NAFTA in order to generate a better market for Mexican buyers. On the other hand, NAFTA local content rules, particularly in the automobile and textile industries, will cause some intermediate goods that are currently imported from outside North America to be replaced by goods produced in North America. The effects of NAFTA on South-East Asian exporters is described in connection with the discussion of that region in section I of the present chapter.

B. Japan

The Japanese economy appears to be following a path of gradual upward movement after the sharp decline in economic growth in 1992. The after-effects of the punctured bubbles of asset inflation distinguish the recovery this time from earlier ones. Banks have become more careful in lending as a result of the mass of non-performing loans related to land and stock speculations.* Consumers seem to have lost confidence, while enterprises have been hit by profit falls and uncertain sales prospects, and trade disputes with the United States and further yen appreciation cloud the near-term picture. Positive thrusts for growth, however, are coming from strong export demand in the Asia-Pacific Basin, from signs of economic recovery in North America and from the government fiscal stimulation package. The stimulus package consists of $90 billion of additional government spending, mainly on infrastructure projects. Because government debt in Japan is low, the increase in spending is not likely to have any adverse effects on business or consumer confidence, as such deficit spending measures might have in many other OECD countries. On the other hand, $90 billion is small in relation to the size of the Japanese economy, and is meant only to help initiate recovery and restore confidence. The Government is clearly relying on private investment as the main engine of growth. Intermediate and long-run prospects appear good, especially because of proven techno-industrial prowess in the capital goods and engineering-intensive sectors.

In 1992, GDP grew by only 0.8 per cent, compared with 4.4 per cent in 1991 and 5.2 per cent in 1990. A GDP growth rate of 1.1 per cent for 1993 and 2.5 per cent for 1994 is foreseen as likely. MVA declined

*At the height of asset inflation in December 1990, the Tokyo stock market was worth over 40 per cent of all the world stock markets combined. By the end of 1992, Tokyo's worth had fallen by some 60 per cent.

sharply in 1992 (-6.2 per cent). The decline should continue in 1993 (-0.8 per cent), with growth of 1.8 per cent expected in 1994 (see table I.1). Led by industries such as electrical and non-electrical machinery, transport equipment and chemicals, MVA grew by an average of 3.6 per cent during the period from 1980 to 1990. During the period from 1990 to 1992, however, declines, averaging -0.9 per cent, were recorded in most industrial branches (see table II.6). Only 10 out of 28 industries achieved positive growth. During 1990/92 the industries that experienced the sharpest declines in output were industrial chemicals (-7.7), leather and fur products (-6.5), wood and cork products (-5.2), glass and glass products (-5.4) and non-electrical machinery (-5.6). Partially offsetting declines in these industries were large increases in output in petroleum refining (27.8), miscellaneous petroleum and coal products (17.5) and tobacco manufactures (11.2) industries. All three of these industries are ones in which output declined during the 1980s. From figure II.3 it can be seen that the share of MVA in Japanese GDP stopped growing as of 1991, and since then labour productivity and manufacturing employment have also fallen.

A medium-term (1992-1997) projection for annual growth in various industries indicates a return to higher growth (see table II.7). The leading industries include electrical machinery (5.4 per cent), general machinery (4.7 per cent), precision instruments (3.9 per cent), chemicals (3.6 per cent) etc., although transport equipment provides the exception (only 1.3 per cent).*

The relatively weak recovery process indicates that the aggressive investment experienced from 1988 to 1990 is not likely to be repeated in the near future. It should be recalled that the economy recorded double-digit invest-

*The high-technology-intensive industries are also expected to lead the export growth of Japan in 1993. For instance, machinery-and-equipment exports will grow at 9.1 per cent and non-metallic mineral manufactures at 9.7 per cent, compared with an average growth of 8.8 per cent for all exports in the same year. This export projection was supplied by the Japan Center for Economic Research (Tokyo).

Table II.6. Growth rates of MVA in 28 industries, 1970-1992, and 1990 industry shares: Japan
(Percentage)

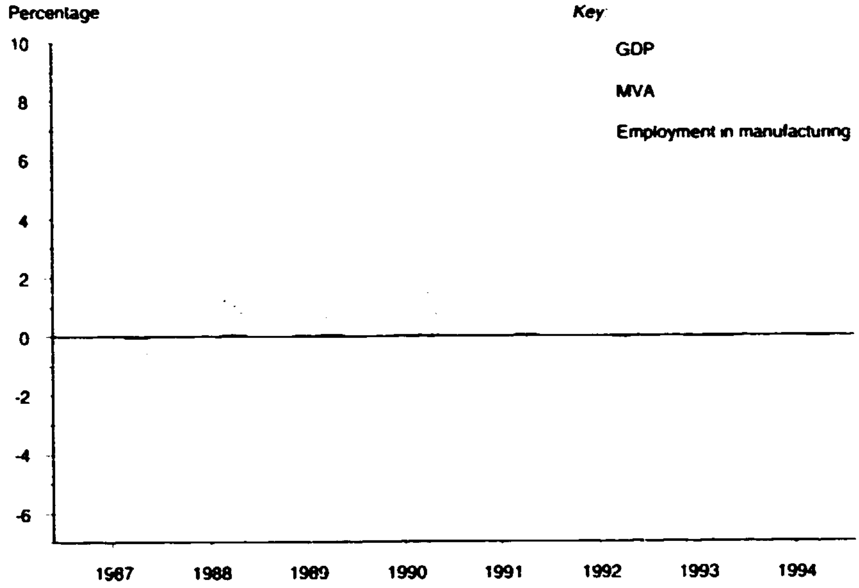
ISIC	Industry	Average annual growth rates 1970-1980	1980-1990	1990-1992	Share in total MVA[a] 1990
311	Food	5.7	3.4	2.2	7.5
313	Beverages	1.8	1.1	-0.6	1.2
314	Tobacco manufactures	6.4	-5.4	11.2	0.2
321	Textiles	-0.1	-0.5	-1.0	3.0
322	Wearing apparel	5.4	2.3	2.2	1.3
323	Leather and fur products	3.3	1.4	-6.5	0.2
324	Footwear, excluding rubber or plastic	4.5	1.4	-1.7	0.2
331	Wood and cork products	1.6	-1.7	-5.2	1.6
332	Furniture and fixtures	5.7	2.3	3.5	1.0
341	Paper and paper products	2.1	2.7	-1.6	2.5
342	Printing and publishing	5.5	4.3	-1.1	5.4
351	Industrial chemicals	-1.3	4.1	-7.7	4.3
352	Other chemical products	4.6	5.1	6.3	5.2
353	Petroleum refineries	9.9	-8.8	27.8	0.5
354	Miscellaneous petroleum and coal products	6.3	-2.4	17.5	0.2
355	Rubber products	3.8	4.1	-4.7	1.3
356	Plastic products n.e.c.	6.7	5.8	4.2	3.5
361	Pottery, china and earthenware	3.4	-	-2.6	0.3
362	Glass and glass products	1.4	4.8	-5.4	0.9
369	Other non-metallic mineral products	4.6	1.4	-1.5	3.0
371	Iron and steel	3.9	-	-3.4	5.4
372	Non-ferrous metals	4.7	-1.4	-3.3	1.3
381	Metal products, excluding machinery	2.8	4.3	1.1	7.1
382	Non-electrical machinery	2.8	5.8	-5.6	14.2
383	Electrical machinery	3.1	6.5	-1.9	15.0
384	Transport equipment	3.4	4.9	-0.2	10.7
385	Professional and scientific goods	6.3	2.0	6.0	1.4
390	Other manufactures	2.8	3.7	-2.3	1.5
	Total	3.3	3.6	-0.9	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

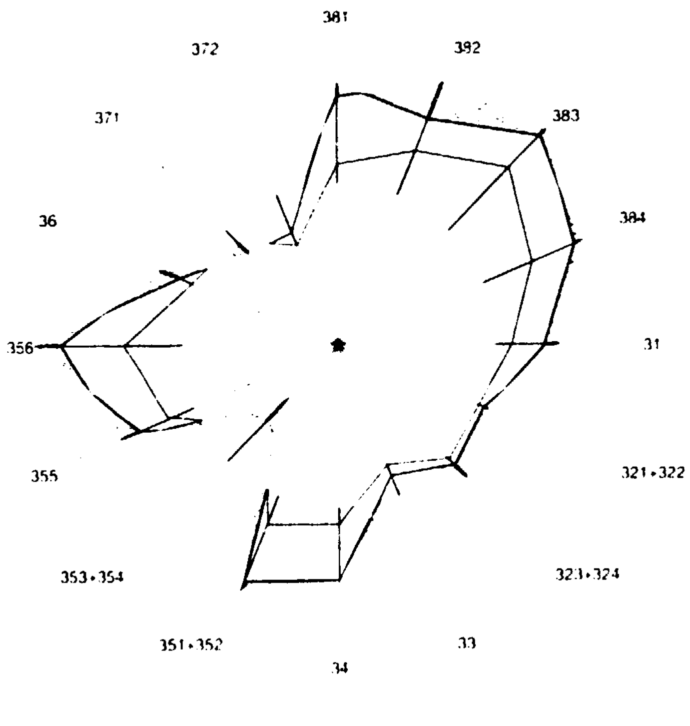
Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

[a] Total MVA for the country in 1990 was $891,779 million.

Figure II.3. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: Japan



Industrial structural change
(Index of value added 1980=100)



g = 2.26, θ = 11.86

Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

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

Table II.7. Projected average annual growth rates of industries in Japan, 1992-1997

Industry	Percentage
Electrical machinery	5.4
General machinery	4.7
Services	4.6
Banking and insurance	4.3
Communications	3.9
Precision instruments	3.9
Chemicals	3.6
Metal products	3.6
Pulp and paper products	3.6
Real estate	2.5
Other manufacturing	2.5
Foods, beverages and tobacco	2.1
Primary metals	1.6
Petroleum and coal	1.5
Transport equipment	1.3
Textiles	1.2
Mining	-0.6
Agriculture, forestry, fishery	-1.1

Source: Japan Center for Economic Research (Tokyo).

ment growth for plant and equipment for three years consecutively—namely, 16.3 per cent in 1988, 14.3 per cent in 1989 and 11.2 per cent in 1990. Then in 1991 the rate fell to 2.7 per cent followed by -4.6 per cent in 1992. According to a sample survey by the Kogyo Bank, the growth rate of investment for plant and equipment will continue to be negative in 1993 (see table II.8 for industry details). The collapse of asset prices in 1992

Table II.8. Growth rates of planned expenditure on plant and equipment by industries in Japan, 1992 and 1993

Industry	1992	1993
Manufacturing	-11.8	-12.9
Iron and steel	-0.8	-21.3
Non-ferrous metals	-14.6	-10.2
Electrical machinery	-24.6	-3.3
Shipbuilding	31.3	-13.9
Automobile	-10.5	-7.0
General machinery	-12.4	-14.4
Petroleum refining	1.0	-13.0
Chemicals	-20.2	-13.7
Textiles	-0.3	-11.3
Pulp and paper products	-20.0	-24.5
Pottery	-14.7	-24.2
Foods	-6.1	-10.9
Other manufactures	-10.1	-29.2
Non-manufacturing	-1.0	-5.3
Electricity	11.1	6.2
Mining	15.5	4.2
Gas	-10.9	4.2
Construction	-16.6	7.2
Real estate	-6.2	-15.8
Total	-2.5	-5.4

Source: Sample survey by Kogyo Bank (Tokyo), reported in *Asahi Shimbun*, 6 October 1992, p. 9.

reduced the ability of enterprises to borrow on collateral. Excess production capacity and accumulated inventories coupled with sluggish consumer demand (1.2 per cent and 2.4 per cent growth estimated for 1992 and 1993, respectively) all tend to erase needs to add capacity. The ability of Japanese banks to provide investment finance has also weakened; average return on equity of major banks dropped from 9.9 per cent in 1990 to 5.9 per cent in 1991, and to 4.8 per cent in 1992 [9].

Negative investment growth is also observable in Japanese investment abroad. Total foreign direct investment dropped by 28 per cent, to $17 billion, during fiscal 1992 (running to end March 1993), compared to a peak of $50 billion in 1990 [10]. The Ministry of Finance reported that in the second quarter of 1992, compared to one year earlier, foreign direct investment in manufacturing tumbled by 20.1 per cent, while non-manufacturing fell by 7.0 per cent. By region, foreign direct investment in the United States fell by 8.3 per cent, and in Western Europe by 25.4 per cent; in contrast, in the Asian region it rose by 5.5 per cent. This distribution seems to reflect recent profitability differences. Indeed, a recent study by the Nomura and Mitsubishi Research Institutes shows that only 20 per cent of Japanese foreign direct investment in the United States during the late 1980s began yielding profits within two years; the figure for Asia was 80 per cent [11].

At the enterprise level, the short-run adjustments have taken various forms, such as slashing annual recruitment of college graduates, reducing working hours, closing unprofitable product lines, freezing promotions, cutting executive remunerations by as much as 35 per cent in some cases, and eliminating workers' bonuses. However, it is noteworthy that while planned expenditures for plant and equipment in 1992 were sharply down, those for R and D hardly changed (see tables II.8 and II.9). It is evident that Japanese firms believe that in the long run technological progress matters, and they are not willing to compromise it for short-run considerations.

I. Policy issues

The year 1992 saw yet another record trade surplus amounting to $44 billion with the United States, $42 billion with Asia, and $31 billion with the EC, and the current account surplus rose by 40 per cent in fiscal 1992, to a record $126 billion. The Japan Center for Economic Research projects that the current account surplus of Japan will increase to $143.1 billion in fiscal 1993, or 3.5 per cent of nominal GNP [12]. The result has been increased international pressure on Japanese policy makers to improve international trade and investment access to the domestic market of Japan and to reflate the Japanese economy.

The new administration in the United States has been actively seeking to reduce the large trade deficit with Japan. Japan, with its huge exports of motor vehicles and electronic goods to the United States and relatively low import penetration in its home market, has become the focus of attention of United States trade policy makers, whereas Japan claims to be allowing firms to follow the dictates of comparative advantage and United States consumer choices. Specific industry targets established in the past have included the agreement to give United States producers 20 per cent of the Japanese market in

Box II.1. Japanese high technology and the techno-paradigm shift

Technology fusion is embodied in the changes that swept across industry during the last decade. With the emergence of high technology, changes are occurring in the whole framework of corporate strategy. From past studies the following four categories of this paradigm shift can be derived:

(a) Manufacturing companies—from a producing to a thinking organization;

(b) Business dynamics—from a single to a multi-technologies basis;

(c) R and D activities—from visible to invisible enemies;

(d) Technology development—from a linear to a demand articulation process.

First, a redefinition of the manufacturing company is taking place. The manufacturing company is traditionally a site for production, and the formulation of the economist is a production function: capital plus labour equals output. But in many Japanese manufacturing companies, R and D investment is much greater than capital investment. R and D investment surpassed capital investment quite recently in Japan, and the change occurred rapidly. So as R and D investment surpasses capital investment, the corporation shifts from being a place for production to being a place for thinking.

Second, there are changes in the business environment. In the past, one technology corresponded to a company. But now, especially in Japan, technological diversification has progressed so much that it is hard to distinguish a company's principal business from its secondary business. In many cases, the principal business of a company is now overtaken by its secondary business. Today's leading Japanese companies have entered the stage where they survive by adapting to the environment, relying on consistent, dependable R and D.

Third, major changes are observed in the field of R and D investment decision-making. Investment decisions are no longer based on rates of return. It is more like the principle of surfing: the waves of innovations come one after another, and there must be investment; if even one opportunity is missed, the company is left behind. The pattern of competition is also changing. Competitors used to be solely companies within the same industry, but that is no longer true. Thus high-technology companies have to monitor not only direct competitors in their own industry, but also companies in other industries. In effect, this means that high-technology companies must engage in R and D competition with "invisible enemies".

Fourth, there are changes in the technology development process. In the high-technology era, the key issue of technology strategy has become not how to break through technological bottlenecks, but how to put existing technology to the best possible use. Accordingly, a day of reckoning has come for technology strategy, which traditionally has emphasized the supply side of technology development. A need has now arisen for a technology strategy that works from the demand side. In developing a new strategy to meet this need, the most important element is the process of demand articulation. Through this process, the need for a specific technology manifests itself, and the R and D effort is targeted toward developing and perfecting it.

It is easy to synthesize these four categories of techno-paradigm shift around the concept of technology fusion. There is a strong relationship between technology fusion and manufacturing companies becoming thinking organizations. Technical terms are increasingly being used as catch-phrases for corporate identity and for defining a corporate business domain. For example, C & C (computer and communication) is used by NEC, E & E (energy and electronics) by Toshiba, and IM & M (information movement and management) by AT & T in the United States. As those phrases imply, technology fusion is envisioned clearly, and such phrasing has helped shift these companies into growth markets.

Technological diversification is a necessary condition for technology fusion. In Japan, technology fusion is attained through diversification of R and D. Through the technological diversification efforts already made, Japanese companies have established the fundamental basis for technology fusion.

The techno-paradigm shift in R and D activities will facilitate the realization of technology fusion. Because of the competitive threat from companies in other industries solving critical technical problems first, some companies are forming alliances with outside companies. Alliances between companies in different industries work not only as a competitive hedge against major technological surprises that might be brought about by companies in different industries, but also as a device that facilitates technology fusion.

Technology fusion is intrinsic to the process of demand articulation. Demand articulation is a process of converting the customer's vague wants into a set of R and D projects. Because R and D is demand-driven, companies may very well not have the technological capabilities in-house to solve the technical challenges. To accumulate the necessary expertise requires a search and selection process outside the company. As companies develop their skill at articulating demand, they will also develop a skill at fusion. Indeed, demand articulation drives technology fusion.

The changing focus of manufacturing companies, the diversification of R and D, the changing pattern of R and D activities, and the increasing importance of demand articulation are all related. Taken together, the message to management is clear: technology fusion is becoming an increasingly important strategy for creating new products and new materials.

Source: Fumio Kodama, "Technology Fusion and the New R and D", *Harvard Business Review*, vol. 70, No. 4 (July-August 1992), p. 73.

Table II.9. Expenditures on plant and equipment and R and D by selected companies in Japan, 1991 and 1992
(Billion yen)

Company	Plant and equipment		R and D	
	1991 (actual)	1992 (planned)	1991 (actual)	1992 (planned)
Hitachi	207.5	140.0	411.6	400.0
Toshiba	241.0	150.0	279.2	270.0
Mitsubishi	140.0	90.0	180.0	182.0
Matsushita	156.9	80.0	418.1	430.0
NEC	260.0	19.0	320.0	310.0
Fujitsu	198.3	110.0	317.9	325.0

Source: *Nihon Keizai Shimbun*, 28 October 1992, p. 3.

computer chips. The United States Government has proposed that a broad range of such targets be negotiated, but the Japanese have so far resisted this approach as contrary to the principles of free trade.

In the past, it has been thought that yen appreciation would correct trade surpluses. But Japanese enterprises have repeatedly succeeded in maintaining their competitiveness through technological progress that offset the effect of exchange rate adjustment. Some have argued that appreciation of the yen has provided a stimulus for Japanese enterprises to step up their efforts to develop new technologies and increase productivity (see box II.1). If the fundamental driving force for trade and competition comes from technology development, then the effect of exchange rate adjustments may be muted.

A search for new policy tools may be warranted under the circumstance. In such an endeavour, Japan could make use of its advantages, such as the "technological capital" combined with the dollar assets that Japan holds, all for some new form of "cooperation cum competition" to help its trading partners reduce their trade deficits with Japan, if only to maintain a viable global trading system. This could provide a truly market-opening process as well as the global "leadership" demanded of Japan. One Japanese policy analyst has argued that "in many cases, changing rules will necessitate changing patterns of behaviour. When Japanese systems are so different from international norms that the resultant friction is inimical to Japanese interests, it behoves Japan to take the initiative and change its systems. This is the kind of leadership that Japan needs today. Indeed, the essence of leadership is in the ability to transform reality. As is clear from the lessons of history, it is very difficult to effect reforms when the established modalities still have some life left in them, but neither Japan nor the rest of the world can afford to wait for systemic collapse" [13].

C. Western Europe

1. Short-run outlook

Largely for reasons discussed in the present section, rather good growth expectations for most countries in Western Europe began to be revised sharply downward as of the latter half of 1992. In particular, Germany ceased to be the "engine of growth" for the region, and sudden troubles related to exchange rate coordination, including devaluation of many European currencies against the deutsche mark, created widespread market uncertainty. For most of the region, GDP growth ceased or became negative in 1993, and in the EC unemployment is expected to rise to about 12 per cent of the workforce. Manufacturing has suffered more than service industries; even major companies are reporting sharply lower sales and profits.

Growth of regional GDP, 1.2 per cent in 1992, is expected to become negative in 1993, to -0.3 per cent (see table I.1). But for recovery in the United Kingdom after several years of decline, the regional average would have been even worse. Starting with Germany, where GDP growth is expected to drop to -1.7 per cent in the western part of the country, economic slow-down spread swiftly throughout the region.

The recession is expected to be short-lived, however. General economic recovery is forecast for Western Europe in 1994, with GDP growth rising to 1.9 per cent. It should be noted that this assumes somewhat lower inflation and interest rates, especially in Germany, and greater stability among European currencies, assumptions which (as of mid-1993) some will consider optimistic.

The share of manufacturing in regional GDP is continuing to decline. Following negative MVA growth in both 1991 and 1992, a further decline, -2.8 per cent, is expected for 1993. Economic recovery forecast for 1994 is expected to boost regional MVA growth for the year to 1.1 per cent, still below that of GDP.

High wages and non-wage benefits apparently are eroding industrial competitiveness in much of Western Europe. Major industries such as automobiles and electronics are currently suffering from high operating costs, so that companies are shedding labour and seeking lower-cost production sites. German automobile manufacturers, for example, are increasingly looking towards eastern European bases for the supply of parts and assembly. Small cars may soon be produced only in eastern or southern European countries [14]. Wage differences, such as a one-to-six ratio between the Czech Republic and neighbouring Bavaria, are providing a strong incentive to relocate.

Germany, nevertheless, accounts for the largest share of regional manufacturing, 35 per cent as of 1990 (see table II.10). France, the United Kingdom and Italy accounted together for another 39 per cent. Production of non-electrical and electrical machinery and transport equipment dominate regional manufacturing. Together these industries accounted for one third of 1990 regional MVA. Figure II.4 illustrates a general decline in MVA and regional manufacturing employment in the 1990s, as well as declining labour productivity relative to the late 1980s.

2. Delays in forming a single European market

Until about mid-1992, movement towards a greater European polity and economy within a few years did not seem in doubt. The Single European Act of 1987, which was designed to remove inconsistencies in economic and business regulations and practices within the EC by the beginning of 1993, had been agreed. The Maastricht Treaty, signed in early 1992, outlined a wide range of changes that would greatly strengthen efficient decision-making within the EC, including a common currency (by

Table II.10. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: Western Europe
(Percentage)

Country or industry (ISIC) and total		Average annual growth rates 1970-1980	1980-1990	1990-1992	Share in total MVA[a] 1990
A. Country breakdown					
Germany (western part)		1.0	3.2	0.5	31.6
France		2.0	1.0	-1.6	14.9
United Kingdom		0.2	0.8	-2.8	14.7
Italy		4.3	-1.2	-2.5	9.5
Spain		7.6	0.2	-1.4	5.1
Germany (eastern part)[b]		3.9	-2.5	-16.6	3.4
Switzerland		-1.7	1.7	0.1	3.4
Sweden		0.9	1.0	-6.7	3.0
Netherlands		-0.8	2.5	0.7	3.0
Belgium		1.4	1.1	-4.1	2.5
Austria		1.7	2.1	1.9	2.1
Finland		5.0	-0.2	-4.4	1.5
Denmark		1.5	1.8	1.9	1.4
Ireland		6.5	4.8	6.9	0.9
Norway		0.5	-0.9	-	0.8
Portugal		6.5	1.3	-3.5	0.7
Greece		6.1	0.8	-0.5	0.7
Israel		7.8	-0.4	7.9	0.6
Luxembourg		-1.8	3.2	0.8	0.1
Iceland		8.5	-1.9	-5.6	-
Malta		13.4	3.1	4.0	-
B. Industry breakdown					
311	Food	2.8	0.8	0.6	8.7
313	Beverages	0.5	1.2	1.3	2.4
314	Tobacco manufactures	-0.6	1.4	2.8	1.4
321	Textiles	-0.5	-1.2	-4.5	3.3
322	Wearing apparel	0.5	-1.7	-3.4	1.8
323	Leather and fur products	-	-1.9	-7.3	0.4
324	Footwear, excluding rubber or plastic	2.3	-3.2	-5.2	0.5
331	Wood and cork products	2.1	-1.4	-3.1	1.6
332	Furniture and fixtures	3.7	0.1	0.6	1.8
341	Paper and paper products	1.3	2.0	0.3	2.9
342	Printing and publishing	2.2	2.7	-	4.5
351	Industrial chemicals	1.5	3.1	0.7	6.4
352	Other chemical products	1.5	4.3	-	5.1
353	Petroleum refineries	2.9	-0.7	2.3	3.0
354	Miscellaneous petroleum and coal products	1.7	1.2	0.5	0.3
355	Rubber products	1.7	-	-0.4	1.3
356	Plastic products n.e.c.	4.9	4.7	-0.2	2.9
361	Pottery, china and earthenware	3.5	-1.1	-4.3	0.5
362	Glass and glass products	1.9	0.7	-0.2	1.0
369	Other non-metallic mineral products	1.9	0.1	-3.1	3.0
371	Iron and steel	-0.2	-2.8	-4.7	3.7
372	Non-ferrous metals	-0.3	1.9	-3.4	1.5
381	Metal products, excluding machinery	1.7	1.7	-1.7	6.7
382	Non-electrical machinery	2.0	2.1	-5.8	12.1
383	Electrical machinery	3.0	2.2	-0.9	10.4
384	Transport equipment	2.9	1.7	-1.9	10.5
385	Professional and scientific goods	2.3	-1.3	-0.8	1.5
390	Other manufactures	1.7	-	-0.8	0.9
Total[c]		1.9	1.2	-1.3	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

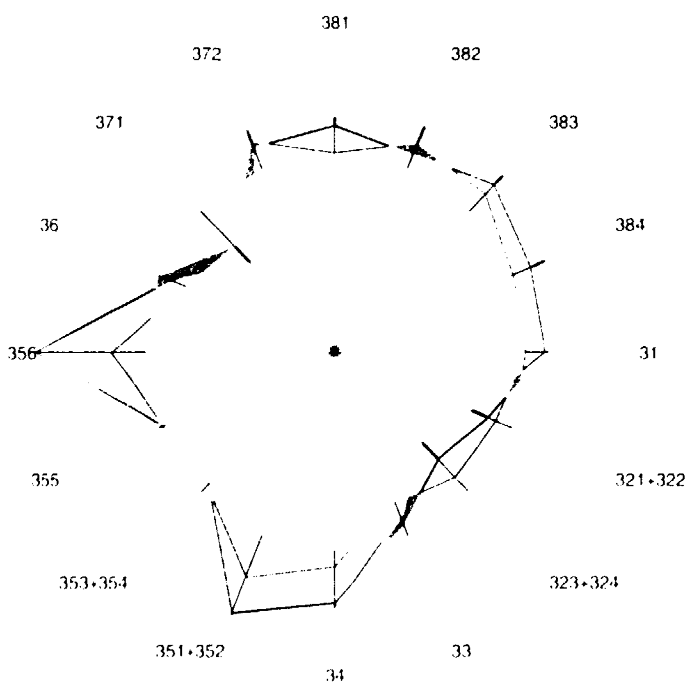
[a] Total MVA for the region in 1990 was $1,721,791 million.

[b] Territory of the former German Democratic Republic.

[c] For both country and industry breakdown.

Figure II.4. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: Western Europe

Industrial structural change
(Index of value added 1980=100)



g = 0.52, θ = 9.53

Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

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

1999 at latest), convergent fiscal policy and EC-wide business law and regulations. Widening of the EC, that is, adding new member countries, was also being negotiated.

At mid-year, a referendum in Denmark went against the Treaty, reinforcing doubts in several EC countries about greater central authority, and leading to the chaotic changes in the EC exchange rate mechanism (ERM) starting in September (several countries devalued or dropped out of ERM). The problem was exacerbated because the German Bundesbank decided that it could not lower interest rates because government spending on rehabilitation in the eastern part of Germany was threatening to cause higher inflation. Plans for a common European currency by 1999 now seemed optimistic at mid-1993, and continued pressures on the ERM threaten its existence.* Meanwhile, in major countries such as Italy, France and the United Kingdom, as well as Germany, political pressures were weakening government policy options. As of writing, the presidency and the Government of France are once again divided along party lines, in Italy political corruption accusations have led to a complete reorganization of the system of government, and in Germany the east-west problem, inflation and the budget deficit are pushing other issues aside in political debate.

Many changes in national legislation required by the Single European Act, which came into force on 1 January 1993, have yet to be made, so that some border restrictions are unclear; Asian exporters have reported shipments that have been delayed or blocked [15], [16]. And negotiations between EC and EFTA countries regarding the establishment of a European economic area, which would provide a bridging framework until EC membership is widened, are also being delayed.

Other important trade issues have been affected. A common stance on finalization of the GATT Uruguay Round, which aims at world trade liberalization, has been disrupted by a number of disputes at national level involving "sensitive" activities. Several of these problems are also complicating trade relations between the EC and the United States, creating the threat of selective increases in protectionist measures on both sides. Eastern European exporters of steel and many other products are complaining of high EC import barriers, and that they need trade more than aid.

3. *Longer-term prospects*

Once Western Europe has recovered from the economic shocks caused primarily by German unification and the negative outcome of the first Danish referendum on the Maastricht Treaty, and has reconstructed ERM, the delayed process of EC deepening and widening will help to bring the region back to a positive growth track. But prospects for manufacturing in the region are not particularly good. Too much of industrial production remains in "sunset" industries such as steel, innovation and productivity growth tends (with significant exceptions) to be lower than that of major competitors (especially those from East Asia), and labour costs are relatively high (for example, China now produces simple manufactures at a small fraction of Western European costs). One result of declining competitiveness has been that EC manufacturing exports to non-members, as a share in world manufacturing exports, has declined steadily from over 22 per cent in 1980 to under 18 per cent in 1992.

The *Economist*, in a recent survey of the European Community [17] has summarized the problem thus:

> "European competitiveness has been continuing to slip. The Community's share of world exports in manufactures has fallen by a fifth since 1980. It has a widening deficit in trade in high technology: a study by the commission showed that, between 1982 and 1990, the volume of EC high-tech exports to the rest of the world grew by only 2 per cent a year, while high-tech imports grew by 7.7 per cent a year.
>
> Improvement in manufacturing productivity in the EC has been sluggish. Between 1979 and 1990, according to the Confederation of British Industry, value added per person employed in manufacturing rose by 4.6 per cent a year in Japan and 3.5 per cent in America, but by only 2.5 per cent a year in the Community. Persistently high West European unemployment—the EC's 10-per-cent-plus compares with 7 per cent in America and just 2.3 per cent in Japan—reflects labour-market rigidities that are especially damaging at a time when businesses are looking for more and more flexible ways of organizing production and when investment capital moves freely round the world in search of cheap, efficient labour.
>
> EC labour is hardly cheap. Not only are wages high, but so are non-wage costs (such as social security payments and fringe benefits). In Italy, the European champion at this, non-wage costs make up half the total labour costs in manufacturing. West Europeans are pricing themselves out of jobs compared with Americans and Japanese, let alone Indians and Chinese.
>
> Back to Germany. Its labour costs are the highest in the world. Right next door, in the Czech Republic, is a skilled labour force that costs one sixth as much. More German companies are discovering that they can make German-quality goods more cheaply outside Germany."

As mentioned earlier, the share of MVA in regional GDP has been declining. This trend should continue, with production involving low technology and low skills being encouraged to relocate to low-cost areas within the region or to Eastern Europe or to developing countries. The future of manufacturing in Western Europe needs to be based on carefully selected, lean, efficient production of high-technology products based on high-skill technologies, in other words, on the region's dynamic comparative advantages. A consequence of this prospect will be, unfortunately, that manufacturing will provide fewer jobs for unskilled labour; rapid growth in service industries will therefore be needed.

D. Eastern Europe and the former USSR

Throughout Eastern Europe and the former USSR the search for new political, economic and social rules to replace the discredited previous system continued in 1992 and 1993. Like the costs of German reunification, the process has proven to be much more difficult than most observers had (optimistically) foreseen at the end of

*ERM all but collapsed in early August 1993, when, under pressure from speculators, the exchange-rate band spread (permitted fluctuation) was widened from 2.25 (core currencies) to 15 per cent, plus or minus (for all currencies excepting the Netherlands guilder in relation to the deutsche mark). ERM breakdown could result in a delay of the recovery projected for 1994.

communist rule, central planning and Soviet predominance. The situation is less surprising when it is considered that in most of the region no historical experience of democracy or market competition existed previously, many of the people now in power are new to government and public administration, and 22 new States have so far emerged from the former USSR (15), Yugoslavia (5) and Czechoslovakia (2). Disagreements at the political level are imposing severe constraints on possibilities for renewal of economic policies and institutions. The Commonwealth of Independent States (CIS), for example, seems now to have become mainly a forum for discussion.

Before discussing the regional situation, the major negative consequences of events since 1989 on the world economy should be mentioned. First, the world's second largest manufacturing economy (as of 1990 still just ahead of Japan, ignoring factors such as quality and military use) has collapsed, so that manufacturing output in the Russian Federation in 1993 will be about equal to that of France or Italy (and well below that of united Germany). Second, the demise of the trading system of the Council for Mutual Economic Assistance (CMEA) and of the rouble as a stable unit of exchange has disrupted trade both within the region and with external partners, including many developing countries. Furthermore, the massive capital requirements associated with the efforts of the Government of Germany to quickly rebuild the economy of the eastern part of the country has resulted in Germany moving from being a net supplier to a net consumer of international financial capital. This has contributed to the rise in interest rates and fall in growth which has gripped Europe. The tightening in European credit markets has also increased worries that the flow of investment funds to developing countries may be negatively affected. Overall, a major development problem for the 1990s has been created. Figure II.5 dramatically illustrates the decline, particularly in manufacturing, since 1990.

1. Short-run outlook

The fall in GDP accelerated in almost all countries of the region during 1991 (see tables II.11 and II.12).* For most countries the decline was greater than 10 per cent. For 1992 there were signs of recovery in several Eastern European countries; rates of decline slowed in Bulgaria, Czechoslovakia and Hungary; and in Poland the decline halted. For the countries of the former USSR, however, estimated rates of decline were even higher than for 1991. General decline is expected to continue in the countries of the former USSR in 1993, but positive growth seems likely in the Czech Republic, Hungary, Poland and Slovenia.

Industrial output (which includes mining, utilities and petroleum, as well as manufacturing) continued to drop in the first three quarters of 1992 in all countries except Poland (1 per cent gain) (see table II.12). In the Russian Federation, consumer goods output dropped by 15 per cent (foodstuffs by 22 per cent), crude steel by 13 per cent, and output in the machine-building and chemical industries by at least 20 per cent.

UNIDO's estimates of the decline from 1990 to 1992 in regional MVA at the three-digit ISIC level (28 sectors) are shown in table II.13. MVA in all countries and all manufacturing sectors fell sharply.

The Russian Federation, as the largest economy in the region, with the bulk of natural resources, supplier industries and consumer demand, remains the key country regarding the general economic recovery of the region, and in particular the other countries of the former USSR. Economic progress is being held back by political conflicts—at the central level, between the central level and

*As mentioned in *Industry and Development: Global Report 1992/93*, statistical data for the region should be treated with caution. A major problem is high and variable inflation rates and currency valuation; new currencies are being adopted in some countries, and transactions are often based on United States dollars. Accounting for small new market transactions may be incomplete.

Table II.11. Gross domestic product in selected countries of Eastern Europe and the former USSR, 1990-1993
(Percentage change; constant prices)

	1990	1991[a]	1992 estimate	1993 forecast
Bulgaria	-9.1	-16.7	-15	-7
Croatia[b]	-9.3	-28.7	-24	..
Czechoslovakia	-0.4	-15.9	-8	
Czech Republic	-0.4 [c]	-15.1 [c]	-7	-
Slovakia	-2.7 [c]	-15.3	-10	-5 to -3
Hungary	-3.3	-10.2	-5	-2 to 2
Poland	-11.6	-7.6	-1 to 1	1 to 2
Romania	-7.4	-13.7	-15	-5
Russian Federation[c]	-2	-9	-19	-15
Slovenia	-3.4	-9.3	-8	-1
Ukraine[c]	-2.4	-11.2	-15 to -13	-20 to -10
Total[d]	-3.5	-10.4	-15	-12 to -10

Source: National statistics; and the Wiener Institut für Internationale Wirtschaftsvergleiche (Vienna).

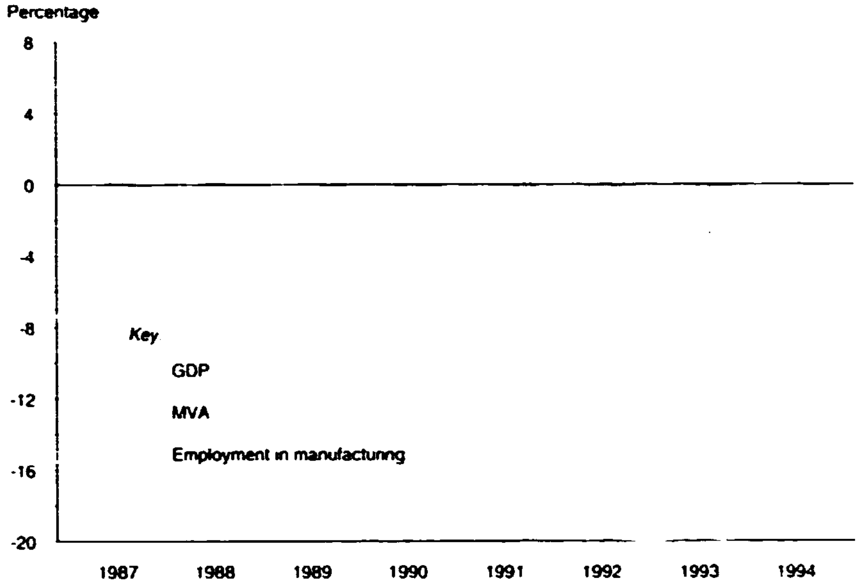
a/ Preliminary.

b/ Social product based on definition used in the former Yugoslavia.

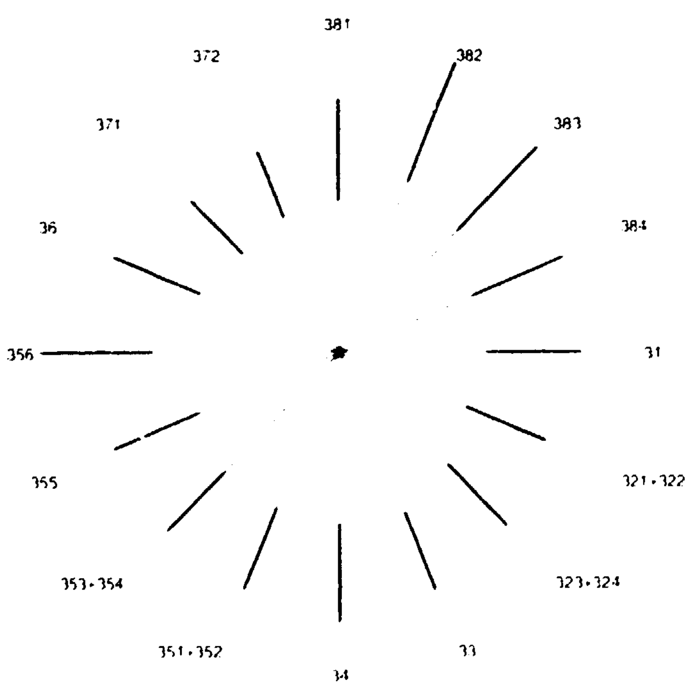
c/ GNP.

d/ Weighted averages.

Figure II.5. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: Eastern Europe and the former USSR



Industrial structural change
(Index of value added 1980=100)



g = -1.45, θ = 6.21

Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

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

Table II.12. Industrial output in selected countries of Eastern Europe and the former USSR, 1990-1992
(Percentage change; constant prices)

	1990	1991[a]	January-September 1991	January-September 1992
Bulgaria[b]	-18	-28	-28	-22
Croatia	-11	-29	..	-22
Czechoslovakia	-4	-25	-21	-16
Hungary	-5	-19	-17	-13
Poland[c]	-24	-12	-11	1
Romania	-19	-20	-18	-24
Russian Federation	-	-8	-3	-18
Slovenia	-11	-12	..	-15
Ukraine	-1	-20	..	-10
Total[d]	-5	-13	-9	-15

Sources: National statistics; and the Wiener Institut für Internationale Wirtschaftsvergleiche (Vienna).

a/ Preliminary.

b/ Without private sector.

c/ Sales.

d/ Weighted averages.

state or lower levels, and between the Russian Federation and other CIS countries. Resolution of such conflicts is therefore urgently needed.

2. *Macroeconomic and enterprise reform*

Poland was first in the region to take the "big bang" approach to economic reform, whereas Hungary has proceeded on the gradual path which it started even before 1989. A large literature has developed since on the relative merits of these seemingly extreme possible paths to economic reform, but theory seems outweighed by differences in practical circumstances. In either approach, the need for strong political backing when the economic situation appears to be weakening, as the new policies "bite", seems essential. Poland wavered in mid-1992, for example, but quickly regained its economic momentum; inflation continues to decline, and private foreign investment is expanding rapidly. Czechoslovakia also introduced a strongly market-based economic reform. The split of the country at the beginning of 1993 has mainly caused problems for the economically weaker part, Slovakia (with much heavy industry unprofitable at market prices, having been previously tied closely to the economy of the former USSR).

Most countries have made considerable progress in reforming their foreign trade and exchange regimes, although changes continue to be made. A summary of the situation as of mid-1992 is shown in table II.14.

Privatization of industrial enterprises, mostly of small or medium size, has been or is being introduced in most East European countries. The "voucher" schemes differ considerably depending on whether they are auctioned, distributed per capita or to workers and managers, on the extent to which foreigners may participate, the involvement of pooled investment funds, the "rights" involved (for example, whether they are directly resaleable) etc. At the time of writing, the Polish scheme was being revised; the initial proposal was rejected as giving too much to foreign consultant firms (which would act as "managers" for the large firms), and the Czech Republic was imposing rights restrictions on Slovak voucher holders. The issue is extremely complex in terms of economics, law and politics, and unfortunately may be hindering quick economic recovery and political resolution of issues relating thereto. Particularly for large industrial firms, an agenda expressed in terms of "commercialization" might seem more immediately resolvable.

Whereas the economic situation was still very severe in the countries of Eastern Europe as of early 1993, the worst seems over (except for parts of the former Yugoslavia and Albania). That is not the case, however, for the 15 countries of the former USSR.

The Russian Federation had the greatest potential for quick economic recovery since it was least dependent on linkages with other parts of the former USSR and CMEA trading partners, and has the bulk of natural resources, consumer demand and rouble control. The new reform Government initiated harsh economic reforms at the beginning of 1992, including drastic price increases for most products, so that real incomes suffered. Political debate since late 1992 have resulted in a near collapse of economic reforms and a more conservative regime. Inflation is soaring at an annualized rate of about 1,500 per cent, the rouble is weakening as a unit of exchange (near 1,000 per United States dollar in May 1993, compared to below 200 in late 1992), etc. Prospects are grim to say the least.

At the time of writing all attempts at economic reform had ground to a halt, at least temporarily, as a result of the constitutional crisis centering on the powers of president versus the legislature. The pace and path of further economic reform will depend crucially on the outcome; meanwhile, "muddling through" describes the economy.

In other countries that have emerged from the former USSR, even worse conditions generally prevail. All are far from reaching internal agreement on the basic conditions for political and economic reforms, and although some have human capital and others have national resources, they are all weak in the short term (having been cut off from the CMEA trading system, and/or having to pay world prices, especially for energy), and all are seeking replacement currencies for the rouble and ways of implementing price liberalization and enterprise ownership and control that do not exacerbate soaring inflation.

3. *Western assistance, private foreign investment and trade barriers*

Although $24 billion in aid had been pledged by the Group of Seven major industrialized countries for the countries of the former USSR, so far very little has been disbursed, largely because conditions imposed by the IMF relating to economic reform have mostly not been met. However, the proposed package by the Group of Seven was revised upward in April 1993 to provide the Russian Federation with a total of $43 billion for stabilization, structural reform and essential imports and debt rescheduling. An additional $4 billion fund to promote large-scale privatization is being considered [18], so that significant aid flows may soon begin. As of late March 1993, the Russian Federation had threatened to impose a unilateral six-month freeze on debt repayment, as well as announcing measures to cut inflation and strengthen the rouble, but policies remain in a state of flux.

Table II.13. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: Eastern Europe and the former USSR
(Percentage)

Country or industry (ISIC) and total		Average annual growth rates			Share in total MVA[a]
		1970-1980	1980-1990	1990-1992	1990
		A. Country breakdown			
Former USSR		5.9	3.3	-16.2	83.1
Former Yugoslavia		6.8	4.7	-16.7	4.6
Poland		5.6	-2.4	-5.7	3.8
Romania		0.6	-1.3	-22.5	2.6
Bulgaria		8.0	2.1	-25.3	2.4
Czechoslovakia		7.1	-2.6	-18.6	2.1
Hungary		-0.2	-0.7	-10.5	1.3
Albania		6.3	0.9	-5.4	-
		B. Industry breakdown			
311	Food	3.2	3.0	-16.5	16.0
313	Beverages	5.4	-2.3	-14.4	2.1
314	Tobacco manufactures	4.6	-	-14.9	0.6
321	Textiles	3.9	0.9	-16.9	7.5
322	Wearing apparel	4.8	2.2	-15.7	4.7
323	Leather and fur products	3.1	0.1	-16.7	0.5
324	Footwear, excluding rubber or plastic	3.5	3.0	-15.8	1.3
331	Wood and cork products	3.1	1.4	-16.6	1.4
332	Furniture and fixtures	6.3	3.7	-14.0	1.3
341	Paper and paper products	4.9	3.0	-16.3	1.0
342	Printing and publishing	4.4	2.8	-16.3	0.8
351	Industrial chemicals	8.0	2.4	-16.3	4.0
352	Other chemical products	5.2	2.2	-14.7	2.2
353	Petroleum refineries	6.0	1.4	-15.6	1.6
354	Miscellaneous petroleum and coal products	3.7	2.6	-15.2	2.4
355	Rubber products	5.5	2.1	-17.4	1.1
356	Plastic products n.e.c.	9.5	4.3	-17.1	0.7
361	Pottery, china and earthenware	8.0	3.5	-17.0	0.6
362	Glass and glass products	8.1	2.1	-16.1	0.5
369	Other non-metallic mineral products	4.5	1.9	-16.8	3.4
371	Iron and steel	3.3	0.5	-15.0	3.5
372	Non-ferrous metals	4.1	0.7	-14.3	1.8
381	Metal products, excluding machinery	8.8	2.3	-16.2	2.7
382	Non-electrical machinery	9.7	4.5	-16.2	23.9
383	Electrical machinery	7.7	3.7	-16.3	3.7
384	Transport equipment	4.6	2.2	-16.1	4.3
385	Professional and scientific goods	7.8	4.3	-16.3	2.9
390	Other manufactures	6.1	3.3	-16.6	3.5
Total[b]		5.6	2.7	-16.2	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

[a] Total MVA for the region in 1990 was $603,884 million.

[b] For both country and industry breakdown.

Table II.14. Foreign trade and exchange regimes in transition economies of Eastern Europe and the former USSR as of mid-1992

Country	Exports			Imports				Allocation of foreign currency to the enterprise sector through			Exchange rate mechanism		
	Direct State intervention	General use of quotas/licences	Export tax	Direct State intervention	General use of quotas/licences	Global quota system for consumer goods	Average tariff (percentage)	Internal convertibility	Retention quota system	Currency auctions	Unified exchange rates	Fixed rate against a basket	Other
Albania	No	No, except for fuels, food, raw matrials	No	No	No	Yes	..	No	Yes, but inoperative in practice	Yes	Since January 1991	No	Floating since July 1992
Bulgaria	No	No, except for fuels and some raw materials	No	No		No	16.7[a/]	Limited	No	Yes	Since February 1991	No	Floating
Czechoslovakia	No	No, some 20 per cent of exports require licensing	No	No	No, except crude oil and natural gas	Yes for agricultural products	5.8[b/]	Since January 1991	No	No	Since January 1991	Yes, 49 per cent per dollar and 51 per cent four European currencies	No
Estonia	No	No, except alcohol, tobacco, grain shale, hides	No	Yes	No, except for alcohol, motor vehicles and tobacco	No	-	Since June 1992	No	Yes	Yes	No	Fixed against the deutsche mark (de facto currency board arrangement)
Hungary	No	No, except for fuels and basic food stuffs	No	No	No, except for fuels, some agricultural products, industrial consumer goods, tobacco, etc.	Yes	13.0	De facto since about 1990	No, never used	Yes, Interbank market since July 1992	Since 1976	Yes, 50 per cent ECU and 50 per cent per dollar	No
Latvia	No	No, except sensitive goods (national security, health)	Yes	Yes	No	No	15.0	No	?	?	Yes	Yes	No

Table II.14. (*Continued*)

Country	Exports			Imports				Allocation of foreign currency to the enterprise sector through			Exchange rate mechanism		
	Direct State intervention	General use of quotas/licences	Export tax	Direct State intervention	General use of quotas/licences	Global quota system for consumer goods	Average tariff (percentage)	Internal convertibility	Retention quota system	Currency auctions	Unified exchange rates	Fixed rate against a basket	Other
Lithuania	..	..	Yes	Yes	No, except sensitive goods (national security, health)	No	-	No	?	Yes	Yes	No	Floating
Poland	No	No	No	No	No, except for gasoline, alcoholic beverages, tobacco and dairy products	No	18.4	Since January 1990	No	No	Since January 1990	No	Crawling peg
Romania	No	No, but export of butter, meat, etc. is prohibited	No	No	Yes	..	17.8	Declared in November 1991 but suspended in May 1992	Yes	Yes	Since July 1992	No	Floating since June 1992
Russian Federation and rouble zone	Yes	Yes	Yes	No	No	No, except medicines, pesticides, etc.	15.0	No	Yes	Yes	No	No	Floating
Slovenia	No	No	No, except on raw materials	No	No	Yes, for agricultural products, textiles, clothing	10.4[b]	Since October 1991	No	Yes, with limitations	Yes	No	Floating with the deutsche mark as reference

Sources: National newspaper reports and GATT, IMF and OECD databases, as reported in Economic Commission for Europe, *Economic Bulletin for Europe*, vol. 44 (New York, United Nations, 1993), tables 2.1.4, 2.1.6 and 2.1.7.

[a] Introduced in July 1992.

[b] In January - April 1992.

Private foreign investment flows to the countries of the former USSR have virtually dried up due to the generally poor state of their economies, uncertainties regarding political will and reform policies (including privatization and ownership law) and lack of IMF "approval".

In other countries of the region, particularly the Czech Republic, Hungary, Poland and Slovenia, the situation regarding private foreign investment is much more favourable. Even in Romania private foreign investment is growing rapidly, more than doubling in dollar terms betwen 1990 and 1992 [19].

A major complaint of all countries in the region is that export potential, for both manufactures, such as steel and chemicals, and agriculture products is being curtailed by import barriers imposed by Western countries, especially EC. Negotiations are under way to relax some restrictions.

4. *Industrial (in)efficiency*

Problems at the political and macroeconomic levels have been made difficult to resolve partly by the poor state of public enterprises, especially large industrial ones, throughout the region. The actual extent of enterprise loss-making and inefficiency first became apparent when the *Treuhandanstalt*, the holding company formed to oversee the transition of business in the Eastern part of Germany to a market economy, began adding up real assets and net revenues of the companies placed under its control. An equally bad, or even worse, situation has since been found to prevail throughout Eastern Europe and the former USSR.

A relatively simple method of measuring economic efficiency is to compare domestic resources used up in production with the net benefit of output in terms of foreign exchange equivalent. If domestic resource costs exceed the output gain, the indicator of domestic resource costs is greater than one, and the activity is inefficient (loss-making) (see table II.15).* Industrial policy should aim at reducing domestic resource costs, especially very high or negative ones (which may indicate "white elephants" beyond reform and in need of immediate closure).

Table II.15 shows sectoral domestic resource costs, based on input-output data for the late 1980s, for Bulgaria, Czechoslovakia, Hungary, Poland and the former USSR. Negative domestic resource costs, which indicate

*The two most important features of the method are that tradeable goods are valued at world-market rather than (distorted) domestic prices, and indirect as well as direct inputs are included (using an input-output table). The method, which is a static cost-benefit procedure, is discussed in Hughes and Hare [20].

Table II.15. Domestic resource costs by industry for Central and Eastern Europe, late 1980s
(Based on value added at domestic prices)

Industry	Bulgaria	Czechoslovakia	Hungary	Poland	USSR
Meat, fish and dairy products	2.06	-0.56	-0.26	0.43	-1.06
Fruit and vegetable products	-3.07	-2.92	-0.57	7.68	-2.68
Oils and fats	1.15	-0.77	-1.17	0.73	-4.09
Cereal products	-	-10.04	1.21	2.44	-13.86
Sugar and confectionery	-	-4.83	5.03	1.29	-5.26
Other foodstuffs	2.36	30.53	-	0.39	-5.99
Beverages	3.21	-3.91	2.53	1.14	2.42
Tobacco products	3.88	-0.83	1.66	0.78	10.55
Textiles	4.37	3.96	2.07	1.12	4.58
Clothing	3.92	1.37	0.78	1.29	1.22
Leather products	4.34	-31.74	0.66	1.09	-
Footwear	3.93	1.12	0.54	1.58	9.05
Wood products	1.01	1.30	0.90	1.08	3.37
Wooden furniture	1.38	17.24	7.20	1.19	10.37
Paper products	2.04	1.10	1.16	1.22	1.45
Printing	2.63	2.49	1.46	0.51	-
Basic chemicals	-6.38	1.97	1.73	1.63	6.17
Other chemicals	2.41	12.32	1.11	1.01	1.59
Rubber products	2.71	1.35	1.37	1.06	0.77
Plastic products	1.75	0.88	1.68	1.03	49.92
Pottery and chinawear	5.33	0.97	2.01	1.09	-
Glass and glassware	2.54	0.97	1.15	1.19	1.85
Cement	-0.60	2.49	0.76	1.34	2.85
Structural clay products	-	1.86	0.88	1.19	0.62
Other non-metallic mineral products	1.99	2.07	1.19	1.36	6.45
Ferrous metallurgy	0.75	1.23	-6.22	1.10	0.56
Non-ferrous metallurgy	0.93	0.79	7.98	1.76	0.53
Fabricated metal products	2.97	1.89	1.15	1.07	-3.20
Machinery	2.64	0.93	1.15	1.03	0.63
Electrical equipment	1.58	4.78	1.27	1.19	2.44
Transport equipment	8.54	0.99	1.27	1.42	1.20
Professional and scientific goods	3.15	1.33	1.10	0.91	4.30
Other manufactures	9.66	0.99	1.25	1.22	1.34

Source: *Oxford Review of Economic Policy*, vol. 8, No. 1 (1992) an absolute loss to the economy (because the value of output as measured in foreign exchange equivalent after deducting foreign inputs is less than zero) are reported for Bulgaria (3 sectors), Czechoslovakia (8 sectors), Hungary (4 sectors) and the former USSR (7 sectors). These are particularly worrying, but many very high domestic resource costs are also reported for Bulgaria, Czechoslovakia and the former USSR. Only three domestic resource costs above 2.53 are shown for Hungary. Poland turns out to be least inefficient, with only one very high domestic resource cost.

Poland has only 6 sectors with domestic resource costs below 1, about the same as Czechoslovakia (7), Hungary (6) and the former USSR (5). However, Poland shows not only less overall inefficiency and less sectoral variability than the other countries, but also a difference in comparative advantage; 4 of its efficient sectors are in food processing and tobacco, whereas for the other countries efficient sectors tend to be located in the areas of chemicals and metals.

Although these domestic resource costs should not be taken as perfectly accurate, they illustrate the nature and degree of the problem of raising industrial efficiency in the region.* For most countries and sectors, future progress will depend critically on the extent to which losses can be eliminated and economic efficiency and international competitiveness achieved.

E. Latin America and the Caribbean

1. Short-run outlook

The upswing in Latin America that began with an increase in GDP growth from 0.5 per cent in 1990 to 2.9 per cent in 1991 lost a little of its momentum in 1992 when growth fell to 2.3 per cent. In a number of countries lower growth was the result of policies to curb inflation. On the basis of the IMF mid-year inflation estimates for 1993, Argentina will have reduced inflation from 171.7 per cent in 1990 to 9.3 per cent in 1993, Chile from 21.8 to 11.9 per cent, and Mexico from 22.7 to 8.0 per cent. Venezuela and Columbia were less successful, but have held inflation in the 30-per-cent range since 1990 [21]. In Brazil inflation was brought down from nearly 3,000 per cent in 1990 to 413 per cent in 1991, but then increased to just over 1,000 per cent in 1992 and the IMF mid-year forecast for 1993 is that it will continue at about the same rate.

Table II.16 reflects the extent of the gap in manufacturing performance between the 1970s and 1980s in Latin America. Brazil and Venezuela provide the most striking contrasts. The manufacturing sector in Brazil grew at an 11.8 per cent annual rate in the 1970s and declined at a 2.7 per cent rate during the 1980s; after growing at 12.4 per cent per year during the 1970s, the manufacturing sector in Venezuela was able to manage growth of only 1.3 per cent per year in the 1980s. For the region as a whole there were very few manufacturing sectors where output increased by more than 2 per cent per year, and none averaged over 2.9 per cent over the decade. Since 1990 the situation has improved for the region as a whole, with average annual growth of 2.2 per cent for all manufacturing.

*Taking differences in quality into consideration, the DRC's are even worse (see Hughes and Hare [20]).

GDP growth in Latin America in 1993 is expected to be 3.1 per cent and rise slightly to 3.5 per cent in 1994. Regional MVA is expected to grow by 3.0 per cent and 3.8 per cent in 1993 and 1994, respectively. The forecast 1993 GDP and MVA growth rates, if achieved, would be higher than in any year since 1986, when GDP growth was 3.4 per cent and MVA growth was 5.0 per cent. One downward risk in this forecast may be the 3.0 per cent GDP growth forecast for Brazil in 1994. With inflation continuing to exceed 1,000 per cent, the main question is how much it will cost Brazil in terms of economic growth in order to stabilize the price level. This time macroeconomic stabilization will be working together with considerable progress already made in privatization, the rationalization of industrial and financial regulations, and trade liberalization. The new Government has announced the main outlines of a fresh start. Price freezes and shock treatment have been ruled out. The emphasis will be on reducing the budget deficit and slowing the growth of the money supply. Whether a durable coalition can be formed with the legislature to support this programme is still open, but some successes have already been achieved in measures to increase government revenues.

For Mexico, another downward risk is the assumption that NAFTA* will take effect on schedule. Implementation of NAFTA is scheduled to begin on 1 January 1994, but there is a possibility that it will not make it through the United States Congress in time to meet that schedule. The possibility of delayed implementation may be causing some firms to delay or scale back investment projects geared to the trading arrangements that will prevail under NAFTA. Foreign direct investment in Mexico was down slightly in 1992 to $10.2 billion from $11.1 billion in 1991. Whether this reflected uncertainty concerning the priority that would be attached to NAFTA by the new United States Administration is difficult to say, but in any event it clearly did not have the same impact on Mexican investors, since overall investment increased by 13.9 per cent in 1992, up from 6.1 per cent in 1991. Delayed implementation of NAFTA would delay the surge in trade that is expected to accompany implementation. Some observers, writing in 1992, had predicted that imports would increase much more rapidly than exports in the initial few years of implementation, but as it turns out, already in 1992 exports increased by 8.2 per cent versus 24.3 per cent for imports. As a result the trade deficit increased from $7.2 billion in 1991 to $15.9 billion in 1992. It seems clear that whether NAFTA is implemented on schedule or not the trade gap, in percentage terms, will narrow in the next few years. The first quarter of 1993 seems to indicate that this may happen sooner rather than later; exports were up 11.1 per cent over the first quarter of 1992, while imports were up 10.3 per cent.

2. Longer-term prospects

While the short-run outlook for Latin America is for only moderately increasing growth, it is realistic to believe that long-term recovery has begun. The debt crisis has past, and the renewal of growth and access to inter-

*NAFTA is discussed in more detail in the section on North America in the present chapter.

Table II.16. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: Latin America and the Caribbean
(Percentage)

Country or industry (ISIC) and total		Average annual growth rates 1970-1980	1980-1990	1990-1992	Share in total MVA[a/] 1990
		A. Country breakdown			
Brazil		11.8	-2.7	-2.9	33.8
Mexico		6.5	2.3	3.0	26.5
Argentina		1.8	-4.7	10.0	14.4
Venezuela		12.4	1.3	5.8	5.6
Chile		0.1	6.3	11.2	4.0
Colombia		6.9	3.9	1.1	3.8
Peru		5.0	-3.7	-0.1	3.3
Cuba		0.2	2.2	-6.1	2.8
Uruguay		0.5	1.5	4.2	1.0
Nicaragua		-1.2	0.5	0.5	0.8
Dominican Republic		4.8	1.9	2.9	0.6
Costa Rica		5.1	2.6	4.7	0.4
Bolivia		7.1	-2.6	4.2	0.4
Ecuador		9.5	-1.3	9.2	0.4
Guatemala		5.7	1.9	2.4	0.4
Jamaica		-1.9	5.5	1.9	0.3
Paraguay		7.4	2.6	5.6	0.3
El Salvador		2.5	-2.7	5.0	0.3
Panama		5.2	-0.4	7.4	0.2
Trinidad and Tobago		2.0	-6.3	10.7	0.2
Honduras		5.5	4.0	3.1	0.2
Barbados		0.2	-0.2	-4.8	-
		B. Industry breakdown			
311	Food	5.2	-0.6	-	14.5
313	Beverages	5.8	0.3	3.2	4.7
314	Tobacco manufactures	2.9	0.8	-0.3	2.8
321	Textiles	3.7	-2.9	2.0	5.6
322	Wearing apparel	5.5	-3.6	-2.2	2.4
323	Leather and fur products	2.6	-2.3	1.4	0.7
324	Footwear, excluding rubber or plastic	3.4	-2.6	-3.6	1.2
331	Wood and cork products	6.9	-5.9	1.3	1.3
332	Furniture and fixtures	7.2	-4.6	-0.3	0.9
341	Paper and paper products	7.5	-	2.6	3.1
342	Printing and publishing	4.9	-0.5	1.7	2.8
351	Industrial chemicals	8.5	1.2	4.4	5.3
352	Other chemical products	6.3	1.0	1.5	6.4
353	Petroleum refineries	7.4	0.5	8.5	9.4
354	Miscellaneous petroleum and coal products	15.5	-2.4	2.1	0.8
355	Rubber products	4.7	-0.1	2.1	1.6
356	Plastic products n.e.c.	10.1	-1.4	1.9	2.1
361	Pottery, china and earthenware	1.9	1.8	2.9	0.7
362	Glass and glass products	6.7	-1.5	3.4	0.9
369	Other non-metallic mineral products	7.2	-4.9	3.2	2.5
371	Iron and steel	8.1	0.7	1.6	5.4
372	Non-ferrous metals	4.0	1.6	3.9	2.8
381	Metal products, excluding machinery	6.8	-2.9	3.8	3.9
382	Non-electrical machinery	12.0	-4.2	-4.5	4.7
383	Electrical machinery	7.3	-0.6	2.0	4.9
384	Transport equipment	6.9	-2.0	2.6	6.5
385	Professional and scientific goods	14.0	2.8	6.1	0.7
390	Other manufactures	5.5	0.6	3.9	1.6
Total[b/]		6.4	-1.1	2.2	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

a/ Total MVA for the region in 1990 was $216,695 million.

b/ For both country and industry breakdown.

national capital markets will gradually lighten the residual burden of debt over the course of the decade. Net capital flows into the region have become positive and increased from $16.3 billion in 1990 to $35.8 billion in 1991, and further to $44.1 billion in 1992 [22]. Many of the reform programmes are well along, and, except for Brazil, substantial progress has been made in reducing inflation. Investment as a share of GDP remains too low, but there are indications that this may be improving. In Mexico investment has grown by an average of 10 per cent per year since 1990, compared with an average yearly 4 per cent decline during the 1980s. The prospects for Mexico as a result of NAFTA seem especially promising. For the rest of Latin America the Enterprise for the Americas Initiative or accession to NAFTA may be feasible, but more critical is a successful conclusion of the Uruguay round of GATT tariff negotiations. Geographical proximity still counts for a lot in international trade, and various regional trade agreements and a general lowering of trade barriers among Latin American countries is encouraging (see figure II.6 and table II.17). Finally, over the next two to three years the expected gradual recovery in the global economy will help.

While primary products are still an import export item, the main impetus for export growth is in the manufacturing sector. Despite the vast expansion in world trade in manufactures during the 1980s, Latin America slightly increased its share of the world total from 1.5 to 1.7 per cent during the period (see table II.18). In the high-technology industries, where R and D costs tend to be a larger share of total production costs, Latin America also increased its share of the world market between 1980 and 1989. In table II.18 the high-technology industries are chemicals, medicinal and pharmaceutical products, plastic materials, non-electrical and electrical machinery, transport equipment, and professional, scientific and controlling instruments. Latin American producers have increased their share of world exports in five of these seven industries. These are also the industries that have shown the most rapid export growth in Latin America over the past 20 years. In table II.19 it can seen that in Brazil and Mexico, which together account for 90 per cent of the Latin American total, high technology exports have been growing at an average annual rate of over 20 per cent since 1970. In 1989 high-technology exports accounted for over half of total manufacturing exports in both countries (54 per cent in Brazil and 60 per cent in Mexico). However, nearly all of their increase in the share of total exports came during the 1970s. This is also reflected in table II.18, which shows that the gains in world market shares were much greater for all industries during the 1970s than during the 1980s, and this difference between gains during the 1970s and 1980s was even more pronounced in the high-technology industries. In an analysis of manufactures exports, the Inter-American Development Bank offers a number of observations on the lessons to be learned from recent experiences [23]. Some of these observations might be summarized as follows:

(a) For further development of high technology there is a need for more investment in human resource development including the training of research scientists and engineers. Table II.20 summarizes the results of a recent study of the technology resources in some NIC's [24];

(b) In labour-intensive industries the best prospects for Latin America are in leather, footwear, fertilizers and non-metallic mineral manufactures. The prospects are also good in such higher-technology areas as chemicals, iron and steel, and plastic materials, but an increased degree of regional integration to capture economies of scale will be an important factor affecting the success of the region in these industries;

(c) The role of foreign direct investment and transnational corporations in the high-technology industries will continue to be important. Individual countries will face competition from inside and outside the region in attracting international investment;

(d) Marketing is generally underdeveloped in the region, and areas such as increased product differentiation in terms of quality, design, location and brand names should be given more emphasis in order to increase the competitiveness of the products of the region;

(e) Trade policies should be neutral with respect to production for the local market versus exports. Not only do export subsidies tend to misallocate resources, but a habit of providing export subsidies, through, for example, an undervalued exchange rate, would probably provoke retaliation by trade partners;

(f) Programmes that provide special export zones or in-bond operations, such as the Mexican *maquilidoras*, may provide opportunities for other Latin American countries, but the benefits must be understood. The *maquilidora* programme provides about 20 per cent of the manufacturing export earnings of Mexico, but prior to the introduction of trade and investment reforms, it had been almost entirely an enclave programme with very few local linkages or technology transfer and human resource development opportunities;

(g) The successful coordination of macroeconomic policies with trade policies is one of the most important challenges facing the Latin American countries. Among the countries that have successfully combined the two are Chile, Colombia, Costa Rica and Mexico;

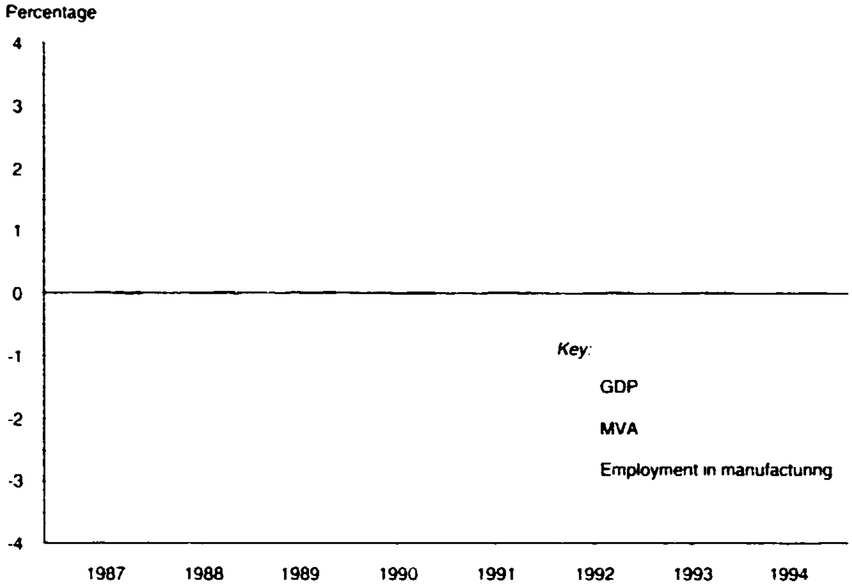
(h) There is still a lot of room for expansion of interregional trade, and this could be achieved through further tariff reductions and the elimination of non-tariff trade barriers.

An example of high-technology foreign direct investment involving IBM and its Mexican subsidiary, IBM Mexico, is described in a recent study [25]. IBM Mexico has announced a $62 million investment plan aimed at upgrading manufacturing and marketing activities. In contrast to IBM's retrenchment elsewhere in the world, its Mexican operation has been adding employment at an annual rate of 7 per cent for several years to meet the burgeoning demand for computer-related products, which has been growing at about 25 per cent per year. The IBM investment is expected also to generate a set of positive "spillovers" for Mexican semiconductor technology capability. The technology transfer component of this project may be summarized as follows:

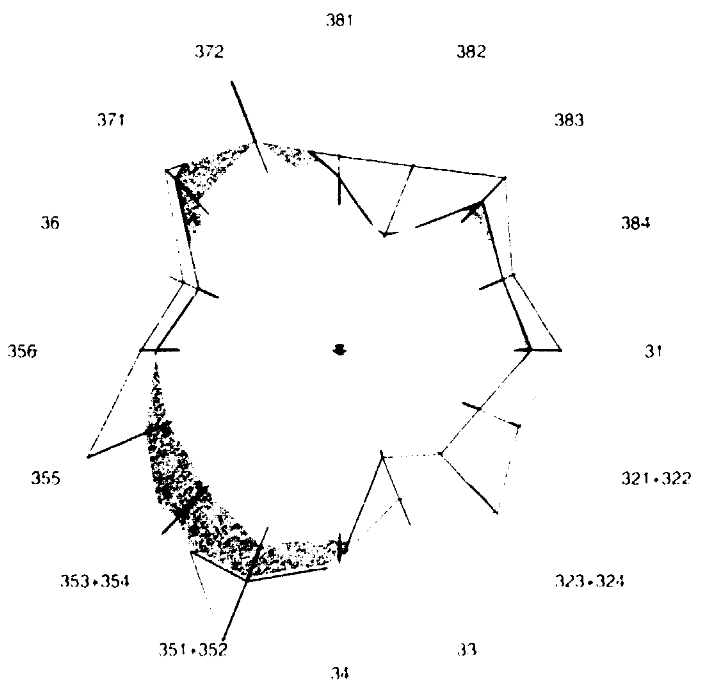
(a) Development of an international distribution centre to support export operations to over 30 countries;

(b) A software centre to distribute software to Spanish-speaking Latin America;

Figure II.6. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: Latin America and the Caribbean



Industrial structural change
(Index of value added 1980=100)



g = 0 24, θ = 10.53

Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

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

Table II.17. Reductions in tariffs and quantitative restrictions in Latin America

Country	Tariff rates	Quantitative restrictions
Argentina	Tariff rates in the range of 5 to 40 per cent	Elimination of import licensing, except for 25 items (certain paper products and motor vehicles and parts)
Bolivia	In 1990, tariff rates for all items except capital goods were reduced from 15 to 10 per cent, and tariff rates for capital goods were reduced from 10 to 5 per cent	Elimination of all import restrictions, except those maintained for public health and safety reasons
Brazil	The average tariff rate will be reduced from 37 per cent in 1990 to 20 per cent by 1994	The suspension of issuance of import licences affecting 1,200 items was discontinued and company import quotas were eliminated in June 1990
Chile	Uniform tariff rate of 15 per cent	Quantitative restrictions are prohibited by law (Ley Orgánica Constitucional 18840)
Colombia	The trade-weighted average tariff rate was reduced from 22 per cent in 1988 to 10 per cent in 1992	Elimination of import prohibitions; gradual elimination of discretionary licensing. The percentage of items under automatic licence increased from 30 per cent in 1989 to 96.7 per cent in 1990. A surtax of 18 per cent was reduced to 13 per cent in November 1990
Costa Rica	Tariffs range from 1 to 40 per cent, except for some items which are subject to higher rates	Elimination of additional import taxes and surcharges exceeding the bound tariff rates; gradual elimination, or application in accordance with GATT rules, of import licences within four years
Honduras	Tariff ranges are as follows: from 2 to 40 per cent until 31 December 1990; from 4 to 35 per cent until 31 December 1991; from 5 to 20 per cent after 1 January 1992	
Jamaica	Tariffs in the range of 5 to 30 per cent as of 1991	Gradual elimination of import licences starting in mid-1985. Import licences were required in 1990 for some 330 items, or 3 per cent of the total number of tariff items. Decrees signed in December 1989 allowed for the importation of automobiles, although imports in 1991 and 1992 were restricted to 15 per cent of the domestic markets. Also, in 1989 local content requirements were lowered
Mexico	Tariffs range from zero to 20 per cent	
Nicaragua	In September 1990, tariffs were reduced as follows: from up to 5 per cent to zero; from 10-40 per cent to 5 per cent; from 40-60 per cent to 10 per cent. All other rates were reduced to a maximum of 20 per cent	
Peru	In September 1990, tariffs were reduced substantially and the tariff structure was simplified. Tariff rates now are 15, 25 and 50 per cent, the rate for most items being 25 per cent	Import prohibitions imposed for balance of payments reasons and other non-tariff measures such as licensing were lifted in 1990
Venezuela	Most tariffs of above 10 per cent were reduced substantially in May 1990. The maximum tariff rate was reduced from 80 to 50 per cent	Elimination of quantitative restrictions (5 per cent of the tariff items are still prohibited and 5 per cent are still subject to licensing)

Source: Inter-American Development Bank, *Economic and Social Progress in Latin America, 1992 Report* (Washington, D.C., Johns Hopkins University Press, 1992), p. 248.

Table II.18. Top 20 manufacturing exports of Latin America[a]

Industry	Export value in 1989 (million dollars)	Share of total in 1989 (percentage)	Latin America's world market share 1970	1980 (percentage)	1989
Non-electrical machinery	5 842	19.2	0.5	1.1	1.6
Transport equipment	5 381	17.7	0.2	1.2	1.6
Chemical elements and compounds	2 526	8.3	1.6	3.5	3.0
Iron and steel	2 376	7.8	1.2	1.8	2.1
Electrical machinery, apparatus and appliances	1 972	6.5	0.5	0.7	0.9
Textile yarn, fabrics and related products	1 524	5.0	1.0	2.4	2.0
Footwear	1 382	4.6	0.9	4.4	7.5
Non-metallic mineral manufactures	1 156	3.8	1.3	1.4	2.1
Plastic materials, regenerated cellulose etc.	1 085	3.6	0.2	0.6	2.0
Clothing	1 060	3.5	0.7	1.9	1.4
Paper, paperboard and manufactures	1 027	3.4	0.5	1.2	2.0
Leather and leather manufactures	993	3.3	6.3	10.3	10.3
Manufactures of metal, n.e.s.	915	3.0	0.8	1.3	1.8
Miscellaneous manufactured goods, n.e.s.	882	2.7	1.0	1.2	0.7
Professional, scientific and controlling instruments	556	1.8	0.2	0.5	0.7
Chemical materials and products, n.e.s.	501	1.6	1.2	2.1	1.8
Rubber manufactures	448	1.5	0.8	1.3	2.2
Wood and cork manufactures	305	1.0	2.6	3.4	2.2
Dyeing, tanning, and colouring materials	262	0.9	1.6	1.6	1.6
Medicinal and pharmaceutical products	243	0.8	2.4	2.0	0.8
TOTAL	30 374	100.0	0.8	1.5	1.7

Source: Division of the United Nations Secretariat, COMTRADE database, as reported in Inter-American Development Bank, *Economic and Social Progress in Latin America, 1992 Report* (Washington, D.C., Johns Hopkins University Press, 1992), p. 219.

[a] The figures are for the 11 countries for which 1989 data are available, and which would account for over 90 per cent of the manufacturing exports of the region. The countries are Argentina, Barbados, Brazil, Colombia, Ecuador, Honduras, Mexico, Panama, Paraguay, Trinidad and Tobago and Uruguay.

Table II.19. Latin American exports of high-technology products

Country	High-technology exports: Value in 1989 (million dollars)	Regional share in 1989 (percentage)	Share of high-technology exports in total manufacturing exports 1970	1980 (percentage)	1989	Growth rate of high-technology exports 1970-1989 (percentage)
Brazil	8 700	49.4	33	53	54	23.7
Mexico	7 090	40.2	51	60	60	20.3
Argentina	1 212	6.8	41	43	28	10.4
Trinidad and Tobago	238	1.3	37	49	43	17.2
Colombia	208	1.1	23	19	13	12.1
Uruguay	81	0.4	5	15	12	19.1
Bolivia	38	0.2	90	37	88	-5.7
Ecuador	14	..	40	36	21	9.5
Paraguay	9	..	..	1	9	13.1
Panama	9	..	54	6	14	10.1
Honduras	5	..	8	4	6	6.9
TOTAL	17 603	100.0	39	49	50	19.8

Source: Division of the United Nations Secretariat, COMTRADE database, as reported in Inter-American Development Bank, *Economic and Social Progress in Latin America, 1992 Report* (Washington, D.C., Johns Hopkins University Press, 1992), p. 213.

Note: High-technology exports include the following goods classified at the two-digit level of the Standard International Trade Classification (SITC), Revision 1: chemicals (51), medicinal and pharmaceutical products (54), plastics (58), non-electrical machinery (71), electrical machinery (72), transport equipment (73) and professional, scientific and controlling instruments (86). Latin America is defined here to include the 11 countries for which data were available in [illegible]

Table II.20. Indicators of national technological capability in selected NICs

	Republic of Korea	Taiwan Province	Hong Kong	Singapore	Brazil	Mexico	India	Thailand
			A. Structure and performance					
MVA in billion dollars (1985)	24.5	22.2	6.7	4.3	58.1	43.6	35.6	7.7
Manufacturing growth								
1965-1980	18.7	16.4	17.0	13.3	9.6	7.4	4.3	10.9
1980-1986	9.8	12.9	7.0	2.2	8.2	..	8.2	5.2
Manufactured exports in billion dollars (1986)	31.9	35.9	32.6	14.7	9.1	4.9	7.2	3.9
Growth of merchandise exports								
1965-1980	27.3	19.0	9.5	4.7	9.4	7.7	3.7	8.5
1980-1986	13.1	12.7	10.7	6.1	4.3	7.7	3.8	9.2
Gross domestic investment as percentage of GDP (1986)	29	19	23	40	21	21	23	21
Capital goods production as percentage of total manufacturing (1985)	23	24	21	49	24	14	26	13
Capital goods imports in billion dollars (1985)	10.6	5.6	7.1	8.1	2.2	6.1	3.7	2.7
As percentage of MVA	43.3	25.2	106.0	188.4	3.8	14.0	10.4	35.1
Stock of foreign direct investment in billion dollars (1984-1986)	2.8	8.5	6.0-8.0	9.4	28.8	19.3	1.5	4.0-5.0
Foreign direct investment stock as percentage GDP	2.8	8.1	20-26	53.8	9.6	13.6	0.7	10.5-13.1
			B. Education					
Education expenditure as percentage of household consumption (1980-1985)	6	..	5	12	5	5	4	6
Public expenditure percentage of GNP	4.9	5.1	12	4	5	6	5	
Year	1985	1986	1987	1980	1984	1985	1985	1984
Central government expenditure on education, percentage of total government expenditure (1986)	18.1	20.4	..	21.6	3.0	11.5	2.1	19.5
Percentage of age group enrolled (1985)								
Primary	96	100	105	115	104	115	92	97
Secondary	94	91	69	71	35	55	35	30
Tertiary	32	13	13	12	11	16	9	20
Vocational education enrolment (1984)								
Number of students (thousands)	815	405	32	9	1 481	854	398	288.0
as percentage of population of working age	3.06	3.24	0.86	0.5	1.83	2.0	0.07	0.96
Number of tertiary-level students								
In science and engineering fields (thousands)	585	207	36	22	535	563	1 443	360
As percentage of population	1.39	1.06	0.89	0.67	0.40	0.70	0.21	0.70
Year	1987	1984	1984	1984	1983	1986	1980	1985
In engineering (thousands)	228	129	21	15	165	282	397	..
As percentage of population	0.54	0.68	0.41	0.61	0.13	0.35	0.06	
			C. Science and technology					
Patents granted: total (1986),	3 741	10 615	..	598	3 843	2 005	2 500	..
of which local percentage	69	56	..	8	9	9	20	..
R and D percentage of GNP	2.3	1.1	..	0.5	0.7	0.6	0.9	0.3
Year	1987	1986	..	1984	1982	1984	1984	1985
R and D in productive sector (percentage of GNP)	1.5	0.7	..	0.2	0.2	0.2	0.2	..
R and D financed by productive enterprises (percentage of GNP)	1.9	0.6	..	0.2	0.1	0.01	0.1	0.04
Scientists and engineers in R and D per million population	1 283	1 426	..	960	256	217	132	150
All scientists and engineers								
Total number (thousands)	361.3	..	145.5	38.3	1 362.2	565.6	1 000-1 000	20.3
Per million population	8 706	..	26 459	15 304	11 475	10 720	1 282-2 564	472
Year	1986	..	1986	1980	1980	1970	1985	1975

Source: Sanjaya Lall, "Technological capabilities and industrialization", *World Development*, vol. 30, No. 2 (1992), pp. 174-175.

(c) International purchasing programme to assist local industry in developing products for IBM manufacturing facilities worldwide;

(d) Partnership programmes with Mexican universities and technical schools;

(e) Scholarship programmes for Mexican scientists to study at IBM plants and laboratories worldwide.

These activities in high-technology industries and the related spillovers will have positive long-term impacts on factor productivity and industrial efficiency in the region, provided that macroeconomic policy is right. In this respect, policy makers in the region have gained insights from the experience of the East Asian NICs, where Governments have been active in supporting private industrial enterprises by encouraging risk-taking for innovation, mastering new technology whether imported or invested, and by investing in human resource development and institution-building. This approach differs greatly from the major features of government intervention in Latin America common only a decade earlier, that is, establishment of public enterprises for direct production and marketing, heavy protection from import competition, and the provision of subsidies to cover loss-making enterprises. Latin American Governments are now using privatization as an effective policy tool (see box II.2).

Box II.2. Privatization—a tool for industrialization for Latin America

Most Latin American countries are instituting economic reforms to correct structural problems that have caused economic stagnation and price instability. Many are adopting policies to redefine fundamentally the role of the State, to divest public capital through the sale of State enterprises, to promote freer, more efficient markets, and to install better regulatory policies. These and other privatization issues have been analysed in case-studies on Chile, Mexico, Argentina and Colombia.

A. Chile

Chile has more experience with privatization and economic liberalization policies than any other Latin American country. In 1973, 596 public enterprises produced 39 per cent of GDP, a huge expansion from 1965 when the public sector produced only 3 per cent of GDP. Between 1974 and 1989, 532 public enterprises were returned to the private sector. Today, the State controls only the natural monopolies and companies of strategic importance, such as copper mining and processing. The study on Chile analyses six large State enterprises that were privatized: the Bank of Chile (privatized in two tranches, in 1974 and 1986), the State steel monopoly (Compañia de Acero del Pacifico), the most important telecommunications and telephone company (Compañia de Teléfonos de Chile), the main forestry products enterprise (Celulosa Arauco y Constitución), and the principal electricity company (ENDESA).

Using a cost-benefit analysis approach the study concludes that the success of privatization depends on:

(a) Sound macroeconomic policies and creation of a healthy business environment for privatized firms;

(b) The means of ownership transfer (purchases of shares with workers' pension funds, debt to equity swaps, and outright sales of shares).

Other lessons include the need for a transparent transfer of ownership to avoid corruption and other irregularities, and the need to prohibit credit sales even when equity purchases are not possible (because national savings are insufficient). There are liquidity and other constraints, because of the problems associated with highly leveraged buy-outs.

B. Mexico, Argentina and Colombia

The Mexican privatization programme is the second longest-running after that of Chile, and the second largest after the $20 billion programme of Brazil. The privatization strategy of Mexico has been an integral component of the macroeconomic stabilization programme of that country and a clear response to the debt crisis of 1982, as well as to the second shock, which culminated in 1986 when oil prices plunged to levels less than half those prevailing in 1985. As a result, real GDP contracted by nearly 4 per cent in 1986, and inflation rose from 54 per cent in 1985 to 88 per cent in 1986, and 136 per cent in 1987 (measured in wholesale prices).

The government response to this second crisis was to transform the economy through massive structural reform. The divestiture programme—which had previously concentrated on small, relatively insignificant firms—began to include large firms, eventually reaching some of the biggest public sector enterprises. In 1982 the Government of Mexico had 1,155 public enterprises. Today it has fewer than 200. The accumulated sales revenue since 1984 from privatization is $16 billion.

The study on Mexico analyses the micro-economic and macroeconomic impacts of privatization in five large enterprises—Teléfonos de México (TELMEX), Ingenios Azucareros (sugar mills, including agricultural property), Compañia Minera de Cananea (a mining concern and a regional development project), Tereftalatos Mexicanos (a duopolistic chemical firm that produces fertilizers) and Compañia Mexicana de Aviación (an airline).

The case-studies of Argentina reveal the impact of ownership change in the natural resource industries (oil and gas), and in the large natural monopolies. A primary objective of the Government of Argentina has been to obtain revenue quickly. Privatization has therefore been virtually devoid of changes in regulations or of modifications to market structure. The macroeconomic effects of the privatization programme of Argentina, assessed in the study, have been significant.

In Colombia, the participation of the public sector in the economy is a mere 10 per cent, lower than in most other Latin American countries. While privatization is less of a central issue in Colombia than in many others, a 10 per cent share is still significant. The Colombian Government is currently crafting an overall policy on privatization, providing an opportunity for the Regional Research Network privatization studies to serve as inputs for the final design of the policy. The study on Colombia examined the privatization of

Box II.2. *(continued)*

two automobile companies, a bank, garbage collection services in two areas of Bogotá, and a student scholarship programme.

The main conclusions are as follows:

(a) In general, privatization is most successful when combined with other economic and financial reforms. In particular, measures to support free markets and promote greater efficiency as well as changes in regulations are important if private ownership is to be more efficient than government ownership;

(b) The benefits from properly executed privatization are considerable. This is true not only as gauged by measures of micro-economic welfare (allocative efficiency, investment efficiency etc.), but also by the macroeconomic (fiscal and balance of payment) benefits, the latter being especially important in Mexico and Argentina;

(c) Privatizing large companies, including natural monopolies, can be an efficient way of raising substantial revenue for the Government in the short-run, and can play a key role in macroeconomic stabilization and adjustment;

(d) Two major factors affect the outcomes of privatization. One is the nature of the market into which the enterprise will be divested—for example, competitive versus oligopolistic or monopolistic. In competitive markets, and especially in the production of tradables, privatization can yield solid and rapid economic benefits to producers and consumers. Second are national macroeconomic policies and conditions; in open, liberalized economies, the privatized enterprises will generally yield greater benefits than in more closed economies;

(e) For enterprises producing non-tradable commodities in non-competitive markets (with the studies examining such cases as Compañia de Teléfonos de Chile, TELMEX of Mexico and ENTEL and Yacimientos Petrolíferos Fiscales in Argentina), regulatory mechanism must be designed and put into place before divestiture;

(f) Consolidation of divestiture activity in a centralized unit, which supervises sales and serves as a conduit for potential buyers, can be effective;

(g) A clear and transparent divestiture process with full information and orderly sequencing, including selling in tranches, is an important factor for success;

The cooperation of labour is also important, and workers should therefore participate in the gains from divestiture.

Source: Inter-American Development Bank, *Development Policy* (Washington, D.C., December 1992), pp. 9-10.

Ongoing reforms in Latin America parallel what happened in East-Asian NICs. During the decade of 1970-1980, the East and South-East Asian region achieved 7.05 per cent annual employment growth along with 4.09 per cent labour productivity growth annually. Likewise, during the decade of 1980-1990 it annually recorded 3.31 per cent employment growth and 5.01 per cent labour productivity growth. In contrast, the Latin American region annually recorded -0.63 per cent employment growth and 1.75 per cent labour productivity growth during the 1980-1990 period (see table II.21 for a country breakdown). A similar record could be achieved by Latin America with the right policies in the decade ahead.

Table II.21. Average annual growth rate of manufacturing employment and labour productivity in Latin America, 1970-1992

Country	Number of employees in manufacturing 1990	MVA per employee in 1990 dollars	Average annual growth rates of employment 1970-1980	1980-1990	1990-1992	Average annual growth rates of labour productivity 1970-1980	1980-1990	1990-1992
Argentina	949 500	39 751	-1.4	-3.4	-1.8	3.3	9.6	0.6
Barbados	5 110	16 941	0.8	-4.0	-7.8	-0.6	3.5	4.6
Bolivia	169 600	5 303	3.7	5.2	5.0	3.3	-7.3	-3.6
Brazil	3 980 700	29 834	8.0	-1.1	-0.6	3.5	3.3	3.3
Chile	250 100	37 737	-1.6	1.9	5.8	1.8	5.0	5.0
Costa Rica	133 600	6 929	7.2	7.6	7.7	-1.9	-4.7	-3.9
Cuba	710 800	8 489	2.6	3.6	2.9	-2.5	-1.2	-1.1
Dominican Republic	138 600	9 470	2.8	-0.5	-0.8	2.0	2.6	0.5
Ecuador	111 700	7 696	9.0	-	1.4	0.5	-1.3	2.2
El Salvador	26 200	22 531	-1.4	-3.9	-2.1	4.0	1.1	2.7
Guatemala	95 300	8 569	7.6	2.5	1.7	-2.0	1.4	2.8
Honduras	70 280	6 016	7.6	2.5	1.7	-2.0	1.4	2.8
Jamaica	63 500	9 683	0.3	3.7	4.8	2.1	0.1	[illegible]
Mexico	2 145 200	26 796	3.4	-1.2	1.3	3.0	3.5	4.1
Nicaragua	46 230	36 049	6.8	3.1	2.2	2.5	-3.2	3.6
Panama	34 140	16 036	3.6	0.8	0.5	1.5	-1.2	0.9
Paraguay	130 060	4 398	6.6	3.1	3.3	0.8	-1.5	1.2
Peru	243 800	24 615	3.4	0.8	0.7	1.5	-4.5	1.9
Trinidad and Tobago	31 650	14 883	3.5	-3.3	-2.6	-1.5	3.1	0.5
Uruguay	122 500	18 366	-0.1	-2.7	-0.4	0.6	4.3	2.9
Venezuela	463 400	26 218	6.9	0.9	1.8	5.2	0.4	1.9
TOTAL	10 466 600	25 718	4.1	0.6	-0.1	2.2	1.8	2.2

Source: UNIDO database.

F. Tropical Africa

After independence, most countries of Tropical Africa saw industrialization as the centre-piece of their economic development hopes and plans. Import substitution schemes were initiated, focused on consumer goods, with the expectation that development of local intermediate- and capital-goods industries would follow. Private entrepreneurial, managerial and technical capacities, as well as capital assets, were hardly available except in a few countries. Hence Governments, with foreign aid, tended to build a few "strategic", large-scale public-sector enterprises; these were protected from import competition and largely relied on imported intermediate inputs and capital equipment.

Initially, most of these manufacturing enterprises grew rather rapidly, but by the mid-1970s serious problems arose. Small local markets were not growing, and production was not competitive internationally. Foreign exchange, for various reasons internal and external, became increasingly difficult to obtain, so that production halts became common because of the lack of spare parts, imported intermediates or fuel-oil supplies. Management was often not efficiency-oriented, and the overall macroeconomic environment was not conducive to industrial expansion. The result was stagnation or decline in virtually all manufacturing sectors (excepting beer, with growing local demand and often under control of one or the other of the major European breweries). Industrial parastatals, often operating with very low capacity utilization (rates of 20 per cent have not been uncommon), required large government subsidies to remain open.

By the early 1980s, it became increasingly apparent that policy changes were essential. Pushed by the World Bank and IMF and pulled by comparison of their poor situation with the successes of the East-Asian NICs, African policy makers in country after country initiated radical, market-oriented reforms. Ironically, part of the industrial problem had been that Governments had neglected agriculture and, to raise revenue, imposed levels of effective taxation that gave farmers only a small share of the world price of their products; output and exports declined, resulting in foreign exchange constraints and low rural demand for manufactures, thus creating a vicious circle for industry. A large part of the macroeconomic reform policies aims at redressing this imbalance. And at the micro-economic level, inefficient parastatal industries are being reorganized, rehabilitated and privatized (or closed down in a few cases) in order to improve efficiency.

1. *Short-run outlook*

The manufacturing sector in many countries of the region remains in dire straits relative to other developing regions, but the short-term outlook is good in comparison to a decade earlier. GDP grew by 1.0 per cent and 0.5 per cent in 1991 and 1992, well below the population growth rate. The forecast for 1993 is 2.0 per cent growth and for 1994, 2.4 per cent. MVA growth fell from 3.6 per cent in 1990 to 0.2 per cent in 1991 and to 0.1 per cent in 1992. The 1992 average would have been higher but for negative growth in Zimbabwe, with the second largest industrial sector (and most diversified) in the region after Nigeria (drought throughout southern Africa affected the result). Regional prospects are better for 1993 (2.7 per cent) and 1994 (3.3 per cent) (see table I.1).

The share of Tropical Africa in global manufacturing, 0.3 per cent, is tiny and not growing (see table II.22). Also, the share of MVA in GDP has generally not been increasing, and MVA growth has largely been due to greater employment, rather than greater productivity (see figure II.7 for GDP and MVA growth in recent years and also for the pattern of structural change in industry). Most manufacturing is fairly basic, with food products (19.1 per cent of the 1990 total) and beverages (14.7 per cent) predominating (see table II.22). In other industries, particularly those dominated by large-scale parastatals, capacity utilization and efficiency tend to be low (but now improving). Macroeconomic policy reforms, better management and greater emphasis on domestic-resource-based activities will help to improve the short-term picture, but the region, which includes most of the least developed countries, remains generally very weak in its manufacturing capabilities.

Virtually all countries in the region are in the process of liberalizing their policy regimes, usually as part of the World Bank-IMF adjustment programmes (for a somewhat unorthodox view of African industrial strategy, see box II.3). Positive results are being achieved, albeit more slowly than was expected when the first policy reforms (in Ghana, for example, starting in 1983) were initiated. Recently, "social support" packages, providing assistance to the unemployed etc., have been appended to the reform policies.

2. *Longer-term prospects*

Growth of manufacturing is, obviously, constrained by lack of resources such as capital, foreign exchange and technology. But above all, the overriding constraint to overcome is that of human capital—lack of high-quality managers, public administrators, technicians and skilled workers in general. Unfortunately, human capital development takes decades not years, but this will need to be the overriding long-term priority of Governments and supporting institutions, both local and international. Past levels of improvement are simply not good enough, even for the region to keep from falling behind in a global manufacturing economy that is now dominated by fast-changing technologies, by huge drops in the real cost of obtaining information, and by hard managerial decisions that cut costs to the bone.

Each country will need to re-examine its particular relative strengths and weaknesses, decide on where it might best fit into the new dynamics of global manufacturing, and obtain support for its industrial strategy from the international aid institutions, and perhaps more importantly from private foreign investors willing to undertake joint ventures. Development of human capital, in order to best use other resources, must be the primary objective, not just for manufacturing, but also for socio-economic progress in general.

No country in the region, not even Nigeria (see box II.4 on Nigerian industrial problems), is big and

Box II.3. African industrialization strategy

The disappointing performance of African economies in the 1980s is well known. In sub-Saharan Africa as a whole, industrial production declined in real terms over the decade, and exports of manufactures from the region grew more slowly, even from a low base, than in other parts of the developing world (see table below).

Comparison of sector growth rates in two country groups, 1980-1989
(Percentage average annual growth)

Sector	*Sub-Saharan Africa*	*Low- and middle-income economies*
Agriculture	1.8	3.7
Industry (1980-1989)	-0.2	5.3
Manufacturing exports (1980-1986)	4.8	9.5

Source: World Bank, *World Development Report* (Washington, D.C., 1990.)

The World Bank interpretation of this experience stresses internal policy errors [26]. High on the list are government policies that led to market intervention and created serious biases, particularly against agriculture (through low producer prices to farmers) and against exports (through import protection and overvalued exchange rates); excessive public industrial investment that crowded out the private sector and left much of industry operating on non-commercial lines; and misguided import-substitution investments that relied heavily on imported inputs, and never achieved levels of capacity utilization that would allow costs to reach internationally competitive levels. In this view, negative external shocks—like the declining terms of trade for primary exports in the 1980s—were influential, but not critical, and policy reform to eradicate past errors, combined with generous concessionary aid flows, will turn the tide and allow industry in most countries to expand again.

The key to recovery is seen as revival in agriculture combined with greater support for small- and medium-scale, as opposed to large-scale, industry. Small- and medium-scale enterprises are "the missing middle" providing a link between imported and local technology, and a breeding ground for the entrepreneurs needed to take the lead in private-sector industrial initiative. There are elements of this interpretation which must be accepted even by those critical of the role of international institutions in Africa. A large number of parastatal enterprises and high barriers to imports are clearly not sufficient for socialist development, and in many instances no doubt operated to reduce productive efficiency. However, the arguments about privatization and reductions in government intervention cannot be carried too far. In many countries the class base for major private-sector expansion remains weak, so that privatization can mean denationalization with private investors bringing in more powerful foreign partners. Further, where the general economic environment is one of monopoly and trade protection, a simple change of ownership on its own will not stimulate greater efficiency. The case is much stronger for rationalizing, as opposed to abandoning government protection. For example, there can be strong reasons for removing the wide variance in effective rates of protection through tariff reform, but this is not the same as advocating free trade.

Old-style import substitution of import-intensive consumer goods for the small, relatively high-income segment of the domestic market is now unlikely to find many supporters, and in most countries has been associated with high-cost activities. However, given the large share of industrial imports in total demand in many African economies, the scope for efficient import-substitution where domestic costs exceed world prices by no more than a margin justified by infant industry or externality arguments remains significant. Encouragement of this type of industry should not be seen as an alternative to export promotion. Experience in South-East Asia, for example, has shown that with a careful balance of incentives, exports can emerge fairly quickly from initially protected import-substitution activities [27]. None the less, given the difficulties known to be associated with exporting, it cannot be realistically expected that the export market will provide a major share of future demand for African industry. A focus on the home market as the initial base for expansion leads back to the link between agricultural and industrial growth.

It can be argued that one of the major errors of past industrial policy was to attempt to replicate domestically production of too many goods of an international standard. Not all industrial goods need to be internationally tradable, as low prices may undersell imports, while low quality prevents exports. Such non-traded goods are likely to be produced by small- and medium-scale enterprises serving the low-income segment of the domestic market. Emphasis on this form of industrial production finds support from diverse intellectual traditions. It is in the spirit of the socialist industrialization strategy for small economies, which argues that production should meet local needs based on local materials using local technology [28]. In addition, it is in line with the current World Bank emphasis on small- and medium-scale enterprises [26].

However, central to the success of such industries is the growth of the domestic market. First, the supply response to higher producer prices within agriculture may be critical. If because of various supply bottlenecks, or simply because of normal crop gestation periods, higher output is not forthcoming, the rise in producer prices may not have a major impact on total agricultural incomes. Secondly, there is the impact of higher agricultural and therefore food prices on the incomes of urban dwellers. Rising food prices will lower urban real incomes, and thus reduce demand for manufactures. How far this counter-effect of a shrinking urban market is significant will depend on the relative size of rural and urban markets for manufactures. Thirdly, there is the question of the import content of demand from the rural sector. Clearly the higher this is, the weaker will be the demand effect on domestic industry from a rise in agricultural incomes. In general, rising agricultural prices and incomes are expected to stimulate non-traded industry in the region. However, the speed of the process and the extent to which it counteracts other recessionary pressures in the economy will clearly vary.

Box II.3 *(continued)*

If internal demand expansion is slow and export prospects for manufacturing are poor, there is the danger that foreign grants and credits will go unutilized, as local firms will lack the confidence to borrow for sale to a depressed internal market. A fully worked-out scheme for economic adjustment that notes the importance of internal demand, and rejects the reasoning of orthodox measures, still remains to be developed [29]. However, the situation of industry in many economies in the region can be cited as evidence of the need to develop such an alternative perspective.

Source: John Weiss, "Perspectives on African industrialization", in *African Development Perspectives Yearbook 1990/91*, H. H. Bass and others, eds. (Münster, Lit Verlag, 1992), vol. II.

Box II.4. Falling industrial production in Nigeria

By any yardstick Nigeria is under-industrialized. In a $30 billion market with a population of more than 90 million people, manufacturing accounts for only 8.5 per cent of GDP, well below the average for countries at this stage of the development cycle.

Indeed, in the past 11 years MVA has grown at a mere 1.5 per cent annually, which means that, on a per capita basis, industrial production has been falling.

There can be few more classic examples in Africa of the failure of import substitution. The latest survey by the Manufacturers' Association of Nigeria covering the first half of 1992 tells the story: capacity utilization of 34.5 per cent for manufacturing as a whole, lowest in vehicle assembly, steel, engineering and electronics, and highest in wood and furniture, textiles, plastics and rubber, food and non-metallic minerals, primarily cement.

Over the past three survey periods, imported raw materials have averaged 55 per cent of the total, while MVA as a whole was estimated in 1989 at 46 per cent, compared with 92 per cent in the oil sector and 83 per cent in agriculture. Aside from mainstream consumer goods, the main investment interest in recent years has focused on downstream oil and gas activities and textiles.

In a high-inflation, high-devaluation economy, it is hardly surprising that entrepreneurs should have targeted trade and finance rather than manufacturing. Pre-tax returns on investment are highest in trading (up to 100 per cent), followed by construction (50 per cent) and the finance sector (30 per cent).

Manufacturing output in Nigeria, 1985-1992

Year	*Index*
1985	100
1986	78
1987	131
1988	135
1989	154
1990	215
1991	183
1992	231

Source: Central Bank of Nigeria.

Five crucial constraints to industrialization in Nigeria have been identified, as follows:

(a) Poor profitability relative to trade, finance and construction;

(b) Infrastructural and regulatory constraints, which mean that operating costs are up to a third higher in Nigeria than elsewhere. Investment costs are estimated to be some 50 per cent above international standards;

(c) The high-risk climate of political and economic uncertainty that makes long-term planning extremely difficult;

(d) The absence of an enabling environment in terms of macroeconomic stability, observance of legal contracts, inadequate patent law provisions, the high and escalating crime rate etc.;

(e) Restrictions on ownership in the form of the Nigeria Enterprise Promotion Decrees (NEPD).

There is no quick way out of this morass, though there are at least two administrative steps that the Government could usefully take. It could first amend the NEPD, thereby allowing foreign firms already in Nigeria to have majority ownership of their subsidiaries, and then abolish the existing system whereby new investments must run the gauntlet of official approval, setting up an investment promotion agency to replace the existing approval machinery.

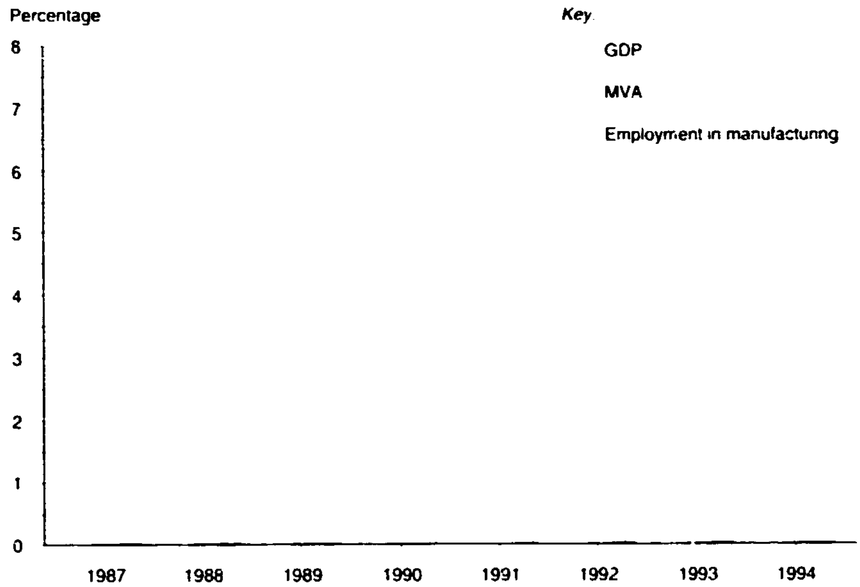
The accelerated depreciation of the naira over the past year will boost local sourcing and exports, but there are still some hard policy choices to be made. The privatization agency's gloomy conclusion that the country's six vehicle assembly plants cannot be privatized because of low capacity utilization and deteriorating commercial and financial performance underscores the need for a new strategy towards capital-intensive low-value-added activities in which Nigeria has no competitive advantage.

Yet the federal government has actually increased its investment in capital-intensive manufacturing, through the recapitalization of Savannah Sugar and new investment in the Ajaokuta steel project, the aluminium smelter, the fertilizer industry and Nigerian Machine Tools.

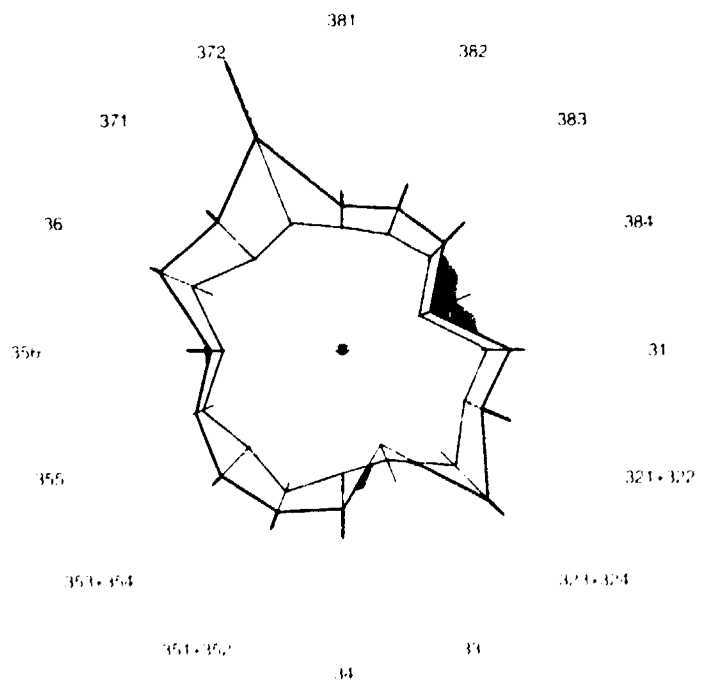
One of the first tasks of a future civilian administration will be to develop a coherent industrial strategy, which in all probability will mean some short-term deindustrialization as low-value-added, highly protected activities are restructured or phased out. Industrial growth will have to come from labour-intensive, consumer-goods activities, as well as upstream and downstream petroleum- and gas-related manufacturing.

Source: "Nigeria survey", *Financial Times*, 1 April 1993.

Figure II.7. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: Tropical Africa



Industrial structural change
(Index of value added 1980=100)



g = 1.51, θ = 5.75

Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

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

Table II.22. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: Tropical Africa
(Percentage)

Country or industry (ISIC) and total		Average annual growth rates 1970-1980	1980-1990	1990-1992	Share in total MVA[a/] 1990
		A. Country breakdown			
Nigeria		11.7	-2.4	7.1	20.0
Zimbabwe		6.4	5.0	-1.5	16.3
Côte d'Ivoire		6.2	-1.2	-0.2	10.1
Zambia		7.7	1.5	-6.7	7.2
Kenya		8.4	2.3	0.8	6.4
Ethiopia		6.8	4.0	-2.9	6.0
Cameroon		9.2	-4.0	10.7	5.8
Senegal		0.1	6.8	-0.2	4.5
Ghana		-3.4	8.1	5.2	4.3
Mauritius		7.4	12.0	6.4	3.4
Gabon		6.4	-1.3	1.7	1.8
Swaziland		6.8	7.4	0.9	1.6
Rwanda		14.3	1.0	-5.8	1.6
Burkina Faso		2.5	2.6	2.9	1.4
Botswana		9.5	12.3	6.5	1.0
Madagascar		0.4	-0.8	-9.4	1.0
Malawi		8.2	-1.1	2.6	0.9
Mali		6.2	3.0	-0.3	0.8
Congo		-3.5	0.7	0.5	0.7
Togo		-4.5	3.3	-1.6	0.7
Benin		-3.3	1.6	3.4	0.7
Zaire		-16.7	2.2	2.2	0.7
Burundi		4.2	5.0	3.1	0.6
United Republic of Tanzania		6.7	-5.0	3.3	0.6
Lesotho		4.8	14.0	11.0	0.5
Central African Republic		-4.6	0.5	4.5	0.3
Niger		7.0	-0.2	1.0	0.2
Somalia		1.1	-4.4	-1.0	0.2
Cape Verde		-1.2	15.4	8.7	0.1
Gambia		10.3	0.2	2.5	0.1
		B. Industry breakdown			
311	Food	5.1	1.8	2.8	19.1
313	Beverages	5.5	2.6	0.1	14.7
314	Tobacco manufactures	2.7	0.3	-0.8	4.1
321	Textiles	4.2	-0.2	3.0	9.0
322	Wearing apparel	2.4	4.5	2.8	2.9
323	Leather and fur products	9.2	4.4	3.1	1.0
324	Footwear, excluding rubber or plastic	4.9	3.6	-0.8	1.5
331	Wood and cork products	6.7	-3.7	0.7	2.4
332	Furniture and fixtures	8.6	-2.5	1.7	1.2
341	Paper and paper products	8.3	3.2	5.5	2.4
342	Printing and publishing	7.0	-0.8	1.4	2.3
351	Industrial chemicals	4.5	1.8	-0.2	2.3
352	Other chemical products	10.7	2.1	1.7	6.4
353	Petroleum refineries	1.9	2.3	1.2	4.8
354	Miscellaneous petroleum and coal products	9.1	-1.2	-3.3	0.1
355	Rubber products	2.4	1.3	-1.4	1.2
356	Plastic products n.e.c.	18.1	-0.5	3.9	1.6
361	Pottery, china and earthenware	7.1	3.3	-17.9	0.2
362	Glass and glass products	9.9	-1.9	1.7	0.4
369	Other non-metallic mineral products	3.9	4.4	1.6	4.0
371	Iron and steel	9.6	2.4	0.5	2.6
372	Non-ferrous metals	1.5	4.8	8.0	1.6
381	Metal products, excluding machinery	6.1	0.1	0.4	4.7

Table II.22 (*Continued*)

Country or industry (ISIC) and total		Average annual growth rates			Share in total MVA[a]
		1970-1980	1980-1990	1990-1992	1990
382	Non-electrical machinery	8.8	0.6	3.9	1.1
383	Electrical machinery	9.7	0.5	3.2	1.8
384	Transport equipment	18.7	-3.6	4.9	5.5
385	Professional and scientific goods	15.5	10.8	4.6	0.1
390	Other manufactures	6.6	-0.3	0.2	1.0
Total[b]		6.2	1.1	1.9	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

[a] Total MVA for the region in 1990 was $14,268 million.

[b] For both country and industry breakdown.

strong enough to attempt to produce everything. (In this connection, India's lack of success until recently should be compared with the successes of the small East-Asian NICs.) Each will need to find its niche based on dynamic comparative advantage. In this connection good government administration has a useful role to play. The promotion of garment exports by the Government of Mauritius is an example of policy designed to fill a niche. Priority must also be given to human capital, in particular technical education, management and public administration.

To attract foreign investment, improvement in physical infrastructure (telecommunications, electricity, roads etc.) will be needed. The World Bank is funding many such development projects, and these must be encouraged. By such means, for example, a garment exporter operating under a joint venture between firms in Ghana and the Republic of Korea can keep up to date with the wishes of the United States market and supply the type and quality of product required in a timely manner. Especially for the many land-locked countries of the region, transport costs to and from the major developed-country markets remain very high.

Many of the large-scale parastatal manufacturing firms, sometimes using 30-to-40-year-old second-hand machinery imported from Eastern Europe, are being rehabilitated and some privatized. But much greater emphasis and encouragement needs to be given to small-scale firms, which have been neglected. These have great potential for meeting local consumer demand at reasonable prices, and for providing employment, training and development of managerial and technical skills.

Much more also needs to be done regarding the development of agro-industrial linkages, both backward and forward. Agriculture will remain the key economic sector for most countries of the region for at least the rest of the 1990s, providing employment and exports. Small-scale rural industries can both provide an important "multiplier effect" for agriculture and thrive on its growth. Especially for the smaller, poorer land-locked countries of the region, such manufacturing activities could provide the best hope for industrial development in the 1990s.

G. North Africa and Western Asia

In North Africa GDP growth is expected to rise slightly, from 1.3 per cent in 1992 to 1.4 per cent in 1993 and 2.9 per cent in 1994. GDP growth in Western Asia reached 6.4 per cent in 1992, but for 1993 and 1994 growth of 5.2 and 4.4 per cent, respectively, is expected (see table I.1). The 1993 slow-down in growth is largely a reflection of lower growth in the Islamic Republic of Iran (see figure II.8 for GDP and MVA growth in recent years and also for the pattern of structural change in industry).

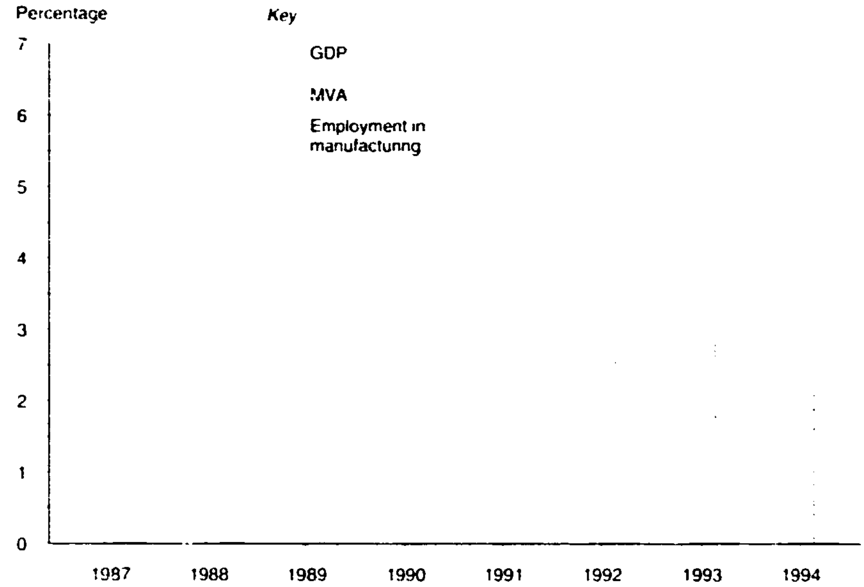
For the countries of the Gulf Cooperation Council (GCC), growth will continue at a modest pace, basically influenced by production and price levels of crude oil determined by the world market. Growth will also be determined by the pace of reconstruction of primarily oil facilities and physical infrastructure in Kuwait and Iraq; in the case of the former, crude production has already reached the pre-war level. Accelerated business activity resulting from the Persian Gulf war and its aftermath will slow down in the next few years, but non-oil economic activities will continue to be greatly influenced by government spending on defence and reconstruction. Defence expenditures have been estimated for the Middle East at $35 billion for actual and planned expenditure of weapons since the outbreak of the Persian Gulf crisis.

In countries with diversified economies (non-oil-based), Governments will continue to pursue tight fiscal and monetary policies, and there will be a need for increased concessionary finance and aid, mainly provided by the Persian Gulf States, to complete infrastructural and public industrial plans. Price stabilization will continue to be top priority in government policy, since high inflation not only obstructs economic planning and development, but represents a serious source of popular discontent.

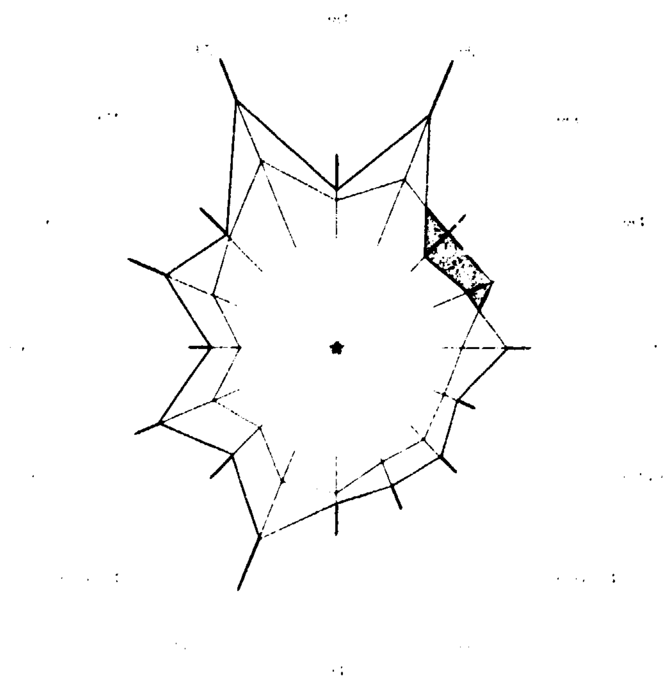
1. Manufacturing outlook

Regional MVA growth averaged 4.7 per cent from 1990 to 1992, with the highest growth (16.1 per cent) in the miscellaneous petroleum and coal products industry. In the two largest manufacturing countries, the Islamic

Figure II.8. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: North Africa and Western Asia



Industrial structural change
(Index of value added 1980=100)



Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

g 4.16 θ 8.93

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

Republic of Iran and Turkey (accounting for two thirds of regional MVA in 1990), MVA growth was 5.6 and 4.5 per cent, respectively (see table II.23). MVA growth in North Africa is expected to decline slightly from 4.1 per cent in 1992 to 3.5 per cent in 1993, largely as a result of the decline in Algeria. In Western Asia, growth will also decline from 7.6 per cent in 1992 to 6.7 per cent in 1993 and 6.4 per cent in 1994.

In the diversified economies, the revival of manufacturing activities will depend on the efficient implementation of viable economic reform programmes, the ability of the countries concerned to secure sustained new export markets for their manufacturing products and a good performance in the agricultural sector. The trend in these countries seems to be to allow private sector companies more autonomy and management responsibility. In this context, Governments will continue to gradually introduce trade liberalization measures. Training programmes for public sector managers have been initiated as part of the effort to transform the management of public enterprises to a more commercial basis.

Perhaps the most serious constraint on economic development in the region is human resources and large imbalances in labour supply among countries of the region. Egypt and Turkey, for example, have labour surpluses, whereas GCC countries and the Libyan Arab Jamahiriya have serious labour shortages (compounded by the unwillingness of most men, because of their oil wealth, to accept low-paid blue-collar jobs, and by the fact that women are not expected to work outside the home). Additionally, the oil-rich economies suffer from the so-called Dutch disease (characterized by oil dollars driving up all prices and costs so that other activities appear to be unprofitable). Such conditions, combined with the human resource problem, makes industrial diversification difficult, even though investment funds are not lacking.

2. *Search for new export markets*

With a small home market in most countries of the region, except for Egypt, Islamic Republic of Iran and Turkey, increased efforts need to be exerted towards the creation of new export markets for manufactured products, particularly since trade with Eastern Europe and the former USSR has collapsed. Arab trade with countries of the former CMEA averaged $8 billion to $10 billion per year during most of the 1980s, and the trade surplus amounted to more than $2 billion in 1990 in favour of the Arab countries.

Changes taking place in the new States arising from the breakup of the former USSR have forced its former trading partners in the region to adjust their policies and trading patterns, and tremendous opportunities for trade have opened up with the southern States adjacent to the Islamic Republic of Iran and Turkey. The countries of the region most affected by lost markets were Iraq, Syrian Arab Republic and, to a lesser extent, Jordan, but the impact will be felt more by exporters in the Syrian Arab Republic. The latter was, in rouble terms, the leading exporter in Western Asia to the former USSR from 1989 to 1991. Public and private exporters in the Syrian Arab Republic had adjusted to exporting low-quality goods to the former USSR. New market prospects lie in renegotiating trade relations, especially with the Russian Federation and the southern States. In this regard, Egypt has been quick to act, reaching an agreement with the Russian Federation that respects all contracts signed with the former USSR except financing accords. Instead, projects involving companies of the Russian Federation will now be financed mainly by barter. As the Russian Federation needs quick commodity-based repayments and financial resources, a cash-and-barter approach is adopted in promoting its trade. It has reached agreements with Egypt, Jordan and Syrian Arab Republic, which export manufacturing goods such as pharmaceuticals, soaps, cosmetics, fertilizers, minerals and other consumer commodities.

3. *Investment and the offset programmes*

The GCC countries are looking to their trading partners to help them in the process of economic diversification by participation in joint ventures in the region and becoming, in effect, the region's industrial partners. In their drive to diversify decisively away from dependence on oil and gas production, and having already evaluated dozens of major manufacturing schemes, the Persian Gulf States are now basically seeking foreign partners to achieve their aims through the acquisition of additional capital, technology, management services and guaranteed export markets.

The offset investment programmes were introduced in most GCC countries to ensure that GCC member States would benefit more substantially from the large, mainly defence-related contracts awarded to foreign suppliers and contractors. These foreign counterparts are expected to offset the cost to the local Government by investing, as in the case of Saudi Arabia, 35 per cent of the contract value in industrial joint ventures in the domestic market. In Saudi Arabia, joint ventures under its offset programme are expected to generate more than $4 billion in new industrial projects by the end of the 1990s. Confusion arising from the lack of clarity of measures regarding foreign investment will have to be resolved. How these programmes will be reconciled with the major defence equipment orders needs to be clarified.

Nevertheless, the pace of new investment under the programme has generally been slow. In Saudi Arabia, identified areas of investment under the various offset programmes involve preliminary space technology ventures for satellite communications, a mobile digital-telephone assembly plant, a packet-switching plant for private and public applications, a software development company for management, logistics and security applications and an automotive battery plant. Other identified and proposed projects under the same programmes involve gold-refining, a potato-processing plant, alkyd resin:, a steel sheet plant, high technology defence-related projects, primary metals and fabrication, building materials, plastic and chemical products, pharmaceutical and drug packaging, aluminium containers and the establishment of new consumer industries.

4. *Liberalization*

GCC countries, seeking to expand manufacturing activities, continue their attempts to liberalize their economies and eliminate some of the structural weaknesses

Table II.23. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: North Africa and Western Asia
(Percentage)

Country or industry (ISIC) and total	Average annual growth rates			Share in total MVA[a]
	1970-1980	1980-1990	1990-1992	1990
A. Country breakdown				
Iran, Islamic Republic of	5.1	2.4	5.6	41.4
Turkey	6.9	7.8	4.5	26.9
Algeria	6.3	3.8	-2.8	5.3
Saudi Arabia	7.9	9.0	10.5	5.0
Egypt	6.3	6.0	3.2	4.7
Iraq	4.3	4.6	-5.5	3.5
Morocco	5.2	8.4	6.7	3.0
Kuwait	16.2	1.8	3.1	2.4
Syrian Arab Republic	9.3	-2.4	8.0	1.7
Tunisia	11.9	5.5	6.7	1.5
Sudan	-1.3	2.3	6.0	1.2
Libyan Arab Jamahiriya	6.2	5.3	7.6	1.1
Cyprus	10.3	4.6	3.5	0.7
United Arab Emirates	5.5	2.7	7.7	0.6
Jordan	12.8	4.7	3.4	0.5
Yemen[b]	3.8	7.6	8.9	0.4
B. Industry breakdown				
311 Food	3.3	2.4	5.1	10.0
313 Beverages	3.8	5.7	5.3	2.8
314 Tobacco manufactures	-4.9	11.2	0.1	6.3
321 Textiles	5.2	1.2	3.0	10.4
322 Wearing apparel	7.9	8.9	3.6	2.3
323 Leather and fur products	5.4	5.8	4.0	0.6
324 Footwear, excluding rubber or plastic	-1.0	2.3	3.2	1.0
331 Wood and cork products	6.2	3.8	4.2	1.1
332 Furniture and fixtures	6.4	2.3	2.4	0.6
341 Paper and paper products	7.5	2.5	4.2	1.6
342 Printing and publishing	3.1	5.3	4.4	1.3
351 Industrial chemicals	9.7	6.7	11.9	4.8
352 Other chemical products	5.8	6.7	-0.1	4.8
353 Petroleum refineries	16.1	3.2	3.5	14.7
354 Miscellaneous petroleum and coal products	21.2	7.3	16.1	0.9
355 Rubber products	6.9	6.2	2.5	1.4
356 Plastic products n.e.c.	14.6	1.7	3.0	1.5
361 Pottery, china and earthenware	9.1	7.5	3.6	0.7
362 Glass and glass products	5.9	4.5	5.5	1.1
369 Other non-metallic mineral products	7.8	5.8	6.4	10.1
371 Iron and steel	7.4	4.0	5.4	4.5
372 Non-ferrous metals	13.4	9.4	3.5	1.8
381 Metal products, excluding machinery	3.4	3.8	5.6	4.1
382 Non-electrical machinery	12.0	8.8	6.9	4.3
383 Electrical machinery	5.6	1.7	10.7	3.2
384 Transport equipment	0.5	2.9	4.0	3.6
385 Professional and scientific goods	9.8	6.5	2.6	0.3
390 Other manufactures	9.7	5.7	5.6	0.4
Total[c]	5.9	4.3	4.7	100.0

Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

[a] Total MVA for the region in 1990 was $109,183 million.

[b] Data for the territory of the former Democratic Yemen not included.

[c] For both country and industry breakdown.

which might constrain diversification from oil. Throughout the region, diversification away from hydrocarbons is being intensified, particularly in Bahrain and Saudi Arabia, especially as most GCC States continue to worry about depleting their oil reserves and the possibility that new technologies will eventually emerge that will make crude oil redundant. Anticipated bank reform will be the next step taken to mobilize the region's private capital for industrial purposes. In Bahrain, the Government has recently taken a decision to amend the country's agency legislation, breaking the monopoly enjoyed by commercial agents.

All these liberalization measures are radical in a region where nationals have usually enjoyed considerable protection from external competition, and major industrial projects are in the public domain. These reforms will allow even State-run hydrocarbon industries to be opened up to private investment (most recently in Qatar). It should provide substantial opportunities for business in downstream activities in the hydrocarbon and aluminium industries. Consumer industries have great prospects for private investment, since the GCC region has a fast-growing market, forecast to grow at an average real rate of 3 to 5 per cent per annum during the 1990s, with a total population in the six countries of already more than 21 million people enjoying very high levels of purchasing power, reflected in an average per capita income among the highest in the world.

5. *Progress in the unification of the GCC market*

Progress in the implementation of the GCC economic cooperation agreements is reportedly still very slow, partly because of the eruption of the Persian Gulf crisis in 1990 and its aftermath. According to estimates of the Economic and Social Commission for Western Asia, intra-GCC trade currently still accounts for less than 7 per cent of total GCC trade of approximately $90 billion a year. Various impediments to the full implementation of the agreements have been identified, mainly in the area of business activities, trade relations, status of free zones and national industries set up therein, procedural and regulatory matters and problems relating to country-of-origin certificates. Nevertheless, there have been signs of cooperation to resolve these problems, examples of which are not few: Saudi Arabia has been lifting tariffs on goods originating in the United Arab Emirates under GCC accords aimed at phasing out customs duties; Oman has agreed to allow nationals of the United Arab Emirates to trade in the share of Omani companies on the Muscat stock exchange; and most importantly, the central bank governors have been planning to coordinate their monetary, banking and financial policies.

6. *Prospects of GCC-EC agreements*

With the establishment of the single European market at the end of 1992, the GCC countries are becoming increasingly concerned about prospects of improved trade relations with the EC. The latest talks on free trade between the EC and GCC confirmed that they are still far from reaching an agreement on the issue of lowering tariff barriers against Persian Gulf petrochemicals exports to the EC. The main obstacle to a trade agreement between the two groupings has been the 13 to 15 per cent EC tariff barrier on Persian Gulf petrochemical exports, imposed in order to protect the ageing European chemical industry. A cooperation agreement reached between the two parties in 1989 came into force in January 1992. Negotiations on a free trade agreement between the two parties were initiated in October 1990, but have yet not been concluded. The EC submitted a proposal in January 1992 to which the GCC responded negatively. The proposal suggested a transitional period of 12 years before the EC totally lifts tariff barriers on Persian Gulf petrochemical exports. However, official Saudi Arabian sources are reported [30] to have indicated that the EC proposal would result in an annual loss of $800 million to Saudi Arabia in the first year of its implementation. The matter was further complicated by the recent EC proposal to introduce a $10-per-barrel energy tax on crude oil imports, as part of efforts to control environmental pollution. Preliminary studies indicate that implementation of this proposal would cost OPEC member countries annual losses of some $14 billion.

Great difficulties are expected to continue to surround the negotiations, particularly those relating to GCC exports of petrochemicals to EC countries. The latter are not expected to provide major market opportunities for GCC producers in the 1990s. The drop in energy prices, which is expected to continue, is likely to provide industrialized countries with a competitive advantage for the establishment of the increased petrochemical capacity that will be required in the 1990s. Trade relations between GCC and the EC are already robust, with the value of bilateral trade amounting to $30.7 billion, and with EC exports to the GCC market totalling $17.8 billion and imports from that market reaching $12.8 billion, resulting in a trade deficit of $5 billion, which the Persian Gulf States are greatly concerned to reduce.

7. *Prospects for new markets*

The GCC countries will have to intensify their drive to find new markets, expand existing ones, and consider new trade arrangements to promote manufacturing exports. Eastern Europe and the CIS, particularly the latter, are huge markets for their petrochemical and industrial exports. The Saudi Basic Industries Corporation and the Saudi Cable Company already export to this region, and they are exploring the possibility of expanding their trade further. China, India, Pakistan and Turkey enjoy robust and well-diversified economic relations with GCC. Merchandise trade and the South-Asian and East-Asian labour force in the Persian Gulf countries are important aspects of this relationship. Another important aspect is the direct investment of South-Asian textile and clothing companies in factories in Oman and the United Arab Emirates, the products of which are exported to the United States. Above all, to profit from the huge investments in petrochemicals, aluminium-refining and other large-scale capital-intensive plants made in the 1980s, markets for the products need to be further developed, and in the longer term, a more diversified manufacturing structure must be created. The latter, especially, will depend on improvements in the human capital resources of the region.

H. Indian Subcontinent

Prospects for higher industrial growth in the region in 1993 and over the next few years are good. GDP growth rose from 2.1 per cent in 1991 to 4.4 per cent in 1992, and is expected to increase to 4.7 per cent in 1993. MVA growth rose from -0.2 per cent in 1991 to 3.3 per cent in 1992; 7.9 per cent growth is expected for 1993 and 6.9 per cent for 1994 (see table I.1). Labour productivity growth rates are also expected to be high (see figure II.9). High MVA growth will be achieved by most countries, but recovery of the large Indian economy is of special significance.

Generally, factors such as better harvests and low oil prices have helped to improve the macroeconomic environment, but factors such as lower inflation, easing of balance-of-payments difficulties and increased foreign investment may be largely attributed to recent policy reforms, including trade and financial liberalization, deregulation of industry and greater encouragement for private-sector investment, which together are raising production efficiency and competitiveness. Bangladesh, Nepal and Sri Lanka are all implementing significant reforms. But the major change has been in India, which produced four fifths of the manufactures of the region in 1990 (see table II.24). Following a period of low growth (MVA grew by only 2.2 per cent from 1990 to 1992, the lowest in the region), partly due to exogenous shocks, the country, which for decades had followed policies favouring public-sector investment and controls over the private sector, thus inhibiting efficient investment and market forces, is now dismantling many restrictions. The implications are discussed below, followed by a summary of changes in other countries of the region.

Table II.24. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: Indian Subcontinent
(Percentage)

Country or industry (ISIC) and total		Average annual growth rates			Share in total MVA[a/]
		1970-1980	1980-1990	1990-1992	1990
A. Country breakdown					
India		3.0	6.1	2.2	77.3
Pakistan		4.8	6.9	7.2	15.0
Bangladesh		3.1	1.1	8.8	3.8
Sri Lanka		10.3	8.7	4.2	3.2
Nepal		2.2	9.5	6.3	0.7
B. Industry breakdown					
311	Food	1.2	8.4	4.3	11.0
313	Beverages	4.9	10.9	1.5	1.5
314	Tobacco manufactures	4.2	5.7	5.5	4.1
321	Textiles	2.2	0.9	3.0	12.8
322	Wearing apparel	9.1	19.0	3.0	1.6
323	Leather and fur products	4.5	3.0	3.1	0.5
324	Footwear, excluding rubber or plastic	11.0	10.5	3.1	0.4
331	Wood and cork products	4.2	4.2	2.5	0.4
332	Furniture and fixtures	-0.9	1.4	2.8	0.1
341	Paper and paper products	1.5	2.8	3.6	1.6
342	Printing and publishing	1.1	4.7	1.0	1.5
351	Industrial chemicals	2.6	8.9	4.0	7.3
352	Other chemical products	5.2	5.3	4.2	7.4
353	Petroleum refineries	4.1	11.0	2.4	4.0
354	Miscellaneous petroleum and coal products	16.4	7.2	4.2	1.1
355	Rubber products	0.1	10.8	0.9	2.6
356	Plastic products n.e.c.	4.0	9.1	1.4	0.9
361	Pottery, china and earthenware	7.1	6.0	5.3	0.3
362	Glass and glass products	2.2	6.0	4.2	0.5
369	Other non-metallic mineral products	4.5	7.6	4.2	4.2
371	Iron and steel	4.8	6.1	3.4	9.7
372	Non-ferrous metals	-8.8	19.2	3.7	1.6
381	Metal products, excluding machinery	2.2	6.1	2.4	2.8
382	Non-electrical machinery	5.4	4.7	3.0	6.1
383	Electrical machinery	5.7	7.8	3.5	8.1
384	Transport equipment	5.2	5.8	1.5	6.9
385	Professional and scientific goods	3.6	7.3	0.9	0.7
390	Other manufactures	-0.8	3.3	3.2	0.5
Total[b/]		3.4	6.1	3.3	100.0

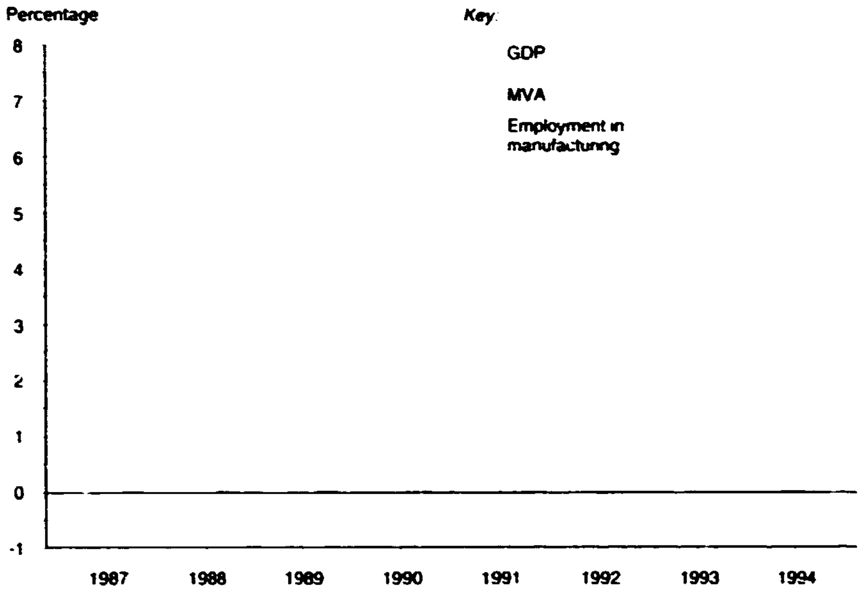
Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

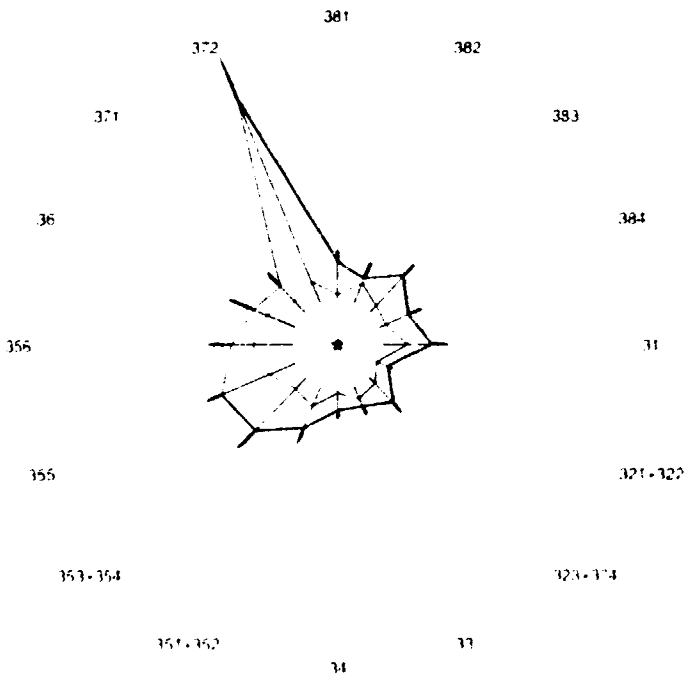
a/ Total MVA for the region in 1990 was $29,232 million.

b/ For both country and industry breakdown.

Figure II.9. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: Indian Subcontinent



Industrial structural change
(Index of value added 1980=100)



g = 5.23, 0 = 15.30

Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

0 = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

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

1. Growth and reform in India

The policy changes are already creating new attitudes towards doing business in India. For instance, blue-chip transnational corporations are becoming interested in investing in India (see table II.25). During the period from August 1991 through October 1992 foreign collaboration approvals were granted to 1,876 proposals amounting to $1,224 million [31]. Also, in 1992 capital issues by private Indian enterprises increased to 98.5 billion rupees ($3.3 billion) from 15.8 billion rupees in 1991. These and other signs suggest that the slow-down within the region bottomed out in 1991/92.

Particularly for Indian industry, fiscal year 1991/92 was an exceptionally bad year*. Production declined by 2.3 per cent. Several constraints on industrial growth were identified to explain this: a poor harvest, sustained inflationary pressure, restricted government expenditure, severe import compression, a tight money policy and stagnation in exports. In 1992/93, an improvement in agricul-

*Fiscal years start on 1 April.

Table II.25. Leading transnational investors in India from Japan and the United States

Indian company	Headquarters	Collaborator	Product
		A. With Japanese collaboration	
In 1990			
Indian Telephone Industries	Delhi	NEC Corporation	Digital microwave systems
Dunlop India	Calcutta	Sumitomo Rubber Ltd.	Radial tyres and tubes
Hyderabad Allwyn Ltd.	Hyderabad	N.P. Foods Ltd.	Prawn crackers and snacks
In 1991			
Gujarat Communications	Baroda	Sony Corporation	Professional videotape recorders
Hyderabad Allwyn Ltd.	Hyderabad	Seiko	Watches
Larsen and Toubro	Bombay	Western Digital Corporation	Hard disk drives
Wipro Infotech	Bombay	Seiko Epson Kabushiki	Dot-matrix printers
In 1992			
BPL Sanyo	Bangalore	Sanyo Electric	Vide cassette recorders and mechanism players and videotape deck
Vintron Industries	Delhi	JPN and Sony Corporation	Floppy disks
Bee Electronic Machines	Bombay	Canon	Facsimile machines
TVS Suzuki	Madras	Suzuki	Motorcycles and derivatives
		B. With United States collaboration	
In 1990			
Montari Industries	Delhi	Bausch and Lamb	Soft contact lenses
Haftkine Corporation	Bombay	New York Blook Centre	Blood products
Kancor Flavours Ltd.	Ernakulam	McCormick and Sons	Spice alternatives, emulsions
Averina International Resorts	Margao	Radisson Hotels	Hotels and restaurants
Hewlett Packard	Delhi	Hewlett Packard	Computer printers
In 1991			
Samcor Glass	Delhi	Corning Glass Work	Colour television glass shells
Uday Management Services	Bombay	Best Western	Hotel industry products
Tata, Inc.	Bombay	IBM World Trade	Computers
Digital Tools	Bombay	Digital Tools, Inc.	Software and consultancy
In 1992			
Vintage Cards and Greetings	Pune	Hall Mark Cards	Greeting cards
Procter and Gamble	Bombay	Richardson Vicks	Synthetic detergents
Apar Ltd.	Bombay	General Electric Co.	Energy-efficient lamps
Motorola Blue Star	Bangalore	Motorola Corporation	High-technology communications
Indian Shaving Products	Delhi	Gillette Co.	Advanced shaving systems
Pepsi Foods	Chandigarh	Pepsico	Processed foods
Hindustan Motors	Calcutta	General Motors	Cars and commercial vehicles
Godrej and Boyce	Bombay	General Electrics	Compressors and household goods

Source: *The Times of India* (12 February, 1993).

ture was achieved, restrictions on imports were eased, inflation dropped, exports began to grow, and the Government budgeted a higher increase in public investment.

There was no increase in government investment in real terms in 1991/92. The budgeted increase in 1992/93 (16 per cent) should stimulate the demand for capital goods. More is, however, expected from the increase in private investment, which on current indications may be higher (18 per cent) than forecast (15.5 per cent). In 1992/93 the minimum interest rate was lowered from 19 to 18 per cent and credit limits were unfrozen. With government market borrowings drastically reduced, the credit situation improved.

Exports in 1992/93 are estimated to have grown at 10 per cent (in dollars). This was a substantial improvement on the decline of 5 per cent in the previous year. Fiscal 1991/92 was admittedly an exceptional year. It was the year of the reforms, monsoon failure, dismantling of the former USSR and of India's trade with it, and severe compression of imports. Devaluation and partial convertibility of the rupee, better monsoon and removal of constraints on imports all helped to boost exports in 1992/93.

While exports in convertible currencies grew rapidly, exports in the rupee payment area—basically trade with the former USSR under long-term agreements continued to decline.* Benefits from the revised exchange rate policy proved not to be as great as foreseen. Under partial convertibility of the rupee, while export earnings were converted at the average of the official and market rates, imports were converted at the market rate—the market rate being around 15 per cent higher than the official rate. Export industries using substantial amounts of imported materials thus suffered. Among the low-import-intensive industries that benefited were garments and leather products, whose exports flourished. Industry was quick to draw the attention of the Government to this shortcoming in the exchange rate policy, and asked for the application of the same rate for converting export earnings and payments for imports. The Government responded by promising full convertibility soon. Indeed, on 1 March 1993, the Government decided to float the rupee in the currency market and to adopt a single market rate for trade—the first step toward full convertibility (capital account restrictions remain).

The trade deficit in 1991/92 declined from $5.93 billion to $1.6 billion or by 70 per cent, reflecting the severity of import compression during that year. Foreign exchange reserves, which had plummeted to a meagre $1.4 billion at the beginning of fiscal 1991/92 (April 1991), rose to $5.6 billion by the end of the year (March 1992) on account of the substantial support received from international financial agencies and two special schemes for drawing funds from non-resident Indians.

The external debt of India in September 1992 was about $70 billion (25 per cent of GNP) and the debt service ratio (ratio of total debt service to exports of goods and services) was 34 per cent. The foreign exchange reserves of India, excluding special drawing rights and gold, were $5.5 billion in April 1992. By December 1992 reserves had declined to $5.1 billion, but are viewed as adequate.

Another bright side of 1992/93 has been a deceleration in the rate of inflation. The point-to-point increase in the wholesale price index has consistently declined each month since September 1992, and the wholesale price index at the end of March 1993 is not expected to be higher than 7 per cent above that of the previous March. The decline in price has been shared by all commodity groups except fuel, power and lubricants. Deceleration in the inflationary rate has been most marked in primary products, which are dominated by food.

*In 1990/91, exports in the rupee payments area were 17 per cent of total exports. In 1992/93, they are expected to be about 5 per cent.

2. *Challenges of techno-industrial reforms in India*

The major economic reforms introduced by the Government of India in early 1993 include a much more liberal policy on foreign technology agreements. For the case of 33 high-priority industries and products (see list below), permission will be automatically granted, with up to 51 per cent foreign equity. This contrasts with earlier (pre-1985) practices of reserving these industries for State-owned enterprises. Apparently, the basic aim of the measure is to accelerate the technical progress of Indian industries by relying on foreign technology sources—a turnaround from the position of "technological independence, self-sufficiency, or self-reliance" espoused earlier.

Industries to receive automatic approval of foreign technology agreements, with up to 51 per cent foreign equity approvals*

Metallurgical industries
Boilers and steam-generating plants
Prime movers
Electrical equipment
Transportation
Industrial machinery
General machines
Agricultural machinery
Earth-moving machinery
Industrial instruments
Scientific and electromedical instruments and laboratory equipment
Nitrogenous and phosphatic fertilizers
Chemicals
Drugs and pharmaceuticals, in accordance with drug policy

Paper and pulp, including paper products and industrial laminates
Rubber products
Plate glass
Ceramics
Cement production
High-technology reproduction and multiplication equipment
Carbon and carbon products
Pre-tensioned high-pressure pipes
Rubber machinery
Printing machinery
Welding electrodes other than those for welding mild steel
Industrial synthetic diamonds
Extraction and upgrading of minor oils
Prefabricated building material
Soya products
Certified high-yielding hybrid seeds and synthetic seed and certified high-yielding plantlets developed through plant tissue culture
All food-processing industries other than milk food, malted foods and flour, but excluding items reserved for the small-scale sector
All items of packaging for food-processing industries, excluding items reserved for the small-scale sector
Hotels and tourism-related industry

*Details of government listing omitted.

Nevertheless, policy measures for deregulation and liberalization still seem to have room for further improvement—improvement in the sense of reducing "transaction costs" facing private enterprises. The following observation is worth quoting in some length [32]:

"A sample of the restrictive nature of bureaucratic control as compiled by the Confederation of Indian Industry included the following:

(i) Even after liberalization the number of notifications, circulars laying down new guidelines for foreign equity participation and collaboration agreements totalled 377 for Customs, 117 for Excise, 21 for direct taxes, 78 for import trade control and seven for export trade control. This added to confusion and caused harassment;

(ii) On matters relating to tax laws, while all obligations of an assessee were time-bound the obligations of tax enforcement authorities were not;

(iii) Insofar as the Industries Development and Regulation (ID&R) Act and licensing was concerned, for getting clearance even now there were 13 agencies. There should be a single window clearance;

(iv) In regard to foreign collaboration, under the existing system, foreign equity and foreign exchange requirement for imported capital goods (CG) should balance. But this called for complete details of CG with specifications, literature, etc. After examination by the authorities, the applicant is subject to a question and answer session. Strangely, since under the new import-export policy, the CGs are freely importable why should the above condition be applicable;

(v) For ensuring speedier action, dividend repatriation should be cleared, of course, subject to a certain limit by authorized dealers instead of sending each case to the Central office of the Reserve Bank of India."

If these statements are valid, the current industrial policy reforms retain the characteristics of a "regulatory regime", quite remote from the "developmental regime" observable in some Asian countries.* The developmental regime characteristically creates new institutional devices to reduce transaction costs facing enterprises as well as uncertainties, so as to encourage risk-taking for continuous innovation, even under conditions of uncertainty or external shock.

3. *Reforms in other countries*

Economic reforms in other countries of the region have been broadly similar to those of India, but some were initiated earlier. In Bangladesh, reforms of finance, investment and industrial and trade policy got underway in 1989. A value-added tax was introduced, and credit and interest restrictions were relaxed. Promotion of the private sector, divestment of public enterprises, support for foreign investment (including 100 per cent foreign equity), and development of export-oriented and small-scale industries has been introduced. Import prohibitions are being eliminated, tariffs lowered and tariff schedules simplified. Results are already apparent. Exports of ready-made gar-

*For an insightful analysis of these regimes see Chalmers Johnson, "Political institutions and economic performance: the government-business relation in Japan, South Korea and Taiwan", in *The Political Economy of the New Asian Industrialism*, Frederic C. Deyo, ed. (Ithaca, Cornell University Press, 1987), pp. 136-164. Similarly, an in-depth study comparing the policy regime of India with those of Brazil, Japan and the Republic of Korea led to the following conclusion [33]:

"If the interpretations of the Indian and comparative material offered here are convincing, they have implications for third-world policy makers. Programmes of liberalization tend to have only a negative agenda with respect to the State—"shrinking the State", "reducing State intervention", etc. This analysis suggests that there should be a positive agenda as well. The emphasis of central government agencies can be shifted away from custodial tasks, which strain bureaucratic capacity and too often serve primarily to generate rental havens, and focused more on supportive functions, gathering and transmitting information, helping to set goals and define needed infrastructural improvements. This is not a passive role. Active, entrepreneurial engagement with real problems of industrial development must be combined with the ability to build durable, effective public-private networks."

ments are growing rapidly, accounting for over half of total export earnings in 1992. High MVA growth of at least 7 per cent is expected to continue in 1993.

In Pakistan, deregulation, privatization, import liberalization and increased fiscal incentives helped to increase investment in manufacturing by over 30 per cent in 1992. Much of the manufacturing industry of the country remains highly protected by tariffs and other trade measures, but a reform programme is expected in 1994, and continued high MVA growth is forecast.

In the past few years, Sri Lanka has initiated a liberalization programme focused on private sector investment, particularly investment in export-oriented manufactures, and export processing zones have been promoted. The strategy has largely been successful. Private foreign investment has been increasing rapidly, to almost $800 million in 1992, as have manufactured exports, especially garments. High growth for both, as well as manufactures in general, should continue during 1993/94.

Garment exports are becoming important throughout the region. The success of this industry has been largely based on two factors: low labour costs and the quota system of the Multifibre Arrangement, which has tended to restrict growth of garments exports from traditional suppliers, such as NICs, to the big United States and European markets. But the recent policy reforms described above are allowing countries of the region to take advantage of their natural competitive advantage: cheap labour. Can such policy reforms help the region to emulate the successes of East Asia? Just lowering a tariff here or there obviously will not be enough; economic reform in the region must continue.

I. East and South-East Asia

Industrial growth in the East and South-East Asian region has led the world over most of the past several decades. High growth in manufacturing, focused on export markets, first spread from Japan to four NICs— Hong Kong, Republic of Korea, Singapore and Taiwan Province. The nexus of production, investment and trade links then spread throughout the ASEAN countries, with the poorest of none, Indonesia, being the most recent to benefit. Now China is also being brought into the regional industrial network (see section J). All this has been based on enterprise-level, market-based decisions, rather than formal intergovernmental agreements.

The region's share in world MVA grew from 1.3 per cent in 1975 to 4.3 per cent in 1990, and is expected to reach 5.4 per cent in 1993 (see table II.26). As of 1990, two thirds of regional MVA was accounted for by the Republic of Korea (43.2 per cent) and Taiwan Province (23.9 per cent). Regional MVA growth averaged 11.4 per cent annually during the 1970s, slowing to 8.8 per cent in the 1980s and 6.2 per cent from 1990 to 1992, as the world economy slowed. Most of the region's growth has been in advanced technology sectors such as machinery and chemicals. East and South-East Asia accounted for a noteworthy 6.3 per cent share of worldwide manufacture of electrical machinery as of 1990. Labour productivity gains have been among the world's highest (see figure II.10 for GDP and MVA growth in recent years and also for the pattern of structural change in industry).

Regional GDP growth is expected to pick up from "only" 5.5 per cent in 1992 to 6.2 per cent in 1993 and 6.8 per cent in 1994 (see table I.1). Manufacturing will continue to provide the driving economic force, although service activities are also growing rapidly in countries and areas such as Hong Kong and Singapore. MVA growth is expected to rise from 6.0 per cent in 1992 to 7.4 per cent in 1993 and 8.8 per cent in 1994, and most countries in the region, being participants in the dynamic economic system mentioned above, will contribute to and benefit from high regional MVA growth.

1. Trade and foreign investment

Trade and foreign investment patterns in East and South-East Asia have become complex as well as rapidly growing, and manufactured products dominant both (for example, 96 per cent of Taiwan Province exports in 1992 were manufactures). As a further case in point, for example, cars made in Malaysia are products of joint ventures with major Japanese companies, parts being sourced from many countries of the region. Japan remains the source of many of the most advanced, high-technology industrial inputs (thus returning a trade surplus with the region), and actual manufacturing activity has moved to areas with the lowest labour cost such as China (although wages in the coastal areas have increased, so that the next move will be into central China).

Trade linkages for 1991 including China, Japan and South Asia (the last named, as reflected in the table, is not part of the East Asian network, having low regional trade linkages) are shown in table II.27. Total exports of the four NICs are about the same as those of Japan, about three times greater than the rest of South-East Asia, and four to five times greater than China. It can be seen that trade linkages are strong within the East and South-East Asian region and with Japan and China. Most of this trade consists of manufactures (accounting for 96 per cent of exports of Taiwan Province in 1991), of which a large part is industrial inputs (Japanese exports to the region are largely in this category).

The network of manufacturing production, trade and foreign investment linking the region with Japan and China is largely based on a hierarchy of differences in skills and wage costs. The most advanced, high-technology, high-value-added products are made in Japan, where wages are highest; next come the NICs. Indonesia and China, where wages are lowest, provide production platforms for labour-intensive, low-skill activities. New products tend to be made first in Japan, and are later shifted to countries lower in the hierarchy. Video recorders, for example, are no longer at the technological apex, and are therefore being produced mainly in the low-wage countries. To illustrate this phenomenon, table II.28 shows that although labour productivity has been increasing very rapidly in Taiwan Province, the increase in wages has been even greater. Unit labour costs have therefore risen considerably, thus helping to drive basic manufacturing activities to mainland China. But even in Taiwan Province, where GDP per capita is now above $10,000, higher than that of Greece, labour costs in 1990 were only 19 per cent of the labour costs of the United States (they were 7 per cent during the period from 1976 to 1978) [34].

Table II.26. Growth rates of MVA in individual countries and in 28 industries, 1970-1992, and 1990 country and industry shares: East and South-East Asia
(Percentage)

Country or area or industry (ISIC) and total		Average annual growth rates			Share in total MVA[a]
		1970-1980	1980-1990	1990-1992	1990
		A. Country breakdown			
Republic of Korea		13.8	12.9	7.4	43.2
Taiwan Province		11.7	7.4	4.3	23.9
Thailand		8.7	6.9	8.0	9.8
Indonesia		14.0	13.4	5.4	5.3
Hong Kong		10.4	1.3	0.9	5.2
Singapore		14.4	6.9	6.5	5.1
Malaysia		13.6	7.4	10.2	3.9
Philippines		5.3	3.2	0.9	3.1
Macau		0.4	3.8	0.5	0.2
Papua New Guinea		7.4	-0.2	7.4	0.1
Fiji		6.2	1.0	-	0.1
		B. Industry breakdown			
311	Food	7.1	6.1	5.2	8.1
313	Beverages	4.3	7.7	2.9	2.5
314	Tobacco manufactures	7.2	5.3	3.3	2.7
321	Textiles	11.6	4.6	2.9	7.8
322	Wearing apparel	13.2	6.3	4.7	4.9
323	Leather and fur products	19.2	16.1	5.2	1.3
324	Footwear, excluding rubber or plastic	14.4	10.6	4.8	0.5
331	Wood and cork products	7.2	4.2	2.5	1.6
332	Furniture and fixtures	12.0	9.3	8.4	0.9
341	Paper and paper products	11.2	9.6	5.6	2.3
342	Printing and publishing	10.9	9.7	7.8	2.4
351	Industrial chemicals	11.0	9.4	8.7	3.8
352	Other chemical products	10.0	9.8	8.0	4.3
353	Petroleum refineries	10.0	6.5	7.7	4.5
354	Miscellaneous petroleum and coal products	12.1	4.1	3.9	0.3
355	Rubber products	12.2	8.8	6.8	2.4
356	Plastic products n.e.c.	11.6	9.4	3.8	3.6
361	Pottery, china and earthenware	13.8	10.6	4.0	0.5
362	Glass and glass products	7.9	10.3	3.4	0.7
369	Other non-metallic mineral products	12.4	7.5	9.1	2.9
371	Iron and steel	17.9	10.4	7.2	4.9
372	Non-ferrous metals	18.3	7.5	10.2	0.9
381	Metal products, excluding machinery	13.8	10.9	8.4	4.9
382	Non-electrical machinery	15.9	13.9	9.0	5.2
383	Electrical machinery	17.7	12.3	6.5	14.0
384	Transport equipment	13.7	12.8	8.1	7.4
385	Professional and scientific goods	27.8	8.0	4.8	1.4
390	Other manufactures	11.2	9.8	1.2	3.3
Total[b]		11.4	8.8	6.2	100.0

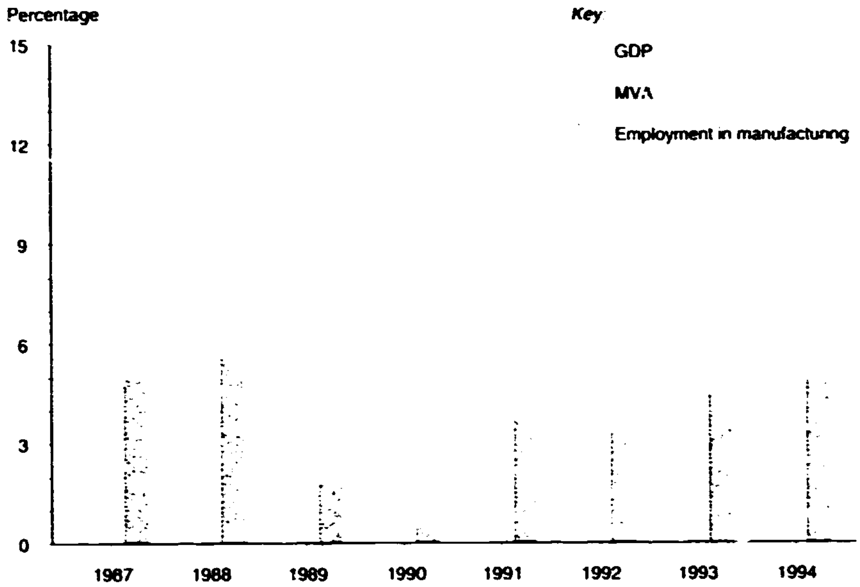
Source: UNIDO Industrial Statistics Database and UNIDO/PPD/IPP/GLO.

Note: In computing regional MVA growth rates, sectoral MVA for each country is valued in national currency at 1990 prices and then aggregated to regional totals at 1990 United States dollar exchange rates.

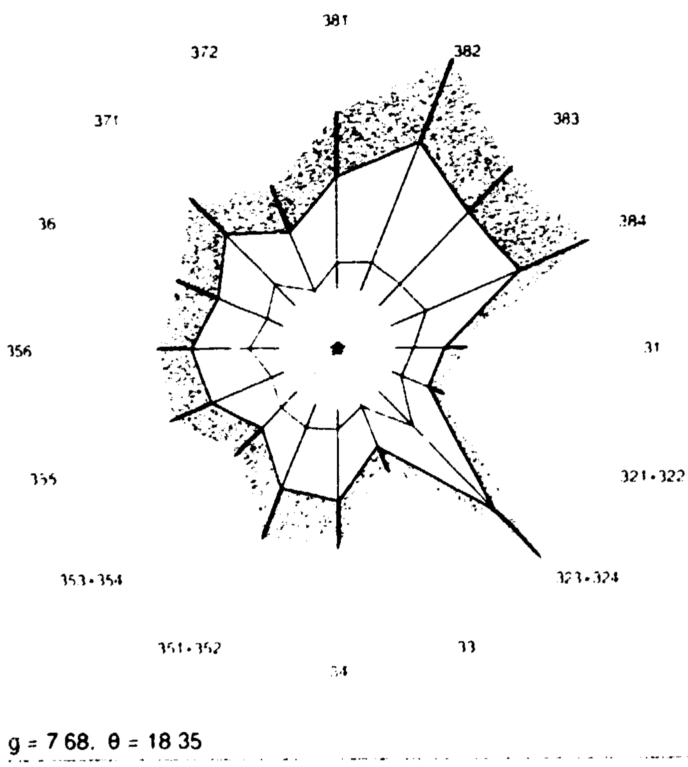
[a] Total MVA for the region in 1990 was $231,703 million.

[b] For both country and industry breakdown.

Figure II.10. Growth rates of GDP, MVA and manufacturing employment, 1987-1994, and industrial structural change, 1980-1994: East and South-East Asia



Industrial structural change
(Index of value added 1980=100)



Key:

Deflated prices of 1985

g = Average annual growth rate, 1980–1994 (percentage)

θ = Index of structural change, 1980–1994

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)

1990-1994 forecast
1985-1990
1980-1985

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

Table II.27. Matrix of intra-Asian exports: 1991

Exports from	Destination and value of exports							
	China	NICs	South-East Asia	South Asia	Pacific Islands	Total, excluding Japan	Japan	World total
				A. Value in millions of dollars				
China	-	36 300	2 140	1 381	23	39 844	10 265	70 451
NICs	27 901	41 704	24 875	4 249	313	99 041	32 092	307 819
South-East Asia	2 392	23 343	4 519	1 492	62	31 807	23 640	102 420
South Asia	285	2 731	1 223	812	5	5 057	2 700	28 527
Pacific Islands[a/]	16	165	68	4	4	257	421	1 796
Total, excluding Japan	30 594	104 243	32 825	7 938	407	176 006	69 119	511 013
Japan	8 605	66 928	25 593	3 602	278	105 006	-	314 786
				B. Percentage change from previous year				
China	-	22.6	15.9	12.6	-4.2	21.8	11.5	15.0
NICs	32.[illegible]	25.8	17.7	0.3	4.7	23.9	6.4	15.6
South-East Asia	30.3	22.4	11.7	-1.1	50.7	20.0	9.6	16.9
South Asia	88.3	41.4	66.3	-10.4	64.3	35.6	16.9	2.8
Pacific Islands[a/]	191.1	18.4	-7.5	-3.0	-15.4	13.2	-9.5	-20.6
Total, excluding Japan	32.3	24.2	17.9	0.7	9.4	23.0	8.5	24.8
Japan	40.4	17.8	13.9	0.8	-27.0	17.5	-	9.5
				C. Percentage share in exports to world				
China	-	51.53	3.04	1.96	..	56.56	14.57	100.0
NICs	9.06	13.55	8.08	1.38	0.01	32.18	10.43	100.0
South-East Asia	2.34	22.79	4.41	1.46	..	31.06	23.08	100.0
South Asia	1.00	9.57	4.29	2.85	..	17.73	9.47	100.0
Pacific Islands[a/]	0.89	0.92	3.79	0.02	0.02	14.31	2.34	100.0
Total, excluding Japan	5.99	20.40	6.42	1.55	..	34.44	13.53	100.0
Japan	2.73	21.26	8.13	1.14	..	33.36	-	100.0

Source: Asian Development Bank, *Asian Development Outlook* (Manila, 1993), p. 15.
a/ Fiji, Papua New Guinea, Solomon Islands and Vanuatu.

As part of the change referred to above, regional exports to China have been increasing rapidly. Taiwan Province exports to China—largely through Hong Kong—reached about 13 per cent of its total exports in 1992, up from less than 3 per cent in 1987 [35]. The change in the location of manufacturing production provides some interesting statistics. For example, in both 1987 and in 1992, China, Hong Kong and Taiwan Province together had a trade surplus with the United States of about $28 billion, but in 1987 Taiwan Province accounted for about $25 billion of the total, whereas in 1992 it accounted for less than $10 billion of the total, reflecting the shift in the location of final manufacturing [36].

Table II.28. Indices of labour productivity, employee earnings and unit labour cost in manufacturing, 1974-1992: Taiwan Province

Year	Labour productivity	Employee earnings	Unit labour cost
1974	52.10	..	39.15
1975	56.98	..	41.33
1976	62.80	..	43.63
1977	66.08	..	49.86
1978	76.24	..	48.62
1979	77.70	46.89	57.97
1980	79.15	57.48	69.57
1981	84.63	69.21	81.24
1982	85.25	74.86	88.56
1983	91.72	79.61	87.19
1984	91.39	87.12	94.57
1985	93.35	90.83	99.50
1986 a/	100.00	100.00	100.00
1987	107.95	109.92	101.29
1988	115.98	121.90	106.01
1989	27.82	139.68	112.05
1990	137.85	158.54	119.02
1991	152.92	175.94	118.99
1992	158.93	194.03	126.52

Source: *Industry of Free China*, vol. LXXIX, No. 4 (February 1993), tables 12, 13, 14.
a/ Base year.

Table II.29 shows foreign direct investment in the region. Singapore has been one of the largest recipients of foreign investment (by far the largest in per capita terms), but Indonesia, Malaysia, Taiwan Province and Thailand have also received large foreign investments. The Republic of Korea and Taiwan Province have been providing foreign direct investment to lower-wage-cost countries in the region and to China.

2. *Longer-term prospects*

Prospects for manufacturing in East and South-East Asia remain very good, although basic manufacturing is shifting rapidly into lower-wage-cost countries of the region and into China. NICs will soon be producing only high-technology, high-value-added manufactures, and growth of services, mainly financial, will exceed MVA. Although the economies and economic policies of the countries and areas are quite different, the Republic of Korea, for example, having a few very large companies working closely with an activist government policy, whereas in Taiwan Province companies are small and in Hong Kong government policy has been *laissez-faire*, all have provided a sound policy environment which encourages manufacturing, production, investment and export, as well as rapid change to meet the challenge of altering world markets. The Government of the Republic of Korea, for example, has had an active industrial policy, providing support for its future comparative advantage. Table II.30 shows a list of products that it wishes to market soon. One implication of the table is that the East-Asian NICs would no longer be considered in the developing-country category.

Table II.29. Foreign direct investment in selected countries and areas of East and South-East Asia, 1986-1991
(Million dollars)

Country or area	1986	1987	1988	1989	1990	1991	1986-1991
Newly industrializing countries							
Republic of Korea	435	601	871	758	715	1 116	4 496
Singapore	1 710	2 836	3 655	2 770	3 861	3 584	18 416
Taiwan Province	326	715	959	1 604	1 330	1 271	6 205
Total, A	2 471	4 152	5 485	5 132	5 906	5 971	29 117
South-East Asia							
Indonesia	258	385	576	682	1 093	1 482	4 476
Malaysia	489	423	719	1 668	2 514	3 454	9 267
Philippines	127	307	936	563	530	544	3 007
Thailand	263	352	1 105	1 775	2 444	2 014	7 953
Total, B	1 137	1 467	3 336	4 688	6 581	7 494	24 703
Pacific Islands							
Fiji	8	-11	23	13	75	7	115
Papua New Guinea	91	93	153	203	..	..	540
Solomon Islands	-1	8	3	6	13	19	48
Vanuatu	2	13	11	9	13	18	66
Total, C	100	103	190	231	101	44	769
Total, A, B and C	3 708	5 722	9 011	10 051	12 588	13 509	54 589

Source: Asian Development Bank, *Asian Development Outlook* (Manila, 1993), p. 17.

Table II.30. New products targeted by the Republic of Korea for commercialization, 1993-2001

Industry	Products	Target date for commercialization
Automobiles	Electric car	1996
Bioengineering	Advanced waste treatment	..
	Alternatives to chloro-fluorocarbons	..
Computers	Multimedia computers	1994
	Neural networks	1997
	Voice recognition	2000
Consumer electronics[a/]	HDTV monitors	1993
	HDTV transmission	1994
	Flat panel displays	1997
Energy	Light-water nuclear reactor	2001
Manufacturing	Computer integration	1996
	Intelligent manufacturing	2000
Materials	Alloys and polymers	1997
Medicine	Genetically engineered DNA	1993
	Herbally based biotechnology	1996
	Genetically engineered drugs	1997
Telecommunications	Advanced switches (ATMs)	1996
	Digital network (ISDN)	2001

Source: *Far Eastern Economic Review*, 8 April 1993, p. 61.
a/ HDTV = high-definition television.

J. China

1. Short-run outlook

In 1992 GDP in China grew by 12.8 per cent, and industrial output increased by 20.7 per cent. UNIDO expects growth to slow in the second half of 1993 and to register 10 per cent in 1993 and 8.2 per cent in 1994. Growth of MVA is also expected to slow down, to 15 per cent in 1993 and 10 per cent in 1994. One factor, on the supply side, that contributed to rapid 1992 growth was the existence of substantial excess manufacturing capacity. For example, estimated 1991 factory utilization rates were 45.3 per cent for colour television sets, 40.1 per cent for washing-machines, and 39 per cent for tractors [37]. In the case of tractors, output was up 19.5 per cent in 1992, but this would still leave capacity utilization well below what would be considered a normal operating range. Other fast-growing manufacturing branches included cement at 22.6 per cent, machine tools at 40.6 per cent, and motor vehicles at 57.1 per cent, all measured in units of physical output. While electricity production was up 10.7 per cent and installed capacity increased by 15.9 per cent, overall fuel production grew by only 1.8 per cent. Growth rates in light and heavy industry were nearly identical at 20.9 and 20.7 per cent. The same was true in 1991, when light industry grew by 14.5 per cent and heavy industry by 13.9 per cent. While the expansion was led by industry, services also increased strongly, at nearly 10 per cent. Agricultural output lagged behind at a much more modest growth of 3.7 per cent, though this was also an improvement over 1991 when it grew at 3.0 per cent.

The highest growth rates of MVA and GDP were associated with the southern coastal provinces. The State Statistical Board reported that 1992 GNP growth reached 20 per cent in Guangdong province. The coastal provinces are the provinces which are most closely linked to the global economy, in many cases through business connections in Hong Kong and Taiwan Province. The upsurge in economic activity has been accompanied by a large increase in activity in the international sector. Exports increased by 16.5 per cent and imports were up by 26.0 per cent in 1992. These figures are the more remarkable, because China has already become a major trading economy. The combined imports and exports of China now total more than those of any of the NICs except Hong Kong. The combined trade of China plus Hong Kong would rank along side that of France and the United Kingdom among the top five trading countries in the world. Foreign direct investment took off in 1992, registering a 180 per cent gain over 1991. A large part of this investment has come from Hong Kong and Taiwan Province, but other countries are also represented. The number of transnational corporations without a presence in China is decreasing rapidly.

There are probably few risks in forecasting 10 per cent GDP growth in 1993, but the growth rate of 8.2 per cent forecast for 1994 does carry some downward risks. Given the growth rate of 12.8 per cent registered in 1992, inflation was remarkably low for the country as a whole, only 5.4 per cent, but there was a large difference in the rate at which urban versus rural prices increased. In the rural areas prices rose only 4.7 per cent during the year, while in urban areas they increased by 10.9 per cent. Furthermore, the trend has been clearly upward. At mid-year prices in urban areas in the fast-growing southern provinces were reported to be rising at annual rates in excess of 20 per cent. As a result, in July 1993 the Government initiated a retrenchment programme. With growth in the first half of the year running at an estimated 14 per cent, some wondered if the Government had not waited too long. The programme involved steps to achieve the following [38]:

(a) To call in loans for speculative projects, particularly property deals;

(b) To guarantee sufficient funds for loans for agriculture and important infrastructure projects;

(c) To complete government bond sales;

(d) To raise interest rates;

(e) To reduce government spending by 20 per cent;

(f) To suspend further price reform for the rest of the year;

(g) To eliminate the issuance of IOUs to farmers;

(h) To strengthen the central bank;

(i) To send central government work teams to localities to enforce directives;

(j) To strengthen real-estate law and require developers to provide 20 per cent of units to local residents.

Removal of price controls on a number of products and price increases for products still subject to controls have contributed to inflation. However, since the share of output traded at controlled prices has diminished, this source of inflation will wane in the remainder of 1993 and beyond. Other sources of inflationary pressure include bottlenecks in supplies of some intermediate and final goods. The labour cost situation is mixed. For some skill categories labour shortages are being reported. At the same time, some firms, particularly in the State sector, are expected to cut staff as they reorganize in order to become more efficient. Electricity shortages have constrained output in some areas, although both electricity production and installed capacity increased substantially in 1992. Transportation is also in short supply. Total road and rail freight increased by only 3.8 per cent in 1992, and overall freight volume (rail, road, water and air) actually decreased by 1.0 per cent in the first five months of 1993 relative to the same period of 1992 [39]. This indicates a serious threat to future growth. There are some mitigating factors with respect to transportation. One is the pace of road construction, particularly in the rapidly growing southern provinces. The other is the fact that the prevailing freight schedules are reported to result in considerable misallocation of capacity. A rationalization of shipping rates could introduce gains that would help keep critical goods moving while additional freight-carrying capacity is being built.

During the 1989 anti-inflation campaign there was very extensive direct intervention at the level of individual projects and enterprises to slow growth. The current retrenchment programme is expected to give more emphasis to general fiscal and monetary instruments. One consequence of the 1989 austerity programme was a large decrease in the number of private-enterprise establishments. In mid-1988 some 225,000 private establishments employed 3.6 million workers; following the 1989 austerity programme there were only 98,000 establishments, employing 1.7 million workers ([40], p. 221). Private enterprise will fare better in the current retrenchment programme if greater emphasis is placed on macroeconomic aggregates such as the rate of growth of the money supply and government spending and taxation levels. Trade liberalization measures that have been implemented in the last few years will also help to curb inflation. Freer access to imports will help to alleviate supply bottlenecks that would otherwise result in sharp price increases.

2. *Longer-term prospects*

(a) *High levels of investment and rapid growth*

The dominant factor in the long-term outlook for China is the large share of GDP that is being devoted to capital formation. Even during the 1970s investment in China averaged nearly a third of GDP, and GDP growth averaged 7.9 per cent. Since 1980 an increased share of GDP devoted to investment has been coupled with economic reforms and an opening-up of the country to contacts with the rest of the world. As a result GDP growth increased to average 10 per cent since 1980. In the medium term it seems likely that the growth trends established over the last decade will continue. China's development progress over the next decade will have a major impact on the world, in terms of international trade, geopolitics and the effects of its industrialization on the global environment. On the basis of GDP converted to United States dollars at prevailing exchange rates, China ranks among the top 10 economies in the world. Under this measure GDP would come out to about $400 per capita, which in fact reflects a standard of living much lower than that enjoyed by the Chinese population. An alternative measure of output can be obtained from the United Nations International Comparison Programme, which provides estimates at five-year intervals of total output measured at uniform international prices. Thus, for example, a bicycle of a specific type and quality would have the same ICP price no matter where in the world it was produced. Under such ICP prices, per capita GDP in China in 1992 would be equivalent to $2,460. The International Monetary Fund has also developed a set of purchasing power parity prices, which it used to value GDP for China, as well as other countries [21]. Under these prices, China in 1992 ranks as the world's third largest economy, behind the United States and Japan.

Growth in China in the medium-term will depend on its continuing to devote a large portion of GDP to investment. The course of the reform process and its trade and investment relationships with the rest of the world will also be important. The cumulative effect of reform measures implemented over the past 15 years has been profound, but there remains considerable growth impetus in the reform process. Both the extent of the reforms carried out so far and the way left to go are evident in nearly all areas. While State enterprises have been given considerable leeway in making business decisions and disposing of the profits they earn, there has been less emphasis on their accepting the consequences of bad decisions in terms of losses. Village and township enterprises operate almost entirely in the context of the market economy, with wide discretion in disposing of their profits, and they must generally absorb their losses. But aside from foreign joint ventures and farming, private enterprise plays a very small role. Price reform, though extensive, is not yet complete, and further price reforms were suspended during the second half of 1993 as part of the retrenchment programme. Central plan allocations, implemented largely in terms of specific inputs and outputs, continue to be important for State-owned enterprises. The system of public finance has been reformed to allow taxes to replace profits as the main source of central and local government revenues, but continues to rely too heavily on ad hoc firm-by-firm or industry-by-industry determinations of tax rates.

Foreign exchange can be purchased and sold at market-determined rates in the swap market, and equity exchanges have been set up to handle national and international transactions. But further financial reform, particularly in banking, is an urgent requirement. Lending through the State banking system has been used to make up for revenue short falls in the State-owned enterprises, which by some estimates account for 80 per cent of all bank loans [41]. In the current economic framework there are still too many constraints on the operations of such enterprises for profits and losses to be a valid indicator of whether they are being efficiently managed. But using the banking system to allocate and fund subsidies has some drawbacks in relation to financing subsidies directly out of tax revenues. Combining financial intermediation, regulation of the money supply and enterprise subsidy policy may operate to the detriment of all three areas. Loans are not made on the basis of sound commercial or economic efficiency criteria; regulation of the money supply may be influenced by the quality of the loan portfolio of the State bank; and the criteria for allocating subsidies is obscured.

For State-owned enterprises, the reform process so far has emphasized coaxing them into more efficient behaviour by allowing them to charge market prices for that part of their production which is outside central plan allocations, and to retain after-tax profits to reinvest or pay out in higher wages or bonuses. One element in this scheme has been the dual price system. Under the dual price system the State-owned enterprises are required to produce a specific amount of output to meet allocations set under the central plan. Output prices are fixed under the plan, as are the prices of the inputs required to produce the specific plan outputs. Input and output prices for enterprise production outside the plan are largely market-determined. One effect of the dual price system has been to induce the State-owned enterprises to concentrate their efforts on those activities, outside the required plan activities, in areas where the surplus of revenues over costs is greatest. It has given firms the opportunity to move into areas where they can in effect prove that they are efficient producers on the basis of market criteria. But having two prices for the same commodity is not a long-run solution. It dilutes the effectiveness of market forces, and leads to socially wasteful effort being expended on non-productive activities associated with exploiting the opportunities for gain under the dual price system, for example by devising "legal" ways to buy inputs under central plan prices and sell them at market prices. Official policy statements, the desire to meet the conditions for membership of GATT and the mounting cost of subsidizing State-owned enterprises would all seem to point in the direction of a smaller role for direct allocation of inputs and outputs under future central planning exercises.

The process of industrialization at the rate at which it has been occurring in China brings rapid social change. Rising incomes, greater social and geographical mobility and improvements in nearly all the basic indicators of the quality of life have accompanied the industrialization process in China over the past 15 years. Another social aspect of industrialization is, as the term implies, the larger role of industry in the economy. The role of the service sector also increases; it is agriculture that declines. During the first few years following the introduction of reforms, farm output and income soared, yet opportunities in the rest of the economy were sufficiently enticing to result in a large shift of workers away from the farm sector. Between 1978 and 1987 the proportion of the labour force engaged in agriculture fell from 70.7 to 60.1 per cent [42]. More recently there have been reports of discontent with economic conditions in the rural areas. In part these seem to be related to the underdeveloped tax system, which farmers see as discriminatory. The government practice of issuing IOUs instead of cash payments for State purchases of agricultural produce has also not been well received, and one of the elements of the current retrenchment has been the abolition of the practice. Better credit conditions for farmers is also an element of the retrenchment. But none of this can alter the fact that industrialization implies a movement of labour out of agriculture and into the industry and service sectors. While farm life has its attractions, so does life in the big city, and there may well be some movement of labour off the farm for reasons of life-style preference. But the main incentive for labour to move out of agriculture is and will continue to be higher income opportunities off the farm. In 1985 farm earnings were 58 per cent of the earnings of workers in the cities, and by 1991 had fallen to 42 per cent [38]. Living expenses are higher in the cities, and have been rising faster than living expenses in the countryside, so the income gap may not be as high or have widened as much as these figures would seem to indicate. But it does seem clear that industrialization will involve difficult social and political problems as the role of agriculture is diminished. The solution is not to prop up farm income. While agricultural subsidies are affordable to the wealthy industrial economies with only 2 to 3 per cent of the labour force engaged in agriculture, to prop up farm incomes by enough to make a difference in China, with over 50 per cent of the labour force in agriculture, would be very costly, and cause a significant slowdown in development.

(b) *Trade and foreign direct investment*

Despite the fact that China adopted a policy of openness at the time reforms were initiated, foreign investment has not played an especially important role. This seems likely to change. In 1992, foreign direct investment increased by 180 per cent, from $4 billion to $11.2 billion. This represents nearly 10 per cent of total gross domestic investment, and so adds to an already high level of capital formation. But the main contribution of foreign direct investment in China is access to technology, marketing and management know-how that results from the presence of international business. A large share of exports are generated by foreign firms with investments in China. An estimate for 1991 put the share of exports that occur through foreign firms at 25 per cent, and as a result of the surge in foreign direct investment this share may now be approaching 35 per cent.

A significant portion of foreign investment has been in small-scale operations, similar to the enterprises that were important during the 1970s in fuelling the export drive of Taiwan Province. These investments provide access to business know-how in light industry and the service sector. Tourism and real estate are areas that have attracted a substantial amount of foreign investment. Gaining a presence in the manufacturing sector in China is important for some of these investors, but the major consideration for most is to take advantage of low wage costs. In many cases the investors are from Taiwan Province or Hong Kong, and are fleeing increasing labour costs at home. Investment from Singapore and the Republic of Korea has also increased substantially over the past two years. Until recently over half of all foreign direct investment in China was officially listed as coming from Hong Kong. Often this was because outside investors wanted to work through trusted partners in Hong Kong who were more familiar with the business environment in China. Investors from Taiwan Province, who until recently were prohibited by law from most types of direct business dealings in China, channelled investments through corporations based in Hong Kong. Table II.31 shows the distribution of contracted foreign direct investment in China in terms of the major investor

Table II.31. Foreign direct investment in China by source, 1979-1991
(Contracted investment in million dollars)

Investment source	1979-1984	1985	1986	1987	1988	1989	1990	1991
Hong Kong	6 495	4 134	1 449	2 466	4 033	3 645	4 258	7 215
Japan	1 158	471	283	385	371	515	478	812
United States	1 025	1 152	541	361	383	646	366	548
Taiwan Province	..	..	..	100	420	480	1 000	..
Singapore	117	77	141	80	137	148	107	155
Australia	91	14	32	47	17	84	18	44
Canada	66	9	91	34	40	49	21	31
Republic of Korea	..	0.1	1.8	6	5.4	14.5	47	..
All sources	11 791	6 333	3 330	4 319	6 191	6 294	6 986	11 977

Sources: Korean Overseas Trade Association for data on the Republic of Korea; Xinhua News Agency for data on Taiwan Province; and China Resources Advertising Co., *Almanac of China's Foreign Relations and Trade* (Beijing, various issues), and Edward K.Y. Chen, "Foreign direct investment in East Asia", *Asian Development Review*, vol. 11, No. 1 (1993), table 13, for data on other economies.

countries. Contracted foreign direct investment has tended to exceed the actual flows by a significant amount, since the contracts do not generally bind the parties to actually achieving the approved level of investment.

Foreign direct investment in labour-intensive enterprises is likely to be an important source of growth for the Chinese economy in the coming years. With its vast labour force and the desire to reduce employment levels in overstaffed State enterprises, job creation is an important consideration. Over the long term, it may have the potential for developing-country producers in East and South-East Asia to generate the same type of industrial growth in China that fuelled their own growth as Japan moved labour-intensive production offshore to the Republic of Korea and other low-wage countries in the region.

Transnational firms are generally associated with larger projects that involve joint ventures with State-owned enterprises. Most such investment comes from developed countries, mainly the United States and Japan. There have also been deals made with large firms from developing countries within the region for large-scale investment projects. The opportunities for technology transfer are generally an important consideration from the Chinese side, and the potential for sales in the growing Chinese domestic market are important considerations for the transnational corporations. For an example of training benefits that can be associated with transnational joint ventures, see box II.5.

(c) Trade and the Asian developing countries

The exports of China have grown by over 15 per cent per year in each of the past six years except 1989. In 1992 they increased by 16.5 per cent. The Asian Development Bank is projecting growth at about 15 per cent for 1993 and 1994 as well. The growth of imports has been more uneven, dipping from 27.4 per cent in 1988 to 5.3 per cent in 1989, and to -13.3 per cent in 1990. In 1991 and 1992 imports again shot up, increasing 18.5 per cent in 1991 and 26.0 per cent in 1992. The Asian Development Bank projects a growth in imports of about 25 per cent in 1993 and 1994 ([40], tables A11 and A12). Large inflows of foreign direct investment will minimize the risk associated with the trade deficit resulting from the growth in imports. The share of exports that China sends to developing countries in Asia increased from 38.2 per cent in 1985 to 55.4 per cent in 1991. There has also been a slight increase in the share of exports going to the EC. The share of total exports to Japan fell from 22.3 per cent in 1985 to 14.3 per cent in 1991. Exports to other countries outside these three regions also fell, from 22.5 to 12.0 per cent over the same period, mainly reflecting the collapse of trade with the transition economies of Eastern Europe and the former USSR. The regional structure of imports has evolved in a similar way. In 1992, China sourced 61 per cent of its imports from the Asian region [46].

The increase in Chinese imports from the Asian region has been an important source of growth for the developing economies of the region. The boom in Chinese imports has enabled developing countries of the region to maintain growth in the export sector despite the slowdown in the United States and Europe. For NICs the expansion of the Chinese market has also provided the opportunity to increase exports in more technologically sophisticated and more capital-intensive goods. Rising labour costs in NICs have forced them to shift out of the manufacture of labour-intensive goods in order to remain internationally competitive. This is illustrated in the case of Taiwan Province. Manufactures in four technologically sophisticated industries accounted for two thirds of its exports to China in 1992, namely, synthetic fibres, machinery and equipment, plastics materials, and electrical and electronic parts and components. Trade between China and the Republic of Korea, which established formal diplomatic relations in 1992, has been the most rapidly growing bilateral flow in the region. The Republic of Korea's exports to China nearly doubled in 1992 to $7 billion.

In the medium term the pattern of trade among developing countries of East and South-East Asia will continue to emphasize the comparative advantages of NICs in manufacturing, and in particular their move into more sophisticated products. But China will continue to develop its manufacturing technology with the help of joint ventures with partners from NICs and from developed

Box II.5. Foreign direct investment and training: an example

While the scope for technology transfer includes a wide range of activities, employee training is one important form that many transnational corporations can provide. For example, the German firm Siemens, after sending employees of its joint venture with Beijing International Switching Corporation to Germany for training, found that the expense would be less if it established a training centre in China. Investing $25 million in establishing a training centre owned and operated by the Beijing municipal government, it trains several hundred employees a year at a fraction of the cost of sending staff to Germany for training. Other high-technology transnational corporations have established similar facilities. Compaq has established a training centre at Qinghua University, the leading technical university in China, operated along the same lines. Chinese universities have been encouraged to establish commercial operations in order to supplement scarce governmental resources for higher education. Qinghua University, for example, has some 40 to 50 affiliated companies, and most of its 28 academic departments operate their own subsidiary companies as part of their normal operations ([43], [44]). Such training ventures help to fill a critical need for skilled workers in China, which has one of the lowest percentages of workers with higher education in countries of East and South-East Asia. Only about 1 per cent of the Chinese population aged 25 and over has attained a university education. For comparison, the percentages in some other countries and areas in the region are: Philippines 15.2 per cent, Republic of Korea 8.9 per cent, Hong Kong 7.7 per cent, Malaysia 5.1 per cent, Singapore 3.4 per cent, Thailand 2.9 per cent, Viet Nam 1.2 per cent and Indonesia 0.8 per cent [45].

countries. As it does so, it will itself move into the manufacture of more sophisticated products. In order to maintain wage and productivity growth, NICs will have to continue to invest in new technologies in order to maintain their comparative advantage in these areas in relation to China. A recent World Bank investigation of China's comparative advantage in foreign trade notes that the rapid growth of exports of manufactures by the four Asian NICs during the 1970s and 1980s had a significant effect on the structural adjustment problems in developed countries [47]. Similar growth in exports from China could have a much larger impact, since it is a much larger economy. The key question, according to the World Bank study, is whether China will primarily compete with other countries in the region, or whether it will produce opportunities for further regional integration. The answer so far is that China will do both. In order to take advantage of the emergence of China as a major player in the international economy, NICs will have to give up their comparative advantage in labour-intensive manufacturing. But as they move into more capital- and technology-intensive manufacturing, they will for a time at least have a major opportunity in supplying these goods to the Chinese market. For the developing economies of the region, the story is somewhat different. It seems likely that they will be forced to compete head on with China in international markets from the outset. Whether this will slow their development or not depends on how competitive they will be in attracting foreign direct investment and in mobilizing domestic labour and capital resources. Growth in the region will furnish an expanding market and opportunity for all to gain from trade, but some will position themselves better than others to gain from the opportunity.

III. Trade and industrialization

A. Overview

Trade and industrialization have been metaphorically described as the Siamese twins in development literature. One can hardly be discussed in isolation from the other. However, in recent years there has been a fundamental shift in the way economists and policy makers think about the symbiotic relationship between trade and industrialization, and particularly the role of trade in industrialization. The key notions seem to be the demise of the inward-looking import substitution industrialization (ISI) strategy based on State intervention and the ascendancy of trade liberalization and the export-oriented industrialization (EOI) strategy based on free-market principles.

"Getting the prices right" is clearly the slogan of the day. Market reforms and trade liberalization have been the heart of stabilization and adjustment programmes supported by IMF and the World Bank in developing countries. In particular, inward-looking industrialization through aid has been replaced by outward-oriented industrialization through trade. The crucial questions concern: the universality of the efficacy of free-market and free-trade principles across economies regardless of the level of industrialization and social and economic conditions; and the relative importance of trade as opposed to non-trade factors in accelerating industrialization.

Moreover, recent rapid changes in the global economic environment have considerably altered the traditional role of trade and its relative importance as an instrument to promote industrialization in both developed and developing countries. The increased globalization of production and investment lubricated by the worldwide integration of financial and capital markets raises some fundamental questions about the validity and relevance of traditional trade policy instruments which are formulated on the basis of a conceptual distinction between national firms and foreign enterprises. In developed countries, ever-increasing foreign direct investment (FDI) and on-site production, partly motivated by the desire to circumvent mounting protectionism and ensure a market share, as in the case of Japanese investments in the United States and Europe in recent years, present an alternative to trade between developed countries, and would reduce its volume. On the other hand, FDI in developing countries is often attracted by lower labour costs and access to raw materials, with a substantial part of the output being re-exported, as in the case of Japanese investments in South-East Asia, and hence may increase the volume of exports from developing countries.

More significantly, according to a recent United Nations study [1], transnational corporations, which are currently estimated to number around 37,000, accumulated more than $2 trillion* worth of foreign direct investment with the addition of $150 billion in 1992. They accounted for one third of all private-sector productive assets all over the world. Moreover, for the first time in history, foreign sales by transnational corporations reached $5.5 trillion, which exceeded total world exports of around $4 trillion in 1992. It is uncertain, however, how much of the total sales by transnational corporations outside their countries are for the domestic markets of host countries, as in the case of Japanese FDI in the United States, and how much of the sales are for re-exports, as in the case of Japanese FDI in South-East Asia. From the perspective of the corporations, FDI is an alternative to exports, but from the viewpoint of the recipient country, FDI is viewed as either a vehicle for promoting exports or for increasing production for domestic consumption. Whether trade-augmenting or domestic-consumption-augmenting, policy issues related to FDI seem to have an importance equal to, if not greater than, that of trade barriers and other trade issues.

The present chapter provides a comparative assessment of the validity and relevance of export-led industrialization strategies in selected Asia-Pacific countries and sub-Saharan African countries. In particular, the study focuses on the implications of greater reliance on market forces and the role of the State in industrialization via trade in the two vastly different contexts of the Asia-Pacific region and sub-Saharan Africa. Some major conceptual issues in trade and industrialization are examined in section B. A quantitative analysis of the relationship between trade and industrialization in the Asia-Pacific region is provided in section C. The 1975 and 1985 international input-output tables linking several Asia-Pacific developing countries with Japan and the United States through their respective import matrices are used to gauge not only the relative importance of imports and exports to industrial growth as opposed to non-trade factors such as domestic markets, import substitution and technological change, but also the extent of external interindustry linkages and economic interdependence achieved in this region. A similar problem in sub-Saharan Africa is dealt with in section D, but with less quantitative analysis because of limited data. The study concludes with trade and industrial policy implications of empirical findings and possible lessons for sub-Saharan Africa from the Asia-Pacific experience.

*1 trillion = 1,000 billion.

B. Conceptual issues

1. The market and the State

The relationship between trade and industrialization has been a topic of intense debate, often charged with ideological passion, in the literature of development economics for the several decades. It is beyond the scope of this study to provide a comprehensive survey of a voluminous literature on the subject.* Instead, the study will focus on a balanced analysis of selected key issues in trade and industrialization, and derive their policy implications.

Within the last decade, the dominant thinking in development economics focused on the central role of the State in economic development and a widespread acceptance of the managed and even planned economy has been replaced by the supremacy of the "neoclassical school", with greater reliance on market forces and consequent economic and trade liberalization. In the earlier decades, from the 1950s to 1970s, the strong role of the State in the process of economic development was predicated on the theory of market failures and externalities. The case for the free market system as a means of achieving the dynamic optimal allocation of resources and welfare maximization under a set of restrictive assumptions can be hardly disputed. Above all, the market provides a decentralized and efficient system of coordinating and reconciling millions of decisions taken daily by countless economic agents in an economy. Guided by the "invisible hand" of self-interest, the market imparts stimulus to growth and technical change through incentives and flexibility, and leads to a harmony between the pursuance of individual self-interest and collective social welfare, while ensuring a fairly close relationship between costs and prices, that is, a competitive equilibrium price is equal to marginal cost and average cost. It is not difficult to see why Adam Smith, in his classic book *The Wealth of Nations* envisioned the role of the State narrowly confined to defence, law and order, provision of public goods and enforcing competition. The remaining vast area of economic affairs is left to the guidance of *laissez-faire* or free market forces.

It is equally evident, however, that certain preconditions have to be met for the price mechanism to achieve the optimal dynamic resource allocation and production. As cogently explained by Scitovsky [4], they include complete and functioning markets, which entails: perfect information and resource mobility with numerous economic agents, none of which is big enough to influence prices and conditions in all markets whether product, labour, financial or capital markets; an absence of economies of scale; and complete tradeability. Obviously, these preconditions rarely exist in reality. In fact, there are many so-called specific "market failures" and externalities which may result in a socially suboptimal allocation of resources in the absence of corrective polices. Many different forms of market failure could be identified. An often-cited example is labour market distortions resulting from labour training externalities. Namely, the benefit of labour training cannot be appropriated by the firm, since trained labour may move to other firms after a period of training. This may cause firms to invest in training less than at the socially desired level. There are also legally imposed or institutional barriers to perfect functioning of the labour market, such as a minimum wage or the bargaining power of trade unions, keeping urban and industrial wages higher and their employment lower than would be in the absence of such barriers. Second, there are informational and technological externalities associated with activities of entrepreneurs related to the development of new techniques of production or exploration of new markets whose benefits can accrue to other entrepreneurs at no cost, and hence may force them to underinvest and underproduce. Third, in case of scale economies, the firm produces at the point where price equals average costs, but is less than marginal costs, thus producing less than at the socially optimal level. Fourth, financial and capital markets are inadequately developed to induce long-term industrial investment in many countries, and particularly in developing countries.*

It is against this backdrop of hotly debated market imperfections that the Latin American structuralists and other development economists emerged in the 1950s, beginning with the works of Prebisch [6], Singer [7] and Hirschman [8]. Among other things, they emphasized structural rigidities and institutional barriers preventing the smooth functioning of free market systems. Public intervention is, therefore, required to remove these bottlenecks and create an environment conducive to the perfect functioning of free market systems. Such public intervention was justified particularly at the initial stages of industrialization where market imperfections can be more pervasive than at later stages of development characterized by greater economic integration.

The structuralist's advocacy of the active role of the State in initiating and accelerating industrialization in the 1950s and 1960s had given rise to an avalanche of neoclassical reactions culminating in the recent dominance of neoclassical thinking firmly embedded in free market principles, free trade and minimum public intervention. The theory of development economics which was constructed around active State intervention was attacked on various fronts. Most of all, the neoclassical critique argues that market distortions *per se* do not provide the rationale for State intervention, even if the sources of such distortions are identified and their quantitative importance can be gauged, tasks which are extremely difficult to perform. The representative view of the new neoclassical school is that public intervention not only fails to correct market distortions, but also would exacerbate the problem. In short, government failures are worse than market failures [9], [10]. Moreover, public intervention would create breeding grounds for rent-seeking activities or "directly unproductive profit-seeking" activities in Bhagwati's terms [11]. Namely, seeking government favours and competition for government contracts and other largesse will distort normal economic activity, which will lead to the suboptimal allocation of resources.

The crux of the issue surrounding the controversy on the State versus the market between traditional development economists and neoclassical followers seems to lie in the ability of the State to "get things right" and bring

*For extensive references to the literature, see H. Pack [2], G. K. Helleiner [3]; and papers presented at the World Institute for Development Economics Research (WIDER) Conference on Trade and Industrialization Reconsidered, held at Ottawa from 5 to 7 September 1990.

*For a more complete discussion on the subject, see Dani Rodrik [5].

about structural change by intervention. The neoclassical critique shows profound distrust in active public policy to correct market failures, while development economists have implicitly assumed the unlimited capacity of the State to direct the development process. In many cases, development economists correctly pinpointed the causes of underdevelopment, but contributed little in the way of explaining how, when and where to intervene, or developing a coherent theory of policy intervention valid for diverse economic and social conditions.

Empirical evidence on the relationship between active State intervention and economic development is not conclusive. On one hand, there are a few economies like that of Hong Kong which has thrived on the relatively *laissez-faire* free markets and free trade regimes. On the other hand, there are a number of success stories as well as failures associated with active State intervention in the economy. Today few doubt that many of the successful East and South-East Asian industrialized countries and areas such as Japan, the Republic of Korea, Taiwan Province and most of the ASEAN countries were strongly interventionist. In particular, at the early stages of industrialization in the 1960s and 1970s, the Republic of Korea heavily supported export industries through export subsidies and other financial incentives, while shielding these industries from foreign competition in the domestic markets where their products were allowed to be sold at prices higher than world market prices. In fact, Amsden [12] argues that the relative prices were manipulated on purpose to shift resources to the key targeted sectors. This is a direct contradiction of the principle of "getting prices right".

The scope for intervention seems to depend on the stages of industrialization at which a given economy finds itself. Based on his study of European industrialization, Gerschenkron argued long ago that the nature and extent of State intervention would change at different stages of industrialization. At the initial stage, where there are no functioning markets, the State has to engage in pump-priming to mobilize resources to create an environment conducive to the smooth functioning of market systems [13]. On the other hand, as the economy advances along the trajectory of industrialization, and its structure becomes more complex and sophisticated, the task of selective policy intervention aimed at specific sectors becomes increasingly difficult to implement without unforeseen distortions in other sectors. In the advanced stages of industrialization, the role of the State will be highly restricted to establishing and maintaining a competitive environment for private enterprise, and the resource allocation will be primarily guided by price signals and market incentives.

One important intervention at the initial stage of industrialization is public investment in infrastructure for transport, communication and utilities, and institution-building for the development of an indigenous business class, educational and legal systems and financial and capital markets. Infrastructure and institution-building would be a precondition for building the industrial supply capacity. A correct price signal alone may not be sufficient to induce and enhance industrial supply capacity without adequate physical and social infrastructure and institutions. In this regard, it must be emphasized that public investment should be viewed as complementary to private investment, since the availability of adequate infrastructure services may be a necessary condition for inducing private capital investment, whereas public investment may "crowd out" private capital and raise interest rates in industrialized countries with well-developed infrastructure and other supporting systems.

State intervention is obviously not a panacea for extricating the economy from the vicious circle of underdevelopment. As correctly pointed out by the neoclassical school, there are many historical cases where bad government prescriptions have proven to worsen the disease that they attempted to cure. Yet, there are also a number of success stories of active government intervention in the development process, particularly in East Asia.* The question is not whether State intervention *per se* is good or bad, but what matters is the nature and quality of intervention. In the final analysis, there is no better alternative to the free market and free trade to stimulate and sustain industrialization and economic growth. As emphasized earlier, "getting prices right" alone is not enough to set in motion the market forces in many developing countries. Many structural and institutional barriers or market failures have to be removed before free market principles could be applied. Perhaps, the State alone may be a sole economic agent to carry out the task of laying down the foundation for the working of capitalism in the early stages of industrialization. However, the outcome of such intervention will depend critically not only on the strong political commitment to reforms, but also on the objective of intervention, for instance, the development of an inward- or outward-oriented economy, and above all on the capability of the State to initiate and guide structural transformation leading to the functioning of free markets. In the past, active policy interventions in most East Asian countries were targeted at the creation of competitive export industries and an outward-oriented economy after the initial phase of import substitution. This process was considerably facilitated by two factors: the political commitment to change; and the existence of efficient government machinery which is capable of overriding the pressure of vested interest groups and of disciplining various economic actors to implement technocratic policies. In many other developing countries, State intervention was equally active, but failed often by misdirecting efforts at an unsustainable strategy such as inward-looking industrialization compounded by the problem of relatively weak government capacity and lack of political commitment to pursue a coherent policy.

2. *Trade regime and industrialization*

It is evident from the foregoing discussion that the nature and extent of State intervention should differ substantially, depending on the kind of industrial strategy and trade regime adopted. For instance, an ISI strategy by nature relies on market restriction to protect domestic industries from external competition, and hence the nature of State intervention has an anti-export bias. On the other hand, EOI may require the kind of State intervention that facilitates the transformation of protected domestic industries into competitive export industries. Therefore, incentive structures and implications for rent-

*For a recent comparative study on pervasive government intervention in five Asian countries, Indonesia, Malaysia, Republic of Korea, Singapore and Thailand, see Yuen, N. F., S. Sudo and D. Crone [14].

seeking activities of special interest groups are likely to differ markedly for both strategies.

The order of the day is undoubtedly EOI strategy. It must be noted, however, that export promotion usually means manufactured exports, excluding exports of primary products. It is well known that raw materials exports could not provide a viable growth strategy, because of low price and income elasticities of demand for primary goods relative to manufactured goods. Commodity exports may not only be subject to a frequent boom-bust cycle characterized by violent price fluctuations, but also their export revenues may fall short of manufactured import bills in the long run. Worse yet, any productivity increase in raw materials would depress world commodity prices instead of generating income and employment gains in the producer country.* This study is mainly concerned with manufactured exports, and hence exports hereafter refer to manufactured exports rather than exports in general, unless otherwise specified.

In recent years, attention has been increasingly focused on the link between exports and industrialization in the light of recent export-led success stories in East Asia. The favourable effects of EOI strategy are numerous and discussed extensively in the literature. They include, among other things, promoting efficient resource allocation, exploiting economies of scale, removing foreign exchange constraints, stimulating competition, generating production externalities (such as the creation of new skills and technological upgrading), facilitating technology transfer, limiting the use of quantitative restrictions, removing the distortions of economic incentives caused by such restrictions, and above all, faster productivity growth.

It seems, however, that the link between exports and productivity is central to the EOI strategy. Manufactured exports may increase industrial productivity from three possible sources. The first source is productivity gains resulting from improved resource allocation. Exports and foreign competition could force a resource transfer from less productive sectors to more productive ones. The second source of industrial productivity growth consists in an improvement in technical efficiency, involving a potential output increase for the same inputs. The third source of industrial productivity increase linked to manufactured exports is through lifting scale efficiency, that is, a potential efficiency gain in production resulting not only from greater capacity utilization in industries where the minimum efficiency size is large relative to the domestic market, but also from moving the optimum scale itself from one level to another as exports expand.

Empirical evidence seems to suggest that industrial performance is likely to be affected by trade more through allocative efficiency than through technical efficiency, particularly at the early stages of an export orientation ([15], [16]). However, as a country advances along the path of EOI strategy, the potential efficiency gain from reallocating disequilibrium factor markets will rapidly diminish, and any further gain in real income has to come from improved technical efficiency or total factor productivity growth, as in the case of the East Asian countries. In short, export-led industrial growth from better allocation of resources may be limited to its early stages of export orientation, and further sustained growth must be driven by productivity growth or improved technical efficiency. However, empirical evidence is not conclusive on whether export orientation would generate greater productivity growth than import substitution [17].

The process of trade-induced technical change in the manufacturing sector is not well understood and a better understanding of the process is often hindered by the concept of a mythical representative firm, as described in traditional economic theory. In reality, efficient and innovative firms are distributed unevenly across all industries, and the distribution of such firms will determine the technical efficiency of the industry in question, and not vice versa. In this regard, it has been suggested that an export orientation may facilitate the exit of inefficient firms and the growth of efficient firms through exposure to external competition, which will lead to improvements in the general level of technical efficiency and reductions in the across-the-firms dispersion in technical efficiency, but the patterns of exit and entry of firms are not clearly associated with trade orientation [18]. Ultimately, industrial productivity and not trade *per se* will serve as an engine of growth in the long run, and how trade will affect industrial productivity beyond the initial stimulating effects of resource reallocation is not yet well understood.

It is widely accepted that certain preconditions need to be established before launching an EOI strategy. Above all, export supply capabilities could be built up by providing a period of protection for so-called "infant industries" in the domestic market. Almost every successful exporter started with import substitution of light consumer goods. The rationale for the infant industry argument is that the period of protection is provided to increase technical efficiency and improve the competitive edge in the world market. It is based on the premise that it is worth taking the risk of "getting prices wrong" through tariffs, other protections, and domestic price controls temporarily in order to reap the dynamic benefits of the production externalities associated with economies of scale, learning by doing, and other elements of productivity growth. The key element in the infant industry argument is a relatively quick transition of protected industries producing for the domestic market to exports, supported by the political will to phase out protection for laggards, once production externalities and learning-by-doing potentials are exhausted or substantially reduced. Otherwise, the strategy of infant industry protection is doomed to failure through perpetuating the production inefficiency of protected industries. The cost of protracted protection could be indeed considerable in terms of artificially high profits maintained for the protected firms, higher costs of local inputs induced by the higher costs of imported inputs, and higher production costs associated with a lower scale of production for small domestic markets, apart from social and political implications of encouraging unproductive rent-seeking activities.

The Republic of Korea is often cited as a successful example of selective protection and promotion of infant industries and subsequent rapid transformation of these industries to export capabilities with interventionist tariffs and export subsidies. Such a transformation in the

*This is part of the so-called Singer-Prebisch thesis, which argues that primary product-exporting developing countries have been experiencing a systematic deterioration in their terms of trade, and have had to export increasing amounts of primary products to import the same amount of manufactured goods from developed countries. This was considered to be one of the major causes for economic stagnation in developing countries (see Prebisch [6] and Singer [7]).

Republic of Korea in a relatively short period of time was possible because of the existence of a skilled labour force and rapid capital accumulation embodying the leading edge of world technology, and most important of all, the capacity of the State to discipline and lead the private sector toward export promotion. The experience of the Republic of Korea may not provide a good model for other countries, if the competent stewardship of Government over the private sector does not exist. However, it points among other factors to the crucial importance of the dedication and commitment of the State to economic development and its capacity to guide structural transformation from protected ISI strategy to a more open EOI strategy at the initial stages of industrialization. In particular, it seems essential to have a better understanding of the political economy of protection and how the administrative capacity to design and implement export-targeted policy interventions is developed.

It is argued that trade-related reforms, and particularly import liberalization, are necessary conditions for export promotion because producers will not be induced to compete in foreign markets while protected domestic markets offer them assured profits. There is no empirical support for this argument. In Sierra Leone and many other African countries import liberalization was introduced in 1980s, but abandoned soon after a surge of imports for which foreign finance could not be found [19]. This is a typical problem encountered when a small undiversified economy with a small manufacturing base liberalizes trade. What is needed most before undertaking trade-related reforms at the early stages of industrialization is the build-up of supply capability. The conventional wisdom is that import substitution preceded export promotion to develop supply capability, which underpins strong growth of manufactured exports in the long run. In fact, it may be logical to introduce import liberalization except for imported inputs only after domestic supply capability is sufficiently developed and a successful export drive is launched. Perhaps the deliberate managed pace of import liberalization in step with the export drive as opposed to a so-called big-bang approach to trade liberalization may warrant serious consideration. Well after an export base is firmly anchored, managed trade liberalization may be achieved through a combination of time-phased relaxation of import controls, selective opening of domestic markets for foreign suppliers, rationalizing the tariff structure, establishing a realistic exchange rate, more transparent effective protection via tariffs rather than quantitative restrictions etc. In this manner, a foreign exchange squeeze could be avoided by the use of growing export revenues to pay for the increasing imported inputs needed for the export drive.

On the other hand, the Big-Bang approach to trade reform may establish the overall credibility of the reform programme and lay the foundations for sustained growth at the early stages of development. However, the success of such a radical approach may depend not only on the political commitment to undertake drastic reforms, but also on the ability of the bureaucracy to formulate and implement the reform programme as well as the availability of an adequate industrial supply capability. For most developing countries with a relatively narrow manufacturing base, the radical approach may run the risk of severe balance-of-payment deficits and macroeconomic problems such as hyperinflation due to a limited domestic supply capability. The export responses of an economy with a limited manufacturing capacity to real exchange rate changes would obviously be almost nil.

The first necessary step in the EOI strategy appears to be the development of export supply capabilities even before considering trade reform. Price signals such as realistic exchange rates favouring production for export are necessary but insufficient for building an export base. The basic conditions for rapid industrialization must be laid down first. They include many interrelated factors which are not directly related to trade and precede the design of a policy framework for export promotion. For instance, the basic physical infrastructure—transport, communication, water, gas, electricity etc.—is essential for manufacturing. On the intangible side, human capital accumulation and skill development through education and training along with the development of an entrepreneurial class are equally, if not more, important. Closely related to human capital development is a concomitant development and continuous upgrading of technological absorptive capacity to assimilate the latest technology, and product design capacity through institution-building for science and technology. Institution-building should also include a key element of development, namely the development of efficient public administration along with a corps of competent technocrats.

The initial task of building human capital, physical infrastructure, and economic and social institutions, often from scratch as in the case of many African developing countries, is undoubtedly a daunting and time-consuming process. The development of social overheads, institutions and human resources is precisely the area where market failures exist, and efficient State intervention rather than non-intervention may be called for. However, a large number of developing countries and particularly those at the initial stages of industrialization may lack the administrative capacity to mobilize resources and direct human and physical capital formation and institution-building to underpin a manufacturing capacity, and at the same time create an environment favourable for a well-functioning price mechanism.

A partial solution to this problem may be the development of manufacturing industry through FDI. The increasing importance of FDI *vis-à-vis* trade has been already underscored earlier. FDI could bring with it not only necessary technical know-how along with foreign capital and inputs, but also export marketing capability. Unlike primary commodities, manufactured exports depend not only on price competitiveness and world-standard product quality, but also the ability to seek potential export markets, and to design and target the product for such markets. FDI may facilitate the process of export market penetration as well as initial import substitution for domestic markets.

Leaving aside the problem of providing adequate financial and fiscal incentive packages, many developing countries may find it difficult to attract FDI, unless adequate infrastructure is already put in place and a reasonably skilled cheap labour force is readily available. The analysis thus goes back to the starting-point, namely the crucial importance of human capital formation and infrastructure building. However, an additional critical factor for inducing FDI, which is often left out of the analysis, is the lack of a legal system protecting ownership rights, enforcing contractual obligations, granting recourse against abuses, and guaranteeing the repatriation of profits. The absence of a legal framework required to establish sound business conditions is today a major stumbling-block deterring foreign investments in the new States that emerged from the former USSR, despite the availability of a skilled labour force and basic infrastructure.

It must be cautioned, however, that FDI is not a panacea for rapid industrialization. Foreign firms do bring in with themselves skills, capital, technology and marketing capability, but they cannot by themselves override the more dominant effects of macroeconomic and microeconomic mismanagement. Moreover, given the potential shortcomings of foreign ownership (such as exploitation, causing pollution and many other types of behaviour contrary to the interests of a host country), the benefits of an alternative to FDI should also be assessed. For instance, foreign capital and inputs could be imported through loans, technology acquired through licences and marketing capability built through marketing consultancy, while avoiding FDI and foreign ownership, as was done by Japan from 1950 to 1970.

Once the conditions for industrial supply capability are established through skill development, social and economic infrastructure, and macroeconomic stabilization as appropriate, export promotion measures could be carefully selected and machinery for implementing them be developed. Among many export incentive schemes are preferential export financing, fiscal and investment incentives, export processing zones, bonded warehouses and factories, duty drawbacks and tax rebates on imported inputs, new export credit, preshipment financing, export credit guarantees, establishment of an export-import bank etc. Meanwhile, protection measures designed for initial import substitution and particularly for infant industries should be streamlined and rationalized. Preferably, quantitative restrictions should be replaced by tariffs, since quantitative restrictions supplant the price mechanism, and yield an economic rent to the winner of an import quota or licence, thus further encouraging rent-seeking activities and possible corruption, while tariffs are transparent and revenues go to the Government. However, it takes more than the transparency and rationality of the structure of trade incentives to build an export base. What is needed here is the stability and predictability of incentive schemes over time, with ad hoc measures and frequent amendments kept to a minimum. A stable and predictable policy environment is required to elicit individual responses to trade incentives. As discussed earlier, once export competitiveness is established, most incentive schemes could be dismantled.

It seems apparent from the foregoing discussion that a proper sequencing of various policy reforms is critically important to the EOI strategy. At the risk of oversimplification, the following reform sequence may be suggested. First of all, apart from the crucial importance of basic infrastructure, the overall manufacturing production capacity must be developed before building up export supply capabilities. It is based on the hypothesis that industrial supply capacity would lead to the export capability and not vice versa. If this is the case, at the early stages of industrialization, the role of manufactured exports as an instrument to accelerate industrialization becomes less important than non-trade policy measures such as selective industrial targeting and encouragement of infant industries, those designed to strengthen intersectoral linkages between manufacturing and agriculture, and between manufacturing and services, backward and forward linkages within the manufacturing sector, rural industrialization etc. Export supply capabilities should be built up after a reasonably broad industrial base is developed. At this juncture, macroeconomic stability may be necessary to create a favourable macroeconomic environment for rapid industrial growth. Therefore, macroeconomic stabilization should precede structural reforms including trade reforms. Moreover, import liberalization should be introduced well after the upsurge of exports. Finally, the liberalization of capital markets should come after trade reforms in order to gain some degree of control of an international capital flow, which is essential to an orderly transition to an export-oriented economy and stability in financial and capital markets.

It is true that each export success story, particularly in East Asian countries, has more to do with unique country experiences than general characteristics of trade policy and reforms, and hence may not provide lessons for other developing countries. Nevertheless, it seems reasonable to deduce and generalize a different set of optimal policies for each stage of industrialization from a broad spectrum of country experiences of both success and failure. At the embryonic stage of industrialization, the State could speed up the growth process through direct resource allocation and other selective interventions as long as it uses market prices as a planning guide. As an economy grows and becomes more complex, it should be guided increasingly by market forces, and the role of Government should be reduced to infrastructure and institution-building. Once a firm manufacturing base is developed, the State could help the private sector to build a beachhead for manufactured exports, initially by tariffs, export subsidies, and other export promotion schemes, and then replace them with competitive real exchange rate mechanisms once the foothold for manufactured exports is firmly established.

C. Trade and industrialization in selected Asia-Pacific economies

1. Overview

At the risk of oversimplification, the pattern of industrialization since the Second World War in Asia-Pacific developing countries could be characterized by two overlapping phases: an ISI strategy during the 1950s and 1960s, and an EOI strategy during the 1970s and 1980s. A stylized model of the sequential process of import substitution begins with the domestic production of consumer non-durable goods, followed by intermediate goods, and finally climaxed by technology- and skill-intensive capital goods.

In line with the theoretical model, the first phase of import substitution in Asia-Pacific developing countries during the 1950s and 1960s was focused on the domestic production of consumer goods protected by tariffs and other trade barriers, and exploiting a ready market created by imports. As the domestic market for consumer non-durables is quickly saturated, import substitution policy may become unsustainable and leads to various disastrous economic consequences such as chronic balance-of-payments problems, export stagnation and inefficient industries fostered by protection, to name but a few.

Emerging from the first phase of ISI strategy, the majority of Asia-Pacific developing countries embarked on the EOI strategy during the 1970s and 1980s, initially concentrating on the natural-resource-based or labour-intensive industries such as food processing, textiles and garments, rubber products and electronic goods. The salient feature of the export-driven industrialization strategy pursued by these countries is that the competitive export industry is built on foreign technology usually linked to FDI. The rapid increase in FDI is followed by a rapid increase in the imports of intermediate and capital goods from the countries providing FDI. As imports of intermediate and capital goods become essential to sustain the export-led growth, these countries launched the second phase of the ISI strategy, this time focusing first on the domestic production of technologically less demanding industrial intermediate goods, and then on the technology-intensive capital goods. The progress made in the import substitution of intermediate and capital goods varied remarkably from country to country, depending upon the stage of industrialization and technological capacity of the country in question.

At this juncture, it may be useful to distinguish between two types of secondary import substitution; namely, import substitution strategy linked to import requirements of the export drive, and import substitution for self-sufficiency and independence from foreign suppliers. A good illustrative example of the latter is the policy switch from a relatively outward-oriented development to an inward-looking strategy of domestic production of machinery and equipment for self-sufficiency introduced in Brazil in 1974, and later in Mexico and Argentina. The apparent failure of secondary import substitution for self-sufficiency seems to be evident by the fact that most Latin American countries have today abandoned such a strategy, and switched back to an export-oriented strategy. Moreover, industrialized countries have moved away from the self-reliance on capital goods and more towards intra-industry specialization or increasing international specialization within the capital goods sector to open up export opportunities in recent decades. The reasons for the failure to achieve a self-reliant capital goods sector are not difficult to find. Most of all, an industrialization strategy which protects domestic industries from international competition, and hence suppresses the inflow of foreign capital goods, tends to run the risk of becoming a technological laggard by delinking itself from the rapidly changing technological world outside. Such a policy is likely to breed inefficient industries at the expense of efficient ones behind a high wall of protection. Also, secondary import substitution for self-sufficiency may not lessen the country's dependence on foreign technology, since emerging protected industries themselves require more imported investment and intermediate goods. In short, the protected industries may remain permanently behind in terms of competitiveness and technological capability in the world markets.

By contrast, under the secondary import substitution linked to the export drive, it is imperative to manufacture products, be it industrial materials, parts, components, or machinery, which are comparable in quality to the imported ones, and equal or cheaper to produce if the industries are to remain competitive in the world markets. Many empirical studies point to significant substitution elasticities for both imported machinery and intermediate inputs in developing countries.* Obviously, the extent to which imported goods could be substituted varies substantially from product to product and from country to country. Moreover, it is often difficult in practice to draw a clear-cut line between inward-oriented and outward-oriented strategies, since many countries tend to produce certain products not only for exports, but also for the expanding domestic market, as in the case of automobile production in the Republic of Korea.

Simultaneous expansion of exports and imports not only resulted in a drastic shift in the structure of imports from consumer goods to intermediate and capital goods, but also export-induced secondary import substitution strategy brought about a fundamental change in the structure of production and the nature of interindustry linkages in these countries. This study attempts to delineate and analyse the export-induced structural change and the relative importance of trade as opposed to non-trade factors in industrial growth in the selected Asia-Pacific economies, using 1975 and 1985 international input-output tables for selected economies of the Asia-Pacific region, constructed by the Institute of Developing Economies in Tokyo, with the collaboration of the countries and areas concerned. The countries and areas chosen for the study were China (1985 only), Indonesia, Japan, Malaysia, Philippines, Republic of Korea, Singapore, Taiwan Province (1985 only), Thailand and United States. Each country table with its own import matrix is aggregated to facilitate a cross-country and intertemporal comparison.

2. *Trade and industrial performance by region from 1960 to 1990*

The Asia-Pacific region has been the most rapidly growing region of the world in terms of both trade and industrial output in the last decade. For instance, table III.1 shows that South and South-East Asia (which includes the Indian Subcontinent) and China outpaced all other regions of the world by a considerable margin in both total exports and total imports from 1980 to 1990, while many developing regions such as Latin America, Africa and Western Asia suffered a standstill or negative growth rate of exports and imports. Economic stagnation and import compression caused by debt problems encountered in Africa and Latin America in the last decade may underlie such negative growth rates. Meanwhile, the share of South and South-East Asia in world manufactured exports soared from 3.27 per cent in 1970 to 12.73 per cent in 1989, while that of Africa remained virtually unchanged at an insignificant level of around 0.4 per cent, and that of Latin America marginally improved from 0.98 per cent to 1.89 per cent (table III.2). MVA also mirrored the same pattern. MVA in East and South-East Asia (excluding the Indian Subcontinent) grew at a far faster rate of 8.5 per cent per year than the 1.1 per cent recorded in Latin America or the 1.8 per cent in Sub-Saharan Africa, while the Indian Subcontinent

*For an extensive empirical test of substitution elasticities, see Hentschel [20].

showed the second-highest growth rate at 5.6 per cent from 1980 to 1990 (table III.3). Perhaps the most revealing indication is purchasing power indices of exports as given in table III.4, which will have a direct effect on the import capacity of a country to import intermediate inputs and capital goods required for industrial production and exports. The purchasing power of exports from South and South-East Asia more than doubled between 1980 and 1990. By contrast, the purchasing power of exports from Africa declined by about 23 per cent, and that of Latin America also fell slightly during the same period.

Table III.1. Annual average growth rates of exports and imports, 1960-1990
(Current prices)

Economic grouping and region	Exports (f.o.b.) 1960-1970	1970-1980	1980-1990	Imports (c.i.f.) 1960-1970	1970-1980	1980-1990
World	9.2	20.3	6.0	9.1	20.2	6.0
Developed market economies	10.0	18.8	7.7	10.2	19.5	7.2
North America	8.7	17.0	5.9	10.9	19.1	8.0
Europe	10.1	19.3	8.2	9.7	19.5	7.4
Japan	17.5	20.8	8.9	14.4	22.0	5.1
Eastern Europe and former USSR	8.7	18.0	2.3	8.1	18.3	3.0
Developing market economies	7.2	25.9	2.2	6.5	23.8	3.1
Africa	9.2	21.7	-3.7	4.7	22.2	-1.9
North Africa	11.5	23.9	-4.5	2.9	25.6	-1.9a/
Sub-Saharan Africa	7.8	20.0	-3.0	6.2	20.1	-3.0a/
Asia	7.7	30.1	3.6	7.0	26.9	5.7a/
Western Asia	9.3	34.3	-6.8	7.4	33.6	-2.7a/
South and South-East Asia	6.7	25.8	10.8	6.9	23.5	9.6a/
China	1.3	20.0	12.8	1.9	23.5	13.5
Latin America	5.0	20.8	0.8	5.6	20.6	-1.3

Source: *Handbook of International Trade and Development Statistics 1991* (United Nations publication, Sales No. E/F.92.II.0.6), tables 1-5 and 1-6.
a/ 1980-1988.

Table III.2. World share and annual growth rates of manufactured exports in current prices by region, 1970, 1980 and 1989

Economic grouping and region	Manufactured exports 1970 (million dollars, f.o.b.)	1980	1989	World share 1970 (percentage)	1980	1989	Annual growth rate 1970-1980 (percentage)	1980-1989
World	189 913	1 085 122	2 106 523	100.00	100.00	100.00	19.04	7.65
Developed market economies	160 352	892 656	1 640 399	84.43	82.26	77.87	18.73	6.99
Europe	103 690	586 866	1 045 133	54.60	54.08	49.61	18.93	6.62
North America	36 598	169 133	309 653	19.27	15.59	14.70	16.54	6.95
Japan	17 870	122 711	264 500	9.41	11.31	12.56	21.25	8.91
Eastern Europe and former USSR	18 032	77 920	91 547	9.49	7.18	4.35	15.76	1.81
Developing market economies	10 455	105 041	344 243	5.51	9.68	16.34	25.95	14.10
Africa	841	3 821	8 879	0.44	0.35	0.42	16.34	9.82
Asia								
Western Asia	464	6 422	16 339	0.24	0.59	0.78	30.05	10.93
South and South-East Asia	6 208	72 153	268 234	3.27	6.65	12.73	27.80	15.71
Latin America	1 855	15 844	39 741	0.98	1.46	1.89	23.92	10.76

Source: See table III.1.

Table III.3. World share and annual growth rates of MVA by region, 1970, 1980 and 1990

Economic grouping and region	World share 1970	1980 (percentage)	1990	Annual growth rates 1970-1980	1980-1990 (1990 dollars)
World	100.00	100.00	100.00	3.10	2.10
Developed market economies	67.40	72.20	75.40	2.50	1.70
North America	31.01	26.80	26.40	2.80	1.30
Western Europe	28.10	33.50	31.90	1.90	1.20
Japan	7.30	11.00	16.20	3.30	3.50
Eastern Europe and former USSR	22.30	14.00	10.60	5.90	2.70
Developing market economies	6.40	11.00	12.40	7.10	3.90
Africa					
North Africa	0.20	0.30	0.30	5.40	5.20
Sub-Saharan Africa	0.20	0.30	0.30	6.00	1.80
Asia					
Western Asia	0.40	0.90	1.70	6.00	4.30
Indian Subcontinent	0.60	0.50	0.50	3.40	5.60
East and South-East Asia	0.80	2.20	4.10	11.50	8.50
Latin America	3.80	6.00	4.90	6.40	1.10
China	3.90	2.90	1.70	1.60	4.80

Source: UNIDO database.

Table III.4. Purchasing power indices of exports, 1960-1990 (1980 = 100)

Economic grouping and region	1960	1970	1975	1981	1985	1990
Developed market economies	28	66	80	100	119	168
Developing market economies	21	37	64	103	90	113
Africa	23	47	64	85	74	61
North Africa	15	38	57	85	72	59
Other	30	56	70	84	77	63
Asia	14	26	61	106	88	129
Western Asia	8	16	64	103	53	53
South and South-East Asia	23	40	56	110	138	241
Latin America	42	64	74	110	109	106

Source: See table III.1.

3. *A change in the structure of trade from 1975 to 1985 in selected Asia-Pacific countries*

The recent publication of the 1985 international input-output table for Asia-Pacific economies coupled with the same table for 1975 makes it possible to gauge a change in the structure of trade and particularly external industrial linkages which had occurred between 1975 and 1985 in those economies. Such changes in the patterns of trade in selected Asia-Pacific economies are summarized in the following tables.

Table III.5 shows a change in the degree of trade dependency in these economies during the period in question. Trade dependency as measured by imports plus exports as a percentage of GDP is remarkably high, and increased markedly between 1975 and 1985 in Malaysia, Republic of Korea, Singapore and Thailand. Trade dependence in Japan and the United States is considerably lower and remained unchanged during the period. It is also worth noting that exports as a percentage of GDP have substantially increased, while the import share either remained the same or slightly declined in all economies examined here except for Malaysia and Thailand, which recorded a substantial increase in the ratio of imports to GDP.

Table III.6 shows sectoral shares of imports and exports in 1975 and 1985. As expected, manufacturing claims a lion's share of both imports and exports, followed by services as a distant second in all countries and areas in both 1975 and 1985. A major exception is exports from Indonesia, dominated by its oil sector.

Table III.7 summarizes the structure and origin of imports. Above all, the results show an asymmetry in the pattern of total imports between developing and developed countries. In particular, a preponderant share of total imports in ASEAN countries and the Republic of Korea originates from Japan, the United States and the rest of the world, primarily Western Europe, but Japan and the United States import mainly from developed countries, with a relatively much smaller share of their total imports, less than 10 per cent, from ASEAN countries. This lopsided pattern changed little between 1975 and 1985. It is worth noting, however, that intra-ASEAN imports, although still relatively small, increased considerably during the period. Also, the intermediate imports accounted for 50 to 90 per cent of total imports across the countries compared, and the share of intermediate imports increased markedly at the expense of imports of final goods for all developing countries compared except for Indonesia. Dependence on imported inputs in production, as measured by intermediate imports as a percentage of intermediate input uses, varied remarkably among countries, ranging from around 6 per cent in the United States to over 50 per cent in Singapore. All developing countries appear to be highly dependent on imported inputs in contrast to Japan and the United States, but their importance declined somewhat during the period, as their intermediate imports from the rest of the world, mainly Western Europe, remained at a high level of over 50 per cent of total intermediate imports in most countries. Intra-ASEAN intermediate imports also increased sharply in most countries except for Indonesia, but a similar intensification of intra-ASEAN trade was not observed in the case of final goods imports.

Table III.5. Trade dependency in selected Asia-Pacific countries and areas, 1975 and 1985

Country or area	Year	Trade[a] as percentage of GDP	Imports as percentage of GDP	Exports as percentage of GDP
Indonesia	1975	40.39	15.41	24.98
	1985	38.82	15.08	23.74
Malaysia	1975	71.95	33.89	38.07
	1985	97.39	43.21	54.19
Philippines	1975	35.92	21.73	14.18
	1985	40.03	17.46	22.57
Republic of Korea	1975	62.50	36.78	25.72
	1985	67.85	32.78	35.07
Singapore	1975	184.55	116.67	67.88
	1985	325.57	115.16	120.12
Thailand	1975	34.63	19.76	14.87
	1985	44.47	26.97	28.60
Japan	1975	26.82	13.20	13.62
	1985	26.46	11.20	15.26
United States	1975	17.20	8.83	8.37
	1985	16.69	10.00	6.69
China	1985	26.12	14.76	11.37
Taiwan Province	1985	101.67	40.52	61.15

Sources: International Input-Output Table for ASEAN Countries 1975 (Tokyo, Institute of Developing Economies, March 1982); and *Asian International Input-Output Table 1985* (Tokyo, Institute of Developing Economies, September 1992).

[a] Combined imports and exports.

The shares of export markets for selected Asia-Pacific economies in 1975 and 1985 are given in table III.8. Japan was by far the most important country for exports in 1975, but in 1985 its importance sharply declined for many developing countries, such as Philippines, Republic of Korea, Singapore and Thailand. In a similar vein, the importance of the United States as the second most important export market for Asia-Pacific developing countries diminished during the period. By contrast, the collective shares of exports to the rest of the world, mainly Western European countries plus Taiwan Province and Hong Kong, were equally significant, and increased steeply during the period in most countries except for Indonesia and Malaysia, which implies a considerable diversification of export markets for these countries.

Table III.9 shows the structure of imports and exports by broad industry group in selected Asia-Pacific countries and areas in 1975 and 1985. As expected, the capital goods industry represents the largest share of total imports closely followed by industrial materials in all the countries and areas, except for Japan and Singapore, where the latter imports were greater. The combined share of the two ranged between 50 and 70 per cent of total imports. By contrast, imports by the primary goods sector were relatively insignificant, accounting for less than 6 per cent, and its share further declined between 1975 and 1985 in most cases. Imports by the service sector were quite considerable, and roughly equal to the import share of light manufacturing in most countries.

The structure of exports as given in table III.9 varied greatly from country to country. In the developed economies of Japan and the United States, exports from the capital goods industry claimed a lion's share, and exports from the service sector ranked second. By contrast, Indonesian exports were dominated by the primary goods sector, namely oil. In the rest of the developing economies except Singapore, exports from light manufacturing industry were most dominant, but its importance declined sharply between 1975 and 1985 except for Thailand, while capital goods and services maintained a sizeable share of total exports. Moreover, in NICs such as Republic of Korea, Singapore and Taiwan Province, the share of exports from the capital goods industry tend to be considerably larger than that of other developing economies in the region.

4. *Imports and interindustry linkages*

A common measure of interindustry linkages is the traditional output multiplier, which is merely the column sum of the Leontief inverse matrix. The output multiplier represents the cumulative input requirements from other sectors and the given sector, resulting from a unit increase in final demand for the output of that sector. There are many variations of backward and forward linkage indices, such as the pioneering work of Hirschman [8] and others developed by Rasmussen [21], Cella [22], Park [23], Park and Chan [24] and Clements and Rossi [25].

Aggregate multipliers for 10 countries are calculated and presented in table III.10. They are the average of all sectoral output multipliers, namely $\Sigma\Sigma r_{ij}/n$, where r_{ij} are elements of the Leontief inverse. They represent the total value of production required from all sectors through the successive rounds of interindustry transactions to deliver one unit value of uniformly distributed final demand, that is, with equal weight assigned to each element of the final demand vector. Therefore, any value exceeding unity by this measure shows the extent of interindustry transactions required to deliver one unit increase in final demand, and hence the extent of interindustry linkages [26].

In table III.10 the first column is derived from the inverse matrices of 24 sectors including imported inputs. These multipliers capture the extent of overall interindustry relations implied by the underlying production technology, and hence represent potential rather than actual linkages. The second column shows domestic multipliers calculated from the input-output matrices net of imported inputs. They represent the extent of linkages

Table III.6. Sectoral share of imports and exports in selected Asia-Pacific countries and areas, 1975 and 1985

Country or area	Year	Total imports[a]						Total exports[a]					
		001	002	003	004	005	006	001	002	003	004	005	006
Indonesia	1975	0.73	0.59	64.99	1.13	14.66	17.91	7.81	67.04	12.33	-	-	12.81
	1985	1.61	1.40	64.64	0.39	9.69	22.28	6.72	55.00	23.88	-	-	13.40
Malaysia	1975	6.47	1.02	77.43	0.68	3.87	10.53	2.77	0.60	93.28	-	-	3.34
	1985	3.62	-0.74	65.06	2.11	10.08	19.86	8.89	21.18	52.94	0.01	-	16.98
Philippines	1975	3.38	0.45	89.81	0.30	2.29	3.78	27.18	14.18	58.11	0.01	-	0.52
	1985	3.08	1.52	66.20	1.19	1.75	26.25	6.87	3.13	46.80	-	1.74	41.46
Republic of Korea	1975	2.43	0.57	85.36	3.43	1.47	6.75	6.78	0.82	82.68	-	-	9.72
	1985	1.27	-0.31	86.17	1.40	1.65	9.81	1.60	0.17	75.59	0.09	0.62	21.93
Singapore	1975	2.81	0.02	82.76	0.89	3.25	10.28	0.91	0.09	91.05	0.01	-	7.95
	1985	1.19	0.02	82.08	0.13	3.96	12.63	0.40	0.18	73.93	0.38	0.01	25.10
Thailand	1975	3.06	2.04	80.32	0.37	4.77	9.45	16.05	1.61	57.91	0.19	-	24.23
	1985	5.20	0.57	69.52	1.19	3.70	19.82	8.39	1.09	59.13	0.01	-	31.39
Japan	1975	2.57	-0.68	76.76	4.39	1.50	15.46	0.38	0.05	78.66	0.01	-	20.90
	1985	1.46	0.34	73.11	7.43	1.67	15.98	0.25	0.04	81.93	0.05	-	17.73
United States	1975	4.31	1.16	61.48	1.68	7.43	23.94	10.59	1.85	61.67	0.20	-	25.68
	1985	1.39	0.78	74.29	1.45	2.64	19.45	6.02	2.29	63.11	0.26	0.02	28.29
China	1985	4.29	0.72	80.97	0.25	8.66	5.10	13.18	6.18	59.62	0.01	-	21.02
Taiwan Province	1985	0.88	1.78	80.55	2.69	0.71	13.38	2.13	0.15	85.34	0.01	-	12.38

Source: See table III.5.

[a] 001 - agriculture; 002 - mining; 003 - manufacturing; 004 - electricity, gas and water; 005 - construction; 006 - services.

based on domestic industrial production capacity. The last column shows the ratios of the domestic to the total multipliers, indicating the extent of overall domestic self-sufficiency in production, the complement of this ratio being construed as the extent of overall import dependence in production.

Total multipliers in the first column show considerable variations across countries and over time in some developing countries. In 1975 multipliers for Japan and the United States and for relatively more industrialized developing countries such as the Republic of Korea and Singapore are considerably greater than those for the rest of the sample group, that is, Indonesia, Malaysia, Philippines and Thailand. However, interindustry linkages implied by the multiplier in Indonesia, Malaysia and Thailand sharply increased and almost caught up with the former group between 1975 and 1985, reflecting rapid export-led industrialization in these countries during that period.

On the other hand, the domestic multipliers in most developing economies as shown in the second column are considerably lower than their total multipliers, except for China, showing a substantial gap between potential and actual output. The implication is that these developing economies built up an export-based industrial structure nearly comparable to that of developed countries like Japan, and the United States, heavily relying on imported inputs as shown in the domestic total ratios in the third column. For instance, import leakages of the output multiplier in Taiwan Province and the Republic of Korea were slightly over 20 per cent. It is well known that these economies vigorously pursued an export-led growth strategy with mounting imports of intermediate and capital goods financed by rapidly rising export earnings. Particularly, import dependence on intermediate goods is very high in Singapore, accounting for almost half of the potential output. The expected result occurred, given the nature of the relatively small entrepôt economy of Singapore, where the bulk of products is imported, processed and re-exported. By contrast, such import dependence in China was very low, at less than 10 per cent in 1985. The relatively low import dependence in China may reflect its emphasis on heavy industries and the consequent broadening of its industrial base at an early stage of development, which is typical of the growth path of most centrally planned economies. However, in the light of economic liberalization, an emphasis on light manufacturing and export promotion policies initiated since 1985, more recent data for China may show a greater gap between potential and actual output than was shown in 1985.

As expected, the United States and Japan showed the strongest domestic linkages with low import dependence, and the extent of domestic linkages slightly increased between 1975 and 1985. The result is not surprising, since these countries grew rapidly after the Second World War, and the interindustry network of production and trade was firmly in place by 1970.

Table III.7. Structure of imports in selected Asia-Pacific countries and areas, 1975 and 1985
(Percentage)

		Total imports (TM)					Intermediate imports (MI)							Final demand imports (MF)						
Country or area	Year	ASEAN	Republic of Korea	Japan	United States	Rest of world[a]	MI/M[b]	TMI/TIP[c]	ASEAN	Republic of Korea	Japan	United States	Rest of world[a]	MF/M[d]	MF/TF[e]	ASEAN	Republic of Korea	Japan	United States	Rest of world[a]
Indonesia	1975	10.47	0.71	33.98	14.16	40.68	60.56	20.14	12.24	1.00	37.60	11.81	37.35	39.44	6.52	7.75	0.27	28.42	17.76	45.80
	1985	6.77	1.50	18.74	12.08	60.91	63.21	15.07	7.98	1.91	21.66	13.60	54.85	36.79	6.00	4.70	0.80	13.72	9.46	71.32
						(4.24)							(4.91)							(3.09)
Malaysia	1975	12.34	0.47	18.12	9.56	59.51	52.99	24.77	12.97	0.50	18.03	7.42	61.08	47.01	15.78	11.62	0.43	18.23	11.97	57.75
	1985	19.11	1.90	17.92	12.31	48.76	74.77	33.79	19.58	1.84	18.07	8.44	52.06	25.23	11.71	17.71	2.10	17.46	23.74	38.98
						(5.55)							(4.69)							(8.11)
Philippines	1975	3.11	0.24	25.92	21.55	49.17	57.24	18.60	3.81	0.29	21.19	17.07	57.64	42.76	8.66	2.19	0.18	32.26	27.54	37.83
	1985	11.01	3.32	7.74	16.55	61.38	66.38	17.18	11.93	3.24	8.18	19.71	56.94	33.62	6.08	9.20	3.47	6.87	10.31	70.15
						(11.57)							(13.84)							(7.10)
Republic of Korea	1975	4.84	-	32.34	25.37	37.45	76.62	23.37	5.96	-	28.38	25.43	40.23	23.38	7.79	1.18	-	45.30	25.15	28.36
	1985	6.92	-	24.34	20.20	48.54	81.97	22.53	9.07	-	21.01	18.69	51.23	18.03	5.82	-2.85	-	39.46	27.07	36.31
						(2.30)							(2.22)							(2.63)
Singapore	1975	14.77	0.60	13.77	13.14	57.72	71.51	51.21	17.15	0.58	12.95	8.86	60.46	28.49	27.20	8.80	0.65	15.84	23.87	50.83
	1985	17.58	1.36	13.55	11.56	55.94	76.53	52.98	19.64	1.16	10.44	8.74	60.02	23.47	26.75	10.86	2.02	23.68	20.78	42.66
						(13.36)							(13.87)							(9.93)
Thailand	1975	3.21	0.89	29.24	5.70	60.96	57.25	16.67	2.00	0.95	28.30	5.67	63.08	42.75	7.96	4.83	0.82	30.51	5.73	58.11
	1985	12.49	1.67	22.19	9.08	54.57	63.60	19.65	16.47	2.06	17.69	7.35	56.43	36.40	9.65	5.53	1.00	30.06	12.10	51.31
						(5.57)							(6.08)							(5.16)
Japan	1975	8.54	2.30	-	17.58	71.57	87.88	9.39	9.24	1.56	-	16.28	72.93	12.12	1.60	3.49	7.69	-	27.06	61.77
	1985	11.31	2.66	-	16.24	69.79	84.89	9.22	12.73	2.10	-	14.60	70.56	15.11	1.75	3.30	5.79	-	25.47	65.45
						(6.81)							(6.07)							(10.98)
United States	1975	3.21	1.07	9.53	-	86.19	61.92	6.24	3.71	0.92	9.13	-	86.25	38.08	3.34	2.39	1.32	10.20	-	86.09
	1985	3.59	2.49	17.08	-	76.84	48.46	5.86	4.76	1.89	11.78	-	81.57	51.54	4.98	2.49	3.05	22.06	-	72.40
						(7.18)							(4.92)							(9.31)
China	1985	2.27	-	32.66	10.49	41.74	53.52	7.68	3.58	-	26.16	9.83	52.80	46.48	6.45	0.75	-	40.15	11.25	28.99
Taiwan Province	1985	5.39	0.76	21.38	18.33	52.77	76.81	22.90	6.10	0.58	19.37	17.26	55.54	23.19	11.02	3.08	1.35	28.05	21.87	43.60

Sources: See Table III.5.

[a] Numbers in parentheses represent a combined share of Hong Kong, Taiwan Province and China.
[b] MI/M - intermediate imports as percentage of total imports.
[c] TMI/TIP - intermediate imports as percentage of total intermediate purchases.
[d] MF/M - final demand imports as percentage of total imports.
[e] MF/TF - final demand imports as percentage of total final demand.

Table III.8. Export markets for selected Asia-Pacific countries and areas, 1975 and 1985
(Percentage)

Country or area	Year	ASEAN	Republic of Korea	Japan	United States	Rest of the world[a/]
Indonesia	1975	7.27	2.36	40.28	27.75	22.35
	1985	6.66	2.83	45.52	21.63	23.36
						(3.33)
Malaysia	1975	9.98	2.74	7.96	21.83	57.49
	1985	18.10	6.22	22.92	13.50	39.25
						(3.42)
Philippines	1975	1.75	1.09	42.43	23.89	30.83
	1985	5.46	1.45	16.35	29.10	47.65
						(2.79)
Republic of Korea	1975	2.38	-	29.34	27.71	40.58
	1985	3.32	-	12.41	30.87	53.40
						(0.57)
Singapore	1975	22.27	0.31	13.44	17.14	46.84
	1985	15.59	1.06	7.11	19.73	56.53
						(2.14)
Thailand	1975	9.80	1.77	26.41	8.01	54.01
	1985	7.10	1.28	9.39	13.39	68.83
						(3.63)
Japan	1975	7.48	3.52	-	18.72	70.53
	1985	4.99	3.57	-	33.33	58.11
						(9.47)
United States	1975	2.13	1.48	9.16	-	87.23
	1985	2.74	2.27	9.12	-	85.86
						(3.36)
China	1985	8.21	-	18.64	11.39	61.76
Taiwan Province	1985	4.18	1.12	8.82	44.13	39.61

Sources: See table III.5.

a/ Numbers in parentheses represent the combined share of China and Taiwan Province.

5. *Structural change*

There is no standard measure against which to gauge structural change over time in a given country. The most serious problem encountered in developing such a measurement method is the nonexistence of an ideal norm against which actual performance could be compared. In the field of development economics, the notion of optimal structure of production of an economy is not only conceptually elusive, but also may vary in time and place as a result of a shift in the international division of labour and comparative advantage, thus making its empirical measurement extremely difficult.

In the absence of a commonly used method, an ad hoc approach based on certain "heroic assumptions" will be used. In particular, assuming that the structures of production implied in the 1985 table of input-output coefficients for Japan and the United States approximate to a desired, if not ideal, form of industrial structure, Japanese and United States coefficients in 1985 are alternatively used as a benchmark against which those in other countries may be compared. The evaluation criterion used for this purpose is the inequality coefficient,* that is, $u = [\Sigma_i\Sigma_j(a_{ij}-a^b_{ij})^2/\Sigma_i\Sigma_j(a^b_{ij})^2]^{1/2}$ where, a^b_{ij} is an input coefficient of the benchmark economy selected, and a_{ij} is an input coefficient of an economy being compared to it.

*For a detailed explanation of the use of the inequality coefficient method, see H. Theil and others [27].

The inequality coefficients of the manufacturing sector and the entire economy for the selected countries and areas of the Asia-Pacific region in 1975 and 1985 are given in table III.11. They provide an overall indication of how close the structure of production of a given economy in a given year came to that of the benchmark economy in 1985. It is obvious that the closer the structure of production of an economy examined to that of a benchmark economy, the smaller the coefficient is, and it becomes zero if the two are identical in the extreme case.

Although Japan and the United States are perhaps the most technologically advanced large economies in the world, the structural characteristics of the two economies are fundamentally different in many respects. For instance, the Japanese economy is poor in natural resources and relatively trade dependent, whereas the economy of the United States is endowed with abundant resources, and hence less trade-dependent than Japan, as shown in table III.5. As a result, the inequality coefficient of a country is expected to differ considerably, depending on the benchmark economy selected for measurement.

The numerical results shown in table III.11 have various implications. When measured against the structure of the Japanese economy, two NICs, namely, the Republic of Korea and Taiwan Province, yielded markedly smaller inequality coefficients than their ASEAN counterparts, Indonesia, Malaysia, Philippines and Thailand, excluding Singapore. The inequality coefficients for the Republic of Korea and Taiwan Province ranged between 0.50 and 0.56 per cent for the economy as a whole, and between

Table III.9. Structure of imports and exports by broad industry group in selected Asia-Pacific countries and areas, 1975 and 1985
(Percentage)

		Total imports							Total exports						
Country or area	Year	Amount (million dollars)	Primary goods [a]	Light manufacturing [b]	Industrial materials [c]	Capital goods [d]	Utilities and construction [e]	Services [f]	Amount (million dollars)	Primary goods [a]	Light manufacturing [b]	Industrial materials [c]	Capital goods [d]	Utilities and construction [e]	Services [f]
Indonesia	1975	5 049	1.32	15.28	9.07	40.64	15.79	17.91	8 185	74.85	2.42	8.59	1.32	.	12.81
	1985	13 244	3.00	8.63	17.67	38.33	10.08	22.28	20 852	62.72	9.21	10.77	3.90	.	13.40
Malaysia	1975	2 754	7.49	18.57	20.02	38.85	4.55	10.53	3 093	3.37	30.20	28.82	34.27	.	3.34
	1985	13 003	2.89	14.82	14.82	35.42	12.19	19.86	16 308	30.70	14.06	17.38	21.50	0.01	16.98
Philippines	1975	3 435	3.82	17.69	29.91	42.21	2.59	3.78	2 241	41.36	48.16	3.78	6.17	0.01	0.52
	1985	5 275	4.60	13.16	29.74	23.31	2.95	26.25	6 819	10.00	21.67	4.23	20.91	1.74	41.46
Republic of Korea	1975	7 396	2.99	24.45	28.29	32.62	4.90	6.75	5 171	7.60	44.03	9.61	29.04	.	9.72
	1985	29 709	0.96	15.52	33.37	37.29	3.06	9.81	31 786	1.78	27.11	11.12	37.36	0.71	21.93
Singapore	1975	5 967	2.82	13.04	39.92	29.80	4.14	10.28	3 472	1.00	7.42	56.11	27.51	0.01	7.95
	1985	19 793	1.21	8.35	42.75	30.97	4.08	12.63	20 646	0.58	6.42	36.91	30.60	0.40	25.10
Thailand	1975	3 371	5.10	11.51	26.97	41.84	5.14	9.45	2 537	17.66	40.16	7.61	10.14	0.19	24.23
	1985	9 833	5.77	12.97	22.65	33.90	4.90	19.82	10 425	9.47	37.52	8.44	13.16	0.01	31.39
Japan	1975	65 920	1.89	20.68	38.77	17.32	5.89	15.46	67 995	0.43	5.32	11.07	62.27	0.01	20.90
	1985	148 480	1.80	16.69	33.84	22.59	9.11	15.98	202 304	0.29	3.40	7.57	70.97	0.05	17.73
United States	1975	133 520	5.47	15.07	14.66	31.76	9.11	23.94	126 554	12.45	6.85	11.76	43.05	0.21	25.68
	1985	394 727	2.18	13.70	15.22	45.37	4.09	19.45	264 304	0.29	3.40	7.57	70.97	0.05	17.73
China	1985	43 055	5.02	14.05	8.17	58.74	8.91	5.10	33 157	19.36	29.61	13.61	16.40	0.01	21.02
Taiwan Province	1985	23 831	2.66	16.50	26.95	37.10	3.41	13.38	35 968	2.27	28.17	10.46	46.70	0.01	12.38

Sources: See table III.5.

Note: For industrial classification, see annex III.

[a] Primary raw materials, 001-007.

[b] Light manufacturing, 008-010.

[c] Industrial materials, 011-015.

[d] Capital goods, 016-019.

[e] Utilities and construction, 020-021.

[f] Services, 022-024.

Table III.10. Aggregate output multipliers in selected Asia-Pacific countries and areas, 1975 and 1985

Country or area	Year	Output multiplier[a/] Total linkages[b/]	Output multiplier[a/] Domestic linkages[c/]	D/T[d/] (percentage)
China	1985	2.0449	1.8929	92.57
Indonesia	1975	1.6697	1.3994	83.81
	1985	1.8191	1.5312	84.17
Japan	1975	2.3144	2.0292	87.68
	1985	2.3236	1.9618	88.23
Malaysia	1975	1.7784	1.4262	80.19
	1985	1.9936	1.4720	73.84
Philippines	1975	1.8791	1.5574	82.88
	1985	1.8652	1.5689	84.11
Republic of Korea	1975	2.1443	1.6530	77.09
	1985	2.1539	1.7156	79.65
Singapore	1975	2.5145	1.4864	59.11
	1985	2.5546	1.4213	55.64
Taiwan Province	1985	2.3105	1.7895	77.45
Thailand	1975	1.7863	1.5161	84.87
	1985	1.9677	1.6176	82.21
United States	1975	2.1322	1.9764	92.70
	1985	2.0881	1.9542	93.59

Sources: See table III.5.

a/ Average of sectoral multipliers, that is, $\sum_i \sum_j r_{ij}/n$, where r_{ij} is an element of the Leontief inverse.

b/ Calculated from total (domestic plus imported) input coefficients.

c/ Calculated from domestic input coefficients only.

d/ Ratio of domestic to total output multiplier.

0.39 and 0.53 for the manufacturing sector, whereas the coefficients for the ASEAN member countries ranged between 0.7 and 1.0 for both measures. This result is not surprising in view of the rapid industrialization achieved by the Republic of Korea and Taiwan Province, relying heavily on Japanese capital goods and industrial technology.

However, when the structural characteristics of these two most successful exporters of East Asia were compared to those of the United States, their inequality coefficients jumped by more than 50 per cent in most cases, and the gaps between these NICs and the ASEAN countries were remarkably reduced, although their inequality coefficients were still smaller than those of the ASEAN countries. This discrepancy may be explained by the fact that the Republic of Korea and Taiwan Province are densely populated and resource-poor like Japan, and resemble Japan more than the United States in terms of their human capital base as well as various social, cultural, economic and institutional factors that shape the industrial structure. By contrast, the ASEAN countries, Indonesia, Malaysia, Philippines and Thailand, are richly endowed in natural resources like the United States, and their economies are still considerably resource based. However, if a similar comparison is made using the more recent data of the years since 1985, during which all these South-East Asian countries, except for the Philippines, have enjoyed faster growth than anywhere else in the world, the results might have shown much more rapid structural change in these countries.

In this regard, it is worth noting that the inequality coefficients of China were appreciably smaller when measured against the United States as a benchmark economy than when compared against Japan. The result was expected, since China is more similar to the structure of the United States economy than to that of Japan in many respects, given its abundant resource endowments and its immense population size and area.

Compared with other NICs, in particular the Republic of Korea and Taiwan Province, the structure of production in Singapore deviated most from that of Japan or the United States as measured by the inequality coefficient. This result also seems plausible, given the special characteristics of the island entrepôt economy of Singapore, with its critical dependence on foreign trade. For instance, in 1988, exports and imports as a percentage of GDP in Singapore were 165 and 205 per cent, respectively, compared with only 13 and 9 per cent, respectively, in Japan.

Table III.11. A comparative measure of structural change in selected Asia-Pacific countries and areas relative to the industrial structure of Japan and the United States in 1985

Country or area	Year	Inequality coefficient[a] Benchmark Japan[b] Economy as a whole	Manufacturing sector	Benchmark United States[c] Economy as a whole	Manufacturing sector
China	1985	0.7274	0.6898	0.6392	0.5494
Indonesia	1975	1 0347	1.1106	0.9055	0.9228
	1985	0.9454	0.9777	0.8557	0.6089
Japan	1975	0.3191	0.2403	0.7293	0.6319
	1985			0.6620	0.6223
Malaysia	1975	0.8471	0.9156	0.9530	0.9669
	1985	0.8056	0.8839	0.7597	0.6848
Philippines	1975	0.7879	0.7495	0.8492	0.7804
	1985	0.8183	0.8307	0.9111	0.8499
Republic of Korea	1975	0.5644	0.5388	0.7577	0.7191
	1985	0.5350	0.4836	0.7816	0.6795
Singapore	1975	0.8183	0.8307	0.9111	0.8499
	1985	0.6545	0.6403	0.7758	0.7177
Taiwan Province	1985	0.5080	0.3907	0.7905	0.6274
Thailand	1975	0.7292	0.7529	0.8571	0.8026
	1985	0.7382	0.7422	0.7844	0.7389
United States	1975	0.6877	0.6804	0.3416	0.3092
	1985	0.6304	0.5696		

Sources: See table III.5.

[a] $u = [\sum_i \sum_j (a_{ij} - a_{ij}^b)^2 / \sum_i \sum_j (a_{ij}^b)^2]^{1/2}$, where a_{ij} is an input coefficient of a sample country, and a_{ij}^b is an input coefficient of the benchmark economy in 1985.

[b] Input coefficients of Japan, 1985 used as a benchmark.

[c] Input coefficients of the United States, 1985 used as a benchmark.

More importantly, a substantial portion of the exports of Singapore consists of re-exports of a wide variety of products ranging from sophisticated electronic goods, such as integrated circuits and computer peripherals, colour television sets and videotape recorders, to industrial raw materials such as rubber and plywood.*

It is not surprising to find that structural change in both Japan and the United States was the most rapid among the sample group as measured by the inequality coefficient, which was reduced by 0.32 per cent for the economy-wide measure and 0.24 per cent for the manufacturing sector for Japan, and by 0.34 and 0.31, respectively, for the United States between 1975 and 1985, when each was measured against its own benchmark. However, when each of the two advanced economies was measured against the benchmark of the other, their inequality coefficients sharply increased to the range of 0.6 to 0.7, a magnitude comparable to those of many developing countries in the region. This may imply that both countries had undergone massive industrial restructuring during the period from 1975 to 1985, and this change was reflected in a substantial reduction of the inequality coefficient when each was measured against its own structure of the economy in 1985. But when compared against each other, these two economies were so vastly different that the structural characteristics of the two economies still remained highly dissimilar in many respects, despite the extensive industrial restructuring that occurred in both countries during the period.

Finally, the results on the whole show a significant gap in the structural balance between developed and developing economies in the region both in 1975 and 1985, if the model of industrialization in Japan and the United States is assumed to be the pattern. This particular assumption may admittedly be open to question.

*For instance, the total exports of Singapore amounted to 87,116 billion Singapore dollars in 1989, of which re-exports accounted for 37 per cent and domestic exports the rest. Refined fuels accounted for about a quarter of domestic exports. In fact, Singapore has become the world's third-largest oil-refining centre, although it does not itself produce any crude oil [28].

6. *A decomposition analysis of the sources of industrial growth*

The purpose of this section is to estimate the relative contribution of various sources of growth to sectoral output growth and particularly the effect of exports on industrial output growth. The analytical method used here is an input-output growth accounting method, and a full description of the decomposition method is given in annex I to the present chapter.* The changes in sectoral output between 1975 and 1985 were decomposed into the four sources of growth, namely, (1) final demand, (2) final demand import substitution, (3) exports and (4) technical change and input import substitution. It was mathematically intractable to separate the effect of technical change from that of input import substitution in the last term. Prior to decomposition, the 1975 international input-output tables were deflated to the 1985 prices. A detailed description of the sectoral deflators used in this study is also given in annex II.

Before turning to empirical results, some of the limitations associated with the applications of the method presented above must be considered. First, the estimate is devoid of any causal relationships by nature of the identity relation. The technique is useful in disaggregating the past output growth into its different components, but it fails to offer any explanations as to why a given component, for example, exports, is the dominant factor in explaining actual output changes in a given country. Nevertheless, the technique helps to identify the areas in which the explanations can be sought. Second, the technique is not stochastic in form, and hence it is not valid for econometric projections; the procedure can be used only to analyse the *ex post facto* performance. Third, the conclusions drawn from a decomposition analysis are valid only for the particular time period chosen and the level of industry disaggregation used. An alternative set of these parameters may produce different results and perhaps variant conclusions. Lastly, the demand-side decomposition is partial and needs to be complemented by the supply-side decomposition to obtain a more complete picture of the growth process.

Table III.12 summarizes the overall decomposition of the five sectoral output changes of the selected Asia-Pacific countries into the four effects—final demand, final demand import substitution, exports, and technical change and input import substitution combined between 1975 and 1985.

Obviously, factors affecting the growth of the manufacturing sector are of crucial importance to a study of industrialization. The manufacturing sector was the fastest-growing sector during the period from 1975 to 1985, accounting for the largest share of total output change in all the sample countries with the exception of the United States: 31 per cent for Indonesia; 44 per cent for Japan; 40 per cent for Malaysia; 38 per cent for the Philippines; 51 per cent for the Republic of Korea; 49 per cent for Singapore; 41 per cent for Thailand and 33 per cent for the United States. Among the four factors affecting the growth of manufacturing output, final demand effect was the strongest in all countries, except for Singapore, where exports dominated final demand. In particular, the relative importance of domestic markets for manufactured goods was more pronounced in developed countries such as Japan and the United States, and also in some developing countries such as Indonesia, all amounting to over 90 per cent, while the percentage contribution of final demand to manufacturing output in more successful exporters in the rest of the group was considerably lower, all below 80 per cent.

Despite the primary importance of the domestic market, manufactured exports were clearly shown as the second most important contributing factor to the growth of manufacturing output in all sample countries. The exports share of manufacturing output growth was nearly 15 per cent in Indonesia, 25 per cent in Japan, 50 per cent in Malaysia, 21 per cent in the Philippines, 34 per cent in the Republic of Korea, 83 per cent in Singapore, 29 per cent in Thailand and 12 per cent in the United States. The empirical results seem to confirm the crucial role of manufactured exports in accelerating industrialization among most successful export-oriented economies such as Japan, Malaysia, Republic of Korea, Singapore and Thailand. Moreover, the effect of final demand may have been overestimated and that of manufactured exports underestimated, since the strong output multiplier effect of manufactured exports on domestic demand is not properly taken into account in the numerical results.

The effect of import substitution of final manufactured products was negative in all countries, and relatively weaker than the effects of overall final demand and exports, but its strength varied considerably among the countries compared. Negative import substitution may imply a decrease in demand for domestic manufactured goods in favour of imported goods because of import liberalization. A negative import substitution effect was relatively significant in Singapore (–22 per cent), Malaysia (–16 per cent), Thailand (–12 per cent), and the United States (–11 per cent), whereas the same effect was relatively weaker in Indonesia (–9 per cent), Republic of Korea (–6 per cent) and Japan (–3 per cent).

The last source of growth corresponds to the net effect of the two types of change, namely the changes in domestic input-output coefficients and changes in the import matrix of intermediate goods. The changes in the import matrix of inputs are brought about by imports of new inputs as well as the domestic substitution of imported inputs as manifested in local contents programmes pursued in many Asia-Pacific developing countries. The changes in domestic input-output coefficients are basically caused by changes in production technology, as well as by substitution among various inputs, often induced by changes in relative prices. The two effects are closely interrelated and difficult to separate algebraically one from the other, as discussed earlier. The combined effects of technical changes and import substitution of inputs varied in positive and negative signs among countries, and are generally small, less than 10 per cent in most cases, with the exception of Japan, perhaps reflecting the mutual cancellation of domestic substitution of existing imported inputs and imports of new intermediate goods required by the changes in production technology.

The second most important sector in terms of sectoral output change is the service sector in all countries, with the exception of the United States, where service contribution to total output changes was greater than that of manufacturing. The service share of output contribution ranked closely behind the manufacturing sector in most

*For a comprehensive discussion of the methodology of multisector comparative analysis including input-output growth accounting, see H. Chenery and others [29], chapter 5.

countries, ranging between 30 per cent and 50 per cent. The growth of the service sector is generally predominantly influenced by the domestic market, but the effect of service exports is quite considerable in some countries such as Malaysia (23 per cent), the Philippines (22 per cent), Republic of Korea (20 per cent), Thailand (17 per cent) and particularly in Singapore, where service exports contributed to more than a half of the output growth of the sector. Apart from tourism, Singapore is a well-known centre for financial and other services as an entrêpot in the region. Other effects on service output seem to be relatively negligible.

The agricultural share of total output change amounted to less than 10 per cent in most countries, with the exception of the lesser developed countries of the sample group, namely Indonesia and the Philippines. Domestic demand was shown to be the dominant factor for changes in agricultural output. However, export effects are also quite strong in resource-rich countries such as Malaysia, Thailand and United States.

The share of mining and quarrying in total output change is insignificant, usually less than 3 per cent across countries. The major exceptions are oil-exporting Indonesia (12 per cent) and mineral-exporting Malaysia (9 per cent). As expected, the export effects dominate all other effects in Indonesia and Malaysia. Notably, the growth of the mining sector appears to be significantly affected by technological change and input imports substitution in many countries such as Indonesia, Philippines, Republic of Korea, Thailand and United States.

Table III.12. Decomposition of sources of growth in selected Asia-Pacific countries
(Percentage)

Country and sector	1975-1985 Output change (thousand dollars)	Percentage share	Decomposition: Final demand	Final demand import substitution	Exports	Technical change and import input substitution	Unexplained
Indonesia							
Agriculture, livestock, forestry	21 765 444	14.65	65.16	-2.64	10.60	27.48	-0.60
Mining and quarrying	18 224 875	12.27	10.22	0.57	64.40	22.24	3.71
Manufacturing	45 986 802	30.96	93.89	-8.60	14.87	1.16	-1.31
Electricity, gas and water supply	1 616 852	1.09	58.40	-1.59	5.81	37.89	-0.51
Construction	15 969 463	10.75	99.19	-0.33	0.77	0.38	-0.02
Services, trade and transport	44 969 672	30.28	88.60	-4.65	8.05	8.65	-0.66
Total	148 533 109	100.00					
Japan							
Agriculture, livestock, forestry	71 451 772	2.60	83.09	-3.29	13.95	6.84	-0.59
Mining and quarrying	8 008 016	0.29	104.11	-6.42	13.15	-10.26	-0.57
Manufacturing	1 209 292 571	43.99	95.52	-2.56	25.34	-17.81	-0.50
Electricity, gas and water supply	75 672 339	2.75	78.04	-0.85	7.82	15.20	-0.20
Construction	233 371 485	8.49	96.62	-0.07	0.56	2.89	-0.01
Services, trade and transport	1 151 473 969	41.88	104.44	-1.13	9.14	-12.41	-0.03
Total	2 749 270 153	100.00					
Malaysia							
Agriculture, livestock, forestry	5 568 272	9.14	68.23	-9.46	47.87	-4.57	-2.07
Mining and quarrying	5 513 079	9.05	15.70	2.96	71.68	6.86	2.80
Manufacturing	24 253 031	39.80	73.01	-15.61	49.38	-7.85	1.07
Electricity, gas and water supply	1 363 229	2.24	51.07	-3.34	12.15	40.64	-0.52
Construction	5 619 530	9.22	86.42	-0.48	2.31	12.16	-0.41
Services, trade and transport	18 625 458	30.56	72.08	-4.87	23.34	13.71	-4.27
Total	60 942 600	100.00					
Philippines							
Agriculture, livestock, forestry	9 747 478	17.34	84.15	-3.47	17.52	2.20	-0.39
Mining and quarrying	1 062 695	1.89	35.28	-1.32	24.55	38.33	3.16
Manufacturing	21 227 983	37.76	78.22	-5.31	21.44	4.10	1.55
Electricity, gas and water supply	1 345 051	2.39	68.58	-2.55	9.35	23.04	1.58
Construction	3 230 834	5.75	94.00	-0.71	4.37	2.20	0.14
Services, trade and transport	19 606 023	34.87	94.18	-6.68	21.92	-11.72	2.31
Total	56 220 064	100.00					
Republic of Korea							
Agriculture, livestock, forestry	16 907 171	8.00	64.79	-2.78	16.22	20.84	0.92
Mining and quarrying	1 553 071	0.74	24.45	4.94	13.40	57.87	-0.66
Manufacturing	108 699 867	51.45	67.80	-6.32	34.44	4.00	0.08
Electricity, gas and water supply	5 098 742	2.41	75.60	-3.58	23.27	5.01	-0.30
Construction	17 729 122	8.39	95.33	-0.17	2.31	2.60	-0.07
Services, trade and transport	61 288 871	29.01	83.00	-2.53	19.15	1.76	-1.37
Total	211 276 844	100.00					

Country and sector	1975-1985 Output change (thousand dollars)	Percentage share	Decomposition: Final demand	Final demand import substitution	Exports	Technical change and import input substitution	Unexplained
Singapore							
Agriculture, livestock, forestry	294 887	0.63	156.56	-76.77	101.68	-76.87	-4.61
Mining and quarrying	105 951	0.23	-10.56	-5.49	56.49	62.79	-3.22
Manufacturing	22 833 749	49.08	43.98	-22.46	83.49	-2.96	-2.05
Electricity, gas and water supply	835 664	1.80	21.40	-0.98	13.97	62.43	3.17
Construction	3 698 675	7.95	102.42	-0.77	4.68	-6.25	-0.08
Services, trade and transport	18 758 969	40.32	56.56	-7.67	52.71	-0.50	-1.19
Total	46 527 895	100.00					
Thailand							
Agriculture, livestock, forestry	7 670 261	10.44	87.79	-11.01	32.67	-7.92	-1.53
Mining and quarrying	1 526 561	2.08	45.28	-4.88	16.46	46.56	-3.42
Manufacturing	29 946 002	40.76	74.76	-11.95	28.88	8.14	0.24
Electricity, gas and water supply	1 988 988	2.71	66.02	-6.25	11.81	28.43	-0.02
Construction	4 743 629	6.46	101.44	-0.75	2.27	-2.94	-0.02
Services, trade and transport	27 597 336	37.56	79.11	-4.39	17.46	7.98	-0.17
Total	73 472 776	100.00					
United States							
Agriculture, livestock, forestry	190 041 744	2.60	113.90	-10.82	20.89	-24.06	0.10
Mining and quarrying	177 966 973	2.44	76.74	-6.25	10.37	19.33	-0.20
Manufacturing	2 401 566 877	32.88	109.68	-10.93	12.26	-11.22	0.21
Electricity, gas and water supply	289 112 537	3.96	87.99	-2.82	3.16	11.63	0.04
Construction	481 189 171	6.59	104.54	-0.78	1.13	-4.89	..
Services, trade and transport	3 763 831 670	51.53	96.87	-2.76	4.15	1.79	-0.05
Total	7 303 708 972	100.00					

Sources: See table III.5.

The quantitative importance of public utilities, namely, electricity, gas and water, in total output change is very small, although essential, and its growth is strongly affected by two factors, final demand and technological change in most cases. By contrast, the share of construction in total output growth is considerably greater than that of public utilities. Since construction is basically non-tradeable, the growth of construction is expected to be little affected by exports, but predominantly determined by domestic final demand. Empirical results confirm theoretical expectations. Finally, the unexplained terms are negligible enough to be ignored in most cases.

The sources of growth at disaggregate manufacturing industry levels are graphically represented in figure III.1. The results by the broad manufacturing groups are also summarized in table III.13 to facilitate a comparative analysis. The first column in table III.13 for each industry group represents the effect of final demand, the second column that of exports, and the third the ratio of the two effects. It is evident that final demand is the largest source of manufacturing output growth and exports the second most important source across the manufacturing industries in all countries, with the important exception of Singapore. However, the relative importance of exports as opposed to final demand varies considerably across countries and among the industries compared.

In Indonesia, the export effects of both light manufacturing and capital goods are insignificant compared to the strength of its domestic market, but the exports of the intermediate goods sector, largely petroleum, timber, rubber and metal products, were shown to be a major source of growth for these industries. By contrast, exports are an important source of output growth across almost all industries in the Republic of Korea. In particular, textiles, garments and leather goods, rubber products and metal products derived output growth from abroad more than from domestic markets, while the exports of the capital goods sector were equal to about 65 per cent of its domestic market effects. It is evident that many manufacturing industries in Malaysia are export-driven, particularly intermediate goods industries and machinery industry producing mainly electronic products. Those industries whose exports are more important than the domestic market as a source of output growth are timber and wooden products, chemical, petroleum, rubber and metal products, all industrial-materials-processing industries, textiles, garments and leather goods, and the electronic goods industry. As expected, the contribution of exports to industrial output growth is less significant in the Philippines compared to more successful exporters of the region such as Malaysia, Republic of Korea and Singapore. However, a few industries, particularly textiles, garments and leather goods, metal products and machinery showed remarkably strong exports effects, almost equal to that of final demand. In Thailand, final demand dominates exports in all industries except rubber products. Exports effects are relatively strongest in the light manufacturing group and weakest in the capital goods group, and the intermediate goods group was found in between. The decomposition results obtained for Singapore are not surprising in view of the special characteristics of the island entrepôt economy as described earlier. Exports dominate domestic markets in almost all industries, and cover a wide array of products ranging from light manufacturing and industrial raw materials to sophisticated capital goods. For instance, refined fuels accounted for 41 per cent of total manufacturing output change, and more than 70 per cent of this growth was accounted for by its exports, while final demand contributed about 11 per cent. Likewise, the share of machinery industry in the total change in manufacturing output between 1975 and 1985 was around 25 per cent, and more than 100 per cent of this change was due to its exports; the domestic market contributed about a 50 per cent of its growth, while the positive effects of exports and domestic markets were partially offset by negative import substitution and technical change effects.

It is expected a priori that the larger and more developed an economy is, the less trade-dependent and more domestic-market-oriented it becomes. By and large, empirical results for the United States and Japan confirm this expectation. Domestic markets are by far more important than exports as a source of growth in most industries in both countries, with one major exception. In Japan, exports of capital goods were a major factor for the growth of that industry, amounting to more than a half of the proportion explained by the final demand factor, while exports of industrial raw materials were an important source of the growth of that industry in the relatively resource-abundant United States, with the export effect reaching about 40 per cent of the final demand effect.

Turning to the import substitution of final demand, the negative sign for this variable may imply that all the countries examined here imported more final products than were substituted for by domestic production as a result, for instance, of import liberalization, thus partially offsetting the expansionary output effects of final demand and exports described above (see table III.14). It is worth noting, however, that the negative import substitution effect varied considerably, depending on the category of manufactured goods. In general, the import substitution effects are relatively weak for light manufacturing and intermediate goods, with the exception of Singapore and the United States, but notably strong for capital goods in all countries except for Japan. Particularly, the negative import substitution effects are quite substantial for all ASEAN economies, that is Indonesia, Malaysia, Philippines, Singapore, Thailand, and to a lesser extent the Republic of Korea. This may imply that these countries imported on a large scale a wide range of capital goods to broaden an industrial base and strengthen their export capacity. By contrast, Japan is a major exporter of capital goods, and attained a high level of self-sufficiency in machinery and transport equipment. This was reflected in the negligible effect of import substitution of capital goods for Japan. Meanwhile, the significant effects for the United States may suggest that the United States economy depends substantially on imported capital goods as well as light manufacturing goods, and the relative largeness and openness of United States markets *vis-à-vis* other market economies may have contributed partly to this import pattern.

Table III.13. Comparison of the effects of final demand and manufactured exports in selected Asia-Pacific countries
(Percentage)

Country	Light manufacturing			Intermediate goods			Capital goods		
	Final demand	Exports	Exports/ final demand	Final demand	Exports	Exports/ final demand	Final demand	Exports	Exports/ final demand
Indonesia	102.60	6.41	6.25	71.35	28.64	40.14	125.84	10.24	8.14
Malaysia	85.83	25.42	29.62	57.38	61.47	107.13	86.88	64.28	73.99
Philippines	80.72	14.08	17.44	71.66	23.60	32.93	85.63	54.01	63.07
Republic of Korea	71.48	31.74	44.40	69.08	33.97	49.17	67.01	44.04	65.72
Singapore	93.88	89.61	95.45	27.63	77.34	279.91	61.40	91.93	149.72
Thailand	65.77	28.80	43.78	75.79	29.30	38.66	107.77	27.77	25.72
Japan	103.99	5.96	5.73	120.32	26.78	22.26	69.88	36.38	52.06
United States	102.60	6.41	6.25	71.35	28.64	40.14	125.84	10.25	8.14

Sources: See table III.5.

Table III.14. Effects of final demand import substitution in selected Asia-Pacific countries
(Percentage)

Country	Light manufacturing	Intermediate goods	Capital goods
Indonesia	-1.89	-4.90	-36.35
Malaysia	-7.46	-5.63	-54.27
Philippines	-2.31	-4.00	-27.47
Republic of Korea	-1.22	-4.41	-17.68
Singapore	-46.44	-8.77	-42.73
Thailand	-2.53	-13.57	-42.91
Japan	-3.14	-2.34	-2.60
United States	-10.35	-7.92	-14.83

Sources: See table III.5.

As expected, the combined effects of technical change and input import substitution showed wide variations in both signs and magnitude across the countries and among the manufacturing industries examined here. By and large, the production of intermediate goods seems to be more sensitive to these changes than light manufacturing or capital goods industries. The result is not surprising, since this variable captures the net effect of changes in the structure of inputs induced by both a change in production technology and input import substitution. The most affected industries in Indonesia are all in the intermediate goods sector, namely timber and wooden products, petroleum products and non-metallic mineral products. In the Republic of Korea, the intermediate goods industries most affected were also timber and wooden products, petroleum products and rubber products, but machinery and other manufacturing showed an appreciable positive effect, perhaps reflecting the effect of an aggressive localization programme to reduce dependence on imported inputs. In Malaysia, the industries significantly affected were non-metallic mineral products, rubber products and textiles, garments and leather goods; in the Philippines, timber and wooden products, petroleum products, transport equipment and other manufacturing; in Singapore, timber and wooden products, pulp and paper, rubber products and transport equipment; and in Thailand, paper and pulp, petroleum products, non-metallic mineral products and metal products. The most discernible effects were observed in the industrial materials industries also in Japan, namely timber and wooden products, petroleum products and non-metallic mineral and metal products, and a similar situation prevailed also in the United States, as the list is headed by metal and non-metallic mineral products, rubber products and paper and pulp.

D. Trade and industrialization in sub-Saharan Africa

The last decade was a lost decade for sub-Saharan Africa in every sense. Both exports and imports shrunk by 3 per cent per year (table III.1), real per capita GDP dropped by 2.5 per cent per year, and gross domestic investment declined by 4.3 per cent per year over the 1980s. The GDP share of gross domestic investment and domestic savings declined from 20 to 16 per cent and 22 to 13 per cent, respectively, for Africa between 1980 and 1990 ([30], tables 8 and 9). The structure of production and trade, consumption patterns, and social and economic institutions inherited from the colonial era have either changed little or worsened in the last decade in most sub-Saharan African countries. As a result, the majority of sub-Saharan African countries are still producing what is not appropriate for domestic consumption, and consuming what they do not produce. Industrialization is hampered by crushing debt burdens, the lack of efficient trade and financial institutions, and the paucity of trained and skilled labour. The structure of sub-Saharan African exports is still characterized by the preponderant share of primary commodities and concentration in a few commodities, with the lion's share of leading commodities going to a small number of countries. In nearly all cases, the share of primary commodities in total exports is extremely high, in excess of 90 per cent in most cases.

Figure III.1. Decomposition of sources of growth in manufacturing industries in selected Asia-Pacific countries, 1975-1985

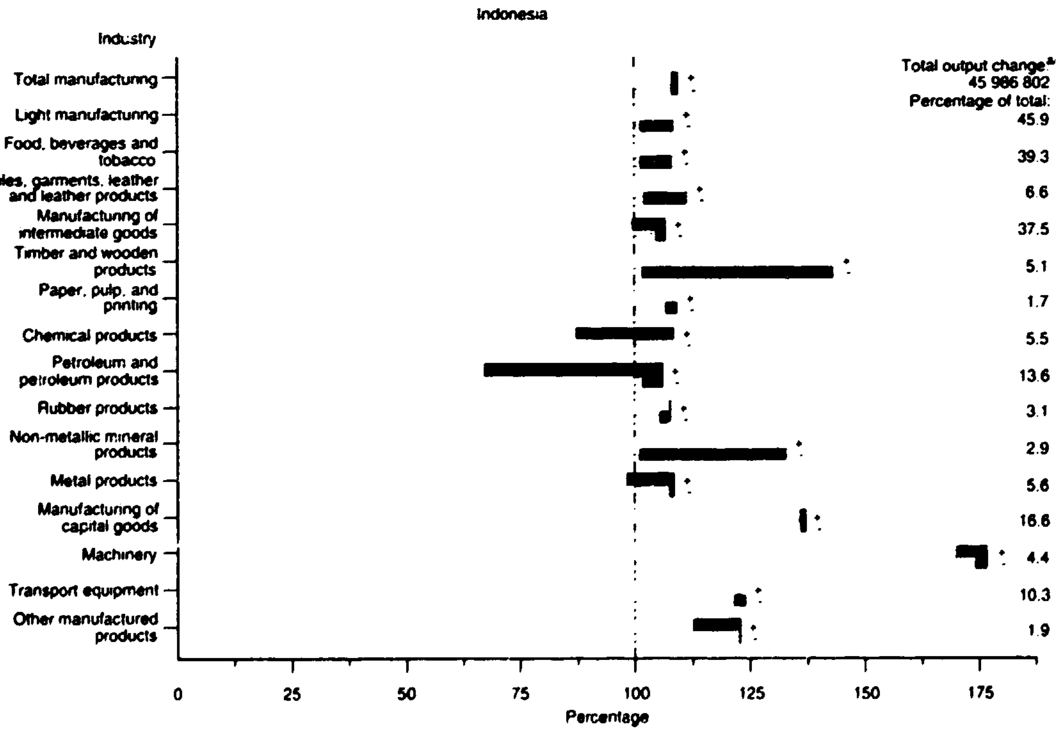
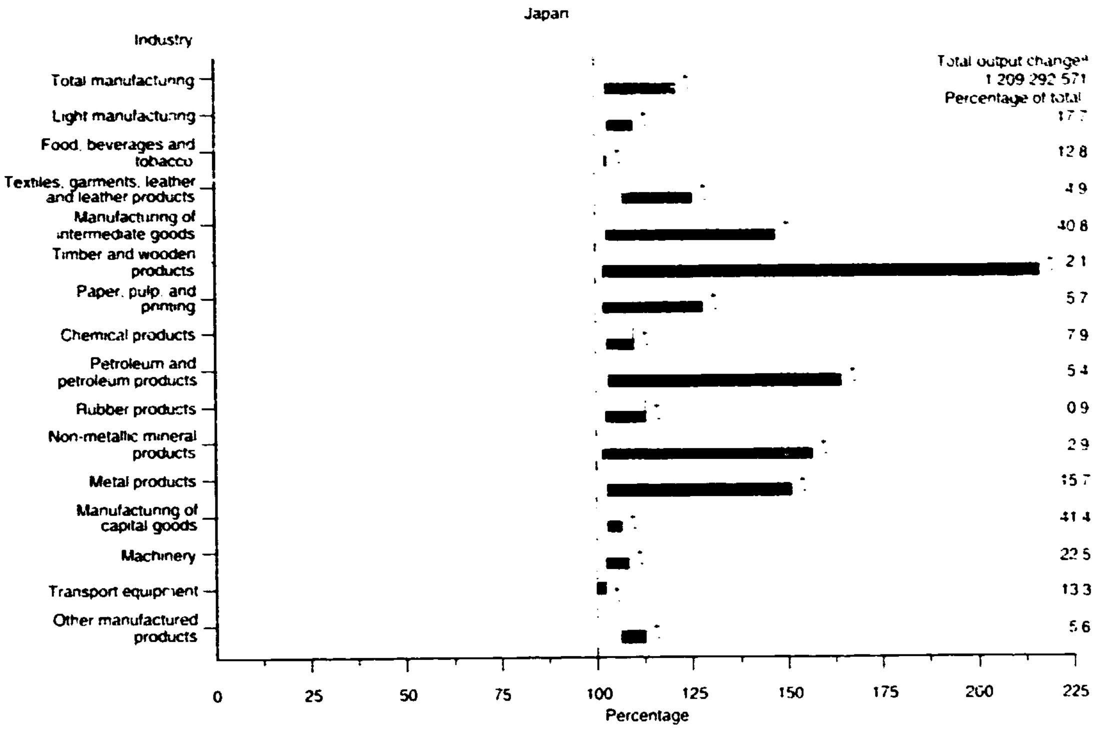
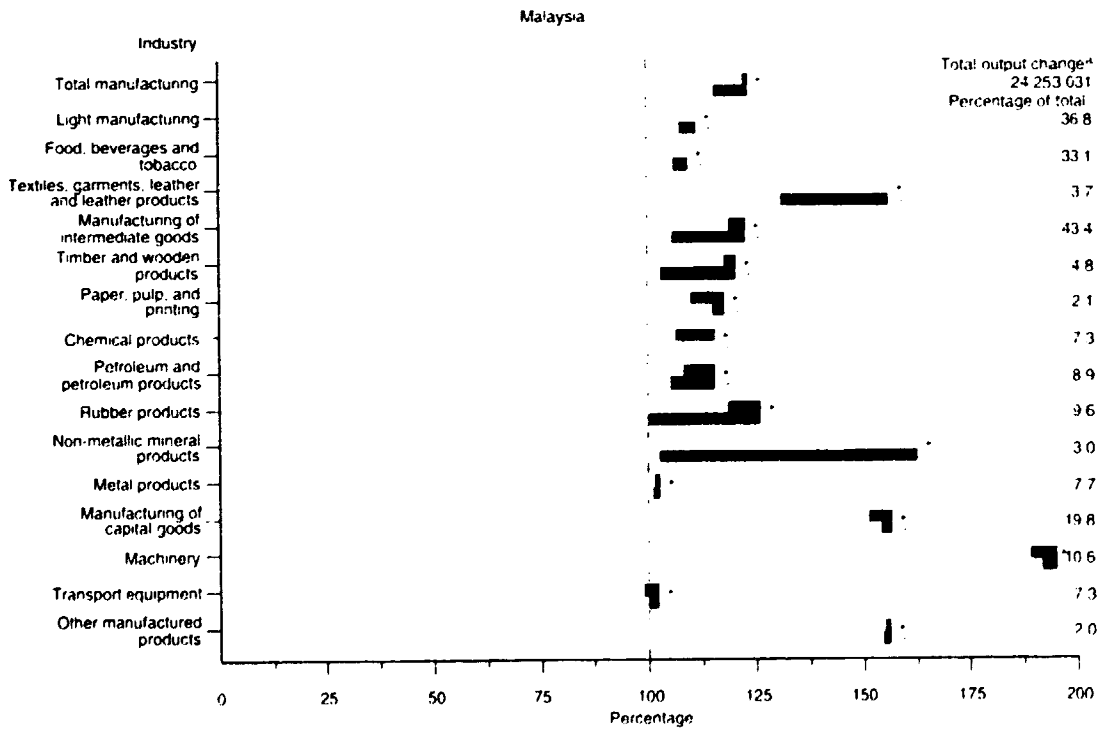
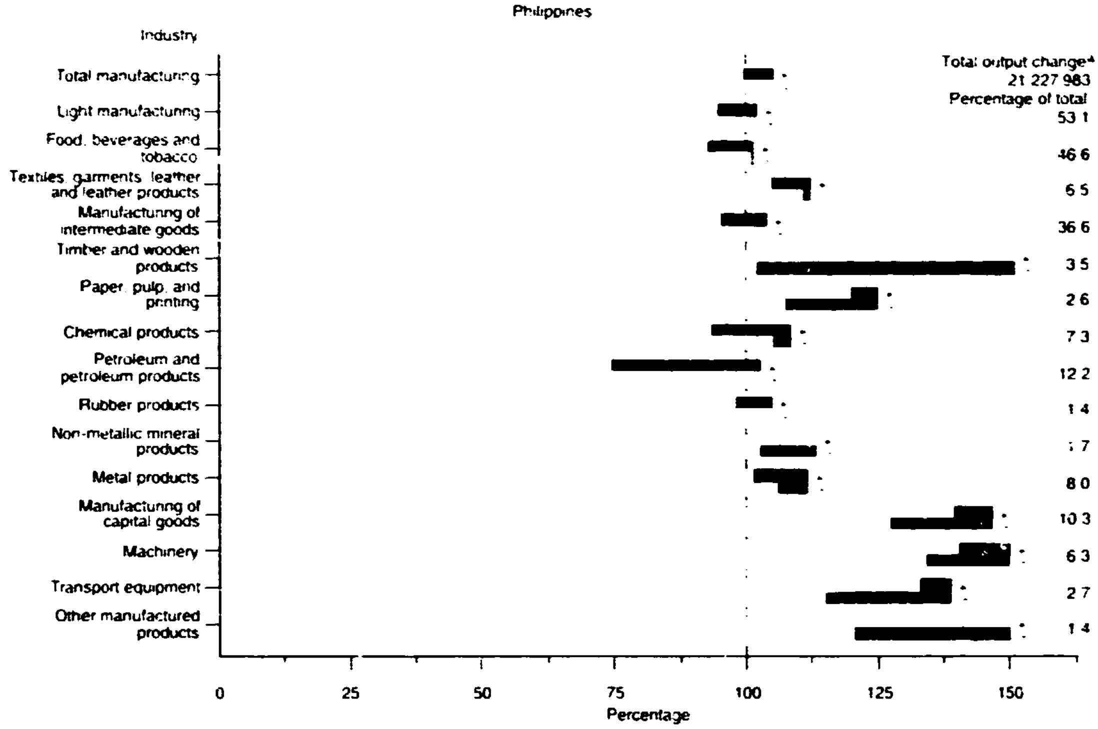


Figure III.I

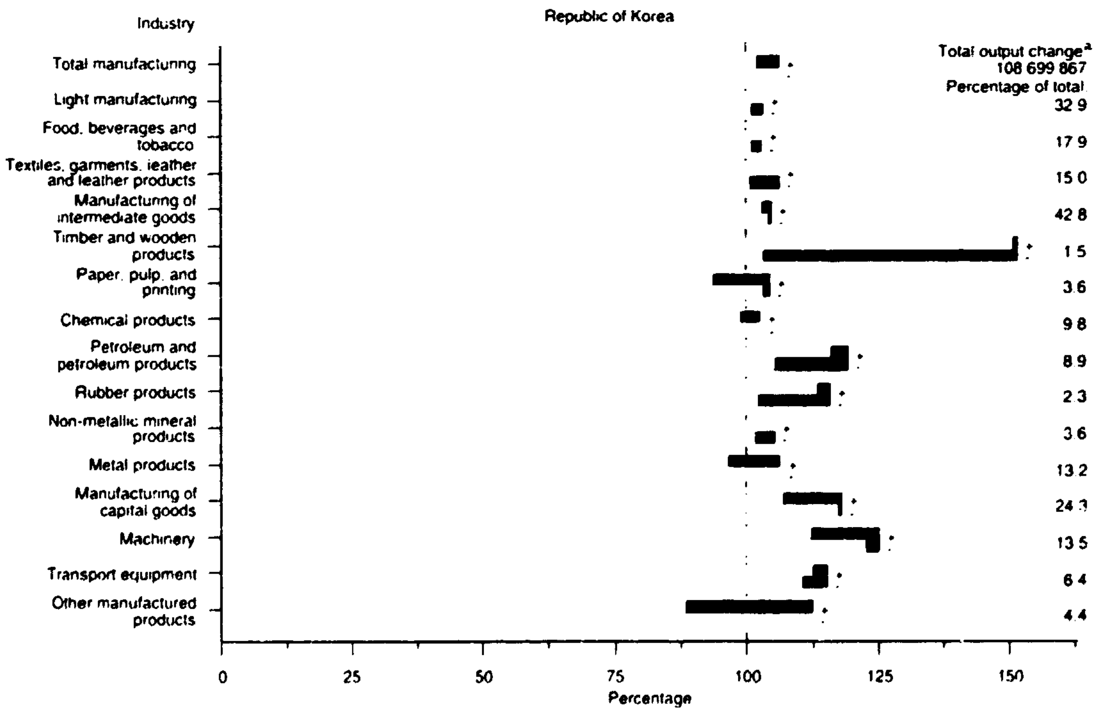

Japan
Industry
Total output change[a]
1 209 292 571
Percentage of total
Total manufacturing
Light manufacturing
Food, beverages and tobacco
Textiles, garments, leather and leather products
Manufacturing of intermediate goods
Timber and wooden products
Paper, pulp, and printing
Chemical products
Petroleum and petroleum products
Rubber products
Non-metallic mineral products
Metal products
Manufacturing of capital goods
Machinery
Transport equipment
Other manufactured products
12 8
4 9
40 8
2 1
5 7
7 9
5 4
0 9
2 9
41 4
22 5
13 3
5 6
0
25
50
75
100
125
150
175
200
225
Percentage


Malaysia
Industry
Total output change[a]
24 253 031
Percentage of total
Total manufacturing
Light manufacturing
Food, beverages and tobacco
Textiles, garments, leather and leather products
Manufacturing of intermediate goods
Timber and wooden products
Paper, pulp, and printing
Chemical products
Petroleum and petroleum products
Rubber products
Non-metallic mineral products
Metal products
Manufacturing of capital goods
Machinery
Transport equipment
Other manufactured products
36 8
33 1
3 7
43 4
4 8
2 1
7 3
8 9
9 6
3 0
7 7
19 8
10 6
7 3
2 0
0
25
50
75
100
125
150
175
200
Percentage

(continued)

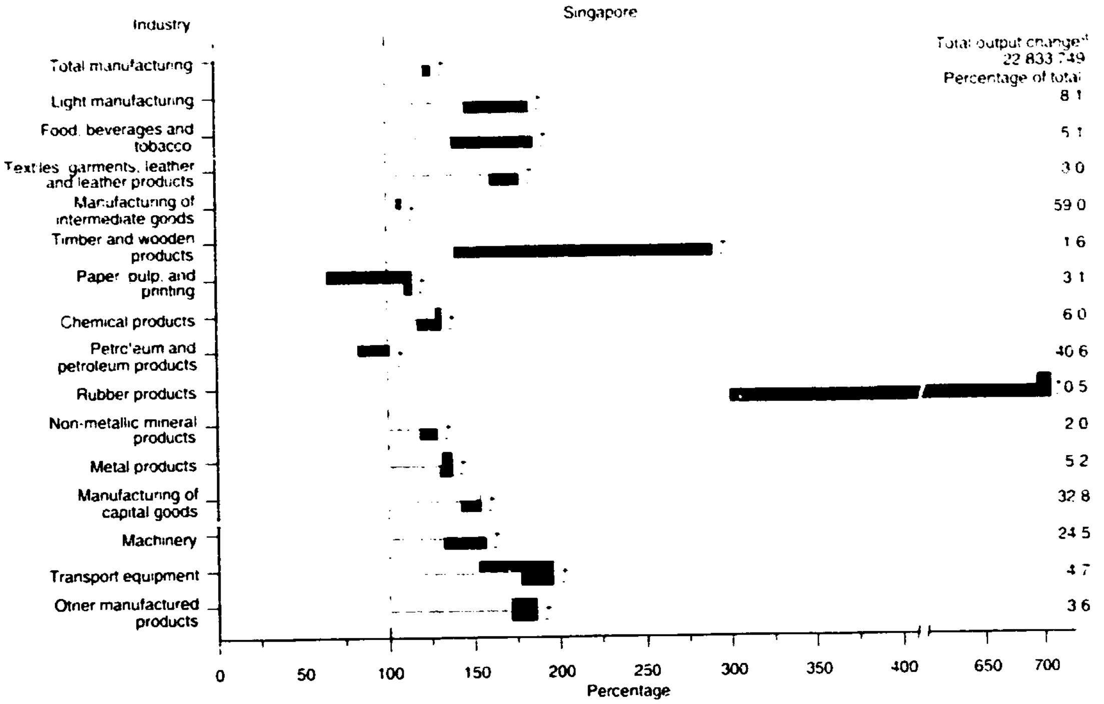


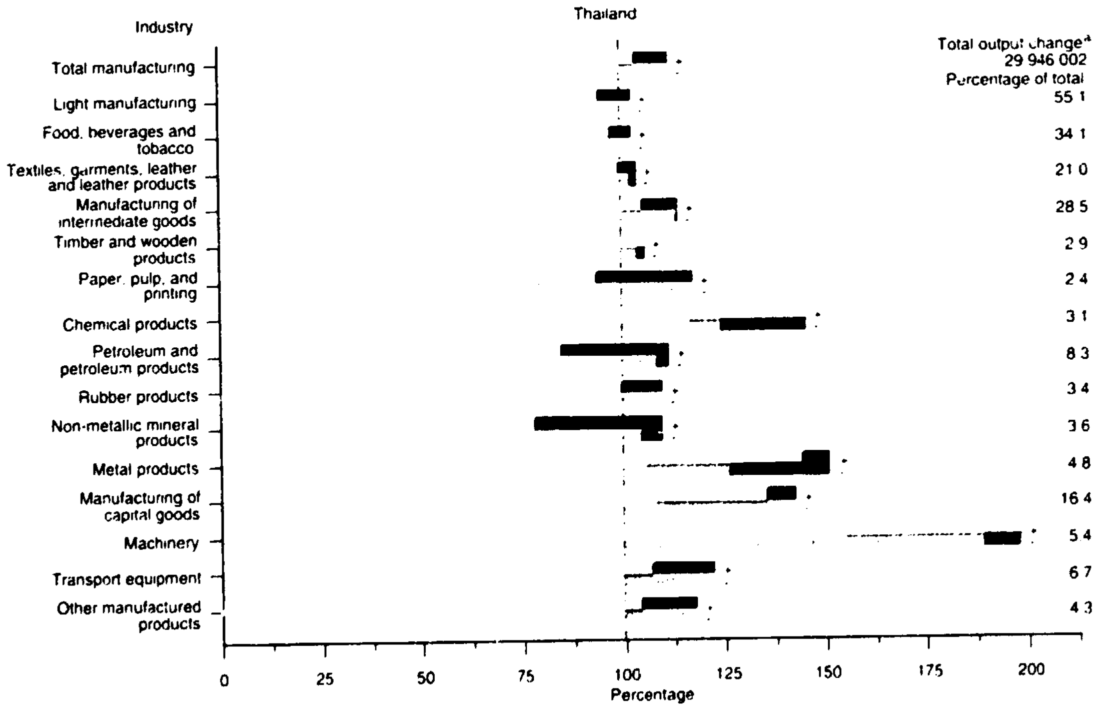
Philippines
Industry
Total manufacturing
Light manufacturing
Food, beverages and tobacco
Textiles, garments, leather and leather products
Manufacturing of intermediate goods
Timber and wooden products
Paper, pulp, and printing
Chemical products
Petroleum and petroleum products
Rubber products
Non-metallic mineral products
Metal products
Manufacturing of capital goods
Machinery
Transport equipment
Other manufactured products
Total output change[a]
21 227 983
Percentage of total
53 1
46 6
6 5
36 6
3 5
2 6
7 3
12 2
1 4
7
8 0
10 3
6 3
2 7
1 4
0
25
50
75
100
125
150
Percentage



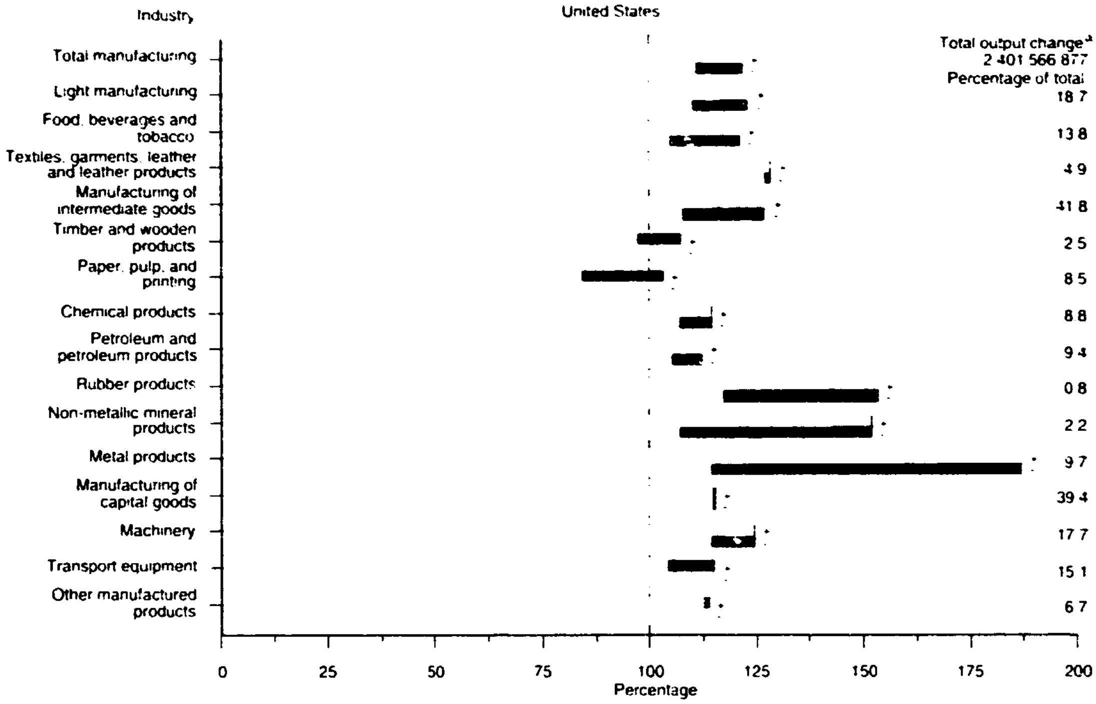
Republic of Korea
Industry
Total manufacturing
Light manufacturing
Food, beverages and tobacco
Textiles, garments, leather and leather products
Manufacturing of intermediate goods
Timber and wooden products
Paper, pulp, and printing
Chemical products
Petroleum and petroleum products
Rubber products
Non-metallic mineral products
Metal products
Manufacturing of capital goods
Machinery
Transport equipment
Other manufactured products
Total output change[a]
108 699 867
Percentage of total
32 9
17 9
15 0
42 8
1 5
3 6
9 8
8 9
2 3
3 6
13 2
24 3
13 5
6 4
4 4
0
25
50
75
100
125
150
Percentage

Figure III.I


Singapore
Industry
Total output change[a]
22 833 749
Percentage of total
Total manufacturing
Light manufacturing
8 1
Food, beverages and tobacco
5 1
Textiles, garments, leather and leather products
3 0
Manufacturing of intermediate goods
59 0
Timber and wooden products
1 6
Paper, pulp, and printing
3 1
Chemical products
6 0
Petroleum and petroleum products
40 6
Rubber products
0 5
Non-metallic mineral products
2 0
Metal products
5 2
Manufacturing of capital goods
32 8
Machinery
24 5
Transport equipment
4 7
Other manufactured products
3 6
0
50
100
150
200
250
300
350
400
650
700
Percentage


Thailand
Industry
Total output change[a]
29 946 002
Percentage of total
Total manufacturing
Light manufacturing
55 1
Food, beverages and tobacco
34 1
Textiles, garments, leather and leather products
21 0
Manufacturing of intermediate goods
28 5
Timber and wooden products
2 9
Paper, pulp, and printing
2 4
Chemical products
3 1
Petroleum and petroleum products
8 3
Rubber products
3 4
Non-metallic mineral products
3 6
Metal products
4 8
Manufacturing of capital goods
16 4
Machinery
5 4
Transport equipment
6 7
Other manufactured products
4 3
0
25
50
75
100
125
150
175
200
Percentage

(continued)



Key:

Final demand effects

Import substitution effects

Exports effects

■ Technical change effects

■ Unexplained effects

a In thousands of dollars in 1985 constant prices

The structural fragility of sub-Saharan African economies is underscored by this excessive dependence on a few export commodities. It is well known that primary products tend to be highly inelastic both in supply and demand, and hence suffer from both price and revenue instability. Drastic fluctuation in international prices or in external demand severely cripples a country's capacity to earn foreign exchange, import, generate employment, and for that matter initiate and sustain industrialization. Issues related to trade and industrialization in general, and the role of trade in accelerating industrialization in sub-Saharan Africa in particular, are examined in the following sections.

1. The structure of trade

Sub-Saharan Africa, with a population of about 450 million, accounted for 8.6 per cent of the world population in 1989, but only 0.75 per cent of world GDP, about $150 billion, and slightly less than 1 per cent of both world exports and imports, around $30 billion each in the same year [31]. Although calculated from a very small statistical base, sub-Saharan Africa enjoyed a rapid growth rate of about 20 per cent a year in both its total exports and imports during the 1970s, but suffered a sharp reversal with its total exports and imports both declining by 3 per cent per year during the 1980s, as shown in table III.1. The fundamental weakness of sub-Saharan economies is that primary commodities claimed the lion's share of its total exports, and worse yet, exports are concentrated in a few commodities exported to a small number of markets. Commodity exports account for over 80 per cent of total export earnings in most sub-Saharan countries. Manufactured exports from sub-Saharan Africa are relatively negligible. This structural imbalance in trade is clearly shown in table III.15. The African share of world manufactured exports remained at an insignificant level of around 0.4 per cent, while its share of primary commodity exports declined sharply from around 10 per cent to 6 per cent between 1970 and 1989. Statistics for Africa were not broken down for sub-Saharan Africa, the share of which would obviously be even smaller. Meanwhile, South and South-East Asia contrasts sharply with the African performance, with its share of world manufactured exports rising steeply from 3 to 13 per cent, and the commodity share from 7 to 10 per cent during the same period.

Table III.15. African share of exports in world trade, 1970, 1980 and 1989

Economic grouping, region and item	All manufactured goods[a] 1970	1980	1989	Primary commodities (including fuels)[b] 1970	1980	1989
	(million dollars f.o.b.)			(million dollars f.o.b.)		
World exports	189 913	1 085 112	2 106 523	115 480	869 240	804 322
Developed market economies	160 352	892 656	1 640 399	58 465	338 713	420 360
Developing economies	10 455	105 041	344 243	45 868	456 210	293 039
Africa	841	3 821	8 879	11 169	90 450	46 858
South and South-East Asia	6 208	72 153	268 254	7 960	66 459	76 709
African share (percentage)						
Of world	0.44	0.35	0.42	9.67	10.41	5.83
Of developing countries	8.04	3.64	2.58	24.35	19.82	15.99
Of South and South-East Asia	13.55	5.30	3.31	140.31	136.10	61.11

Source: See table III.1.

a/ Standard International Trade Classification (SITC) (5+6+7+8)-68.

b/ SITC (0+1+2+3+4+68).

Table III.16 reveals fundamental weaknesses of exports from sub-Saharan Africa in sharp contrast to those from East and South-East Asia. Disregarding a minuscule export from Comoros, in 24 of 30 sub-Saharan African countries listed in the table, primary commodities accounted for 80 per cent or more of their total export revenues in 1989. Only six countries, Cameroon, Central African Republic, Mauritius, Senegal, Sierra Leone and Zimbabwe, derived 20 per cent or more of their total export revenues from manufactured exports in the same year. By contrast, the share of manufactured exports in total exports in East and South-East Asia ranged from 32 per cent in Indonesia to 94 per cent in the Republic of Korea in 1989. Moreover, table III.17 shows a percentage distribution of manufactured exports among 30 sub-Saharan African countries. If the level of manufactured exports should be a good guide to the level of industrialization in a country, the results point to the embryonic stage of development of the manufacturing sector in the great majority of sub-Saharan African countries. The combined share of three countries, Côte d'Ivoire, Mauritius and Zimbabwe, amounts to about 54 per cent of total exports of the 30 countries in 1989. What is even more revealing is that the total manufactured exports earnings of these 30 countries, around $3 billion, was less than half the manufactured exports of Indonesia, the smallest of the East and South-East Asian group, and only 5 per cent of the manufactured exports of the Republic of Korea in 1989.

The vulnerability of sub-Saharan economies is also mirrored in the structure of imports. Table III.18 shows the structure of imports by main product groups for a dozen sub-Saharan countries and several East and South-East Asian countries for various periods. Since data for imports are less complete than for exports, the import table includes a smaller number of major sub-Saharan countries. The overall picture is heavy import dependence on manufactured goods in both sub-Saharan Africa and East and South-East Asia, ranging between 50 to 80 per cent of total imports. But the similarity ends there. In most sub-Saharan countries with a few exceptions, the share of both food items and fuels either maintained its 1975 level or considerably increased over the 1980s, while the share of manufactured imports declined in varying degrees during the period. It must be noted that the changes in the distribution of imports would have been much more pronounced in terms of volume rather than values, since world market prices for food, fertilizers and oil fell substantially, while prices for manufactured goods by and large increased during the 1980s. By sharp contrast, the share of manufactured imports increased considerably, while that of food and fuels decreased in all sample countries in East and South-East Asia, except for Indonesia. The implication is clear. In sub-Saharan Africa, the foreign exchange squeeze resulting from debt overhang, falling commodity export revenues and diminished capital inflows forced many countries in the region to compress imports, and the manufactured imports must have borne the brunt of drastic import curtailments. By comparison, the imports of manufactured goods, mainly intermediate inputs and capital goods, increased sharply to sustain the rapid growth of manufactured exports in East and South-East Asia. Import compression at the expense of manufactured imports would clearly have serious implications for industrialization in sub-Saharan Africa, which will be discussed in detail shortly.

2. *Barriers to manufactured exports in sub-Saharan Africa*

The great majority of sub-Saharan countries have a small industrial base and export few manufactured goods as shown earlier. The manufacturing share of GDP is 10 per cent or less in most countries. Table III.3 shows that the sub-Saharan share of world MVA is very insignificant, marginally changing from 0.2 to 0.3 per cent during the 1970s, but stagnating at a 0.3 per cent level with an annual growth rate of 1.6 per cent during the 1980s. The small manufacturing base and stagnation in the manufacturing sector implies that very little import substitution has taken place in sub-Saharan Africa. Although there are a small number of countries with a relatively large manufacturing sector such as Kenya, Côte d'Ivoire, Mauritius and Zimbabwe, they are still at the very early stages of industrialization.

Table III.16. Manufactured export share in selected countries of sub-Saharan Africa, and East and South-East Asia in selected years

Country	Year	Total (million dollars)	Percentage share	Country	Year	Total (million dollars)	Percentage share
			A. Sub-Saharan Africa				
Angola	1975	71.7	7.7	Malawi	1975	5.7	0.6
	1986	13.0	0.4		1989	15.5	0.5
Burkina Faso	1975	2.8	0.3	Mali	1975	4.3	0.5
	1988	11.2	0.4		1989	18.4	0.6
Burundi	1975	0.9	0.1	Mauritania	1975	3.7	0.4
	1989	4.1	0.1		1987	1.7	0.1
Cameroon	1975	47.3	5.1	Mauritius	1975	33.9	3.6
	1988	224.5	7.4		1989	647.3	21.2
Cape Verde	1975	0.3	-	Mozambique	1975	12.9	1.4
	1988	0.4	-		1989	17.7	0.6
Central African Republic	1975	11.2	1.2	Nigeria	1975	16.0	1.7
	1989	60.0	2.0		1989	81.4	2.7
Chad	1975	3.1	0.3	Rwanda	1975	2.0	0.2
	1989	12.0	0.4		1989	1.5	-
Comoros	1975	2.6	0.3	Senegal	1975	69.4	7.4
	1989	3.3	0.1		1989	167.9	5.5
Côte d'Ivoire	1975	132.3	14.2	Sierra Leone	1975	75.9	8.1
	1989	542.3	17.8		1989	28.4	0.9
Ethiopia	1975	3.9	0.4	Togo	1975	7.2	0.8
	1988	11.4	0.4		1989	17.4	0.6
Gabon	1975	9.4	1.0	Uganda	1975	-	-
	1988	115.7	3.8		1989	3.5	0.1
Gambia	1975	-	-	United Republic of Tanzania	1975	41.2	4.4
	1988	4.9	0.2		1989	33.6	1.1
Ghana	1975	10.2	1.1	Zaire	1975	57.1	6.1
	1989	115.7	3.8		1989	134.2	4.4
Kenya	1975	60.2	6.4	Zambia	1975	5.6	0.6
	1987	113.4	3.7		1989	150.9	4.9
Madagascar	1975	12.4	1.3	Zimbabwe	1976	231.5	24.8
	1989	47.1	1.5		1990	453.5	14.9
Total	1975	934.6	100.0				
	1989	3 052.1	100.0				
			B. East and South-East Asia				
Indonesia	1975	85.6	1.2	Singapore	1975	2 231.5	30.0
	1989	6 945.6	5.9		1989	12 229.0	10.3
Malaysia	1975	665.5	9.0	Thailand	1975	317.8	4.3
	1989	12 229.0	10.3		1989	11 293.4	9.5
Republic of Korea	1975	4 127.5	55.6				
	1989	60 622.7	51.2				
Total	1975	7 427.8	100.0				
	1989	118 486.1	100.0				

Source: *Handbook of International Trade and Development Statistics 1991* (United Nations publication, Sales No. E/F.92.II.0.6), table III.1.

Table III.17. Export structure by main categories in selected countries of sub-Saharan Africa and East and South-East Asia in selected years
(Percentage)

Country	Year	Total (million dollars)	Main export categories: All food items	Agricultural raw materials	Fuels	Ores and metals	Manufactured goods	Unallocated
			A. Sub-Saharan Africa					
Angola	1975	969.3	22.7	5.8	61.1	3.1	7.4	-
	1986	1 296.4	16.4	0.3	82.1	-	1.0	0.2
Burkina Faso	1975	43.5	74.8	18.6	-	0.1	6.5	-
	1988	154.0	24.5	43.2	-	0.2	7.3	24.8
Burundi	1975	31.6	91.6	4.7	-	0.9	2.8	-
	1989	77.8	61.1	3.5	0.1	0.9	5.3	29.2
Cameroon	1975	446.3	66.9	14.7	0.3	7.6	10.6	-
	1988	924.0	37.2	17.9	12.3	8.2	24.3	-
Cape Verde	1975	2.0	80.0	5.0	-	-	15.0	-
	1988	3.6	83.3	-	-	2.8	11.1	2.8
Central African Republic	1975	47.2	25.7	50.6	-	-	23.7	-
	1989	140.3	30.6	23.7	-	1.2	42.8	1.7
Chad	1975	40.0	16.2	66.9	7.9	0.8	7.7	0.4
	1989	132.8	44.6	45.9	-	0.3	9.0	0.2
Comoros	1975	9.5	4.7	-	-	-	27.8	67.6
	1989	12.4	71.0	1.6	-	0.8	26.6	-
Côte d'Ivoire	1975	1 181.6	62.5	19.4	5.7	0.5	11.2	0.7
	1989	2 963.4	48.7	15.3	17.1	0.3	18.3	0.3
Ethiopia	1975	215.2	82.3	11.3	3.3	0.4	1.8	0.8
	1988	421.1	77.2	16.8	3.0	0.2	2.7	0.1
Gabon	1975	941.9	0.3	5.6	82.9	10.2	1.0	-
	1988	1 429.0	2.2	13.4	66.0	9.7	8.1	0.7
Gambia	1975	48.1	99.7	0.1	-	-	0.1	0.1
	1988	48.0	87.3	1.6	-	-	10.2	0.9
Ghana	1975	728.2	77.8	9.7	2.8	8.2	1.4	0.1
	1989	1 023.9	44.7	9.9	4.4	25.9	11.3	3.8
Kenya	1975	456.0	48.0	15.4	22.2	1.1	13.2	0.1
	1987	961.0	66.7	5.4	14.4	1.3	11.7	0.5
Madagascar	1975	301.4	75.4	5.6	8.6	6.4	4.1	-
	1989	311.9	71.2	3.4	2.0	8.1	15.1	0.2
Malawi	1975	121.1	92.4	2.2	-	0.1	4.7	0.5
	1989	267.5	89.6	3.0	-	0.1	5.8	1.5
Mali	1975	36.5	41.0	47.0	-	0.2	11.7	-
	1989	270.7	22.6	65.8	0.1	0.1	6.8	4.6
Mauritania	1975	174.3	8.4	0.9	-	86.6	2.1	2.0
	1987	427.8	64.3	0.2	3.9	31.2	0.4	-

Country	Year	Total (million dollars)	Main export categories					
			All food items	Agricultural raw materials	Fuels	Ores and metals	Manufactured goods	Unallocated
Mauritius	1975	294.6	88.4	0.1	-	-	11.5	-
	1987	986.8	33.1	0.5	0.1	0.3	65.6	0.4
Mozambique	1975	202.0	62.8	18.4	10.9	1.5	6.4	-
	1989	101.1	65.7	4.0	0.1	12.1	17.5	0.7
Nigeria	1975	7 983.4	5.2	0.6	93.3	0.5	0.2	0.3
	1989	8 137.7	2.2	2.0	95.3	0.9	1.0	0.5
Rwanda	1975	42.0	71.4	9.5	-	14.3	4.8	-
	1989	98.6	79.5	11.0	-	1.4	1.5	6.6
Senegal	1975	462.4	52.0	2.0	7.0	24.0	15.0	-
	1989	648.4	45.6	2.6	18.6	7.0	25.9	0.3
Sierra Leone	1975	140.0	24.8	0.9	5.9	14.2	54.2	0.1
	1989	137.9	31.1	0.5	3.5	43.4	20.6	0.9
Togo	1975	124.8	27.7	1.0	-	65.5	5.8	-
	1989	245.1	22.1	16.2	-	53.4	7.1	1.2
Uganda	1975	263.0	84.2	11.8	-	3.9	-	-
	1989	249.5	92.1	6.4	-	-	1.4	0.2
United Republic of Tanzania	1975	343.2	54.9	27.1	5.5	0.4	12.0	0.2
	1989	284.9	49.2	22.4	1.5	14.5	11.8	0.5
Zaire	1975	864.8	17.7	3.4	0.7	70.7	6.6	1.0
	1989	1 254.4	15.1	2.6	11.6	56.2	10.7	3.8
Zambia	1975	805.1	1.4	0.1	0.3	97.5	0.7	-
	1989	1 347.5	3.9	1.4	0.1	83.4	11.2	0.1
Zimbabwe	1976	844.8	36.2	9.1	1.2	26.0	27.4	0.1
	1990	1 467.6	44.1	7.3	0.7	15.9	30.9	1.1
			B. East and South-East Asia					
Indonesia	1975	7 130.2	8.1	12.3	74.9	3.5	1.2	-
	1989	21 772.9	12.0	9.3	40.2	6.5	31.9	-
Malaysia	1975	3 846.6	23.2	34.1	10.9	13.9	17.3	0.6
	1989	25 110.8	13.9	17.9	16.2	3.0	48.7	0.3
Republic of Korea	1975	5 070.6	13.2	1.8	2.1	1.3	81.4	0.2
	1989	64 837.1	3.3	1.3	1.0	0.8	93.5	0.1
Singapore	1975	5 377.1	9.5	12.5	33.6	1.0	41.5	1.8
	1989	39 304.9	6.1	4.5	12.8	2.7	69.7	4.2
Thailand	1975	2 162.2	62.7	12.3	0.6	7.4	14.7	2.2
	1989	20 059.3	33.2	7.3	0.8	1.7	56.3	0.7

Source: See table III.1.

Table III.18. Import structure by main categories in selected countries of sub-Saharan Africa and East and South-East Asia in selected years
(Percentage)

Country	Year	Total (million dollars)	By main categories of imports (percentage): All food items	Agricultural raw materials	Fuels	Ores and metals	Manufactured goods	Unallocated
			A. Sub-Saharan Africa					
Burundi	1975	62.7	16.2	5.2	5.9	1.8	69.9	1.1
	1985	193.4	16.0	0.2	17.7	1.3	61.5	3.3
Cameroon	1975	598.3	11.0	0.6	10.1	1.2	77.0	0.2
	1989	1 273.3	16.3	0.4	1.4	1.4	79.6	1.0
Côte d'Ivoire	1975	1 126.5	14.7	0.6	13.9	1.7	68.3	0.9
	1985	1 733.8	17.2	1.0	22.0	1.6	57.5	0.7
Ethiopia	1975	294.0	5.0	1.7	17.4	2.9	72.5	0.5
	1988	1 085.0	17.3	1.7	9.9	0.8	70.2	-
Kenya	1975	910.8	6.0	1.8	10.3	2.0	76.7	3.3
	1987	1 737.8	7.2	2.3	20.1	1.9	68.6	-
Madagascar	1975	366.9	14.2	2.1	20.1	1.0	62.5	0.1
	1986	373.6	15.2	1.8	22.3	0.7	59.8	0.2
Malawi	1975	250.5	9.4	1.1	9.9	1.3	77.9	0.4
	1985	295.2	7.6	1.5	13.2	1.6	75.7	0.4
Nigeria	1975	6 041.2	9.5	1.0	2.7	1.9	84.6	0.3
	1986	4 028.2	16.1	1.2	0.5	2.5	79.6	0.1
Senegal	1975	581.4	24.7	3.2	11.9	1.2	58.7	0.3
	1989	1 534.0	25.5	1.3	23.5	1.9	47.7	-
Sierra Leone	1975	159.3	20.2	1.4	13.7	0.8	62.6	1.3
	1984	126.5	20.7	1.1	19.7	1.1	56.7	0.6
Togo	1975	173.9	14.2	2.2	7.5	1.1	74.8	0.2
	1989	471.9	25.8	1.1	6.1	1.0	65.6	0.4
Zimbabwe	1976	619.7	2.7	2.9	19.9	1.8	67.4	5.2
	1990	1 851.4	3.7	2.6	15.6	2.4	72.8	2.9
			B. East and South-East Asia					
Indonesia	1975	4 769.7	12.5	2.8	5.4	1.9	77.3	-
	1989	10 256.0	6.9	4.1	12.5	3.9	72.1	0.4
Malaysia	1975	3 524.6	18.2	2.1	12.0	5.2	61.7	0.7
	1988	16 232.0	10.8	1.7	5.4	4.1	77.7	0.3
Republic of Korea	1975	7 272.0	14.2	11.4	19.1	4.7	50.7	-
	1989	61 347.5	6.2	8.9	12.4	7.8	65.4	0.2
Singapore	1975	8 135.0	10.8	5.6	24.6	1.3	56.4	1.4
	1989	49 604.6	6.8	2.2	13.9	2.5	73.3	1.4
Thailand	1975	3 279.4	4.3	4.0	21.6	3.9	64.1	2.0
	1989	25 658.7	5.5	4.9	9.1	4.3	72.0	4.1

Source: See table III.1.

It has been argued elsewhere that the development of manufacturing capacity is an essential precondition for building a manufactured export base, and any policy measures to promote manufactured exports such as trade liberalization are relevant only well after the manufacturing supply capacity is firmly established. It is evident, therefore, that sub-Saharan Africa should industrialize first and accelerate the pace of industrialization through manufactured exports at later stages of its development, on the thesis elaborated earlier that manufactured exports follows industrialization and not vice versa. Many obstacles stand in the way of industrialization, and in the following sections some of them, both external and internal, and some endemic to sub-Saharan Africa are dealt with. Various policies to overcome those obstacles and to accelerate industrialization through trade will then be discussed.

(a) Foreign exchange squeeze and import compression

Policies that affect both the import capacity and its stability are critically important for fledgling manufacturing industries in sub-Saharan Africa, given the high import dependence of production and investment in the manufacturing sector as shown in table III.18. In the preceding section, some statistical evidence of import compression in most sub-Saharan countries was analysed, and it was further shown that manufactured goods have borne the brunt of import compression. Since the bulk of manufactured imports consists of parts and machinery and industrial raw materials, severe curtailment of manufactured imports is likely to contribute directly to serious capacity underutilization and often a complete stoppage of plant operation. A decline in capacity utilization will affect adversely not only short-run efficiency by raising per unit production costs, but also lower long-term returns to investment. Moreover, it has been shown that the cost penalties associated with capacity underutilization increase faster below a 30 per cent level, and hence the production efficiency drops more rapidly and the wastage of scarce capital becomes greater as the import compression tightens [32].

Statistics on manufacturing capacity utilization in Africa are difficult to come by. Some fragmentary evidence usually found in individual country studies provide a rough guide to the magnitude of the problem facing African countries. For instance, one recent study on Kenyan manufacturing industries reported a wide variation in capacity utilization among industries, ranging from an extremely low capacity of 21 per cent in pharmaceuticals, 23 per cent in transport vehicles and 22 per cent in steel rolling, to high capacity utilization of 86 per cent in textiles and 91 per cent in paper in 1987 [33]. Average industrial capacity utilization in the United Republic of Tanzania is estimated to have dropped sharply from a relatively high level of over 75 per cent before 1975 to 29.4 per cent in 1982, and further down to 24.8 per cent in 1985. Actual capacity utilization for major industry groups were as follows: food products (30 per cent), beverages and tobacco (50 per cent), textiles (40 per cent), tanneries and leather (12 per cent), plastics and pharmaceuticals (19 per cent), chemicals and fertilizers (32 per cent), non-metallic minerals (31 per cent), iron, steel and metal products (33 per cent), and machinery and transport equipment (13 per cent) [34]. In Nigeria, the excess industrial capacity built for mineral-processing industries such as petrochemicals and for iron and steel during the oil boom in the 1970s has turned into a serious problem of capacity underutilization in the wake of the collapse of oil revenues and a sharp decline in aggregate demand, with few manufactured exports during the 1980s, and with average capacity utilization in those industries sinking to around 25 per cent in the mid-1980s [35].

It is clear that capacity underutilization is a major contributing factor to poor industrial productivity. The problem of capacity underutilization often arises not only from the import capacity constraint, but also from resource allocation problems related to the non-fungibility of foreign project finance between capacity expansion and capacity utilization. Project funds earmarked for new plants cannot often be transferred to ease the problems of underutilization in the existing plants in the same industry [34].

The import compression which causes capacity underutilization and hence depresses industrial productivity is a direct consequence of the foreign exchange squeeze. The foreign exchange constraint in sub-Saharan Africa is in turn caused, *inter alia*, by the debt overhang and a general decline in commodity exports revenues. The crushing debt burden in sub-Saharan Africa is a major cause for import compression. The African Development Bank estimated the total external debt accumulated in Africa from 1970 to 1988 to be between $225 billion and $250 billion, a sum equal to three years of imports in the late 1980s [36].

The debt of Africa has more than tripled since 1980, partly because of ever-increasing borrowing, but mainly because of the accumulation of unpaid interest over the past decade. Although the total accumulated debt in Africa appears small relative to the massive debt of Latin America, the severity of the African debt burden is clearly underscored by the fact that the debt burden on a per capita basis and in relation to export earnings is heavier than that of the "severely indebted" group in the IBRD classification. For instance, total external debt as a percentage of total exports for sub-Saharan Africa increased drastically from 96.8 per cent in 1980 to 324.3 per cent in 1990, compared to an increase from 180.7 to 273.8 per cent for the severely indebted group during the same period. As a percentage of GNP, the ratio for sub-Saharan Africa jumped from 28.5 to 109.4 per cent between 1980 and 1990, while the ratio for the severely indebted group was up from 34.4 to 46.4 per cent during the same period. However, the total debt service as a percentage of total exports for sub-Saharan Africa was somewhat lower than that of the latter group. The debt service ratio increased from 10.9 to 19.3 per cent between 1980 and 1990, while the ratio for the latter group substantially declined from 35.1 to 25.3 per cent during the period ([30], table 24). The lower debt service ratio for sub-Saharan Africa is mainly due to the fact that the bulk of African debt consists of official concessionary loans, with virtually no private commercial bank debt.

(b) Dependence on primary commodity exports

As discussed extensively earlier in this chapter, sub-Saharan African countries depend excessively on commodity exports for foreign exchange. The general downward trend in the commodity prices coupled with their instability is another major cause of the serious foreign exchange gap and consequent import compression, leading to severe industrial capacity underutilization. African countries collectively account for a dominant share of the world markets for several primary commodities, notably coffee, cocoa beans, groundnuts, groundnut oil, palm nuts, cotton, sisal, bauxite, copper, blister copper, manganese ore and phosphate as shown in table III.19. But individually, African countries export a small share of the world market totals for most primary commodities. The most serious problem with dependence on primary commodity exports is obviously the secular downward trend in most commodity prices and diminishing export revenues. Table III.4 shows that purchasing power of sub-Saharan exports fell by almost 40 per cent between 1980 and 1990, while those of South and South-East Asia increased almost two and half times during the same period. By mid-1987, the real prices of 13 out of 20 African export commodities were at the lowest level since 1900. They included tea, sugar, meat, fruits, fats and vegetable oils, cotton, rubber, tobacco, iron ore, tin, zinc, copper and aluminium [36].

Table III.19. Share of Africa in world and developing-country exports of selected primary commodities, 1970-1987

Commodity	Two main African exporters 1986/87	Value of African exports 1970/71 (million dollars)	Value of African exports 1986/87 (million dollars)	Percentage share in world exports 1970/71	Percentage share in world exports 1986/87	Percentage share of Africa in developing-country exports 1970/71	Percentage share of Africa in developing-country exports 1986/87
Fishery products	Morocco, Senegal	99	1 083	3.1	4.2	9.7	10.1
Bovine meat	Botswana, Zimbabwe	57	65	2.8	0.7	9.8	7.6
Bananas	Côte d'Ivoire, Somalia	35	51	6.6	2.7	7.2	3.0
Sugar	Mauritius, Swaziland	184	637	7.0	6.3	9.5	8.6
Coffee	Côte d'Ivoire, Uganda	805	2 600	27.6	20.4	28.4	22.7
Cocoa beans	Côte d'Ivoire, Ghana	651	1 921	80.6	62.6	81.4	68.2
Cocoa products	Côte d'Ivoire, Ghana	..	294	..	14.6	..	31.4
Tea	Kenya, Malawi	89	319	12.8	15.2	15.5	22.4
Vegetable oils	Tunisia, Côte d'Ivoire	483	365	11.9	2.2	37.4	7.1
Groundnuts	Gambia, Malawi	128	34	59.9	5.9	80.6	22.0
Groundnut oil	Senegal, Gambia	75	63	52.2	29.3	69.8	59.6
Palm nuts	Nigeria, Cameroon	59	10	85.4	78.1	85.8	80.3
Palm kernel oil	Côte d'Ivoire, Zaire	30	16	55.5	7.4	84.7	8.2
Palm oil	Cameroon, Côte d'Ivoire	43	44	17.9	2.4	19.0	2.5
Tobacco	Malawi, Zimbabwe	110	463	8.4	11.8	24.6	27.0
Hides, skins	Namibia, Ethiopia	82	191	6.3	3.0	33.3	40.0
Rubber	Liberia, Côte d'Ivoire	77	182	7.4	5.4	7.6	5.6
Timber	Côte d'Ivoire, Gabon	294	700	12.7	6.8	20.9	10.2
Cotton	Egypt, Sudan	812	1 062	30.3	17.8	47.7	44.8
Sisal	Kenya, United Rep. of Tanzania	40	19	57.7	36.6	58.9	38.8
Bauxite	Guinea, Sierra Leone	9	379	3.2	44.4	4.1	54.0
Alumina	Guinea	46	95	7.7	3.7	17.5	14.6
Aluminium	Egypt, Zaire	47	345	3.2	3.6	54.8	15.6
Copper ore	Morocco, Zaire	10	74	1.6	3.7	3.3	5.9
Blister copper	Zaire, Namibia	394	351	4[illegible].6	35.5	52.3	45.6
Copper	Zaire, Zambia	891	978	28.6	19.4	60.2	33.7
Iron ore	Liberia, Mauritania	332	368	12.5	5.4	31.8	12.7
Tin ore	Namibia, Zaire	21	11	12.8	4.8	14.5	8.8
Tin metal	Zimbabwe, Nigeria	46	12	7.6	1.2	9.7	1.6
Manganese ore	Gabon, Morocco	46	150	25.1	38.7	45.8	73.6
Phosphate	Morocco, Togo	173	587	40.6	41.7	75.2	67.1

Source: African Development Report 1990 (Abidjan, African Development Bank, 1990), p. 62.

The deteriorating export commodity prices in Africa are caused by many interrelated factors such as worldwide recession, substitution of synthetic materials for raw materials in production, the shift in demand towards services and fewer material-intensive goods, and capacity expansion in other regions of the world such as Asia and Latin America. These are unfavourable external environments which negatively affect sub-Saharan export performance either directly through reduced demand or indirectly through unfavourable terms of trade. Poor export performance in sub-Saharan Africa may be also caused by a host of inappropriate government policies such as overvalued real exchange rates, relatively heavy taxation of tradable goods, excessive government regulation and many other anti-export measures.

(c) *Overvalued real exchange rates*

The overvalued real exchange rate is a contentious issue among various policy instruments. The real exchange rate is determined by the nominal exchange rate adjusted for the difference between the domestic rate of inflation and that of the rest of the world or trading partner countries. This implies that monetary and fiscal restraints are to be exercised to avoid large government deficits and rapid monetary expansion, in order to control inflation and hence to maintain a realistic real exchange rate. A large number of sub-Saharan countries have maintained overvalued real exchange rates at different times. The problem is particularly severe in 13 French-speaking West African countries, which use the *Communauté financière africaine* (CFA) franc, a currency which has been pegged to the French franc at a rate of 50 CFA francs to 1 French franc, and has never been devalued for the last 45 years. The real exchange rate of the CFA franc is now estimated to be overvalued by anywhere between 20 and 60 per cent, depending on the country [37].

In theory, a realistic exchange rate is a major element of the incentive package for stimulating exports. The overvalued exchange rate may make exports more expensive and hence less competitive, while the import demand may surge due to lower import prices. Trade deficits may ensue if the national currency is not devalued. However, the impact of devaluation on export earnings and on the supply of exports seems to be inconclusive on both theoretical and empirical grounds. In an import-dependent economy with foreign exchange shortage such as those in sub-Saharan Africa, devaluation of exchange rates may make imports more expensive in domestic currency, and the import compression imposed for balance-of-payments reasons would reduce the aggregate supply through worsening capacity underutilization and often production disruption, as discussed earlier. This would in turn add fuel to inflation, which would require another devaluation, setting in motion a spiral of devaluation and inflation. Simultaneous import liberalization with devaluation would also be untenable because of foreign exchange constraints. Moreover, in the sub-Saharan African context with a dominant share of commodity exports, the export volume may be influenced more strongly by supply factors rather than by exchange rate inducements.

Empirical evidence on the impact of devaluation on export earnings is inconclusive. According to a study by the African Development Bank, overvalued real exchange rates were associated with a decline in export volumes between 1980 and 1985 in such countries as Ghana, Sierra Leone, Uganda and the United Republic of Tanzania. On the other hand, many countries suffered a significant drop in export volume, although they had no serious problems of currency overvaluation during the same period; they include Cameroon, Ethiopia and Kenya [36]. In terms of the association between real exchange rates and economic growth, the CFA franc zone offers two different pictures of currency overvaluation. Until the early 1980s, the CFA countries enjoyed relative monetary stability and economic growth stronger than in the rest of Africa. Yet the same region registered an economic performance worse than the rest of Africa from 1986 to 1990 [37]. Conflicting empirical evidence may simply imply that export expansion as well as economic growth may be influenced by many demand and supply factors other than real exchange rates, and the single-variable explanation may seldom suffice, as with any other economic problems.

(d) Protectionism

Protectionism in developed countries seems to pose no serious barriers to exports of primary commodities and even manufactured goods of sub-Saharan Africa. In fact, sub-Saharan African countries enjoy more favourable treatment than other developing countries under various preferential trade schemes with developed countries. African signatories of GATT, now 29, enjoy most-favoured-nation status within the GATT framework. They are also beneficiaries of preferential treatment under the Lomé Convention and the generalized system of preference (GSP). Under the Lomé Convention, the EEC is required to import from sub-Saharan Africa as well as Caribbean and Pacific countries, duty-free and without quantitative restrictions in principle. Under GSP, many manufactures and semi-manufactures from sub-Saharan Africa have been granted favourable market access to the EEC and Japan since 1971, and to the United States since 1976 [38].

In general, sub-Saharan African countries have failed to take advantage of the special market access offered by developed countries, and gains from both the Lomé Convention and GSP have so far been very modest. In fact, the sub-Saharan African share of manufactured exports in OECD countries fell from an already insignificant level of 0.37 per cent in 1968 to 0.30 per cent in 1988.* There are some isolated incidents of protectionism, such as voluntary export restrictions imposed by the EEC on textile and clothing exports from Mauritius and Côte d'Ivoire. But by and large, protectionism in developed countries poses no major stumbling-blocks to the growth of exports from sub-Saharan Africa in the short and medium terms. For instance, the quotas allocated to sub-Saharan African countries under the Multifibre Arrangement remain unused in most cases. The major obstacle to export expansion in sub-Saharan Africa seems to be on the side of limited domestic supply capacity commonly encountered at the early stages of industrialization, as discussed elsewhere. As sub-Saharan countries broaden their industrial base and build up an export capacity for manufactured goods, protectionism will become a serious issue.

(e) Human capital constraint

It is almost a cliché but nevertheless true that industrialization and economic development critically depend on the quality of human capital. The shortage of indigenous skilled manpower is an overriding bottleneck for industrialization and export promotion in sub-Saharan Africa. The region needs to lessen its dependence on expatriate manpower by developing its own technicians, engineers, scientists and managers. One of the most critical constraints faced by the UNIDO industrial rehabilitation programme has been the acute shortages of professionals and technicians in diverse areas such as plant supervision and management, accounting, finance and marketing, quality control and repair and maintenance [39].

In *Global Report 1992/93*, attention was drawn to the glaring gap between sub-Saharan Africa and other regions of the world in various indicators of human capital accumulation. The average number of years of schooling for sub-Saharan Africa is estimated to be 1.6 years, and this looks pale in comparison with 10 years in developed countries and even with 3.7 years for developing countries as a whole. The rate of adult literacy varied greatly among countries in the region, ranging from 80.2 per cent in Madagascar to 18.2 per cent in Burkina Faso, with an arithmetic mean of 51 per cent for the region in the late 1980s, which is lower than that of all other regions except the Indian Subcontinent. Moreover, Africa had 2.8 students per 1,000 inhabitants enrolled in vocational training in 1987. If North Africa was separated from the statistics, the ratio for sub-Saharan Africa would be even lower. By contrast, Asia registered 6.9 students. Despite the paramount importance of education and training for industrialization in sub-Saharan Africa, education-related expenditures in the region had to be cut back almost by a half on a per capita basis between 1980 and 1987 because of the crushing debt burden coupled with contractionary structural adjustment. In order to keep up payments on the debt, Governments used up billions of dollars worth of scarce foreign exchange, which could have spent on education, health and infrastructure ([40], pp. 73-82).

*For a more detailed account of trade barriers faced by sub-Saharan Africa, see Shaaeldin [38].

3. *Priority issues for industrialization in sub-Saharan Africa*

(a) *Promotion of light manufacturing with the expansion of commodity exports*

The crucial question faced by sub-Saharan Africa is how to initiate and accelerate industrialization in the region. The great majority of sub-Saharan African economies have a very small manufacturing sector and export few manufactured goods except for a small number of countries such as Côte d'Ivoire, Kenya, Mauritius and Zimbabwe, as described earlier. The crux of the matter here is to map out a strategy of industrialization consistent with operational constraints, and particularly the technological capacity of sub-Saharan African countries. Industrialization demanding unavailable advanced skills and technical know-how would be out of the question. The emphasis should be, therefore, on the import substitution of labour-intensive light manufacturing such as food processing, textiles and clothing and leather goods, and the promotion of exports once a firm manufacturing base is put in place. The manufacturing capacity for import substitution of intermediate and capital goods seems to be very limited in most sub-Saharan African countries.

It would require substantial foreign exchange to import parts and machinery and industrial raw materials needed to start light manufacturing, to rehabilitate, expand, and raise the level of utilization of the existing production capacity, and to halt the economic slide and resume growth. Given the severity of the debt overhang and the preponderant importance of primary commodity exports, the majority of sub-Saharan African countries have no choice but to expand export volumes in traditional commodity markets in the short and medium terms in order to earn the foreign exchange needed to launch an industrialization drive, despite the general downward trends in commodity prices in recent decades.

Protectionism is no barrier to sub-Saharan African commodity exports. Africa enjoys preferential market access to the EEC, Japan, the United States and other industrialized countries, as noted earlier. The major problem lies in the slow pace of worldwide demand for primary commodities and their consequent declining prices, which are reflected in the deteriorating terms of trade for commodity exporters. As mentioned above, although African countries collectively account for a substantial share of the world market in several commodities, individual countries sell a small fraction of the total of world trade in most commodities. There is, therefore, ample room for expanding export volumes from most sub-Saharan African countries in a wide array of primary commodities without influencing world prices. Moreover, although declining prices may discourage production expansion, the key question is the investment returns on capacity expansion of traditional exports compared with those in new industries. Often, the cost-price differential is larger and investment requirements are smaller in rehabilitating and expanding the production capacity of traditional exports than in starting new industries, and further investment in the commodity production may prove to be cost-effective in earning foreign exchange in the short and medium terms. It must be noted in this regard that Indonesia, Malaysia and Thailand depended heavily on traditional commodity exports to finance infant industries for import substitution not long ago, and have now been transformed into major exporters of manufactured goods after anchoring a solid manufacturing base. There is no reason why the same strategy of nurturing light manufacturing production first and promoting exports later, while sustaining traditional exports at the same time, could not work in sub-Saharan Africa.

(b) *Resource-based industrialization through raw material processing*

Given the overwhelmingly large share of commodity exports in total exports from sub-Saharan Africa, it is logical to question whether industrialization should begin with further processing of raw materials for export, since economic rents are mostly captured at the processing stage and processing activities deepens interindustry linkages. According to a recent UNIDO study on inter-industry linkages and structural change, most primary industries, namely, agriculture, forestry, livestock, fishery and mining, were found in the lowest quintile in terms of multipiier effects in most Asia-Pacific countries. By contrast, many resource-based industries such as textiles and clothing, leather goods, food, beverages and tobacco, petroleum products and metal products are consistently ranked much higher than their primary supply industries in most cases ([40], chapter III).

A recent study by the African Development Bank underscores the considerable potential for further processing of many primary product exports from sub-Saharan Africa. For instance, Burkina Faso, Central African Republic, Côte d'Ivoire, Mali and Sudan are major exporters of raw cotton, but they are minor exporters of cotton yarn and textiles, while Chad exports such processed products in substantial quantities. Ethiopia, Kenya, Mali and Niger export a significant amount of undressed hides and skins but a relatively small quantity of leather and leather goods. Rough woods are a major export product for Cameroon, Central African Republic, Côte d'Ivoire and Liberia but few processed forest products. Many sub-Saharan African countries are also major exporters of minerals with little further processing. They include the two main copper producers, Zaire and Zambia, the two iron ore producers, Liberia and Mauritania, two main tin ore producers, Namibia and Zaire, as well as Gabon for manganese ore, Togo for phosphate rocks, Niger for uranium ore and Botswana for diamonds [36].

The natural resource endowment alone may not provide economic justification for the development of processing industries. The selection of processing industries should be based on the technological and operational constraints facing the country endowed with raw materials. The operational and technological constraints include, among other things, the minimum-efficiency size of a plant, scale economies, the size of the domestic market for the product, export prospects, managerial and skilled manpower requirements, technological complexity, availability of infrastructure such as water, electricity, telecommunications, transport and warehouses, and a whole host of producer services such as accounting, insurance, engineering consultancy, legal services and repair and maintenance services. In this context, the development of mineral-processing industries may be inconsistent with the operational and technological constraints facing most sub-Saharan African countries, since mineral processing tends to be highly technology- and capital-intensive, to entail large economies of scale and to require highly skilled managerial and labour inputs.

Mineral processing in Nigeria offers some lessons to be learned. Nigeria embarked on resource-based industrialization financed by the oil boom of the 1970s in various mineral-processing projects such as petrochemicals and iron and steel projects. With the drastic fall of oil revenues and a sharp contraction of aggregate demand with few manufactured exports, the capacity utilization of the processing plants dropped to around 25 to 35 per cent. The main reasons cited for the failure of the mineral-processing projects in Nigeria are inadequate technological and managerial capabilities, a domestic market too small for the production capacity, and uncompetitive production costs for export [35].

The implication is that countries endowed with abundant mineral resources should postpone mineral processing until adequate indigenous technological and institutional capacities are developed through technology transfer or learning by doing. Instead, while exporting minerals in unprocessed form, sub-Saharan African countries should be encouraged to push through the relatively easy early phase of industrialization focused on agroprocessing and food processing, and light manufacturing such as textiles and clothing, leather and leather goods, food, beverages and tobacco manufacture, which are less demanding in terms of technological and skill requirements. This seems to be a well-trodden initial path to industrialization. All the successful exporters of manufactured goods in East and South-East Asia without exception went through this initial phase of import substitution and then exports of light manufacturing. There seems to be ample scope for exports of light manufactured goods from sub-Saharan Africa. For instance, as described earlier, exports of textiles and clothing from this region face few trade barriers in industrialized countries either under the Lomé Convention or under the Multifibre Arrangement IV. The great majority of countries in the region have failed to take advantage of these preferential margins over other developing countries, as shown by their large unfilled textile quotas. The share of sub-Saharan African countries in total OECD imports of textiles and clothing in 1986 was less than 2 per cent. The value of these exports was $480 million, of which Mauritius accounted for 87 per cent or $320 million. This leaves a puny share of the total exports for the other countries in the region [41].

(c) *Intra-Africa trade*

Few economies in sub-Saharan Africa have a domestic market big enough to permit the realization of scale economies even in light manufacturing, agroprocessing and food processing, let alone capital-intensive mineral processing. For instance, a study by the African Development Bank shows that the combined GDP of the Economic Community of Western African States (ECOWAS) is roughly equal to that of Denmark with a population of 4 million, and the Danish market is not big enough for developing heavy manufacturing industries in terms of scale economies [36].

Exports obviously offer a way out of this domestic market constraint. But few countries in the region are capable of competing in world markets even in light manufacturing. One alternative under these circumstances would be to promote intra-Africa trade under the common wall of protection against competition from outside Africa. In this context, the formation of a common market or trading blocks could in theory permit the division of labour and specialization, as well as gains from trade among participating countries. In fact, a dozen preferential trade areas and common markets have been created in Africa over the last three decades and three have ceased to exist.* Despite conscious efforts to stimulate intra-Africa trade through various regional or subregional trading groupings, recorded intra-Africa trade remained modest. Recorded trade within sub-Saharan Africa is today estimated at around $4 billion, of which fuels and agricultural products account for the dominant share and manufactured exports an insignificant share. This represents about 5 or 6 per cent of total recorded African trade. Manufactured exports within sub-Saharan Africa are estimated at around 6 to 10 per cent of total manufactured exports from the region [38]. An estimate by the African Development Bank put the share of officially recorded intra-Africa trade at less than 5 per cent of total African trade over the last 20 years [36]. The difficulty with these estimates is the relative size of unrecorded trade, which could be quite substantial, depending on countries. For instance, unrecorded trade within ECOWAS countries is estimated to have been as large as 40 per cent of recorded trade between 1983 and 1987 [42]. Once trade barriers such as export taxes and import tariffs are lowered or dismantled, this illegal trade will obviously disappear. However, substituting legal for illegal trade will not create new trade and increase foreign exchange earnings, which intraregional trade aims at stimulating.

The failure of various economic integration schemes designed to foster intraregional trade in Africa as well as other regions of the world, particularly Latin America, is inherent in the basic structural weaknesses of such schemes. One intractable problem concerns the equitable distribution of benefits among participating countries which are usually so disparate in terms of the level of development and industrialization. The allocation of resources tends to gravitate towards more advanced economies with more efficient production facilities and better infrastructure. Often, solving this problem through political negotiation has proved to be a formidable task. Another related problem is that of trade imbalance. Stronger economies continue to pile up trade surpluses, while weaker ones are plagued with chronic deficits. The settlement of widening trade imbalances in convertible currency has been a well-known recurring problem in Latin America.

The general problems of regional economic integration are compounded with those unique to sub-Saharan Africa. First, the size of a potential market pooled by a trading block in the region may not be sufficiently large to realize economies of scale for many manufacturing industries, except for some labour-intensive light manufacturing such as textiles and clothing, leather and shoes and food processing. Heavy industries such as mineral-processing and capital goods industries may not be justified in terms of scale economies for any trading block in the region for some time to come. This is one of the major arguments against mineral processing in the region, at least in the short and medium terms. However,

*For a survey of regional economic integration efforts in Africa, see [36], chapter 10.

a more fundamental problem is a limited potential for intra-Africa trade creation, since most African countries are largely similar in factor endowments, unskilled labour, technological capabilities and consumption patterns, and hence produce similar products, mainly agricultural. One estimate gives the share of existing products that could be traded within the region as ranging between 6 and 16 per cent of officially recorded trade [43]. On the other hand, great potential for intraregional trade as well as international trade lies in intra-industry trade in capital goods and in intermediate and consumer goods characterized by high product differentiation and high technology content. The rapidly growing portion of international trade is in intra-industry trade, but Africa will not be able to partake in booming intra-industry trade in technologically sophisticated goods for some time to come. In the meantime, realism must be stressed in designing economic integration of more limited scope and with realistic and specific objectives rather than ambitious integration schemes.

(d) *The role of FDI*

The major implication emerging from the foregoing analysis is that the majority of sub-Saharan African countries are not yet ready to compete in world markets, and that they should rather concentrate on import substitution in light manufacturing. Even for some of the basic light-manufacturing industries such as meat and dairy products, canned fruits and vegetables, fabrics, footwear, wood, leather, and some construction materials such as bricks and cement, it may be necessary to produce not only for a small domestic market, but also to export a substantial amount of production to overcome the problem of the minimum efficiency level of production. More importantly, starting light manufacturing industries for both import substitution and exports may require considerable managerial and entrepreneurial skills as well as cheap skilled labour, which are very scarce in sub-Saharan Africa. In fact, there seems to exist a chronic shortage of skills not only in the manufacturing sector, but also in all sectors of the economy including government services and other vital financial, legal and educational services.

FDI appears to be a way out of this dilemma for many sub-Saharan African economies. Transnational corporations operating in global markets are able to supply the necessary technology, management and marketing skills. Such corporations may produce part of the products for domestic markets and the rest for nearby overseas markets or for re-export to their home countries. Many of today's successful exporters of manufactured goods in Asia-Pacific countries such as China, Indonesia, Malaysia and Thailand gained an initial foothold in the export markets through joint ventures or other cooperative arrangements with transnational corporations. The success story of Mauritius in textile exports with foreign collaboration is a good example in Africa. There may be some concern that FDI may perpetuate the dependence of host countries on transnational corporations for technology, management and marketing. This concern is contradicted by recent developments in East and South-East Asian countries, as described earlier. Most of these countries launched an export drive in light manufacturing at first and consumer durable goods and some intermediate and capital goods later, initially making use of foreign technology, expatriate management and imported inputs, together with cheap and skilled domestic labour. While expanding export volumes, conscious efforts have been made to replace an increasingly larger part of imported inputs with domestic inputs through a time-phased local content programme, and over time, to meet a substantial part of the need for managerial and entrepreneurial skills locally through learning by doing. In particular, the second-phase import substitution strategy geared to the needs of export expansion could, as discussed earlier, lessen and eventually eliminate the dependence of host countries on foreign firms for technology, production, management and marketing.

Apart from the fact that total global sales by transnational corporations outside their countries eclipsed total world exports by a considerable margin in 1992 for the first time in history, as noted at the outset, special attention needs to be drawn to the significant increase in FDI by NICs in recent years. Driven by rapidly rising labour costs and the erosion of its low-end manufacturing competitiveness, many Asian NICs, such as Hong Kong, Republic of Korea, Singapore and Taiwan Province, are today shifting their labour-intensive light manufacturing to relatively lower-labour-cost countries such as China, Viet Nam and ASEAN countries. For instance, Taiwan Province investments in China have been estimated at $20 billion in recent years [44]. Total investment by the Republic of Korea in China has now surpassed $600 million with almost 300 projects, which are all concentrated in the coastal regions [45]. In recent years, Chile has been investing heavily in other Latin American countries such as Argentina, Mexico and Peru, with rapidly accumulating privatized pension funds, which so far total $13 billion. FDI by Chile was up steeply from only $10 million in 1988 to $428 million in 1992, according to the central bank of Chile, but an unofficial estimate put the figure at around $800 million if undeclared investments were counted [46]. It may be worthwhile for sub-Saharan African countries to intensify their efforts to attract FDI from Asian and Latin American NICs in manufacturing, in addition to FDI from developed countries, particularly emphasizing their preferential margins *vis-à-vis* other developing countries in terms of special preferential market access to developed countries, which has been little used so far. Such FDI may enable host countries to upgrade their technological capacity over time through learning opportunities provided by the training of management and workers, provision of input specifications, assistance in quality control production techniques and plan layout, and even collaborative design and production. Empirical studies on the impact of foreign-owned firms on industrial development in sub-Saharan Africa are relatively scarce. But results from some available studies point to positive impacts of transnational corporations. For instance, Lall and Streeten examined eight transnational corporations that operated in Kenya in the mid-1960s, accounting for 18 per cent of output and 8 per cent of employment. They estimated the social profitability of these corporations to be around 13 per cent of sales, where social profitability is defined to be social benefits minus social costs calculated by shadow prices. In other words, these corporations generated net benefits to the Kenyan economy [47].

The paucity of managerial and entrepreneurial skills coupled with weak technological capacity argues strongly for the crucial role that FDI could play in building a manufacturing base in the initial phase of industrialization, but current prospects for FDI in sub-Saharan Africa look bleak, given the debt overhang and payment arrears in the region. Moreover, FDI is increasingly attracted by the availability of cheap skilled labour, which it is supposed to develop. High priority should be assigned to the formulation and implementation of policies designed to attract FDI, covering a wide range of incentives such as tax policies, technology policies, transfer pricing control, investment guarantee schemes, dispute settlement and transparent legal and regulatory frameworks conducive to FDI, while concentrating on education and vocational training which are up-to-date and relevant to manufacturing. Above all, international cooperation and particularly financial and technical assistance from international organizations and technical assistance agencies may be essential to create a favourable and competitive environment to attract FDI to sub-Saharan Africa.

(e) *Debt relief*

Debt overhang seems to be the most serious drag on industrialization in sub-Saharan Africa. Sub-Saharan African debt may not be big enough in global terms to be cause for concern for the international banking community. The aggregate figure, however, belies the gravity of the debt burden borne by sub-Saharan countries. Sub-Saharan African debt may not pose a direct threat to the stability of the international financial system, but it has already reached crisis proportions in the informed judgement of many experts and specialists in this field.

It is a crisis because their debt relative to GNP is prohibitively high, and, more importantly, there is little room for demand and supply adjustments to cope with mounting payment difficulties. The root cause of the sub-Saharan African debt crisis is the result not just of a short-term liquidity squeeze but of fundamental structural imbalance. It is the colonial legacy of an economy which specializes in the production and export of a few primary commodities and imports nearly all essential goods and services. It is an economy which is extremely vulnerable to various external shocks such as the plummeting of world commodity prices and oil price variations. It is an economy which is incapable of boosting export sales to generate extra foreign exchange earnings to meet the worsening debt service burden. It is an economy whose per capita incomes hover around the levels of abject poverty, whose imports are already pared to the minimum subsistence level, on the verge of "import strangulation", deprived of critical parts and raw materials and of capital goods, resulting in widespread capacity underutilization and unemployment, as detailed elsewhere in the present chapter.

The limited capacity of sub-Saharan African economies for supply and demand adjustments is compounded by their very restricted access to private capital markets, except for a handful of oil exporters, and the diminishing inflows of official development assistance from developed countries, which are becoming increasingly aid-weary and subject to fiscal retrenchment, particularly at a time of worldwide recession. It must be recognized that the debt problems of sub-Saharan Africa are basically structural ones, requiring the broadening of the industrial base and structural change away from its overdependence on the production of a very narrow range of primary products for export. It is essential to change the rules and practices governing the allocation of financial resources to facilitate structural change in sub-Saharan African countries. In particular, the terms and conditions of official aid need to be relaxed, and the current adjustment period of 5 to 10 years at low interest rates should be lengthened in order to facilitate structural change and to expand resource inflows on a much larger scale than at present.

Most important of all, it must be recognized by the international community, by both donor and recipient countries, that sub-Saharan Africa presents a special problem which deserves special consideration. Indeed, there is a strong case for treating sub-Saharan Africa differently. This calls for sympathetic understanding from other debtor developing countries as well as donor countries. Partial cancellation of sub-Saharan African debt by some donor countries in recent years, although symbolic, is a significant step in the right direction, and further substantial debt relief is essential to revitalizing industries and economies in the region.

E. Conclusions and policy implications

1. *Trade and industrialization*

In the present study, the role of trade in industrialization has been examined at great length. The study concludes, among other things, that trade could be a very powerful instrument of industrialization and economic development, provided that certain important preconditions are met. In particular, the Asia-Pacific model of export-led industrialization coupled with export-linked secondary import substitution has proven very effective in accelerating industrialization over the last two decades. Emerging from the first phase of import substitution during the 1950s and 1960s, the Asia-Pacific countries shifted to the phase of the export drive during the 1970s and 1980s, initially concentrating on the natural-resource-based or labour-intensive products such as food processing, textiles and garments, rubber products and electronic assembly. The competitive export industry was built on foreign technology usually linked to FDI. The rapid increase in FDI was followed by a surge in the imports of intermediate and capital goods from the supplier countries of FDI. As imports of intermediate and capital goods became essential for sustaining the export-led growth, the second phase of import substitution strategy was launched, this time focusing first on the domestic production of technologically less demanding intermediate goods, and then on technology-intensive capital goods through learning by doing and other policy measures designed to upgrade technological capacity. The secondary import substitution has in turn broadened the industrial base, deepened domestic interindustry linkages, and improved technological capacity. Empirical results obtained from an input-output analysis of the structure of trade and a decomposition analysis of the sources of industrial growth in the Asia-Pacific countries confirmed the primacy of manufactured exports in accelerating industrialization and the strategic importance of import capacity and its stability to sustain the export drive.

The logical question to be raised is then: why not the Asia-Pacific model for sub-Saharan Africa? It is widely accepted that certain preconditions may have to be established before launching an EOI strategy. First of all, industrial supply capabilities need to be built up, usually by providing a period of protection for so-called infant industries in the domestic market. Almost every successful exporter started with import substitution of light consumer goods. The rationale for the infant industry argument is that the period of protection is provided to increase technical efficiency and the competitive edge in the world market. Building blocks for industrial supply capabilities include many interrelated aspects of development which are not directly related to trade, and which precede the design of a policy framework for export promotion. For instance, the basic physical infrastructure—transport, communications, water, gas, electricity etc.—is essential to manufacturing. On the intangible side, human capital accumulation and skill improvement through education and training along with the creation of an entrepreneurial class are equally, if not more, important. Closely related to human capital accumulation is a concomitant development and continuous upgrading of technological capacity to assimilate the latest technology, and to enhance product design capacity through institution building for science and technology. Institution building should also focus on the strengthening of administrative capacity along with a corps of competent technocrats.

In general, none of these basic building blocks for manufacturing capacity seems to exist in sub-Saharan Africa. The Asia-Pacific model of EOI strategy is simply not replicable at the early stages of industrialization, in which sub-Saharan Africa finds itself today. It seems evident, therefore, that in sub-Saharan Africa, the role of manufactured exports as an instrument to push industrialization becomes less important than non-trade policy measures such as selective industrial targeting and nurturing of infant industries, agricultural development and rural industrialization, strengthening domestic linkages between agriculture and manufacturing, promoting infrastructure development and institution building. The relative efficacy of the EOI strategy may vary according to time and place, depending on the initial conditions and the level of industrialization of the country in question. In sum, industrial productivity is the basic determinant of economic growth, while exports are a facilitating factor for such growth.

2. *Markets versus State*

Another important question raised at the outset of this study concerns the universality of free market and free trade principles across economies regardless of the level of industrialization and social and economic conditions. Is "getting the prices right" the best policy for industrialization and development? Obviously, a correct price signal alone may not be sufficient to induce and sustain the growth of industrial output without adequate physical infrastructure and socio-economic institutions. It has been argued in this study that the scope for State intervention seems to depend on the stages of industrialization. At the initial stages, where there are no functioning markets, State intervention may be quite extensive, undertaking public investment in infrastructure and institution building and forcing industrialization, given the inability of the private sector to mobilize financial resources and undertake huge investment projects; but the scope for such intervention may diminish progressively as the market plays an increasingly important role in guiding the process of industrialization and the industrial structure becomes mature and complex.

Today few doubt that successful East Asian industrialized countries and areas such as Japan, Republic of Korea, Taiwan Province and most of the ASEAN countries were strongly interventionist. The question is not whether the State intervention *per se* is good or bad, but what matters most is the nature and quality of intervention. The outcome of intervention will critically depend not only on the objective of intervention, for instance, inward- or outward-oriented industrialization, but also on the capability of the State to initiate and guide structural transformations leading to the functioning of free markets. In the past, active policy interventions in the East Asian countries were targeted at the creation of competitive export industries and an outward-oriented economy after the initial phase of import substitution. This transition was considerably facilitated by the development of efficient government machinery capable of overriding the competing demands of vested interest groups and disciplining various economic actors to implement technocratic policies. In many other developing countries, State intervention was equally active, but often failed by misdirecting efforts towards an unsustainable strategy such as inward-looking industrialization, compounded by the problem of weak government capacity to pursue a coherent policy.

Like market reforms, the impact of trade liberalization may also vary considerably from country to country, depending on the level of industrialization of the countries concerned. For instance, for a small undiversified economy with a small manufacturing base, trade liberalization may become soon untenable because of a surge of imports for which foreign finance could not be found. It may seem more logical to introduce import liberalization after domestic manufacturing capacity is sufficiently developed and a successful export drive is launched. To be more specific, trade liberalization may be achieved in step with the progress of the export drive through a combination of time-phased relaxation of import controls, selective opening of domestic markets for foreign suppliers, rationalizing tariff structures, establishing realistic real exchange rates, more transparent effective protection via tariffs rather than quantitative restrictions etc. In this manner, a foreign exchange squeeze could be avoided through growing export revenue paying for the increasing imported inputs needed for expanding exports.

The foregoing discussion seems to suggest that a proper sequencing of various policy reforms is critically important to the EOI strategy. There is clearly no universally applicable approach to the sequencing of policy reforms. The optimal design and sequence may be country-specific and vary considerably across countries, depending on the initial conditions, and especially the degree of political commitment to reforms and the bureaucratic capacity to implement reforms in the country concerned [48]. However, despite considerable intercountry variations, the following broad boundary conditions for sequencing may be suggested. First of all, apart from the crucial importance of basic infrastructure, the overall manufacturing capacity must be developed before building an export base. At the same time, macroeconomic stabilization is essential to create a favourable macroeconomic environment for rapid industrial growth. Therefore, macroeconomic reforms should precede structural reforms, including trade reforms. Moreover, import liberalization should be introduced well after the upsurge of manufactured exports. Finally the liberalization of financial and capital markets should come after trade reforms in order to gain some degree of control over international capital flows, which is essential to an orderly transition to an export-oriented economy and to stability in financial and capital markets.

3. *Agenda for industrial revitalization in sub-Saharan Africa*

Sub-Saharan Africa today confronts a set of formidable external and internal constraints to industrialization. They include crushing debt burdens and crippled import capacity; overwhelming dependence on commodity exports and narrow specialization in a few commodity exports to a small number of countries, leading to instability and a secular decline in export revenues, as well as a foreign exchange squeeze; infrastructure bottlenecks in areas such as transport, communications, water, gas and electricity; acute shortages of managerial and entrepreneurial skills and skilled labour; inadequate administrative capacity and weak technological capacity; and embryonic economic and social institutions, including financial and capital markets, legal systems and other supporting technical services.

Under these external and internal constraints, it is clear that strategy options open to sub-Saharan Africa seem to be very limited. The following points must be taken into account in formulating a viable strategy for industrial revitalization in sub-Saharan Africa.

(a) First and foremost, the onerous debt burdens of sub-Saharan Africa must be substantially alleviated. The debt overhang has caused a severe import compression of vital manufactured inputs and contributed to widespread capacity underutilization, thus stifling the development of small manufacturing industries in the region. The debt burden is obviously one of the most critical constraints to industrialization in sub-Saharan Africa, and its generous relief through outright cancellation or easing of the terms and conditions of debt on a greater scale than hitherto granted by donor countries is an essential precondition for industrial revitalization in sub-Saharan Africa;

(b) It must be recognized that the promotion of manufactured exports catering to world markets as a major vehicle for accelerating the pace of industrialization in the region is beyond the realm of feasibility for sub-Saharan Africa in the short and medium terms;

(c) Despite downward trends for commodity prices, sub-Saharan African countries have no other alternative but to expand traditional commodity exports to earn foreign exchange for industrial finance;

(d) While focusing on import substitution in light manufacturing, the development of resource-based industries could be selectively targeted at the same time. As underscored earlier, resource-based industrialization should be consistent with the operational and technological constraints of an economy. In this regard, the development or revitalization of agroprocessing industries is to be encouraged, while mineral processing is to be postponed until such a time as a broad manufacturing base is firmly established, because of its high technological requirements, scale economies and capital-intensiveness;

(e) No one can afford to stand by idly hoping for economic and technological constraints to disappear. In the light of rapidly growing FDI, whose economic significance may soon equal, if it does not already equal, that of trade, it is essential to start the process of industrialization, first by actively seeking FDI in light manufacturing for both import substitution and exports. Given the considerable competitive disadvantage of the region in attracting private capital flows, concerted efforts must be made to find ways and means of attracting FDI through international cooperation, particularly multilateral and bilateral technical and financial assistance, and of creating a favourable competitive environment for FDI from all sources, including NICs in East Asia and Latin America;

(f) Finally, successful industrialization in sub-Saharan Africa will depend critically on other factors which are not directly related to trade, such as the build-up of basic supply capacity. In this context, the development of physical infrastructure and human capital, institution building, rural industrialization and strengthening manufacturing linkages with agriculture and with the rest of the economy are of paramount importance, and were a major focus of chapter III of the UNIDO *Global Report 1992/93*.

4. *Possible lessons for sub-Saharan Africa from the Asia-Pacific experience*

The universal applicability of free market principles and trade liberalization across countries at different stages of industrialization seems to be contradicted by empirical evidence. Perhaps there may be a different set of optimal policies for each different stage of industrialization. On the other hand, each export success story based on the selective interventionist approach, particularly in East Asian countries, has more to do with unique country experiences than general characteristics of trade policy and market reforms, and hence may not provide a directly useful model for other developing countries. Nevertheless, it seems reasonable to deduce and generalize certain patterns of development discernible from a wide spectrum of country experiences of both success and failure. In this context, almost all aspects of the Asia-Pacific experience may offer broad lessons for policy makers in sub-Saharan Africa. They include, among other things, industrialization strategies, macroeconomic management, trade regimes with export promotion, market incentive structures, human resources development, technological policies, FDI and regional economic integration schemes. It is obviously beyond the scope of this study to provide a comprehensive comparative assessment of the two regions. Instead, the focus will be on the specific aspects of the Asia-Pacific experience in industrialization and trade outlined below, which may serve as useful signposts in the industrialization process to be considered by policy makers in sub-Saharan Africa.

(a) Many of the successful Asia-Pacific exporters of manufactured goods, in particular Indonesia, Malaysia and Thailand, depended heavily on traditional commodity exports to finance infant industries not long ago, and today have been transformed into major exporters of manufactured goods. Sub-Saharan African countries may gain some insight by carefully examining the transition phase during which these Asia-Pacific economies developed from being commodity exporters to being a exporters of manufactured goods, and particularly the strategy of nurturing light manufacturing under protection first, and promoting its exports later while sustaining traditional exports at the same time;

(b) As emphasized earlier, almost all successful exporters of manufactured goods started with import substitution in light manufacturing under protection. The key element in the infant industry argument is a relatively quick transition of protected industries producing for the domestic market to manufactured exports. Such a transition in many Asia-Pacific countries was completed in a relatively short period of time, and many factors were responsible for the rapid transformation. They included among other things the existence of a skilled labour force, rapid capital accumulation embodying the leading edge of world technology, and perhaps most important of all, the capacity of the State to discipline and lead the private sector toward export promotion. It may be worthwhile for policy makers in sub-Saharan African to carefully examine the Asia-Pacific experience in order to gain a better understanding of the political economy of protection;

(c) At the early stages of industrialization, the quality of State intervention is essential to structural transformation leading to the eventual functioning of market systems. In this regard, the East Asia experience may provide valuable lessons, if carefully adapted to local conditions, for sub-Saharan policy makers seeking to upgrade the quality and effectiveness of public administration and to strengthen their technocratic capacity to direct the overall economic transformation;

(d) Many of today's successful exporters of manufactured goods in the Asia-Pacific region, such as China, Indonesia, Malaysia and Thailand, gained an initial foothold in export markets through joint ventures or other cooperative arrangements with transnational corporations. Given the paucity of managerial and entrepreneurial skills coupled with relatively weak technological capacity in sub-Saharan Africa, FDI may be one effective way to build a manufacturing base for import substitution and exports. Despite the current debt overhang, payment arrears, the lack of cheap skilled labour and many other unfavourable factors which may deter FDI in the region, concerted efforts should be made to improve the investment climate, through the formulation and implementation of policies designed to attract FDI. The Asia-Pacific experience may offer some useful lessons for sub-Saharan policy makers in this area;

(e) A wide array of export promotion measures and instruments developed in various Asia-Pacific countries may offer a broad menu from which to choose a set of export instruments suited to the needs and conditions of specific countries in sub-Saharan Africa. Among many export promotion schemes to be considered are technical marketing support to potential exporting firms, direct export subsidies and other preferential export financing, fiscal and investment schemes, export processing zones, bonded warehouses and factories, duty drawbacks and tax rebates on imported inputs, new export credit, pre-shipment financing, export credit guarantees and the establishment of an export-import bank;

(f) Finally, sub-Saharan Africa may benefit from a systematic comparative assessment of export-led industrialization strategies of various Asia-Pacific countries in general, and of the design and sequence of their policy reforms in particular. It was emphasized earlier that a proper sequencing of various policy reforms is crucial to the success of the EOI strategy. Although the strategy pursued by most Asia-Pacific countries can be broadly characterized as export-oriented, the experience of each country may be historically unique and divergent from a stylized EOI strategy, given the vastly different socio-economic conditions and historical legacies of those countries. Great caution must obviously be exercised in drawing lessons for sub-Saharan Africa from the dynamic industrial growth of the Asia-Pacific region, particularly in view of the enormous institutional variations across countries in terms of the political commitment to policy reforms and the organizational capacity to implement them.

Annex I

METHODOLOGY FOR INPUT-OUTPUT DECOMPOSITION

The analytical framework used for the decomposition of the sources of growth is based on an accounting identity of input-output material balance. In other words, each industry output is equal to its various uses, that is, intermediate use, final demand and exports. A change in the material balance between two periods was then taken to match the change in industry output to changes in various uses. In short, it is a demand-side decomposition using a comparative statics framework.

The variables defined below will be used to describe the decomposition method used in the present study. Unless specified otherwise, matrices are henceforth denoted by capital letters and vectors are written as lower-case letters.

A is a (nxn) total input coefficient matrix, that is, domestic plus imported inputs divided by the total output of each industry (column sum).

M is a (nxn) imported input coefficient matrix.

$A^d = A - M$, *a (nxn)* domestic input coefficient matrix.

q is a (nxl) output vector.

f *is a (nxl)* final demand vector.

f^m *is a (nxl)* import demand vector.

$f^d = f - f^m$, *a (nxl)* domestic demand vector.

x *is a (nxl)* export vector.

ε *is a (nxl)* vector of errors, or statistical discrepancy.

Then, an input-output material balance equation is

$$q = A^d q + f^d + x = (I-A^d)^{-1} (f^d + x) = R^d(f^d + x) \quad (1)$$
$$\text{where } R^d = (I-A^d)^{-1}$$

Taking a difference of q between two periods and adding to and subtracting from the equation the same term $R_1^d(f_2^d + x_2)$ will yield

$$\Delta q = q_2 - q_1 = R_2^d (f_2^d + x_2) - R_1^d (f_1^d + x_1) \quad (2)$$
$$= R_2^d (f_2^d + x_2) - R_1^d (f_2^d + x_2) + R_1^d (f_2^d + x_2) - R_1^d (f_1^d + x_1)$$

From the third and fourth terms is derived:

$$R_1^d (f_2^d + x_2) - R_1^d (f_1^d + x_1) = R_1^d (\Delta f^d + \Delta x) \quad (3)$$
$$= R_1^d (\Delta f - \Delta f^m + \Delta x)$$

From the first and second terms is derived:

$$R_2^d (f_2^d + x_2) - R_1^d (f_2^d + x_2) = \Delta R^d(f_2^d + x_2) \quad (4)$$

From equations (3) and (4), a change in output is decomposed as follows:

$\Delta q = R_1^d \Delta f$	(final demand effect)	(5)
$- R_1^d \Delta f^m$	(final demand import substitution effect)	
$+ R_1^d \Delta x$	(export effect)	
$+ \Delta R^d(f_2^d + x_2)$	(effects of technical change + input import substitution)	

Moreover, when the residual vector (or statistical discrepancy), ε, is included in the material balance equation (1), i.e., $q = A^d q + f^d + x + \varepsilon$, the residual vector r is added to the decomposition of a change in output, i.e.:

$$\Delta r = R_2^d \varepsilon_2 - R_1^d \varepsilon_1 \quad (6)$$

Annex II

DEFLATORS FOR INPUT-OUTPUT TABLES

The decomposition analysis requires the appropriate deflation of the input-output tables for each period and each country so that the flows of output are expressed in constant prices. Ideally, the data for all economies and periods should be deflated by a common set of world prices for a representative year. In the absence of such a common deflator, the output sale of each sector to both intermediate and final demand is deflated by the 1985 domestic constant price of that sector. In the present study, the 1975 tables were deflated to the 1985 prices, taking 1985 as the base year. The sectoral output deflators are calculated from the gross domestic product of each country by kind of activity in both current and constant prices, which are given in the United Nations national accounts statistics.* As a result, the sectoral classification adopted for deflators corresponds to that used in the national accounts statistics. The sectors include agriculture, mining, manufacturing, public utilities, construction and services. Deflators for services are a weighted average of the four subactivities of the service sector given in the national accounts, as follows: wholesale and retail; transport and communications; finance, insurance, real estate and business services; and community, social and personal services. Each sectoral output in terms of the 1985 constant national currency was converted into the United States dollar equivalent by multiplying the average exchange rates that prevailed in 1975 and 1985.

With separate sectoral output deflators estimated from national accounts statistics, the purchase of domestic inputs and final expenditure of each sector was deflated by the output deflator of the supplying sector. The imported inputs of each sector were deflated by the sectoral output deflators of the country of origin. Finally, to ensure the consistency of the material balance, value added at constant prices is derived by subtracting the constant price value of domestic and imported intermediate inputs from the constant price value of output. The sectoral output deflators for selected Asia-Pacific countries are given in table III.20.

It should be noted that the relatively large sectoral deflators for the Philippines reflect economic stagnation with marginal changes in real sectoral output together with an almost threefold devaluation of the peso in relation to the United States dollar between 1975 and 1985.

*See *National Accounts Statistics: Main Aggregates and Detailed Tables, 1989* (United Nations publication, Sales No. E.91.XVII.16), parts I and II.

Table III.20. 1975 output deflators for selected Asia-Pacific countries in 1985 prices
(1985 = 100)

Sector and item	Indonesia	Malaysia	Philippines	Republic of Korea	Singapore	Thailand	Japan	United States
Agriculture	64.7	68.5	179.2	151.0	93.7	86.0	84.7	79.6
Mining	37.7	52.6	209.8	164.5	47.2	57.4	81.5	96.0
Manufacturing	25.9	47.1	206.3	56.0	50.5	66.6	44.5	69.2
Public utilities	56.9	42.2	108.7	37.0	41.9	43.8	51.6	76.5
Construction	41.2	42.3	238.6	61.2	38.0	61.1	78.3	90.3
Services	45.8	50.3	196.5	76.4	40.6	66.7	49.4	70.6
GDP	45.3	53.5	195.4	83.6	45.7	69.1	53.5	74.0

Source: *National Accounts Statistics: Main Aggregate and Detailed Tables, 1989* (United Nations publication, Sales No. E 91.XVII.16).

INPUT-OUTPUT INDUSTRIAL CLASSIFICATION SYSTEM

Table III.21. Classification of intermediate industries

Code	7-sector classification	Code	24-sector classification	Code	Basic classification[a]
001	Agriculture, livestock, forestry and fishery	001	Paddy	001	Paddy
		002	Other agricultural products[b]	002	Cassava
				004	Sugar cane and beet
				005	Oil-palm and coconuts
				006	Fibre crops
				007A	Other grain
				007B	Other food crops
				008	Other commercial crops
		003	Livestock	009	Livestock and poultry
		004	Forestry	010	Forestry
		005	Fishery	011	Fishery
002	Mining and quarrying	006	Crude petroleum and natural gas	012	Crude petroleum and natural gas
		007	Other mining	013	Copper ore
				014	Tin ore
				015A	Iron ore
				015B	Other metallic ore
				016	Non-metallic ore and quarrying
003	Manufacturing	008	Food, beverages and tobacco	017	Oil and fats
				018	Milled rice
				019	Other milled grain and flour
				020	Sugar
				021A	Fish products
				021B	Slaughtering and meat products
				021C	Other food products
				022A	Beverages
				022B	Tobacco
		009	Textiles, leather and the products thereof	0023	Spinning
				024	Weaving and dying
				025	Knitting
				026	Wearing apparel
				027	Other made-up textile products
				028	Leather and leather products
		010	Timber and wooden products	029	Timber
				030A	Furniture
				030B	Other wooden products
		011	Pulp, paper and printing	031	Pulp and paper
				032	Printing and publishing
		012	Chemical products	033A	Synthetic resins and plastic
				035B	Other chemical products
		013	Petroleum and petroleum products	036	Refined petroleum and its products
		014	Rubber products	003	Natural rubber
				037	Tyres and tubes
				038	Other rubber products
		015	Non-metallic mineral products	039	Cement and cement products
				040	Glass and glass products
				041	Other non-metallic mineral products
		016	Metal products	042	Iron and steel
				043	Non-ferrous metal
				044	Metal products
		017	Machinery	045A	Agricultural machinery and equipment
				045B	Specialized industrial machinery
				045C	Ordinary industrial machinery
				045D	Heavy electric machinery
				045E	Engines and turbines
				046A	Electronics and electronic products
				046B	Other electric machinery and appliances
		018	Transport equipment	047A	Motor vehicles
				047B	Motor cycles and bicycles
				048A	Aircraft
				048B	Shipbuilding
				048C	Other transport equipment

Code	7-sector classification	Code	24-sector classification	Code	Basic classification[a]
		019	Other manufacturing products	049	Precision machines
				050A	Plastic products
				050B	Other manufacturing products
004	Electricity, gas, and water supply	020	Electricity, gas, and water supply	051	Electricity, gas, and water supply
005	Construction	021	Construction	052A	Building construction
				052B	Other construction
006	Trade and transport	022	Trade and transport	053A	Wholesale and retail trade
				053B	Transportation
007	Services	023	Services	054A	Telephone and telecommunication
				054B	Other business services
				054C	Other services
				056	Unclassified
		024	Public administration	055	Public administration

Source: *Asian International Input-Output Table 1985* (Tokyo, Institute of Developing Economies, 1992).

a/ This is the most detailed classification. In some countries, some sectors are aggregated.

b/ In China, Malaysia and the United States, "paddy" is included in this sector.

IV. A survey of selected manufacturing industries

Thirteen comprehensive industry surveys are presented in the present chapter. Five of these analyse the primary processing industries. Included among the food- and wood-processing industries are cocoa processing (ISIC 3119), seafood processing (ISIC 3114), and market pulp (ISIC 341101-341116). The mineral-resource-based industries selected are copper processing (ISIC 3720041-3720042) and petrochemicals (ISIC 351103-351131). These are followed by surveys of intermediate goods industries with a high-technology content. Included are fine chemicals (parts of ISIC 3512, 3522, 351102), higher-value-added steel (parts of ISIC 3710 and 3819), and advanced materials (part of ISIC 3513, 3610, 3620, 3710 and 3720). The remaining surveys deal with the important issue of financial and technological revitalization of capital-goods industries. The industries covered are semi-conductors (ISIC 383228), power-generating equipment (ISIC 3831), fertilizer equipment (ISIC 3822), industrial lift trucks (ISIC 384315-384319) and numerically controlled machine tools (ISIC 3823).

In the primary processing industry, profitability and subsequent investment vary with the cyclical market conditions induced by changes in the industries requiring its output. This is particularly true of raw materials processors such as the market pulp and copper processing industries. Fluctuations in cocoa also depend on supply problems, and in seafood they vary with price and consumer taste. The petrochemical survey 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.

In the case of intermediate industries, the production level depends not only on the derived demand for their outputs but also on the costs of their inputs. These industries are also critical for their forward and backward linkages to other industries in the overall economy. All the included industries also depend on technological advances to continue their growth. The survey of the fine chemicals industry reveals that it has very close forward linkages with the pharmaceutical, agricultural raw-materials and food industries. New types of chemicals have to be developed as the medical industry strives further to conquer traditional and new diseases. New chemicals are also needed as insect, fungus and weed varieties become hardier and more resistant. The higher-value-added steel survey addresses new technological developments in this growing industry, and also suggests how environmental implications of steel production can be overcome with the new products. The survey of the advanced materials industry reveals the speed of technological change relating to factor inputs taking place in many industries. Advanced materials compete increasingly with steel, copper, wood and chemical products, including plastics, in many areas of product manufacturing. Finally, the survey of the semiconductor industry illustrates how quickly new technologies are advanced and applied. Of particular note is how quickly NICs such as the Republic of Korea and Taiwan Province have been able to enter these high-technology domains.

Among the capital-goods industries, the survey of power-generating equipment illustrates how large industries in the North cover the world markets; yet at the same time, it shows how such industries can operate to the benefit of the South. For instance, power-generating equipment firms are being asked to participate financially in private electricity-generating firms in developing countries. The surveys of fertilizer equipment and copper processing illustrate two industries whose future to a certain extent depends on progress in developing countries. The industrial lift-truck industry depends more on what is happening in the North, particularly as business conditions affect materials handling and transport. The numerically-controlled-machine-tool and the semiconductor industries are technologically sophisticated and still dominated by developed countries in world production and trade. The development of these strategic industries poses a formidable challenge to developing countries. NICs such as the Republic of Korea and Taiwan Province have already taken up the challenge.

The surveys 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 common salient features, which are summarized below:

(a) Growth has levelled off in many industries, reflecting the gathering impact of the world recession in the latter part of 1992 and its continuation in 1993. In some of the resource-based industries, such as copper processing, capacity utilization has been high and stocks for certain products have become low. The steel industry has just gone through a period of retrenchment, and price levels are not yet sufficiently high to stimulate capacity expansion, yet some hope rests in the development of higher-value-added steel products. In the case of fertilizers, demand increases have nudged prices upwards, with some new capacity additions facing the fertilizer equipment industry. Likewise, the currently low level of capacity utilization coupled with environmental

concerns in the petrochemicals industry suggests that no new capacity expansion will soon occur. In capital-goods industries such as industrial lift trucks, sales in some countries are influenced by recession, while growth is occurring in the markets of other countries with growing manufacturing sectors;

(b) A growing trend towards less government intervention and more deregulation and privatization is discernible. One of the most noticeable changes is taking place in the power-generating industries, where a number of Governments are encouraging private electricity generation. The supporting equipment industry has been affected in its requested participation by Governments of the South. In the 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 petrochemicals industry, where government involvement has increased. In the countries of Eastern Europe and the former USSR, the rate of privatization has become extremely high; this movement in fact is likely to dominate economic change in those countries over the next several years. However, progress in the new market-oriented industries is slow, and in the case of the machine tool industry, some time will be required before modernization is completed;

(c) Trends towards consolidation have been evident among the more advanced industries, particularly in high technology, as companies gear up to global competition. Thus, merger and acquisition activity has been extensive in the semiconductor and the power-generating equipment industries. This extensive restructuring has been a response to substantial excess capacity, and adverse economic conditions have weakened demand. The restructuring of these industries worldwide has been carried out not only through the closure of obsolete plants, upgrading capacity, trimming the workforce, increased R and D expenditures and a shift in production towards higher-value-added output, but also through mergers, take-over bids and acquisitions. The copper-processing industry, which is now experiencing greater sales and profits, provides a good example of the benefits gained by industries that engaged in such restructuring. Examples of other such industries include the semiconductor and petrochemicals industries;

(d) In international trade, the United States and Asia are of growing importance as export markets for other countries, the former because it can take advantage of production cost differentials in exporting developing countries, and the latter because demand has far outstripped the capacity of local supply. The countries of Eastern Europe and the former USSR are likely to provide markets eventually for high-technology products such as higher-value-added steels, advanced materials or semiconductors. Another important factor will be the impact on world markets of increasing unification of the EEC countries;

(e) The rapid adoption of new technologies appears to be essential to the survival and expansion of many capital-goods industries. For example, the modernization of the numerically-controlled-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. Technology has also been driving the power-generating equipment industry, where energy costs and environmental controls have fostered more energy-efficient and lower-polluting equipment. Furthermore, many mining and mineral-processing industries have developed or purchased subdivisions that produce advanced materials, which often serve as substitutes for traditional mineral-based products;

(f) 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 power-generating equipment, semiconductors and fine chemicals. However, the location of such industries in developed countries is likely to persist, because of their need for advanced technology and financial resources, and because of their geographic proximity to their respective end-using industries;

(g) Environmental concerns are having a growing impact on the technology choice and the location of highly polluting industries. This has become paramount in the power-generating equipment industry, where users have to make a choice, for example, between natural gas or coal-fired boilers, nuclear power or hydropower. Investment also in other industries such as petrochemicals, industrial lift trucks, seafood processing, higher-value-added steel, copper processing and market pulp for paper are being markedly affected by more stringent environmental regulations and consequent higher costs of pollution abatement. There is thus likely to be relocation of these and other industries to developing countries, where pollution controls are less stringent. In some cases, such as petrochemicals, the production of lower-technology chemicals would also be more suited to production in developing countries. In other cases, the market pulp industry is concerned as to whether Governments will influence increased use of waste paper;

(h) Finally, increased 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 cocoa processing, seafood processing and petrochemicals. In the case of advanced materials the shift has been slower, but some attraction also exists in the availability of raw material feedstocks. An increase in the demand for such manufactured products is also expected in Eastern Europe and the former USSR.

A. Cocoa processing (ISIC 3119)*

1. Recent trends and current situation

For most of the past 10 years the world cocoa processing industry has benefited from strong growth in demand for chocolate confectionery in developed countries. At the same time, however, there has been a surplus in cocoa production. Since supply exceeded demand, cocoa bean prices have been driven downwards for a prolonged period of time. Excessive cocoa bean stocks, as much as two thirds of a year's demand, have also contributed to this downward pressure on prices. Low bean prices, in

*UNIDO acknowledges the contribution of Peter Greenhalgh, Landell Mills Commodities Studies, Cocoa and Coffee Research.

turn, have pushed down the price of cocoa products; for some processors, this has subsequently led to a squeeze on their margins of profitability. Consolidation and rationalization in cocoa-grinding has followed, as several large processing companies, most notably W. R. Grace and Cargill, have taken over many smaller companies.

At the same time, the end-use sector, which is primarily the chocolate confectionery industry, has become ever more concentrated in the hands of fewer and fewer companies. These larger processors who have moved in the direction of more centralized buying are in a better position to negotiate competitive prices for cocoa products. Increasingly, the remaining smaller- and medium-sized cocoa processors, especially those which remain independent from the large transnational corporations and which in turn often supply a dwindling number of independent medium- to small-sized chocolate companies, are moving into nearly finished products. These processors supply products such as coverture and compound coatings which have greater value added, and are reducing the share of their turnover accounted for by cocoa butter and powder sales, which have far less value added.

The growth in processing in countries where beans are grown has also exerted an important influence on the supply of cocoa products. The West African producing countries, as well as Brazil and particularly Ecuador, invested heavily in cocoa processing during the 1970s, and often sold products at or below their costs of production, mainly because of generous subsidies. This put a squeeze on the processors based in consumer countries. The 1980s saw a slight reversal in this trend; some companies retreated from this activity, or, in several cases, transnational processors have taken them over. As a result, the largest transnational corporations are playing a more significant role in cocoa processing at origin. Nevertheless, in the past two years there has been a renewal of local investment in processing in Indonesia, Malaysia and Nigeria.

(a) Production and processing

Tables IV.1 and IV.2 confirm that Western Europe is by far the largest processing region for finished and semi-finished cocoa products. In Europe, as in other cocoa-consuming countries, processors can be divided into two different types: industrial processors, who grind for semi-finished or finished products which are sold to end-users; and confectionery processors, who grind for their own purposes, but who do not sell semi-finished products on the market. Within the group of industrial processors there has been a growing split between the transnational large-scale processors of cocoa butter and powder (Grace Cocoa/De Zaan and Cargill) and the smaller companies that produce near-finished products such as coverture, block chocolate and chips for baking.

The European cocoa-processing industry expanded significantly in the late 1980s in response to what later turned out to be a short-lived boom in the demand for cocoa butter. This sudden surge was due to the reunification of Germany and the liberalization of other Eastern European economies following the downfall of Communist control in those countries. All of a sudden

Table IV.1. World grindings of cocoa beans by country, 1986 and 1991
(Thousand tonnes)

Economic grouping, region and country	Grindings 1986[a]	Grindings 1991[b]	Grindings Percentage change 1986-1991	Final consumption 1986[a]	Final consumption 1991[b]	Final consumption Percentage change 1986-1991
Developed economies						
Western Europe	675.8	995.7	47.3	681.0	975.0	43.2
North America	249.9	358.0	43.3	526.1	613.1	16.5
Eastern Europe and former USSR	213.3	116.3	-45.5	270.0	170.0	-37.0
Japan	35.4	42.0	18.6	79.7	109.3	37.1
Other	19.4	18.0	-7.2	39.9	40.6	1.8
Total, A	1 193.8	1 530.0	28.2	1 596.7	1 908.0	19.5
Developing economies						
Latin America	376.7	357.0	-5.2	150.9	198.9	31.8
Asia						
Market economies	64.1	206.0	221.4	17.7	38.5	117.5
Centrally planned economies (including China)	18.0	25.0	38.9	15.1	29.4	94.7
Western Asia	-	-	-	10.6	22.2	109.4
Africa	186.9	203.0	8.6	-	-	-
Total, B	645.7	791.0	22.5	194.3	289.0	48.7
Total, A and B	1 839.5	2 321.0	26.2	1 791.0	2 197.0	22.7

Sources: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992); and International Cocoa Organization, *Quarterly Bulletin of Statistics* (London, December 1992), vol. XIX, No. 1.

a/ Crop year 1985/86.

b/ Crop year 1990/91.

Table IV.2. World's largest countries grinding and consuming cocoa, 1992[a/]
(Thousand tonnes)

Grinding				Consumption			
Rank	Country	Quantity	Percentage share	Rank	Country	Quantity	Percentage share
1	Germany	300.0	12.9	1	United States	566.2	25.8
2	United States	291.0	12.5	2	Germany	277.6	12.6
3	Netherlands	267.0	11.5	3	United Kingdom	182.5	8.3
4	Brazil	224.0	9.6	4	France	156.4	7.1
5	United Kingdom	136.0	5.9	5	Japan	109.3	5.0
6	Côte d'Ivoire	120.0	5.2	6	Former USSR	93.2	4.2
7	Malaysia	90.0	3.9	7	Brazil	81.2	3.7
8	Former USSR	67.0	2.9	8	Italy	68.3	3.1
9	France	66.0	2.8	9	Spain	56.8	2.6
10	Singapore	60.0	2.6	10	Canada	46.9	2.1
	World	2 328.0	100.0		World	2 203.0	100.0

Sources: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992); and International Cocoa Organization, *Quarterly Bulletin of Statistics* (London, December 1992), vol. XIX, No. 1.

a/ Crop year 1991/92.

Western consumables, including chocolate, were freely available in many shops, and consumers stockpiled those once rare items. Chocolate manufacturers in turn demanded greater quantities of ingredients, including cocoa butter, powder and liquor. Although cocoa bean prices remained historically low, a shortage of these cocoa products in the pipeline pushed up the price of cocoa products. The ratio of the price of cocoa products to cocoa beans increased rapidly; for instance, the ratio of cocoa butter to cocoa beans rose to over 4 for a brief period in 1990, whereas the average is usually somewhere between 2 to 2.5.

Interpreting this as a permanent shift in demand across the former German Democratic Republic and Eastern Europe, processing companies expanded their capacity. In the meantime, income-constrained consumers in Eastern Europe found their problems to be purchasing power rather than the availability of chocolate, and reduced their purchases accordingly. By the time much of the new capacity came on stream, demand had stopped growing at such a swift pace, and ratios for cocoa butter had resumed their more normal levels.

In 1991/92 Germany remained the largest cocoa grinder in the world for a second consecutive year, and made nearly 13 per cent of world grindings, the result of the reunification of Germany and the move in cocoa grindings from east to west, where companies expanded capacity to meet the rise in demand for chocolate products (1991/92 reflects crop year accounting as used in the cocoa industry). Comparing primary, intermediate and final consumption, it is evident that much of Germany's grindings go to supplying the domestic industry. However, Germany also exports sizeable quantities of cocoa liquor, butter and powder, and covers the large European market with its cocoa and chocolate products.

The United States is the second largest cocoa-grinding country in the world, mainly because it is the largest consumer country. Almost the entire output of cocoa products in the United States is consumed domestically. However, the domestic supply of cocoa products is insufficient to meet demand, and imports of cocoa products (on a beans-equivalent basis) are nearly double the amount of domestic grindings. Most of the imports consist of higher-quality products. The United States supply is driven by competitive low prices, which causes the industry to offer low-quality, inferior products, compared to superior imports. Recently, the United States cocoa industry has moved away from primary grinding of cocoa products and towards purchasing basic inputs such as cocoa butter and powder for manufacturing nearly finished products such as coverture and coating. One prominent example of this is Grace Cocoa's shift in its processing plant away from grinding towards the production of a facility for producing finished chocolate products for use in the food-processing industry.

The Netherlands is the third largest global cocoa grinder, accounting for over 11 per cent of world grindings. Given recent capacity expansions, its output has been growing steadily. As a small country, the Netherlands is a relatively small consumer of finished cocoa products; however, it is a significant exporter of semi-finished cocoa products. The explanation for its position as a cocoa products exporter is that Amsterdam has historically been the dominant European cocoa port, and major companies in the cocoa-grinding industry such as Grace Cocoa/De Zaan and Cargill have large factories in the Netherlands. The Netherlands supplies most of Europe as well as other regions of the world, and all major grinders have expanded capacity in recent years, particularly to meet the growth in demand in both Western and Eastern Europe.

Cocoa processing in Brazil expanded rapidly in the 1970s because of generous tax subsidies and concessions which allowed returns of 22 per cent on investments. Processing businesses were given special lines of credit and were borrowing at negative real interest rates. It was possible, and often the case, that companies were selling cocoa products at ratios that did not even cover their costs of beans, and were still earning healthy profits. In the face of such incentives, both transnational corporations and family-owned businesses launched into cocoa processing. Unfortunately, companies were built on the assumption that such financial allowances would continue, and are now facing great difficulty following their withdrawal. This is particularly true for family-owned businesses, as contrasted with transnational corporations, which have the technical, managerial, marketing and financial resources to buttress their Brazilian operations. Currently, Brazil has one of the world's largest grinding capacities. However, it has been running at only about 75 per cent of its potential utilization rate, and this is likely to decrease because of a lack of competitiveness in the face of subsidy cuts.

Côte d'Ivoire, like Brazil, expanded its domestic cocoa-grinding industry in response to a series of government incentives. Production capacity is estimated to be around 120,000 tonnes, and processors have been working at nearly full capacity for the past four years. Cacao Barry owns three factories in Côte d'Ivoire, including a factory that produces primarily chocolate. Among others, Barry supplies its factories in France and the United States with products made in Côte d'Ivoire. Grace/De Zaan and Tardivat also have a stake in another large factory, UNICAO. Government support has gradually been withdrawn from the cocoa-processing industry in Côte d'Ivoire, although it is widely believed that the industry obtains its beans at concessionary prices. Because all the factories have ties with transnational corporations, it is likely that the industry will remain stable, and that grindings will be maintained at current levels over the next few years.

The United Kingdom is also important for cocoa processing. Grindings have been growing steadily, reaching a peak of 136,000 tonnes in 1991/92. Having a large domestic chocolate confectionery industry explains this growth in output. The United Kingdom also imports sizeable quantities of cocoa butter for use in chocolate manufacturing. Its cocoa product imports (in bean equivalent) have ranged between 46 and 76 per cent of its total domestic cocoa bean grindings. Cocoa utilization is sensitive to variations in the price of ingredients, especially since the United Kingdom permits up to 5 per cent of non-cocoa fats to be utilized in chocolate products. Demand for cocoa butter therefore increases during periods of low world prices, while substitution with cocoa butter equivalents rises when the butter price rises. Like France, the United Kingdom chocolate industry has links with territories with which the country has maintained close historic ties. Hence, imports of cocoa products from West Africa feature prominently in the United Kingdom, although the Netherlands is by far the biggest supplier of its cocoa butter. In addition, Malaysia has become a more significant exporter of cocoa butter to the United Kingdom in recent years.

France also has a prominent cocoa-grinding industry. Cacao Barry, with subsidiaries in Côte d'Ivoire and Cameroon, is the largest company operating in France. Annual grindings in France rose in the early 1990s, reaching approximately 66,000 tonnes in 1991/92. Increasingly though, France is relying on imports of semi-finished cocoa products. One reason for this has been the displacement in Cameroon and Côte d'Ivoire of cocoa-processing facilities established and managed by companies based in France. Rationalization and concentration within the cocoa-processing, coverture and chocolate manufacturing industry in France are also accountable for this shift, and are likely to remain the trend in future. One restraining factor on the growth of the chocolate industry in France is a series of controls which have operated on the price of cocoa and other raw materials. While insulating consumers from price fluctuations, these controls might well be responsible for curtailing investment in the expansion of the industry, especially since producers have been operating at lower margins of profitability. The lack of such constraints in other countries is believed to have given foreign competitors an advantage, enabling them to take over financially weakened companies in France.

(b) *Consumption*

The major cocoa-consuming countries are listed in tables IV.2 and IV.3. Some differences exist in the consumption process in each of the major countries. As shown in table IV.4, they include primary consumption or grinding, intermediate consumption, final consumption and imports. Because of a robust demand for chocolate confectionery in Western Europe and North America, grindings in those regions have been advancing, averaging nearly 5.7 per cent per annum between 1980/81 and 1990/91. Nevertheless, the recession appears finally to have had an impact on chocolate consumption, with a slow-down in growth to less than 2 per cent in 1990/91. Another factor that has constrained

Table IV.3. Current five largest countries grinding and consuming cocoa in the South, 1992[a]
(Thousand tonnes)

Grinding				Consumption			
Rank	Country	Quantity	Percentage share	Rank	Country	Quantity	Percentage share
1	Brazil	224	9.6	1	Brazil	81.2	3.7
2	Côte d'Ivoire	120	5.2	2	Mexico	40.2	1.8
3	Malaysia	90	3.9	3	Colombia	40.1	1.8
4	Singapore	60	2.6	4	Argentina	26.4	1.2
5	Colombia	39	1.7	5	China	20.8	0.9
	World	2 328	100.0		World	2 203.0	100.0

Sources: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992); and International Cocoa Organization, *Quarterly Bulletin of Statistics* (London, December 1992), vol. XIX, No. 1.

[a] Crop year 1991/92.

Table IV.4. Thirty leading cocoa-consuming countries using alternative criteria[a]
(Average consumption of beans equivalent between 1985 and 1990)

Rank	Primary consumption (grinding)		Intermediate consumption		Final consumption[c]				Net cocoa products imports[d]	
	Country	Thousand tonnes	Country	Thousand tonnes[b]	Country	Thousand tonnes	Country	Thousand tonnes	Country	Thousand tonnes
1	United States	236.0	United States	490.1	United States	512.9	Switzerland	4.67	United States	276.9
2	Brazil	230.5	Germany	195.4	Germany	188.4	Belgium and Luxembourg	3.81	France	82.4
3	Germany	229.5	Former USSR	184.6	Former USSR	185.0	Austria	3.19	Japan	54.7
4	Netherlands	211.0	United Kingdom	145.8	United Kingdom	145.8	Germany	3.05	Spain	44.3
5	Former USSR	149.3	France	119.0	France	126.9	Norway	2.94	United Kingdom	44.1
6	Côte d'Ivoire	107.8	Italy	65.9	Japan	99.2	United Kingdom	2.55	Former USSR	35.7
7	United Kingdom	101.7	Brazil	63.9	Italy	63.9	France	2.27	Australia	28.5
8	Colombia	46.2	Japan	63.5	Brazil	57.1	United States	2.09	Canada	28.0
9	Italy	46.1	Belgium and Luxembourg	62.0	Canada	49.0	Canada	1.89	Italy	17.8
10	France	44.5	Canada	47.8	Spain	44.3	Australia	1.77	Hungary	16.6
11	Singapore	44.3	Netherlands	43.8	Colombia	42.0	Sweden	1.76	Austria	12.4
12	Malaysia	43.0	Colombia	42.8	Belgium and Luxembourg	38.9	Denmark	1.74	Sweden	11.6
13	Mexico	40.2	Spain	40.9	Mexico	31.0	Hungary	1.57	Switzerland	10.2
14	Ecuador	39.8	Switzerland	40.1	Switzerland	30.8	Germany	1.54	Norway	9.1
15	Belgium and Luxembourg	38.2	Mexico	31.6	Australia	29.3	Israel	1.53	Yugoslavia	2.9
16	Japan	38.1	Australia	31.2	Germany	25.6	Netherlands	1.48	Czechoslovakia	1.6
17	Spain	37.3	Germany	24.1	Austria	24.3	Colombia	1.37	Belgium and Luxembourg	0.7
18	Cameroon	25.1	Austria	20.9	Netherlands	21.9	Greece	1.24	Germany	-41.1
19	Poland	23.0	Poland	20.6	Poland	21.3	Spain	1.14	Brazil	-173.4
20	Ghana	22.9	Sweden	17.7	Czechoslovakia	17.3	New Zealand	1.12	Netherlands	-189.1
21	Canada	21.0	Czechoslovakia	17.2	Hungary	16.6	Italy	1.11		
22	Switzerland	20.6	Hungary	16.5	China	15.7	Czechoslovakia	1.11		
23	China	18.5	Yugoslavia	15.7	Yugoslavia	15.3	Finland	1.05		
24	Germany	18.3	China	15.0	Sweden	14.9	Japan	0.81		
25	Nigeria	17.0	Ireland	13.5	Greece	12.4	Bulgaria	0.80		
26	Czechoslovakia	15.7	Greece	11.7	Norway	12.4	Ecuador	0.68		
27	Indonesia	15.2	Argentina	11.1	Argentina	11.1	Former USSR	0.65		
28	Yugoslavia	12.4	South Africa	10.1	South Africa	10.0	Yugoslavia	0.65		
29	Austria	11.9	Norway	8.9	Denmark	8.9	Poland	0.56		
30	Hungary	11.8	Indonesia	8.7	Republic of Korea	8.3	Brazil	0.39		

Source: International Cocoa Organization, *Quarterly Bulletin of Statistics* (London, March 1991), vol. XVII, No. 2.

[a] This table is intended to highlight the differences in the ranking of cocoa-consuming countries which would ensue from the adoption of different measures of cocoa consumption. With the exception of the estimate of final consumption in the Netherlands, the consumption series, which are based on statistics published in the *Quarterly Bulletin of Statistics of the International Cocoa Organization*, have been computed on a crop-year basis using a single conversion factor in respect of trade in chocolate products. These series are, therefore, necessarily different from those estimates of consumption computed on a calendar-year basis and using a variety of conversion factors in respect of chocolate.

[b] Cocoa consumption by the chocolate-manufacturing industry and other industrial users of cocoa is computed by adding the net imports of cocoa products, in beans equivalent, to grindings.

[c] Cocoa consumption by final consumer is computed by adding net trade in both cocoa products and chocolate products, in beans equivalent, to grindings. A conversion factor of 0.20 was used in cases where chocolate products are identified as containing only half the normal quantity of cocoa.

[d] Imports-exports.

growth is the saturation of the market for newer chocolate products such as chocolate-covered biscuits and puddings.

In Eastern Europe, where grindings have traditionally been prone to large fluctuations, demand has declined steadily over the past three years. As a result of rising unemployment and a related decline in incomes, demand is also likely to remain stagnant for the next two to five years. Meanwhile, many Eastern European countries are relying on imports of finished or semi-finished products to meet domestic demand resulting from the obsolescence and lack of competitiveness of many local processing factories.

Demand has been rising consistently and rapidly in Asia since the early 1980s, although it is growing from a small base as compared with that of countries in Western Europe and North America. Demand in Asia should continue to expand more rapidly than elsewhere through the 1990s.

(c) *Major cocoa-producing countries in the South*

Cocoa is a typical primary commodity in that it is grown mostly in developing countries and consumed largely in developed countries. Tables IV.3 and IV.4 show that it is consumed primarily in the United States and Western Europe. Very little cocoa is consumed at origin, with the exception of Brazil. Consequently, investment in cocoa processing in the producing countries is dependent on the export market for a return. Lack of a domestic market for chocolate products and intense competition with highly efficient companies in cocoa-consuming countries has put processors in the cocoa-producing countries at a distinct disadvantage. The costs of production at origin are such that in all but a few cases cocoa processing is highly unprofitable. This explains the gradual decline in cocoa grinding in Latin America and the significant underutilization of processing capacity in most cocoa-producing countries. However, despite such factors which seem to point away from investing at origin, countries such as Indonesia, Malaysia and Nigeria are going ahead and setting up new processing operations.

As already mentioned, the largest producers of cocoa products in the South are Brazil and Côte d'Ivoire. Indeed, not only are they the largest in the South, but they are among the top 10 countries globally. However, they are not the only countries to have embarked upon an ambitious programme of cocoa processing. Cameroon, Ecuador, Ghana and Nigeria have also invested heavily in processing, with generous support from their Governments. Unfortunately, the withdrawal of government support in recent years, either as a policy decision or as a result of insufficient funds, has led to a collapse in cocoa processing. None the less, the industry in Ecuador has partially recovered because of a rationalization of the sector and investment by Grace Cocoa in one of the larger domestic processing companies. Nigeria is once again embarking on investment in cocoa processing with lending assistance from the Government through the Central Bank of Nigeria and the African Development Bank. The Government is also contemplating an export ban or export levy on cocoa beans to assist the domestic processing industry.

Indonesia and Malaysia are the most recent producers of cocoa beans on a large scale and the newest arrivals on the cocoa-processing scene. Unlike their counterparts in Africa and Latin America, however, their industry is being financed exclusively by the private sector with no known government support. The industry expanded in the late 1980s in response to a mini-boom in cocoa butter prices relative to the price of cocoa beans. However, with the collapse in these ratios, some of the industries are operating at well below capacity.

(d) *Cocoa butter alternatives*

During the past three decades the existence of alternatives to cocoa products has had a growing influence on the market potential of cocoa products, and hence on the size of cocoa-processing operations. Most of these are alternatives to cocoa butter, while alternatives to cocoa powder are a more recent development, and their impact on the market has been small. Nevertheless, alternative vegetable-based fats are becoming both more numerous and more technically complex, and a variety of terms are used to describe them. These include cocoa butter equivalents, which are chemically compatible with cocoa butter and can be mixed with it, cocoa butter replacers, which are not as compatible with cocoa butter, and cocoa butter substitutes, which cannot be used with cocoa butter at all. The development and use of alternatives has been stimulated by both technical and economic factors. The latter are more important in that if an acceptable and cheaper product can be found which does the same or a similar job, then production costs of the final product will be lower. The rise in cocoa bean and butter prices, particularly in the late-1970s and mid-1980s, combined with uncertainty over their future availability, has contributed to the emergence and development of cocoa butter alternatives. The greater the incentive to use alternatives, the higher the price of cocoa products. Existing branded products using cocoa butter and cocoa powder are unlikely to be modified to use cheaper fats because of the costs involved in the change and of the resistance to change a well-established product. However, when developing new products, the situation is more favourable for alternatives, particularly if cocoa products are higher priced. On the technical side, small quantities of alternatives may improve the functional characteristics of the product, and in some uses cocoa butter does not behave as well as alternative fats.

The biggest obstacle to the use of cocoa butter equivalents in chocolate is the existing legislative restrictions in most major markets. The United States and most of the European Community forbid the use of cocoa butter equivalents in products labelled "chocolate". The exceptions are Denmark, Ireland and the United Kingdom, which allow products labelled chocolate to contain up to 5 per cent vegetable fat other than cocoa butter. Upon accession to the EEC, those countries were permitted to retain the use of cocoa butter equivalents in their products. With the 1993 creation of the single European market, it is likely that this "5 per cent rule" will be extended across the EEC, although no decision has yet been taken. If the 5 per cent rule is accepted and adopted by all countries and manufacturers in the EEC, then the use of cocoa butter equivalent could triple by the end of the decade, thus containing the growth in demand for cocoa butter, particularly when prices for it are relatively high.

(e) International trade

Not surprisingly, growth in world grindings has been accompanied by a rise both absolutely and proportionally in the volume of cocoa products entering the international market for semi-finished cocoa products. Certain countries, such as Germany and the Netherlands, are increasing their grindings not only for the domestic market but also for other countries. At the same time, companies in some of those countries are choosing to grind less and buy more of their cocoa in the form of products. In addition, many countries, including Germany and the Netherlands, both import and export a substantial quantity of cocoa products. Tables IV.5 to IV.7 reflect the pattern of trade in cocoa products, while table IV.8 shows the size of the largest import and export markets for cocoa products in terms of their dollar values. In particular, tables IV.5 to IV.7 show gross imports and exports of cocoa butter, powder and liquor. From these it can be seen that the EEC is both the largest importer and exporter of cocoa products. On a net basis, however, the EEC imports only a fourth of the gross quantity of cocoa butter imports, and is a net exporter of cocoa powder. The reason is simply that much of the trade is intra-EEC.

The European cocoa-processing industry is protected by a series of tariff barriers. African, Caribbean and Pacific countries are entitled to export all their cocoa products to the European Community free of tariff duties. The major beneficiaries are the four main West African cocoa-producing countries. Countries operating under the generalized system of preferences, including Brazil, Ecuador, Indonesia, Malaysia and Singapore, pay a 3 per cent tariff on raw cocoa beans, but are subject to higher tariffs on semi-finished products. In 1990, Bolivia, Colombia, Ecuador and Peru were exempted from duties on all goods imported into the EEC. Of those countries, all but Bolivia export cocoa beans and products. However, tonnages shipped to the EEC are negligible. The full tariff rates, paid by all countries which are classified as a "most favoured nation" but which are not under the generalized system of preferences, are slightly higher than for countries under that regime. There has been a proposal that tariffs on most-favoured-nation imports should be reduced, which would in turn lead to a small reduction in rates under the generalized system of preferences.

Tariff barriers are not the only explanation of trade patterns occurring within the EEC. Arguably a more significant factor is the quality of the products manufactured and the type of service offered to end-users by the large European grinders. Economies of scale also give EEC producers a distinct advantage in terms of lower overall costs of production. Many European end-users argue that they prefer to buy their cocoa products from large European manufacturers, since they can produce to the highest quality specifications and can also have their products tailored to their particular requirements. Grinders can also deliver their products, particularly cocoa butter and liquor, in bulk liquid form in heated tankers on a "just-in-time" basis, thus saving end-users costs of storage and overhead. Cocoa processors at origin cannot offer this advantage because of the distance between factories and end-users. Many manufacturers also claim that most of the processors at origin generate products which are not up to their quality specifications, and would only purchase products at origin if they were offered at a substantial discount, often at a price at which processors at origin cannot afford to produce.

As a large reprocessor of cocoa products, the Netherlands imports about one half of its products from countries of origin. The large fluctuations in imports, mainly from suppliers at origin, depend on capacity utilization in the Netherlands and product prices. France is also a relatively large importer of cocoa products from origin, particularly because of Cacao Barry factories in Côte d'Ivoire and Cameroon which supply its factory in France. The United Kingdom is the only other European country known to import substantial quantities of cocoa products, particularly cocoa butter from origin. It obtains butter primarily from Ghana and Nigeria, whose cocoa has the flavour characteristics upon which the United Kingdom built its chocolate tastes and recipes.

Unlike the EEC, the United States exports very little of its domestically produced cocoa products. Its market is far more open to imports of cocoa products from origin countries than is the EEC. Thus, the United States is both a large gross and net importer of cocoa butter, liquor, cake and powder. One reason for its openness to products from origin is that it is more a price-driven than a quality-driven market. Although import standards for hygiene are very high and exacting, flavour aspects are less critical to the end-use sector, particularly for baked goods and for generic, own-brand chocolate companies that produce a substantial amount of chocolate "flavoured" products using cocoa powder and vegetable fat. Pure or plain chocolate bars or pieces also have a flavour inferior to the better-quality imports.

Historically, most Eastern European countries have imported beans and produced their own cocoa products for use in their chocolate production. The former USSR was the one significant exception, in that it used to be a substantial importer of cocoa liquor, primarily obtaining supplies from countries of origin such as Brazil and Côte d'Ivoire. It then used the liquor either directly for chocolate production or, when grinding capacity was fully utilized, for pressing into butter and cake. With the collapse of the former USSR, cocoa product imports have been reduced substantially, and the outlook for the future is uncertain. Across Eastern Europe the future of cocoa processing will depend on whether future investment in the sector will go towards rehabilitating old cocoa-processing factories, or whether the various countries will rely instead on imports of semi-finished or finished products. The purchase by major transnational corporations, such as Nestlé and Jacobs Suchard, of many domestic chocolate confectionery companies in the Czech Republic, Hungary, Poland and Slovakia is already determining the course in favour of imports of semi-finished and finished products from Western Europe. It remains to be seen whether this pattern will be repeated in the former USSR.

(f) Major companies

Currently, the cocoa industry is characterized by a high degree of concentration. As shown in tables IV.9 and IV.10, nine companies accounted for nearly 50 per cent of global capacity and an estimated 62 per cent of world grindings in 1991/92. All nine companies are based in either Europe or the United States, although some of them have a significant share of their capacity in cocoa-producing countries. Turnover and profits of major companies are given in table IV.11.

Table IV.5. World's five largest countries exporting and importing cocoa butter, 1986 and 1991
(Thousand tonnes)

		Exports							Imports				
Rank	Country	Quantity 1986[a]	World percentage share	Quantity 1991[b]	World percentage share	Percentage change 1986-1991	Rank	Country	Quantity 1986[a]	World percentage share	Quantity 1991[b]	World percentage share	Percentage change 1986-1991
1	Netherlands	69 126	28.7	106 678	29.0	54.3	1	United States	68 302	27.5	90 116	24.7	31.9
2	Brazil	41 169	17.1	52 180	14.2	26.7	2	Germany	26 032	10.5	56 244	15.4	116.1
3	Côte d'Ivoire	26 854	11.1	31 373	8.5	16.8	3	Netherlands	15 699	6.3	35 185	9.6	124.1
4	Germany	26 821	11.1	31 129	8.5	16.1	4	United Kingdom	34 273	[illegible]	29 841	8.2	-12.9
5	Malaysia	10 093	4.2	29 225	7.9	189.6	5	France	18 464	[illegible]	27 719	7.6	50.1
	World	241 190	100.0	368 250	100.0	52.7		World	248 340	100.0	365 280	100.0	47.1

Source: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992).
a/ Crop year 1985/86.
b/ Crop year 1990/91.

Table IV.6. World's largest countries exporting and importing cocoa powder and cake, 1986 and 1991
(Thousand tonnes)

		Exports							Imports				
Rank	Country	Quantity 1986[a]	World percentage share	Quantity 1991[b]	World percentage share	Percentage change 1986-1991	Rank	Country	Quantity 1986[a]	World percentage share	Quantity 1991[b]	World percentage share	Percentage change 1986-1991
1	Netherlands	72 304	28.9	101 742	30.7	40.7	1	United States	90 193	37.4	124 369	37.6	37.9
2	Brazil	40 583	16.2	57 835	17.4	42.5	2	Germany	18 393	7.6	27 072	8.2	47.2
3	Germany	29 390	11.7	38 086	11.5	29.6	3	France	19 011	7.9	24 931	7.5	31.1
4	Singapore	14 749	5.9	25 939	7.8	75.9	4	Spain	7 973	3.3	15 299	4.6	91.9
5	Côte d'Ivoire	39 987	16.0	20 498	6.2	-48.7	5	Italy	13 315	5.5	12 963	3.9	-2.6
	World	241 190	100.0	368 250	100.0	52.7		World	240 980	100.0	330 850	100.0	37.3

Sources: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992); and International Cocoa Organization, *Quarterly Bulletin of Statistics* (London, December 1992), vol. XIX, No. 1.
a/ Crop year 1985/86.
b/ Crop year 1990/91.

Table IV.7. World's five largest countries exporting and importing cocoa liquor, 1986 and 1991
(Thousand tonnes)

Rank	Country	Exports: Quantity 1986[a/]	Exports: World percentage share	Exports: Quantity 1991[b/]	Exports: World percentage share	Exports: Percentage change 1986-1991	Rank	Country	Imports: Quantity 1986[a/]	Imports: World percentage share	Imports: Quantity 1991[b/]	Imports: World percentage share	Imports: Percentage change 1986-1991
1	Côte d'Ivoire	26 293	15.8	39 930	23.3	51.9	1	France	28 446	19.3	40 212	28.0	41.4
2	Germany	19 553	11.8	29 700	17.4	51.9	2	United States	56 615	38.4	25 255	17.6	-55.4
3	Brazil	60 190	36.3	26 510	15.5	-56.0	3	Argentina	5 959	4.0	8 320	5.8	39.6
4	Netherlands	3 863	2.3	15 681	9.2	305.9	4	Netherlands	12 397	8.4	8 133	5.7	-34.4
5	Ecuador	32 821	19.8	14 750	8.6	-55.1	5	Former USSR	28 150	19.1	7 336	5.1	-73.9
	World	165 930	100.0	171 060	100.0	3.1		World	147 590	100.0	143 660	100.0	-2.7

Sources: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992); and International Cocoa Organization, *Quarterly Bulletin of Statistics* (London, December 1992), vol. XIX, No. 1.

a/ Crop year 1985/86.

b/ Crop year 1990/91.

Table IV.8. Value of cocoa products for five largest exporting and importing countries, 1986 and 1990
(Million dollars)

Rank	Country	Exports: Value 1986[a/]	Exports: Value 1990[b/]	Exports: Percentage change 1986-1990	Rank	Country	Imports: Value 1986[a/]	Imports: Value 1990[b/]	Imports: Percentage change 1986-1990
1	Netherlands	569	525	-7.7	1	Germany	..	396	..
2	Germany	..	248	..	2	United States	448	369	-17.6
3	Brazil	257	198	-23.0	3	Netherlands	430	341	-20.7
4	Côte d'Ivoire	252	117	-53.6	4	United Kingdom	257	192	-25.3
5	Ecuador	..	65	..	5	Italy	126	88	-30.2

Sources: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992); and International Cocoa Organization, *Quarterly Bulletin of Statistics* (London, December 1992), vol. XIX, No. 1.

a/ Crop year 1985/86.

b/ Crop year 1990/91.

Table IV.9. Estimated grinding capacities of main industries by geographical areas, 1992
(Thousand tonnes)

Economic grouping, industry and company	Capacity	Percentage of total regional capacity
Western Europe		
Cocoa processors		
W.R. Grace Ltd.	166 500	15.1
Cargill Ltd.	150 000	13.6
Barry International (Cacao Barry)	60 000	5.5
E D & F Man	70 000	6.4
Total	446 500	40.6
Finished products		
Cadbury Schweppes, plc	70 000	6.4
Rowntree Mackintosh (Nestlé, SA)	78 000	7.1
Nestlé, SA	51 600	4.7
Mars UK Ltd.	24 000	2.2
Philip Morris Companies, Inc./ Kraft General Foods International	41 000	3.7
Total	264 600	24.1
Mixed industries		
Klaus Jacobs, SA[a]	64 000	5.8
Other Western Europe	324 900	29.5
Total, A	1 100 000	100.0
North America		
Cocoa processors		
Philip Morris Companies, Inc./ Kraft General Foods International	42 000	10.5
W.R. Grace	43 000	10.8
Total	85 000	21.3
Finished products		
Hershey/Peter Paul Cadbury	127 000	31.8
Hershey Food Companies, Inc. (joint venture)	30 000	7.5
Nestlé, Inc.	71 000	17.8
Rowntreee Mackintosh, plc (Nestlé)	2 000	0.5
M & M/Mars, Inc.	18 000	4.5
Cadbury Schweppes, Inc.	10 000	2.5
Total	258 000	64.5
Mixed industries		
Klaus Jacobs, Inc.	5 000	1.3
Other North America	52 000	13.0
Total, B	400 000	100.0
Producer companies		
Cocoa processors		
Cacao Barry	108 000	9.0
E D & F Man	50 000	4.2
W.R. Grace	40 000	3.4
W.R. Grace (joint ventures)	70 000	5.9
Cargill	33 000	2.8
Total	301 000	25.3
Mixed industries		
Hershey	15 000	1.3
Nestlé	49 000	4.1
Cadbury Schweppes, plc	28 500	2.4
Rowntree Mackintosh (Nestlé)	1 200	0.1
Total	93 700	7.8

Table V.9. *(continued)*

Economic grouping, industry and company	Capacity	Percentage of total regional capacity
Other producer companies	799 300	66.9
Total, C	1 194 000	100.0

Source: International Cocoa Organization, *Quarterly Bulletin of Statistics*, vol. XVII, No. 4 (London, September 1992).

a/ Including capacity for Van Houten in Germany.

Table IV.10. World grinding capacities and effective capacities in 1991 and 1992
(Thousand tonnes)

Economic grouping, region and country	Total capacity	Actual capacity	Percentage utilization
Producer countries			
Central and South America	602 000	392 000	65.1
Brazil	331 000	224 000	67.7
Ecuador	101 000	48 000	47.5
Colombia	60 000	40 000	66.7
Mexico	45 000	45 000	100.0
Other	65 000	35 000	53.8
Africa	303 000	186 000	61.4
Côte d'Ivoire	123 000	120 000	97.6
Ghana	77 000	30 000	39.0
Nigeria a/	78 000	18 000	23.1
Cameroon	25 000	18 000	72.0
Asia	289 000	211 000	73.0
Malaysia and Singapore	183 000	150 000	82.0
Philippines	26 000	23 000	88.5
Indonesia b/	70 000	33 000	47.1
Other	10 000	5 000	50.0
Total, A	1 194 000	789 000	66.1
Consumer countries			
Europe	1 435 000	1 111 700	77.5
Western Europe	1 100 000	995 700	90.5
Former USSR	180 000	67 000	37.2
Eastern Europe	155 000	49 000	31.6
North America and Latin America	335 000	323 000	96.4
United States	300 000	291 000	97.0
Canada	25 000	25 000	100.0
Other	10 000	7 000	70.0
Asia	100 000	80 000	80.0
China	40 000	25 000	62.5
Japan	45 000	42 000	93.5
Other	15 000	13 000	86.7
Total, B	1 870 000	1 514 700	81.0
World, A and B	3 064 000	2 303 700	75.2

Source: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992).

a/ As of 1993, Nigeria is expected to have installed at least 50,000 more tonnes of cocoa-processing capacity. Current licensed capacity is for 213,000 tonnes, although not all of this capacity will necessarily be commissioned.

b/ Indonesia is expected to have 70,000 tonnes of capacity in 1993.

Table IV.11. Financial structure of the world's leading cocoa-processing companies, 1990/91
(Million dollars)

Company	Country	Turnover	Operating profit
Cargill, Inc.	United States	..a/	..
W.R. Grace, Inc./Grace Cocoa	United States	684.9	..
Hershey Foods Corporation, Inc.	United States	2 716.0	..
M & M/Maras, Inc.	United States	..a/	..
Philip Morris Companies, Inc./Kraft General Foods International	United States	51 200.0	6 300.0
Barry International (Cacao Barry)	France	302.9	19.7
Cadbury Schweppes, plc	United Kingdom	3 232.3	316.4
E D & F Man Ltd.	United Kingdom	240.5	6.8
Nestlé, SA	Switzerland	36 500.0	1 790.0

Source: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992); and individual company reports, 1990 and 1991.
a/ Private company.

North America is the base for Cargill and Grace Cocoa, which are the world's largest industrial grinders of cocoa. Cargill has a factory in Brazil as well as the Netherlands, and is exploring other investment possibilities. Grace has operations in France, Germany, Netherlands, Singapore and United States, and joint ventures in Ecuador and Côte d'Ivoire as well. Leading chocolate confectionery companies based in the United States include Hershey, M & M/Mars, Inc., and the Philip Morris Company, which owns Kraft General Foods and Jacobs Suchard.

Mars and Philip Morris have a large global presence, and are moving swiftly into the newly liberalized Eastern Europe. Their investment and development of the Eastern European markets will have important implications for the choice of either grinding beans domestically or importing cocoa products, including chocolate, from cocoa-producing countries or Western Europe (the more likely choice).

Western Europe is home to Cacao Barry and E D & F Man, industrial grinders of cocoa beans, and to a number of large chocolate confectionery companies, including Cadbury Schweppes and Nestlé.

2. *Prices and conversion ratios*

Cocoa bean and cocoa product prices tend to move in line with one another, and excess supply in recent years has meant that the prices for cocoa beans, butter, powder and liquor have fallen. However, it is not the absolute prices that matter to cocoa processors, but the margins, since the objective is to earn the highest return on products relative to the price of cocoa beans. In order to analyse price movements in the cocoa-processing industry, it is first necessary to understand the product pricing structure.

There are several ways of evaluating the price of cocoa products. The first is to consider the ratio of the product price to the bean price and compare it with the conversion factors of cocoa beans into cocoa liquor, butter and powder. For instance, 1,000 tonnes of cocoa beans are considered to yield on average 800 tonnes of liquor. A yield of 80 per cent, therefore, requires a liquor price 1.25 times the bean price merely to cover the cost of the raw material. In order to make a profit from processing, the liquor price must average significantly more than 1.25 times the bean price, with the crucial break-even ratio for an individual factory depending on factors such as the scale of operation, capacity utilization, technical efficiency, labour and capital costs.

In an ideal situation, the 800 tonnes of liquor can yield 440 tonnes of butter and 360 tonnes of cocoa solids (cake and powder). However, for various technical and economic reasons, the pressing operation does not recover all the butter, and the defatted cake can contain butter ranging from 6 to 8 per cent up to 22 to 24 per cent. Liquor-pressing can be undertaken using several technologies that may yield different quantities of butter and press cake, and one major function of management of the processor firm is to decide how much butter to recover and how much to leave in the cake. The bulk of world press cake production is either 10 to 12 per cent or 22 to 24 per cent fat. If it is assumed that the ratio of low-fat to high-fat cake produced is 2 to 1, then 800 tonnes of liquor would produce approximately 377 tonnes of butter and 423 tonnes of cocoa powder. It follows that the conversion factors for pricing butter and liquor in bean-equivalent terms are 1.33 and 1.18, respectively. In other words, covering only the costs of the raw material (bean) input requires a butter price at least 1.33 times the bean price and a powder price 1.18 times the bean price. If the butter ratio exceeds 1.33, as is usual, the powder ratio can fall below 1.18, which is also the norm. In order to make a profit, cocoa butter ratios are typically well above 2.00, partly to cover the implied processing loss on powder ratios of under 1.00. Figure IV.1 illustrates the trend in cocoa butter and cocoa powder ratios in Europe and North America since 1970.

The bean and product price information can be used to derive the processing margins for the manufacture of the various products. In order to do this, the product price and the bean price have been compared in table IV.12, where both are expressed per tonne of beans, and where all prices are given in real terms (based on constant purchasing power of the dollar in 1991). The difference between the return from the product (or coproducts, where butter and powder revenues are combined) and the outlay on purchasing beans is equal to the processing margin. For instance, in 1991 the average world butter price (in 1991 purchasing power) was $3,503 per tonne, while the world bean price was $1,201 per tonne. From 1 tonne of beans, 337 kilograms of butter are obtained.

Table IV.12. Cocoa butter and powder ratios and processing margins for grinding operations, 1970-1991[a]

Year	World bean price	World butter price	World powder price	Liquor price	Butter ratio	Powder ratio	Liquor ratio	Butter margin	Powder margin	Butter and powder margin	Liquor margin
	(dollars per tonne)							(dollars per tonne of cocoa beans)			
1970	2 879	6 052	1 659	4 253	2.10	0.58	1.48	-598	-2 178	104	523
1971	2 194	4 734	1 734	3 376	2.16	0.79	1.53	-409	-1 460	325	507
1972	2 541	6 020	1 593	2 836	2.37	0.63	1.51	-271	-1 867	403	-272
1973	3 744	9 173	1 722	2 840	2.45	0.46	1.11	-286	-3 015	443	-1 472
1974	4 303	10 332	2 055	4 268	2.40	0.48	1.21	-408	-3 434	461	-889
1975	2 960	7 163	2 179	3 644	2.42	0.74	1.18	-260	-2 039	662	-45
1976	4 999	10 594	4 089	5 689	2.12	0.82	1.71	-1 005	-3 270	725	-448
1977	8 254	10 566	11 683	7 675	1.28	1.42	1.36	-4 271	-3 312	-671	-2 114
1978	6 216	9 262	9 076	8 622	1.49	1.46	1.52	-2 724	-2 377	1 115	681
1979	5 227	9 986	5 553	7 095	1.91	1.06	1.38	-1 462	-2 878	887	449
1980	3 794	8 652	2 510	4 850	2.28	0.66	1.30	-533	-2 733	529	86
1981	2 989	7 980	1 504	4 296	2.67	0.50	1.62	20	-2 352	656	448
1982	2 536	6 698	1 480	3 805	2.64	0.58	1.63	-11	-1 910	615	508
1983	3 229	6 778	2 442	3 972	2.10	0.76	1.60	-673	-2 196	360	-51
1984	3 734	8 287	2 884	5 040	2.22	0.77	1.59	-610	-2 514	610	298
1985	3 824	8 716	2 290	4 565	2.28	0.60	1.48	-538	-2 855	431	-171
1986	2 716	6 245	1 900	3 529	2.30	0.70	1.37	-361	-1 912	442	108
1987	2 346	5 419	1 544	3 655	2.31	0.70	1.68	-303	-1 651	392	578
1988	1 739	4 419	1 526	2 840	2.54	0.88	1.60	-73	-1 094	572	533
1989	1 391	3 837	1 234	2 723	2.76	0.89	1.71	56	-869	577	788
1990	1 337	3 784	1 145	2 707	2.83	0.86	2.49	90	-853	574	828
1991	1 201	3 503	943	2 404	2.92	0.79	2.26	120	-802	519	723

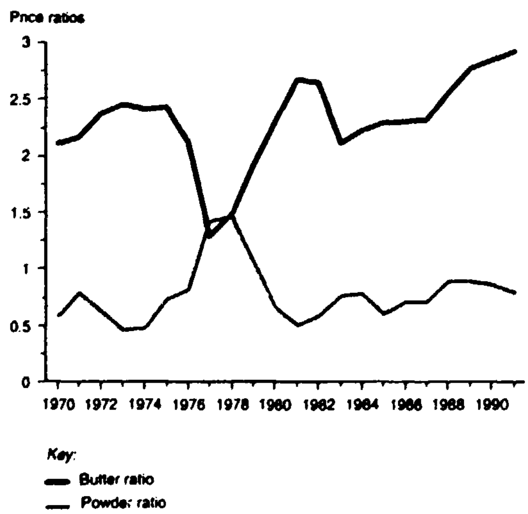
Sources. Gill and Duffus, *Cocoa Market Report* (London, January 1992). International Cocoa Organization, *Quarterly Bulletin of Statistics*, various issues (London, 1980-1991); Statistical Office of the European Communities, *Eurostat*, various issues (Luxembourg, 1980-1991); United States Department of Commerce, *United States Imports for Consumption Report 146*, various issues (Washington, D.C., 1980-1991); United States Department of Commerce, *United States Exports of Domestic and Foreign Merchandise by All Methods of Transportation*, various issues (Washington, D.C., 1980-1991).

[a] All values expressed in 1991 purchasing power and prices deflated by the manufacturing unit value of the Group of Five major industrialized countries (France, Germany, Japan, United Kingdom and the United States). (1991 = 100).

This amount of butter is worth $1,321. Subtracting $1,201, the cost of 1 tonne of beans, from $1,321 yields a processing margin for butter alone of $120 per tonne of beans.

The price of powder in 1991 was $943. Since 423 kilograms of powder are produced from 1 tonne of beans, the revenue from the powder will be equivalent to $399. When set against the cost of the beans, this implies a loss on powder revenues alone of $802 per tonne of beans. Exactly similar calculations for liquor yield a profit of $723 per tonne of beans, under the assumption that 800 kilograms of liquor (sold at an average price of $2,404 per tonne) are produced per tonne of beans. The conventional grinding operation produces both 377 kilograms of butter and 423 kilograms of powder per tonne of beans. Therefore, both product revenues are combined before deducting the cost of beans to derive a processing margin. The revenues from butter ($1,321 per tonne of beans) and from powder ($399) amounted to $1,720 in 1991. Once the cost of the beans ($1,201) is subtracted, the final margin is $519 per tonne of beans.

Figure IV.1. Cocoa butter and powder price ratios, 1970-1991[a]



Source: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992).

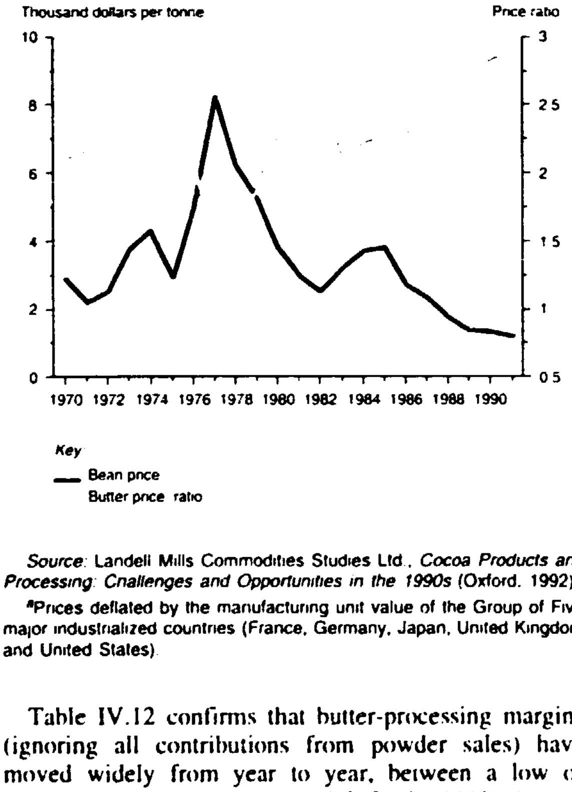
[a]Prices deflated by the manufacturing unit value of the Group of Five major industrialized countries (France, Germany, Japan, United Kingdom and United States).

Given the nature of the conversion ratios, the price ratios of cocoa butter and cake and cocoa powder and the processing margins of European and North American factories over the past two decades will be examined. The major international cocoa prices are the London Terminal Price for cocoa beans and the Gill and Duffus price series for cocoa butter and cocoa powder. Cocoa butter prices are an estimated series for nearby delivery of cocoa butter supplied by the top four processors of the Netherlands; the powder prices are for a fat content of 10 to 12 per cent, with an alkalized quality. Liquor prices are not published as regularly as they are for butter and powder. Therefore, an average of the United States unit import values for liquor from the Netherlands and Côte d'Ivoire has been calculated. All prices are in real terms for 1991 purchasing power as defined above.

(a) *Price ratios of cocoa butter to cocoa cake and powder*

Table IV.12 provides further information on the cocoa price together with the butter and powder price ratios from 1970 to 1991. Both real bean prices and real butter prices move together, although butter prices always remain above the bean price. The gap between the two is wider in some years than in others. Since 1985 both real and nominal prices have been downward. In figure IV.2 which compares the bean price with the butter price ratio, it is clear that the butter ratio moves inversely to the bean price. The simple explanation for this is that, as the bean price falls, the cost of beans falls when expressed as a proportion of the total price of cocoa butter, pushing the ratio of the butter price to bean price higher. The opposite is true when the price of cocoa beans rises. Supply and demand also influence this ratio through the price offered for cocoa butter. If the bean price remains static, but demand and hence cocoa butter prices rise, the ratio behaves similarly. Thus, in 1990 and 1991, despite the low bean price, there was tightness of supply for cocoa butter, which pushed the ratio to high levels, at some points exceeding 4.0. However, the ratio generally averages between 2.0 to 2.5.

Figure IV.2. Bean price and butter price ratio, 1970-1991*



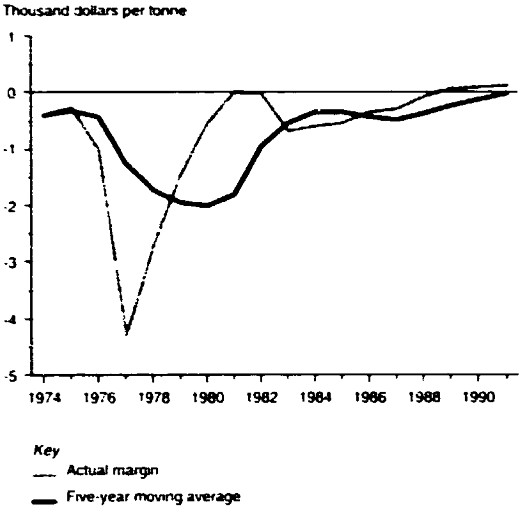
Source: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992).

*Prices deflated by the manufacturing unit value of the Group of Five major industrialized countries (France, Germany, Japan, United Kingdom and United States).

Table IV.12 confirms that butter-processing margins (ignoring all contributions from powder sales) have moved widely from year to year, between a low of -$4,271 in 1977 to a high of $120 in 1991. Annual processing margins do not seem to show much correlation with world cocoa bean prices in recent years. Figure IV.3, which compares the actual annual margins with a five-year moving average of the margin, shows that the margin collapsed during the late 1970s, but in more recent years it has started to move upwards. Worldwide expansion in processing capacity from the late 1980s could be read as a sign that processing margins are sufficiently attractive to warrant new investment.

Cocoa cake and powder tend to sell at a discount to cocoa beans. If cocoa were processed merely for powder, clearly it would be a most uneconomic proposition.

Figure IV.3. Cocoa butter processing margins: actual and five-year moving average, 1974-1991*



Source: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992).

*Prices deflated by the manufacturing unit value of the Group of Five major industrialized countries (France, Germany, Japan, United Kingdom and United States).

However, powder is mainly to be viewed as a secondary product whose price is primarily determined by the balance of supply and demand for powder rather than by the cocoa bean price. In comparing the bean price with the powder ratio, it is evident that they often move together, which is the opposite of the tendency for cocoa butter. However, cocoa powder and butter processing margins do tend to move somewhat in parallel. Cocoa powder processing margins have been consistently negative; but these negative values have been at their smallest magnitude in recent years.

The ratios of cocoa powder and butter generally move in opposite directions. The reason is that when processors increase their butter production in times of low bean prices, they obtain more cocoa powder, which does not have as lucrative or large a market. Therefore, the price of powder is often pushed down in the face of such gluts, and hence the ratio is squeezed as well. Only on two occasions, in 1977 and 1978, did the powder ratio exceed the 1.18 conversion factor threshold. Generally, however, meagre revenues from powder are counterbalanced by better ratios and returns to cocoa butter.

The exceptional behaviour of powder prices in 1977 and 1978 appears, with hindsight, to have been a response to high bean and butter prices. Faced with limited supplies of cocoa butter at an elevated price, some end-users turned to alternative fats. In order to retain the distinctive flavour of their "chocolate-flavoured" foodstuffs, they based their new formulations on mixtures of powder and vegetable fat, thus boosting the demand for powder.

(b) Cocoa liquor

The evolution of cocoa liquor prices and processing margins over the past 20 years is also reflected in table IV.12. Liquor prices have remained consistently above bean prices over that time. As is the case with cocoa butter, cocoa liquor ratios tend to move inversely to the cocoa bean price. The reason behind the similarity is the same as for butter: lower bean prices mean that the cost of beans as a proportion of the total price falls, and vice versa. This ratio has averaged 1.49 during the past 20 years, well above the 1.25 technical conversion factor.

It should be recognized that the above global comparisons do not differentiate between the ratios and margins received by producers at origin. For example, a comparison of the returns to producers of cocoa butter and of liquor at origin and to consuming-country processors reveals that a differentiated market exists; the product at origin tends to be of lower quality and price than the products made in consumer countries. Hence some processors, particularly in Western Europe, are likely to be realizing greater returns than would be indicated by the average in the price series, while other processors could be earning substantially less. The move to expand Western European processing capacity at a time of contraction in the industry in Brazil and Ecuador could be confirmation of the phenomenon.

It appears that in more recent years cocoa-processing margins, expressed in terms of moving averages, have settled down close to their long-term trend values. There are several possible explanations for this. One may be the expansion in processing capacity, particularly in countries of origin, which is augmenting the supply of cocoa products more or less in step with the growth in demand. However, processing capacity in countries of origin is often underutilized. Furthermore, as greater numbers of factories are going into operation in Asia, factories in other regions of origin, particularly Latin America, and, to a lesser degree, Africa, have witnessed a contraction in output. Meanwhile, European and American processors have continued to add to their capacity. The overall balance between origin and consumer-country processing has therefore not shifted markedly, and is not expected to alter in any significant way over the next 10 years. Nevertheless, some Asian and African countries, notably Malaysia and Nigeria, are installing additional capacity, which could rival the recent expansion witnessed in Europe.

3. *Manufacturing capacity of developing countries*

As reflected in table IV.9, the world's largest industrial cocoa processors have a significant presence in cocoa-producing countries. In addition to having grinding facilities in Europe, both E D & F Man and Cacao Barry have factories in origin countries. Man owns Joanes in Brazil, while Cacao Barry has operations in Cameroon and Côte d'Ivoire. Grace Cocoa is in a joint venture in Ecuador and Côte d'Ivoire. Nestlé, Hershey and Cadbury's are also grinding cocoa in producer countries. Altogether, these transnational industrial grinders and chocolate confectionery companies are estimated to account for 33 per cent of the cocoa ground at origin.

In Africa, the transnational corporations are involved in all the cocoa processing in Cameroon and Côte d'Ivoire. In Ghana, the Government owns and operates three cocoa-processing companies which for many years have operated at well below capacity. The processing sector in Nigeria is dominated by locally owned companies, although Cadbury's does grind some cocoa cake for drinking chocolate. None of the factories are particularly large, most of them ranging between a capacity of 5,000 and 10,000 tonnes.

The cocoa sector in Brazil is made up of a mix of smaller family-run companies and a few larger transnational corporations. As already mentioned, with the withdrawal of government subsidies, the smaller companies are now facing economic hardship and operating far below capacity. Cocoa products manufactured in Brazil are in large part sold in the domestic and regional market, although the United States is also a significant export destination. Ecuador is the other large cocoa-processing country in Latin America, and its businesses tend to be smaller independent companies. Factory capacities range between 4,000 and 15,000 tonnes, with the exception of Incacao, the company in which Grace Cocoa has a stake. Nestlé also owns a small cocoa-processing company whose products are destined primarily for the local and regional market.

South-East Asia is the newest frontier for the expansion of cocoa processing. A number of small- and medium-sized factories have been installed, ranging from 3,000 to 15,000 tonnes capacity. Many of them followed the cocoa butter price boom of the late 1980s, and some of them have transnational involvement. The largest is Grace Cocoa/De Zaan Far East, with the largest regional capacity of 40,000 tonnes. Nestlé and Cadbury also have plants in the region. The remainder are small independent companies.

4. *Capacity utilization and expansion plans*

Altogether, Western European grinding capacity for 1991/92 is estimated at 1.1 million tonnes. Table IV.10 further shows capacity utilization to be about 90 per cent, or nearly 996,000 tonnes. A number of industrial processors and chocolate confectionery manufacturers added to their capacity in 1990 and 1991 in response to high cocoa butter ratios and the associated rapid rise in demand in the eastern part of Germany, following reunification. Subsequent to the expansion of capacity, the recession in most of Europe and rising unemployment, particularly in the eastern part of Germany, eroded the growth in demand, and capacity has been less than fully utilized.

As evident from table IV.10, cocoa grinding in most cocoa-producing countries is characterized by a significant underutilization of capacity. Ghana and Nigeria have the highest degree of capacity underutilization. Côte d'Ivoire and Mexico are the only countries operating at nearly full capacity. As already pointed out, the biggest reason for the low level of capacity utilization is the withdrawal of government incentives in many of the countries concerned, particularly in Africa and Latin America. In South-East Asia, many of the factories were built at the beginning of the 1990s in anticipation of higher profits and greater demand than what actually materialized. Furthermore, the large grinders in North America and Western Europe were expanding their factories at the same time, and supplied much of the additional market demand growing out of the boom in Eastern Europe.

Despite a world excess capacity of about 25 per cent for cocoa grinding, Nigeria has witnessed a renewed period of investment in cocoa-processing companies; 15 new processing operations having been licensed since 1990. Construction of new plants in Indonesia and

Malaysia has only recently been suspended. One reason is that investors have been persuaded by the argument that cocoa should be processed in the country of origin in order that producer countries gain the value added. However, countries of origin tend to be far from the large consumer markets, and domestic demand is insignificant, except in Brazil and a few other Latin American countries. Cocoa products from countries of origin are generally regarded as of a lower quality than those produced in Western Europe and North America. They are therefore forced to sell at a discount in order to be competitive. However, because of production costs, few companies can produce profitably.

5. *Restructuring and redeployment*

(a) *Structure of production costs*

In a recent study, processing costs have been estimated for conventional cocoa-processing factories in three bean-producing and three importing regions: Latin America, South-East Asia and West Africa in the first group; and East Asia, North America and Western Europe in the second [1]. The relationship between physical inputs and outputs have been estimated for six factory sizes of 12,000, 15,000, 24,000, 30,000, 40,000, and 70,000 tonnes of beans per annum. The costs of processing are defined solely in terms of the costs of factories, and do not include any costs associated with the acquisition of beans, or revenues derived from the sale of products. Similarly, government assistance is not included. Inputs are divided into eight main categories: unskilled labour, skilled labour, managerial staff, energy and fuel, capital equipment, packaging, transport costs and sundries. The productivity of physical inputs varies from region to region, as do input prices. Both forms of variation are incorporated into the cost estimates.

Economies of scale have proven to be extremely important for both capital and labour inputs. As shown in table IV.13, overall average processing costs are almost halved in every region as the scale of capacity is increased from 12,000 to 70,000 tonnes per annum. Variations in capacity utilization have an equally dramatic impact upon processing costs; a drop from 100 to 50 per cent utilization raises average processing costs by approximately two thirds. South-East Asia is consistently the lowest-cost area for small factories. Latin America is the second lowest cost processor, but is overtaken by Western European processors in larger-capacity plants. North America also surpasses Latin America with lower costs at very high capacities. Asia is uniformly the highest-cost processor of the three consuming regions, but has never been as costly as West African processors. In practice, European and North American grinders are operating with substantial capacity, while many factories at origin are at the smaller end of the spectrum, ranging from 3,000 to 15,000 tonnes. Furthermore, European and North American factories generally work close to full capacity, while their counterparts at origin often work far below full capacity. This compounds the uncompetitiveness of factories at origin.

Once other factors are added to the costs of production, cocoa processors at origin, particularly in West Africa, are shown to be at an even greater disadvantage. If assumptions about the recovery rates of cocoa butter and cake at the factories are relaxed, then the results point to even less profitable factories at origin.

An intervening factor is the quality of the beans used in processing. All producers at origin face the trade-off between, on the one hand, exporting beans and receiving the premiums or discounts prevailing on the world market, and, on the other, processing the beans into products. The trade-off is least favourable for those producers, notably in West Africa, whose beans command the highest prices on world markets, even though processors also use a disproportionate share of substandard beans. It is most favourable for South-East Asia, since its beans attract the largest discounts from importers. The counterpart of high bean prices tends to be high product prices. West African beans attract premium prices and African butter and powder are usually quoted at a premium compared with products from other countries. However, they sell at a discount compared with products generated in consumer countries because of differences in product quality and service. Furthermore, the crucial determinant

Table IV.13. Regional processing costs as a percentage of world average, 1992

	Capacity (thousand tonnes)					
Economic grouping	12	15	24	30	40	70
Importers						
Western Europe	95.0	94.2	93.8	94.3	92.8	91.1
North America	100.8	99.7	98.7	99.4	97.0	94.4
East Asia	107.7	107.9	109.3	110.2	111.1	112.3
Average	101.2	100.6	100.6	101.3	100.3	99.3
Exporters						
West Africa	118.7	117.8	117.7	116.7	116.6	116.2
Latin America	91.9	93.4	93.5	93.4	95.1	97.3
South-East Asia	85.9	86.9	87.1	86.0	87.3	88.6
Average	98.8	99.4	99.4	98.7	99.7	100.7

Source: Landell Mills Commodities Studies Ltd., *Cocoa Products and Processing: Challenges and Opportunities in the 1990s* (Oxford, 1992).

of the viability of processing at origin is whether the net effect of the various premiums and discounts is favourable or not, once recovery ratios are taken into account; usually it is not favourable.

(b) Adjustments to overcapacity

There is a quality difference between cocoa products manufactured in factories in cocoa-consuming countries, particularly North America and Western Europe, and those manufactured in cocoa-producing countries. This explains the discounts received by products from origin. It also explains why, despite an excess capacity worldwide of 25 per cent, large transnational corporations invested in expanding their capacity in Europe in the early 1990s. There was a shortage of the highest-quality products and service provided by those companies. Meanwhile, many factories at origin have been struggling for several years because of the discontinuance of government subsidies (Brazil, Ecuador) or poor demand for their products (Ghana, Nigeria). Brazil and Ecuador responded by cutting back production. Ghana received World Bank assistance to restructure and rehabilitate its cocoa-processing plant with a view to privatization. Overstaffing has been significantly reduced in order to lower production costs. However, factories continue to operate well below capacity, and it is doubtful whether all of them will operate profitably in the future.

That some countries of origin are forging ahead with investment in cocoa processing has little to do with the prospect of financial success. Nigerian industry in particular will have a difficult time being competitive, considering the relatively small size of the factories being installed and the discount they will face for their products. Although labour costs are low, labour productivity is lower than that in competing regions. Both energy and capital costs are also higher than elsewhere. Nevertheless, the willingness of the Government to lend money for these investments has encouraged a number of local entrepreneurs to go ahead.

Many of the factories being erected in South-East Asia are also relatively small. However, the price of their cocoa beans is lower than the prices faced by their counterparts in West Africa. Furthermore, the cocoa butter produced from their beans is relatively hard, a desirable attribute to end-users. Labour productivity is also higher in this region, and energy costs differ little from those in Western Europe. South-East Asian factories, therefore, may be successful if they operate efficiently and effectively at full capacity and manufacture a product of high standard.

6. *Short- and medium-term outlook*

The rapid growth in the consumption of cocoa products during the 1980s was due largely to low cocoa prices and the development of new products and new markets. This level of growth is unlikely to be sustained through the 1990s as markets in North America and Western Europe reach saturation, and growth rates evolve more in line with population increases. The biggest boost to growth is likely to come from the Asia and Pacific regions, although it will be from a small base.

The increase in consumption in Western Europe is likely to benefit European processors rather than processors in cocoa-producing countries. The main reason is the difference in product quality, and the degree of service that European processors can offer end-users because of their proximity to the clients.

With the continued rationalization and concentration in European cocoa processing, efficiency gains may tighten the margins for basic cocoa products. Smaller processors are likely to continue moving away from grinding cocoa beans, and are more likely to move into producing semi-finished and finished products such as coverture and chocolate chips, where the value added is higher. Germany and the Netherlands should assume growing importance in the supply of cocoa products, since the largest grinding operations are located in those countries. Consequently, intra-European trade in cocoa products is expected to rise as Germany and the Netherlands ship to countries where smaller processors are converting to the manufacture of semi-finished and finished products.

In the short to medium term, growth in demand in Eastern Europe is likely to be met by imports of cocoa products and finished chocolate, primarily from Western Europe. This is because transnational processing and chocolate confectionery companies, which now control an important share of regional purchases of cocoa products, will probably import products from Western Europe. It is quite likely that only a minority of the current capacity will survive the 1990s.

After the rapid growth of the 1980s, the demand for chocolate in the United States should reach saturation. Nevertheless, it will remain the largest single consumer market in the world. Because of the neglect of quality, the country relies very heavily on imports of products, and the potential deficit in production capacity is expected to widen by the end of the decade. Smaller processors have come under the pressure of competition from larger factories and in some cases from cheaper imports. Consequently, there will be a moderate growth of cocoa product imports until grinding profit margins in the United States improve. While this could benefit processors at origin, the strongest threat to them in the United States market is the high-quality standards of imports. Another potential threat is that processors in the United States will adopt the European practice of "just-in-time" deliveries of butter and liquor in heated tankers, thus providing better-quality service.

Japanese cocoa demand will grow more rapidly than in other developed countries through the 1990s, although it will be from a lower base. However, like other product markets, the Japanese restrict imports of cocoa products, which will be a constraint to exporters at origin looking for new markets.

Apart from Brazil, there are no sizeable markets for cocoa products in producing countries. This situation is unlikely to change in any significant way through the 1990s. Hence processors at origin will continue to be reliant on export markets. However, much of the capacity for producing cocoa products at origin will be surplus to the requirements of established markets.

West Africa is the least well-placed origin in terms of processing, because consumption is insignificant and because beans from the region attract premium prices from importers, while products tend to fetch premiums that fall short of those that can be earned from bean sales. In this respect, Côte d'Ivoire and Nigeria are most advantageously placed, since their beans sell at a lower price than beans from Cameroon and Ghana. Furthermore, factories in Côte d'Ivoire are relatively large by regional standards, thus lowering their unit costs of production. Their factories also benefit from links with overseas companies. Nigerian processors could see an export levy or a ban introduced on the export of cocoa beans, which could enhance the returns from grinding.

Latin American processors will continue to suffer from the withdrawal of government incentives. Although beans from the region sell at a discount, butter also has to accept large discounts because it is soft, and hence slightly inferior for chocolate production. The net effect is to leave several processors facing losses. Factories with links to international processing companies will be better placed than some of those owned by financially strapped local companies.

The best-placed origin for processing is South-East Asia. Beans from the region attract substantial discounts, but butter produced locally is well received by importers on account of its hardness. Low processing costs are therefore underpinned by an attractive relationship between bean and product prices. However, their competitiveness will also be determined by the efficient utilization of capacity and the installation of factories which offer them economies of scale.

B. Seafood processing (ISIC 3114)*

1. *Recent trends and current situation*

(a) *Production*

Fish and shellfish products include all animals or plants caught or bred in marine areas or inland waters. During the twentieth century, seafood production has experienced spectacular growth. From roughly 5 million tonnes in 1900 and 20 million tonnes in 1940, world catches recently increased to 97.2 million tonnes in 1990. Globally, catches had annual increases in growth rates of 6 per cent in the 1960s, 1 per cent in the 1970s and recently 2.8 per cent in the 1980s. The increases are the results of higher efficiency of fisheries, modernization of transport and improved preservation. Since the 1950s, growth has not been consistent across regions. Declines have occurred in Europe and North America, while stagnation can be found in Africa. In contrast, sharp increases have appeared in East and South-East Asia, as well as in Latin America. In 1990, developing countries accounted for 57.8 per cent of world production, and this share appears to be increasing. Table IV.14 shows changes in world seafood production between 1985 and 1990.

Globally, the producing regions can be distinguished according to three groups of countries. The first group includes China, Japan and the former USSR, which produce more than 10 million tonnes per year. From 1985 to 1990 this group generated one third of the world catch. While production declined in Japan and the former USSR, it increased in China. Indeed, in the 11 years between 1980 and 1990, Chinese landings tripled. The second group accounts for approximately 45 per cent of the world catch, and includes countries that produce from 1 to 10 million tonnes. This group includes Denmark, Iceland, Norway and Spain, as well as Canada, the United States and a number of developing countries (Chile, India, Indonesia, Peru, Philippines, Thailand etc.). The third group is responsible for one fifth of the world's production, and features smaller producers that catch less than 1 million tonnes per year such as Brazil, France, Morocco and Viet Nam.

Inland fisheries supplied 14.4 million tonnes (compared with 6 million tonnes in 1970) of seafood products in 1990, mostly freshwater fish used for human consumption. In 1990, 70 per cent of the inland catch originated in Asia (Bangladesh, China, India, Indonesia, Philippines etc.). Africa had a 13.2 per cent share of the catch, and inland fisheries were well developed in Chad, Egypt, Uganda and United Republic of Tanzania. Elsewhere, production remained weak; some exceptions were the former USSR (6.7 per cent share), United States (1.8 per cent share), Brazil (1.5 per cent share) and Mexico (1.3 per cent share).

Landings by marine fisheries recorded a catch of 82.8 million tonnes in 1990, compared with only 64.5 million tonnes in 1980. The main fishing areas are located in the Pacific (north-west Pacific, south-east Pacific), which represents above 60 per cent of the total catch. The Atlantic area is second, with 30 per cent of the total. Globally, fish represent the major part of marine landings; in 1990 they accounted for 85.4 per cent of the catch, compared with 9.2 per cent for molluscs and 5 per cent for crustaceans. The major species of fish, which include Alaskan pollack, Japanese pilchard, Chilean jack, mackerel, anchoveta and European pilchard, represent approximately 30 per cent of the world catch. This concentration, however, should not overshadow the extreme diversity of fish and shellfish products; they currently include 50,000 seaweed species and approximately 250,000 other species, such as pilchards, herring, anchovies, tuna, mackerel, salmon, shrimp, lobsters, oysters, octopus, sponges, whales and jellyfish, etc. [2].

Overall production data also include aquaculture. In value, world aquacultural supply has doubled since 1985, to reach $26.5 billion in 1990. The decomposition of this total by volume includes carp (32.5 per cent), seaweed (20.8 per cent), mussels (7.1 per cent), oysters (5.7 per cent), salmon (3.9 per cent) and shrimps (3.9 per cent share). Aquaculture is concentrated mostly in Asia (78.3 per cent); also important are Europe (12 per cent) and North America (3.2 per cent). Finally, more than 140 countries practised aquaculture in 1990, compared with only 67 in 1975. But this success masks the high concentration of production, as the first six countries, namely China, Japan, India, Indonesia, Philippines and Norway provide, in value, two thirds of the world aquacultural supply (see figures IV.4 and IV.5).

The world seafood processing industry has increased by 26.8 per cent in 10 years, reaching 36 million tonnes in 1990. As shown in figure IV.6, major processed foods include mostly fresh, chilled and frozen fish (42 per cent), fish-meal (17.5 per cent) and canned products (16.5 per cent). The more valuable products include fresh chilled and frozen fish, crustaceans and molluscs in all forms. The fresh chilled and frozen fish industry has been dominated by Japan and the successor States of the former USSR, as well as North America and Western Europe. Other important producing countries are listed in table IV.15. Crustaceans (shrimps, crabs) and molluscs

*UNIDO acknowledges the contribution of Philippe Guiffre, international consultant for seafood products, Paris, France.

Table IV.14. Growth of world seafood production, 1985 and 1990

Rank in 1990	Economic grouping, region and country	Production 1985 (thousand tonnes)	Production 1990 (thousand tonnes)	Percentage share 1985	Percentage share 1990	Percentage change 1985-1990
1	China	6 778.8	12 095.4	7.8	12.4	78.4
2	Former USSR	10 522.8	10 389.0	12.2	10.7	-1.3
3	Japan	11 408.9	10 353.6	13.2	10.6	-9.3
4	Peru	4 138.1	6 875.1	4.8	7.1	66.1
5	United States	4 949.3	5 856.0	5.7	6.0	18.3
6	Chile	4 804.4	5 195.4	5.6	5.3	8.1
7	India	2 826.1	3 790.6	3.3	3.9	34.1
8	Indonesia	2 332.7	3 080.5	2.7	3.2	32.1
9	Republic of Korea	2 649.9	2 750.0	3.1	2.8	3.8
10	Thailand	2 225.1	2 650.0	2.6	2.7	19.1
11	Philippines	1 865.0	2 208.8	2.2	2.3	18.4
12	Democratic People's Republic of Korea	1 700.0	1 750.1	2.0	1.8	2.9
13	Norway	2 119.0	1 747.1	2.5	1.8	-17.6
14	Canada	1 453.3	1 624.4	1.7	1.7	11.8
15	Denmark	1 764.8	1 517.2	2.0	1.6	-14.0
16	Iceland	1 680.4	1 507.6	1.9	1.6	-10.3
17	Spain	1 482.8	1 458.1	1.7	1.5	-1.7
18	Mexico	1 226.5	1 401.0	1.4	1.4	14.2
19	France	837.7	896.8	1.0	0.9	7.1
20	Viet Nam	808.0	850.0	0.9	0.9	5.2
	Asia [a]	37 734.7	45 337.4	43.7	46.6	20.1
	East and South-East Asia	29 831.9	36 201.7	34.5	37.2	21.4
	Latin America	11 932.4	14 413.8	13.8	14.8	20.8
	Europe [b]	12 926.9	11 466.5	15.0	11.8	-11.3
	EEC	7 192.4	6 764.0	8.3	7.0	-6.0
	Northern Europe	4 558.2	3 902.2	5.3	4.0	-14.4
	Eastern Europe	1 089.7	725.1	1.3	0.7	-33.5
	Former USSR	10 522.8	10 389.0	12.2	10.7	-1.3
	North America	8 375.0	9 525.5	9.7	9.8	13.7
	Africa	4 279.6	5 164.5	4.9	5.3	20.7
	Oceania	606.7	949.0	0.7	1.0	56.4
	North [c]	42 529.1	41 027.7	49.2	42.2	-3.5
	South	43 849.0	56 218.0	50.8	57.8	28.2
World		86 378.1	97 245.7	100.0	100.0	12.6

Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1992).

a/ Including China and Japan.

b/ Excluding former USSR.

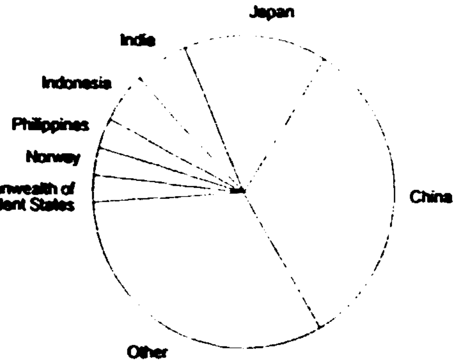
c/ North America, Europe, former USSR, Japan, Oceania, South Africa.

(squid, cuttlefish, octopus) are essentially frozen, particularly in Asia (Japan, Thailand etc.), North America and southern Europe. Crustacean products (canned products and preparations not in airtight containers) are rather an oriental tradition (Japan, Philippines, Thailand), while canned molluscs (clams, mussels) appear more in occidental countries. Products of less value include industrial products (fish-oil and fish-meal), dried, salted and brined fish (Afican or Asian regions) or smoked fish. In this group also are canned products, the latter based mainly in Japan, the United States and the successor States of the former USSR.

(b) Consumption

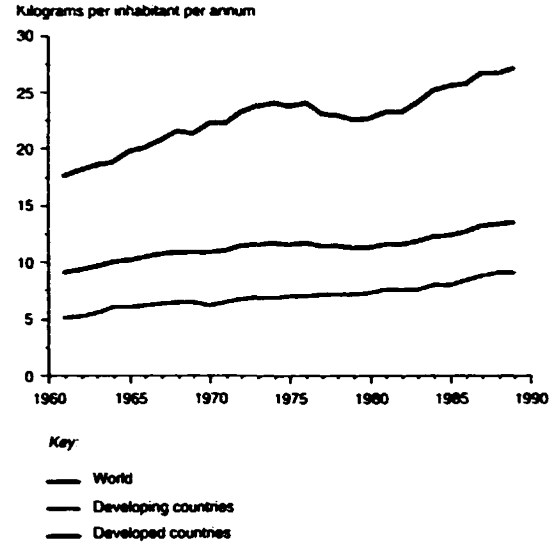
The recent strong increase in consumption has stimulated the current catch increase. Per capita consumption per year in 1989 was 13.4 kilograms, as compared with only 9.1 kilograms in 1961. This increase, however, has not been uniform across countries. Per capita consumption, for example, is three times higher in the developed than in developing countries. In the EEC, it varies from 8 kilograms per capita in the Netherlands to 57.7 kilograms per capita in Portugal. Finally, five countries, namely China, Japan, United States, India and the former

Figure IV.4. World aquaculture supply, 1990



Source: Food and Agriculture Organization of the United Nations, *Aquaculture Supply (1984-1990)* (Rome, 1992).

Figure IV.5. Growth of seafood consumption, 1960-1990



Source: Food and Agriculture Organization of the United Nations, *Fish and Fishery Products, World Apparent Consumption Statistics* (Rome, 1991).

USSR, consume one half of world production. The consumption share of major world regions in 1990 was Asia (51.8 per cent), the former USSR (12.1 per cent), EEC (11.1 per cent) and North America (8.6 per cent). The remaining shares were divided among Africa (6.2 per cent), Latin America (5.5 per cent) and Eastern Europe (1.4 per cent).

About three fourths of all seafood is consumed by humans; one third of this is consumed fresh; a third is frozen; and of the last third, approximately one half is canned and the rest is dried, smoked or salted. Developing countries usually consume fresh or slightly processed (dried, salted or smoked) products. On account of cultural habits (smell, difficulties of preparation etc.), developed countries prefer processed products: frozen fish, canned fish, prepared meals etc. In the former USSR and Eastern Europe, fresh or frozen fish are often scarce. In the former USSR, this shortage of fresh fish can be explained by the distance of important harbours (Murmansk, Ria, Vladivostok etc.) from centres of consumption (Moscow, Kiev etc.). By contrast, canned and dried, salted or smoked products are often appreciated in these countries: herring in the former USSR, cod in Poland, mackerel in Bulgaria etc.

In recent decades, the growth in population, increase in the standard of living (especially in developed countries), and intensive fish-farming have helped to stimulate fish and shellfish demand. In the short term, however, consumption also depends on seafood prices, as many substitutes exist, especially meats. The concern of consumers over contamination or polluted bodies of water also affect seafood use.

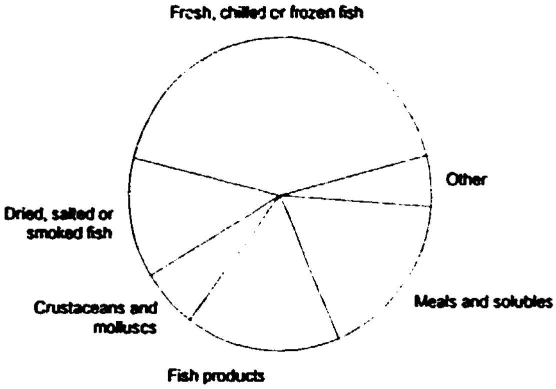
Table IV.15. Growth of world seafood processing, 1981-1990

Products	Production 1981 (thousand tonnes)	Production 1990 (thousand tonnes)	Percentage share 1981	Percentage share 1990	Percentage change 1981-1990	Main producing countries[a]
Fish, fresh, chilled or frozen	11 317.6	15 144.8	39.8	42.0	33.8	Former USSR (20.7), Japan (20.4), Republic of Korea (9.0), China (8.5)
Fish, dried, salted or smoked	3 890.2	4 502.4	13.7	12.5	15.7	Japan (21.9), Indonesia (16.7), Former USSR (16.2), Philippines (5.4), India (4.2), China (4.0)
Crustacean, mollusc, fresh, frozen, dried, salted etc.	1 465.4	2 253.7	5.2	6.2	53.8	Japan (22.5), United States (12.5), Thailand (8.3), China (7.3)
Fish products	5 156.8	5 924.0	18.2	16.5	14.9	Japan (27.4), former USSR (26.4), United States (6.4)
Crustacean and mollusc products	340.9	488.4	1.2	1.4	43.3	Philippines (20.9), Thailand (20.6), Japan (12.6), United States (11.0)
Oils and fats of aquatic animal origin	1 165.9	1 397.9	4.1	3.9	19.9	Japan (29.9), Peru (13.7), Chile (13.5), United States (9.2)
Meals and solubles of aquatic animal origin	5 058.9	6 293.0	17.8	17.5	24.4	Peru (19.1), Chile (17.1), Japan (15.5), former USSR (11.0)
TOTAL	28 395.7	36 004.2	100.0	100.0	26.8	

Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1992).

[a] Numbers in parentheses are percentage shares.

Figure IV.6. Major seafood-processing sectors, 1990



Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1992).

(c) *Prices*

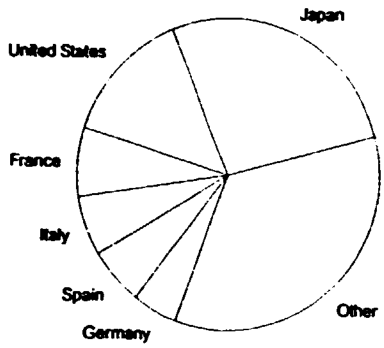
The price (real or deflated) of fish has not only increased more rapidly than other foods, such as meat or grains, but also is more unstable. Rapid growth has resulted from demand exceeding supply, while the instability has stemmed from fluctuations in the catch. Nevertheless, in most OECD countries, both trends and fluctuations are influenced by government policies, such as minimum prices. Much of the world's catch is sold at auctions, and subsequently sold again in national wholesale markets (such as Tsukiji in Tokyo and Rungis in Paris) [3]. Each of these stages involves a price increase, and this occurs again at the retail stage. However, in OECD countries, some cooperatives and commercial chains buy directly from wholesale dealers. In some developing countries, fishermen sell their products directly to consumers, while in other countries (India etc.), the system of distribution is more complex, with a multiplicity of middlemen.

The pricing of processed seafood products is different. Processing industries usually purchase from shipowners, within a framework of forward contracts for delivery. As a result, the purchase price does not fluctuate as much in the short term. However, prices are influenced by arbitration between different national markets. Given the domination of one or two major consumption centres, there is a tendency for other markets to follow these markets as price makers.

2. *International trade*

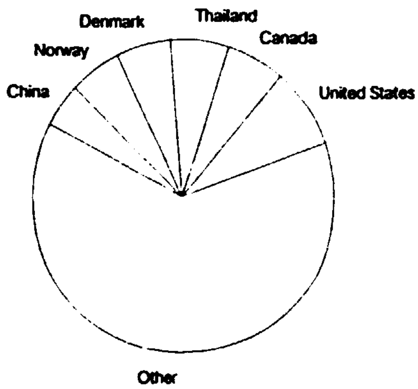
World seafood trade has increased some thirtyfold in the past three decades, reaching $39.4 billion in 1990. As much as 38 per cent of the world catch is sold on international markets; this figure could reach even 52 per cent for fish-meal, and 65 per cent for crustaceans and mollusc products. Table IV.16 indicates that developed countries absorbed 87.2 per cent of total world seafood exports in 1990. Figure IV.7 gives the import share for major countries. The three major world markets, namely the EEC, Japan and United States, account for 80 per cent of that total. In contrast, developing countries (Thailand, Republic of Korea etc.) supplied 44.6 per cent of those exports. In fact, table IV.17 shows that in 1990 Asian exports were the highest among the developing regions, followed by Latin America, Africa and Oceania. The principal exporting countries were Thailand, China, Republic of Korea and Indonesia. The relative importance of major exporting countries is reflected in figure IV.8.

Figure IV.7. Major seafood-importing countries, 1990



Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1992).

Figure IV.8. Major seafood-exporting countries, 1990



Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1992).

The world trade pattern for seafood derives from the location of the supply and demand for the major fish and shellfish species. These include shrimp, ground-fish, tuna, salmon, cephalopods, small pelagics and industrial seafood products. The importance of the major trading regions in these markets is summarized in table IV.18. The trade pattern is discussed below in greater detail for the major species and markets.

(a) *Shrimp*

Various species of shrimp and prawns are traded internationally, each generally with its own specific market. Shrimp production has doubled over the past 15 years, mainly as a result of increased farming. The volume produced, some 750,000 tonnes, currently accounts for about one quarter of world shrimp supplies. Shrimp farming is above all practised in Asian countries such as China, Indonesia and Thailand, and in Latin American countries such as Chile and Ecuador. The volume of world shrimp trade has [illegible] over the past 10 years, now accountin[illegible] sixth of all world seafood trade. Their [illegible] cterized by a high number of sellers and [illegible] number of buyers. Major

Table IV.16. World fish and shellfish imports, 1985 and 1990

Economic grouping, region, country or area	Imports 1985 (thousand dollars)	Imports 1990 (thousand dollars)	Percentage share 1985	Percentage share 1990	Percentage change 1985-1990
Japan	4 744.3	10 668.3	25.5	27.1	124.9
United States	4 051.8	5 573.2	21.8	14.1	37.5
France	1 039.8	2 809.0	5.6	7.1	170.1
Italy	985.0	2 458.1	5.3	6.2	149.6
Spain	412.2	2 360.7	2.2	6.0	472.7
Germany [a/]	854.2	1 916.8	4.6	4.9	124.4
United Kingdom	940.6	1 911.2	5.1	4.8	103.2
Denmark	370.4	1 116.1	2.0	2.8	201.3
Hong Kong	471.6	1 111.9	2.5	2.8	135.8
Netherlands	308.4	843.5	1.7	2.1	173.5
Europe [b/]	6 464.8	16 780.7	34.7	42.6	159.6
EEC	5 538.4	15 080.1	29.7	38.3	172.3
Asia	6 301.9	14 513.2	33.9	36.8	130.3
North America	4 602.5	6 447.3	24.7	16.4	40.1
Africa	653.2	886.4	3.5	2.2	35.7
Oceania	313.9	464.3	1.7	1.2	47.9
Former USSR	157.1	163.0	0.8	0.4	3.8
Latin America	125.8	155.9	0.7	0.4	23.9
North	16 135.0	34 383.6	86.6	87.2	113.1
South	2 484.2	5 027.2	13.4	12.8	102.4
World	18 619.2	39 410.8	100.0	100.0	111.7

Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1987 and 1992).

a/ Unified Germany.

b/ Excluding the former USSR.

Table IV.17. Fish and shellfish exports, 1985 and 1990

Economic grouping, region and country	Exports 1985 (thousand dollars)	Exports 1990 (thousand dollars)	Percentage share 1985	Percentage share 1990	Percentage change 1985-1990
United States	1 162.4	3 019.9	6.7	8.3	159.8
Canada	1 359.2	2 269.8	7.8	6.2	67.0
Thailand	675.1	2 264.9	3.9	6.2	235.5
Denmark	952.7	2 165.5	5.5	5.9	127.3
Norway	922.5	2 059.8	5.3	5.7	123.3
China	366.9	1 622.1	2.1	4.5	342.1
Republic of Korea	796.9	1 363.3	4.6	3.7	71.1
Netherlands	543.7	1 332.9	3.1	3.7	145.2
Iceland	617.4	1 240.3	3.6	3.4	100.9
Indonesia	236.6	978.7	1.4	2.7	313.7
Europe [a/]	5 285.0	12 058.9	30.5	33.1	128.2
Asia	5 322.8	11 650.3	30.7	32.0	118.9
EEC	3 329.8	7 908.9	19.2	21.7	137.5
North America	3 402.9	6 459.2	19.6	17.7	89.8
Latin America	1 490.4	2 638.1	8.6	7.2	77.0
Africa	823.5	1 649.8	4.7	4.5	100.3
Oceania	640.1	1 038.4	3.7	2.9	62.2
Former USSR	383.9	933.5	2.2	2.6	143.2
North	9 684.8	20 167.4	55.8	55.4	108.2
South	7 663.8	16 260.8	44.2	44.6	112.2
World	17 348.6	36 428.2	100.0	100.0	110.0

Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1987 and 1992).

a/ Excluding the former USSR.

Table IV.18. World seafood trade[a]

Products	World trade (percentage)	Main exporting country or area	Main importing economic grouping, country or area
Groundfish	18.2		
Fillets, FCF	10.1	Canada (16.8), Denmark (14.1), Iceland (13.3), Norway (5.2)	United States (30.6), Germany (12.2), United Kingdom (11.8), France (11.4)
Gadiformes, FCF	3.2	Denmark (15.5), United States (15.1), Chile (11.7), Iceland (10.0)	Spain (21.5), Denmark (15.9), United Kingdom (13.8), France (8.0)
Flatfish, FCF	2.4	Netherlands (32.3), United States (12.3) Iceland ([illegible].3), Denmark (7.3)	Japan (22.6), Spain (12.8) Netherlands (12.0)
Gadiformes, DSS	2.5	Norway (36.6), Iceland (21.3), Canada (15.6)	Portugal (38.3), Italy (17.8)
Shrimp, FCF	17.0	China (13.8), Thailand (12.6), Indonesia (10.1), India (5.9), Ecuador (5.8), Hong Kong (4.5), Mexico (3.6)	Japan (38.3), United States (25.0), EEC (21.9)
Tuna	9.2		
FCF	6.3	Republic of Korea (14.9), Spain (8.0), Singapore (6.3), France (5.6), Japan (4.4)	Japan (38.7), Thailand (24.9), United States (10.2)
Canned	2.9	Thailand (47.5), Côte d'Ivoire (9.9), Philippines (8.4)	United States (28.5), France (14.9), United Kingdom (13.0)
Salmonids	6.7		
FCF	5.8	Norway (36.0), United States (31.3)	Japan (40.6), EEC (36.7)
Canned	0.9	Canada (42.1), United States (34.1)	United Kingdom (51.2), Australia (12.6)
Industrial products	4.6		
Fish-meal	4.0	Chile (32.8), Peru (32.0), Denmark (7.5)	EEC (45.0), China (25.0), Japan (10.0)
Fish oils	0.6	Japan (21.7), United States (12.3), Iceland (8.7), Norway (8.5)	United Kingdom (17.9), Netherlands (16.4), Germany (11.5), Norway (8.5)
Cephalopods	4.0		
FCF	3.7	Morocco (15.8), Thailand (14.5), Spain (11.5), Mauritania (10.0)	Japan (47.5), Italy (16.9), Spain (14.7)
DSS	0.3	Thailand (36.7), Viet Nam (16.3)	Japan (34.3), Hong Kong (32.4)
Small pelagics	4.0		
Herring, anchovies, sardines	2.8		
Canned	1.5	Morocco (22.3), Portugal (11.0)	United States (15.5), Germany (15.4), France (10.7), United Kingdom (8.5)
FCF	0.9	United States (17.7), Netherlands (15.5), Norway (12), United Kingdom (7.8), France (7.5)	Japan (32.9), Spain (11.1) Denmark (9.4)
DSS	0.4	Netherlands (16.9), Iceland (16.0), Spain (13.7)	Italy (31.8), Germany (21.4), Spain (15.7)
Mackerel	1.2		
FCF	0.8	Norway (30.3), United Kingdom (15.9), Netherlands (12.7)	Japan (33.1), Netherlands (8.0), France (7.2), Nigeria (5.6)
Canned	0.4	Denmark (27.6), Japan (22.9), Portugal (12.3), Morocco (7.8)	Papua New Guinea (23.5), Italy (19.3), Germany (8.4)

Sources: Food and Agriculture Organization of the United Nations. *Yearbook of Fishery Statistics, Products* (Rome, 1992); and Fish-meal Exporters Organization, papers and proceedings of the Annual Conference held in Paris in 1992.

Note: FCF: fresh/chilled/frozen.
DSS: dried/salted/smoked.

[a] For main exporting and importing countries, data are in volume terms for 1992, and figures in parentheses are percentage shares.

exporters are developing countries, especially in Asia and Latin America, while major importers are Japan, EEC and United States.

Japan is the largest shrimp-trading centre and leads other markets in setting prices. Japanese shrimp prices have recently followed approximately a three-year cycle. For example, prices rose in early 1987 to mid-1988, declined towards the end of 1989 and increased again in 1990, followed by a new decline until mid-1992 and growth in 1993. Factors causing these fluctuations include changes in the value of the yen and fluctuations in demand. For example, Japanese shrimp consumption, weak at the beginning of 1992, increased until September, then declined in the last quarter of 1992.

The Asiatic zone always controls this market, with Japan's imports currently at 80 per cent. However, in the medium term, the influence of countries such as China, India, Indonesia or Malaysia could increase. Freshwater species are now in abundance (for example in Greenland and Norway), and could find important channels on this market. In the United States, shrimp consumption decreased in 1992, while domestic production has fallen, with a weakening of stocks and a decline in landings. The sources of United States imports include Ecuador, Thailand and other major shrimp-exporting countries.

In Europe, imports to three main markets have tripled over the past 10 years: Spain (75,000 tonnes); France (60,000 tonnes); and United Kingdom (50,000 tonnes). Price movements depend on numerous factors. For Nordic species, they follow supply, which was substantial in 1992. Prices accordingly declined. In June 1992 Cranon were sold, for example, at $1.35 per kilogram, compared with $6.90 per kilogram in 1991. This caused imports to increase quickly, especially in France and the United Kingdom. For tropical species, however, prices increased in parallel with world prices. For instance, during the first three quarters of 1992, the price of Indian Brown increased by 20 per cent. The outlook for further growth remains considerable, given that Europeans consume four times less shrimp than the Japanese. As a consequence, sales of black-tiger shrimp from suppliers such as Indonesia, Malaysia and Thailand should increase, to the detriment of the more expensive and rarer cold-water varieties. Processed products (cooked, unshelled and packaged shrimps) from developing countries could also be shipped to the European market in greater volumes.

(b) *Ground-fish*

The ground-fish family mostly includes Gadiformes and flat-fish. Used for human consumption, they represent one fifth of overall world trade in fish and shellfish. Besides the less important dried, smoked and salted fish market, a major part of trade is in the form of fresh, chilled or frozen fish and surimi.

In 1992, cod catches decreased heavily in major producing countries and areas such as Canada, Denmark, Faeroe Islands, Greenland and Iceland. In contrast, other countries experienced a relative abundance; increases were recorded for cod in the Barents Sea (Norway, Russian Federation), capelin (Iceland), hake (Poland etc.) and pollack (Republic of Korea, Russian Federation, United States etc.). At the same time, however, demand remained weak in 1992. In this context prices and trade also declined in Europe and the United States in 1992. While cod prices might stabilize in the United States, they are likely to fall in Europe, given duty-free imports of Norwegian products. To prevent this possibility, the EEC has adopted a minimum import price policy.

Given the abundance of pollack and the collapse of fillet prices, the surimi base price, especially high in 1991, declined in 1992. Japan still processed a major portion of the world supply (1.4 million tonnes) of surimi products, but this production is increasingly meeting with competition from countries in Asia and the Pacific region, such as the Republic of Korea. Exports of surimi by Japan in fact fell by 75 per cent between 1986 and 1991. Over time, none the less, this market is expected to grow, and other fish species may also be bred for this purpose.

(c) *Tuna*

The international tuna market ($3.6 billion in 1990) involves trade in blue-fin, albacore and tropical tuna (yellow-fin, skipjack and patudo). Most are shipped canned and fresh, chilled or frozen. Given the tariffs that exist on canned foods, the fresh, chilled and frozen market is traditionally the more important. The impact of the tuna crisis of 1990 and the increasing supply has been to pressure prices downwards. The market structure can also be said to lower prices, since the market consists of a few major consumers, but a variety of suppliers (Indonesia, Mexico, Republic of Korea, Taiwan Province, United States, EEC etc.). Since 1990, the United States has embargoed varieties of tuna from the eastern central Pacific which are jointly caught with dolphins. It would appear that tuna fishermen possess excess capacity including backward or primitive fishing technologies. There are many ecological reasons for not destroying dolphins, and this embargo has worsened the crisis. The fact that fishermen in the eastern central Pacific have little desire to modernize and control their catch symbolizes an industry guilty of its own decline, with prospects for bankruptcy.

In the 1980s world trade in fresh, chilled or frozen tuna tripled in value. This trade took place mostly on an interregional basis, linking fishing zones to the nearest major consuming markets, the latter including Italy, Japan, Thailand and United States. Dominated by yellow-fin and bigeye, the Japanese market has progressively become more important (two fifths of world imports). It is supplied above all by the Pacific region (Republic of Korea, Taiwan Province etc.).

The other three markets are for canneries species. With the embargo and competition from Asian tuna canners, the United States market is in net decline over the medium term. By contrast, the Italian market has experienced sustained growth, with abundant supplies and growing demand. In Thailand, the volume of tuna imports usually from the Asian region (Japan, Republic of Korea, Taiwan Province etc.) tends to decrease.

In the canned tuna market, the major exporters continue to be developing countries in South-East Asia, West Africa etc., the major import markets being in Europe and the United States. In 1992, the United States market (a quarter of world imports) experienced a downturn, with relatively low prices. While some three quarters of United States imports continued to come from Indonesia, Philippines, Thailand, other Asian exporters were playing an increasing role in the market.

In Europe, low prices, which decreased by one sixth between January and September 1992, helped to stimulate an increase in trade in France and the United Kingdom. By contrast, the demand was more moderate in Germany, with imports falling by 25 per cent during the first three quarters of the year. Although West Africa continues to be an important supplier of France, Madagascar and Asian countries may become increasingly important especially after the establishment of the single European market. Imports by Germany and the United Kingdom originate essentially in South-East Asia, from Thailand and also Indonesia, Maldives and Philippines.

(d) *Salmonids*

Salmonids include many species, but especially salmon and trout. In 1992, the world production of salmon was estimated to be 1.1 million tonnes, one fourth of which were farmed salmon, which has experienced a period of spectacular growth, especially in

Norway and the United Kingdom, but also in Canada, Chile and Japan. This growth, none the less, has led to overcapacity, and farmers have voluntarily reduced their deliveries in 1992. Parallel to this, the world catch of wild salmon, traditionally dominated by Canada, Japan, the former USSR and the United States, decreased in 1992. The existing excess supply caused salmon prices to drop in 1992, particularly because of substantial sales of Norwegian stocks. For example, in March 1992 in Germany, Atlantic salmon was sold for $6.80 per kilogram, compared with $8.70 per kilogram in 1991, and $10 per kilogram in 1988.

Lower prices have stimulated both demand and trade (430,000 tonnes in 1990) in different fresh, chilled or frozen markets. Traditionally, this is regional trade, with Japan importing from the United States (and more and more from Chile) and the EEC importing from Norway and the United Kingdom. In the medium term, supplies of salmonids could continue to grow. The catch of wild salmon will remain variable, but will continue to increase, as long as conservation measures are respected. However, the attempt to reduce the excess salmon supply in Europe may be overcome by increased farming in other countries, such as Canada, Chile and Japan. A great part of the supply will probably find new market opportunities, and salmon is likely to change from being a luxury item to a more common daily food.

(e) *Cephalopods*

The world cephalopod market (squid, cuttlefish, octopus) has doubled in volume over the past 10 years. Trade is highly concentrated, with Japan, Spain and Italy accounting for 80 per cent of all imports. Supplies, however, are more widely scattered, with countries such as Mauritania, Spain and Thailand being the main exporters.

Following the excess supply of 1988 and 1989, until the first quarter of 1992, squid markets faced supply shortages. But with the recovery of fisheries, after April 1992, prices tended to drop, especially as demand weakened in Japan. Only some European markets such as Spain and Italy experienced, at the end of 1992, an increase in prices and a relative shortage of supplies, linked to reductions in Indian landings. Parallel to this, world exchanges, which had dropped in 1991, increased quickly in 1992. In the first three quarters of 1992, Japanese imports increased by one half. In this market, Argentina provides large quantities to the detriment of Eastern European exporters and those in the Pacific, for example, New Zealand, Republic of Korea, Taiwan Province, Thailand. European markets are traditionally supplied by North Africa (Morocco), by Eastern countries (Poland, former USSR) and by Asian countries (India, Thailand).

Cuttlefish is supplied mostly by Southern Europe (France, Italy, Spain) and Asia (Republic of Korea, Thailand). Production has been falling in the medium term. In Japan, consumers are very fond of top-quality cuttlefish, generally eaten raw. Since mid-1987, this market has experienced higher prices. Japanese imports increased slightly in 1992, with Mauritania, Morocco, Spain and Thailand as its main suppliers. In Europe, Italy is a major consumer for small cuttlefish, frozen in blocks. Major exporters to this market remain France (30 per cent) and the West African countries. Spain imports 16,000 tonnes of cuttlefish, mainly from African countries (Mauritania, Morocco, South Africa etc.) and India.

The world catch of octopus in 1992 amounted to some 280,000 tonnes. Major suppliers were Japan, Mauritania, Morocco and Spain. Given the relative abundance of that catch in 1992, especially in the eastern central Atlantic, prices which doubled over the past four years tended to decrease. Japan thus increased its imports from Morocco, and even more from Mauritania and Spain.

The cephalopod market could develop further, given the large resources remaining, notably in the Atlantic. Some 60 species are marketable, and demand should grow in countries such as Italy, Republic of Korea and Spain. New restrictions on the use of the drift net could lessen supply and help conserve these species. Traditionally, Japan and the Republic of Korea caught more than 200,000 tonnes of squid on an annual basis in the North Pacific. Their fleet could therefore fall back on Mexican and Peruvian stocks.

(f) *Small pelagics*

Small pelagic species include sardines, pilchards, anchovies, herring, mackerel etc. Globally, they represent nearly one half of the world seafood catch and a quarter of all canned fish.

Almost one half of all world trade involves sardines of various types, generally canned. Since 1988, with the exception of the beginning of 1989, this market has experienced poor harvests in Italy, Morocco and Spain. At the same time, prices tend to increase, except in Germany. This has caused some shift among the major exporters. In Asia, Thailand replaced Japan, and in Europe, Morocco overtook Portugal (except in France).

The world mackerel catch totalled some 2.6 million tonnes in 1990. Conditions are stable in this market, which accounts for 4.1 per cent of all canned fish production by volume, and 1.2 per cent of world trade in fish and shellfish. Fresh fish is traded mostly in Europe and in the Pacific region. The canned mackerel market is both European (for Atlantic mackerel) and Asian. Denmark continues to be the main supplier to European importers (especially Italy and Germany), with Portugal increasingly displacing Morocco. In 1980, Japan exported 200,000 tonnes of mackerel, compared with only 13,400 tonnes in 1992. This long-term decline is due to several factors: competition from other Asian countries, notably from Thailand; a decline in resources linked to the creation in the early 1980s of a 200-mile economic zone; and the introduction into many Asian waters of the Japanese sardine, a predator to the Spanish mackerel.

Different trade patterns exist for other small pelagics such as anchovies, sauries and jacks. Trade in fresh, chilled or frozen herring increased notably in 1992, with increases in catches and decreases in prices. Most of the great herring markets (North America, Western Europe, Eastern Europe and the former USSR) buy and sell on a regional basis. Only Japan remains truly international, with imports originating from Canada, Europe (Norway) and the United States. Globally, demand for herring will probably not increase notably over the next few years. But production will increase substantially, leading to lower prices, and this is likely to result in further processing for fish-meal.

The future of the small pelagics market remains uncertain. Supplies are fluctuating, and overfishing threatens all species, with the possible exception of anchovies, herring and sardines (Angola, Mauritania). This threatens to limit the potential of the markets; at the same time, world demand seems to be weakening, except perhaps in some developing countries and, in the medium term, in Eastern Europe. Such changes should constitute no great threat to the pelagic fishing industry, in so far as the fish can be alternatively processed into oil and fish-meal.

(g) *Processed oils and meals*

Fish oil is made primarily from fish such as pilchard, menhaden and capelin and is chiefly used by the margarine industry. Some 1.3 million tonnes of fish oil are produced annually, accounting for 2 per cent of world consumption of edible oils. On an average, Japan produces 25 per cent of the world total, Latin American producers (mostly Chile and Peru) some 40 per cent, and a further 20 per cent comes from European producers (chiefly Denmark, Iceland and Norway). Since 1989, this industry has experienced weak supplies. In 1992, fish-oil production decreased, except in some European countries (Iceland etc.), which have an ample supply of herring and capelin. The overall supply decline can be explained by lower production (Japan) or lower yields (Latin America and North America). When fish-oil prices increased in 1989, world trade decreased accordingly, to reach 370,000 tonnes in 1992.

Fish-meal is made from fish such as pilchards, jacks, anchovies, and menhadens. Some 40 per cent of production originates in Latin America (Chile, Peru), 14 per cent from East Asia (China, Japan, Thailand), 12 per cent from Northern Europe (Denmark, Iceland, Norway) and 10 per cent from the former USSR. Estimated at 6.1 million tonnes in 1992, this supply has also declined since 1989, especially in Japan and the former USSR. In Japan, with resources becoming rarer, production dropped by 60 per cent between 1988 and 1992. As a result of the general decay of its fishing fleet, the production of the former USSR is also declining, with a fall of 12.3 per cent in 1992 alone. Given this low supply situation and high prices, fish-meal has been unable to gain in competitiveness relative to soy-meal. Although sales of fish-meal grew by one third between 1980 and 1985, trade has tended to stagnate around 3.3 million tonnes, currently worth $2 billion. Trade used to be on a "North-South" basis. The South still provides most of the total sales, as Latin America alone (Chile, Peru) provides 67 per cent of world exports. Japan has lowered its sales and is now becoming a major importer. Among developed market economies, only Northern Europe (Denmark, Germany, Iceland and Norway) can still be considered a major exporter, with 20 per cent of the world market.

The demand for fish-meal, none the less, is altering rapidly. First, with the development of aquaculture, developing countries such as China, Indonesia, Philippines and Thailand have become important importers. For example, China, which currently produces 30 million tonnes of animal feed per year, imports some 660,000 tonnes of fish-meal. Secondly, and in contrast, successor States of the former USSR, short of hard currency, have progressively disengaged from these markets as buyers. Thirdly, some developed countries such as Germany and the United States now prefer fish-meal to soy-bean meal in animal feeds.

3. *Industry restructuring*

In 1990, some 13 of the 100 major agro-food companies were involved in fish and shellfish processing, with a turnover ranging from $2 billion to $4 billion. Further detail on the profitability and sales of these companies appear in table IV.19. In Japan, companies such as Taiyo Fishery, Nippon Suisan Kaisha, Nichirei, and Nichiro are highly specialized in fish and shellfish. In contrast, in Europe and the United States, agro-food groups have simply diversified their activities into fish and shellfish. Unilever or Nestlé, for example, have entered the seafood sector by adopting different brand names (Findus, Igloo etc.) for fish and shellfish. Nearly all major processing companies have pursued a strategy of concentration, diversification and internationalization.

Given that the traditional fishing process has become highly industrialized, the scale of companies in many countries has increased notably. In Spain, for example, Pescanova, accounts for 40 per cent of the domestic fish market. In Japan, the processing industry is organized around several major companies, the Taiyo Fishery, Nippon Suisan Kaisha, Nichirei, Nichiro and Kyokuyo. This phenomenon of concentration is particularly strong at the canning, freezing and fish-meal stages. In the United States, four groups supply 80 per cent of the domestic tuna market. In Spain, the number of fish and shellfish canneries has been reduced from 463 in 1974 to 170 in 1991. In France, the industry remains organized around three companies, Saupiquet, Pêche et Froid and Pêcheurs de France. In Chile, the Angelini group provides one half of the country's fish-meal production. However, in countries such as China and Norway and in many developing countries, the scale of the industry has remained small.

There has also been a movement towards an increase in vertical integration, as can be witnessed in countries as different as Iceland, Japan or Thailand. In such countries, major companies jointly own fishing, processing and trading activities. The Royal Greenland group, for example, has 11 trawlers, 16 processing factories and several commercial outlets in Germany, Italy, Japan and United Kingdom. Some geographical concentration also exists. In Indonesia, canneries are concentrated near Bali. In India, factories in Kerala represent 40 per cent of the domestic freezing capacity.

Processing companies have also sought to increase their diversification, for example, by entering the delicatessen, poultry and other sectors. Companies that provide storage also have diversified into fruits, vegetables, meat and other food products.

Other companies have chosen to export their factories to developing countries. Some United States canneries, for example, are implanted in Ecuador, Peru and Somoa. French canners have also invested in Côte d'Ivoire and Senegal. Reverse transactions can also be found. In July 1988, the Indonesian group PJ Mantrust, for example, bought Van Camp Seafood, which controls 20 per cent of the United States canning market. On all sides, the internationalization improves the Spanish group, Pescanova, which has subsidiaries in Australia, France, Italy, Namibia, South Africa, Uruguay etc. The Japanese group Mitsubishi controls Princes Food in the United Kingdom and in the latter country, Albert F. .her dominates the mussel industry in the Netherlands.

Table IV.19. Major seafood companies, 1990

Company	Nationality	Turnover (million dollars)	Net profit (million dollars)	Assets (million dollars)	Employees	Activities
Unilever	Netherlands/ United Kingdom	39 972	1 638	24 806	304 000	Food, fish and shellfish products
Nestlé	Switzerland	33 359	1 635	27 859	199 020	Food, fish and shellfish products, mineral water
Conagra	United States	15 518	232	4 804	58 370	Food, fish and shellfish products
Hillsdown Holdings	United Kingdom	7 537	108	4 093	50 000	Fish and shellfish products, meat, fruits and vegetable cans, pet foods, biscuits, jams etc.
Taiyo Fishery	Japan	7 439	40	3 191	2 530	Fish and shellfish products
General Mills	United States	6 487	381	3 290	97 240	Cereals, snacks, condiments, deep-frozen products, fish and shellfish products
H.J. Heinz	United States	6 112	505	4 488	37 300	Sauces, pet foods, condiments, fish and shellfish products
Procordia	Sweden	5 339	54	5 884	44 650	Confectioneries, beer, mineral water, vegetable cans, fish and shellfish products, meat, sugar
Booker PLC	United Kingdom	5 223	185	2 128	22 760	Fish and shellfish products, poultry, seeds, mushrooms
SME	Italy	4 425	100	3 016	20 890	Food, fish and shellfish products
Nippon Suisan Kaisha	Japan	3 690	44	2 169	3 140	Fish and shellfish products
Nichirei corporation	Japan	3 521	20	2 383	2 610	Deep-frozen products (fish, shellfish and meat)
Nichiro corporation	Japan	1 962	6	1 107	1 380	Fish and shellfish products

Source: Centre français du commerce extérieur, *Les 100 leaders de l'industrie agro-alimentaire mondiale en 1990* (Paris, 1992).

4. *Capacity utilization and expansion plans*

Many OECD countries are now confronted with declining populations of both fish and shellfish, largely because of careless overfishing. This has resulted in excess capacity for their fleets. In developing countries, capacity utilization rates can be weak. Many African countries, for example, do not use all the potentialities of their artisanal fisheries. New processing industries (canneries, freezing facilities etc.) could also be used more intensively. In the case of Mauritania, utilization rates of its freezing units did not exceed 25 per cent in 1990, and the distribution network of frozen fish remained largely underutilized.

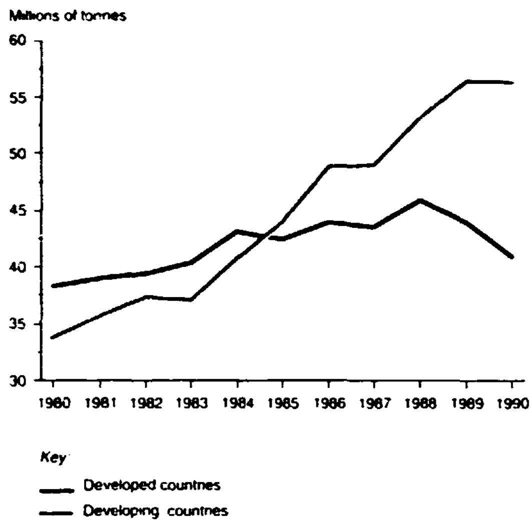
In many OECD countries, recent industry restructuring has lowered production capacities [4]. Between 1985 and 1990, the number of vessels declined by 5 per cent in Canada, 14 per cent in Denmark and 30 per cent in Norway. Much of the reduction has been aided by subsidy policies on the part of Governments. In 1990, for example, subsidy payments reached some $190.4 million in Norway, $91 million in Sweden and $96 million in the EEC. The forms of the interventions vary from one country to another, depending on credit conditions, tax reductions etc. In many countries, such as Australia, Iceland or New Zealand, progressive substitution of total admissible catches and transferable individual contingents have helped to curb subsidies. Governments have also supported mergers and acquisitions as an alternative policy measure. In Europe in 1990, for example, the EEC paid $71 million for mergers, while Sweden and Finland extended loans.

Developing countries need more development than restructuring. In the medium term, they might centre their growth in local markets. This would depend on support for artisanal fisheries, as a substitute for foreign fleets, an expansion of higher value-added products and an improvement in distribution. North-South cooperation, with joint ventures engaged in processing and trading, could further this evolution. But developing countries might also enlarge cooperatives, which would stimulate profitable investments, especially for shipbuilding, fishing, refitting and processing.

5. *Markets and capacities of developing countries*

The share of developing countries in world fisheries has increased regularly. Since 1985 it has exceeded that of OECD countries. But a great part of the expansion has been linked to inland fisheries. In 1990, developing countries accounted for 86.1 per cent of world inland catches, compared with only 80.6 per cent in 1981. In developing countries, this represents a 22.1 per cent of all landings, compared with only 4.8 per cent in OECD. Much of this is due to the success of aquaculture in those countries. In 1990, they accounted for 66.9 per cent in value of the world aquacultural supply, compared with only 61.9 per cent in 1984. Sources of this expansion include marine aquaculture, the farming of shrimp in Ecuador, India, Indonesia and Thailand, the farming of salmon in Chile etc. Marine catches have also experienced a considerable growth in developing countries. Indeed, between 1981 and 1990, catches increased by 50.2 per cent in developing countries, compared with only 4.2 per cent in OECD countries (see figure IV.9).

Figure IV.9. Growth of fisheries in developed and developing countries, 1980-1990



Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Catches and Landings* (Rome, 1982 to 1992).

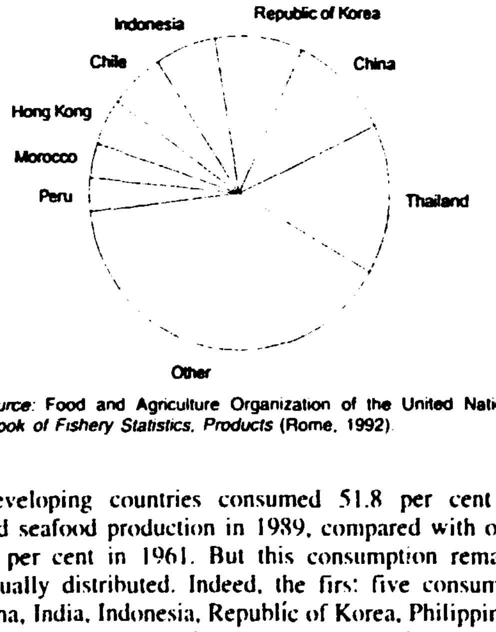
However, much less fishing actually took place in developing countries. In Africa in 1990, landings per capita reached 8 kilograms, compared with 13.9 kilograms in developing countries; 19.7 kilograms in the EEC; 27.1 kilograms in North America; 32.9 kilograms in developed countries and 37.9 kilograms in Japan. However, serious regional distortions still exist. Indeed in 1990, eight countries (Chile, China, India, Indonesia, Peru, Philippines, Republic of Korea and Thailand) accounted for 72 per cent of the total catch and 90 per cent of the increase in the catch of all developing countries. At the same time, Africa has an extremely small industry.

Developing countries do not profit from the richest fishing areas, which are usually in the northern hemisphere. They are also confronted with access problems. Indeed, the 10 richest countries in the world dispose of 36.5 per cent of coastal areas classified as exclusive economic zones, as compared with 1.8 per cent for the 10 poorest countries. But the deficiency of the catching fleet often worsens the situation. Indeed, in developing countries, small boats are commonly used, but face problems such as lack of repair and maintenance, the absence of credit etc., and incur important losses during carriage. From a human point of view, 15 million persons work in developing-country fisheries, often with training problems. Nevertheless, some countries such as Chile, Mauritania and Senegal, have succeeded in creating an industrial fleet.

Another major problem of developing countries is the need to move to higher value-added products. In spite of examples such as Argentina, Indonesia, Morocco and South Africa, canning factories are often scarce in those countries. Many impediments exist, including availability of capital, prohibitive costs of importing cans, lower quality of oils etc. Nevertheless, the canning factories could expand in those countries, as the industry is generally labour-intensive. Freezing facilities are often scarce in those countries, with specific handicaps such as the lack of fish tanks, of isothermal containers, of refrigerators and of ice. Since the drying and salting industry requires only small investment, it is often practised in developing countries by small-scale producers. However, they are confronted with problems such as the deficiency of salt supplies and poor quality in packaging. The fish-meal industry has spread to only a few countries, including Chile, Peru and South Africa, but it is capital- rather than labour-intensive.

Fish and shellfish exports have grown enormously in developing countries (see figure IV.10). In 1990, they amounted to $16.3 billion, compared with only $6.7 billion in 1981. A high concentration could be found; the first 10 exporters, including Thailand, China and Republic of Korea, accounted for 60.2 per cent of seafood trade of developing countries in 1990. In value, three quarters of the trade constituted high-value products (crustaceans and molluscs, fresh, chilled or frozen fish). In contrast, canned fish represented only 17.5 per cent of developing-country exports in 1990, industrial products, 5.8 per cent, and dried, salted or smoked products, 1.7 per cent.

Figure IV.10. Seafood exports by developing countries and areas, 1990



Source: Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics, Products* (Rome, 1992).

Developing countries consumed 51.8 per cent of world seafood production in 1989, compared with only 38.5 per cent in 1961. But this consumption remains unequally distributed. Indeed, the first five consumers (China, India, Indonesia, Republic of Korea, Philippines) represent 50 per cent of total consumption. In 1989, per capita consumption reached 9.1 kilograms for developing countries as a whole, but in several countries, per capita consumption was either extremely low (100 grams in Ethiopia, 80 grams in Bolivia), or extremely high (52 kilograms in Republic of Korea, 42.3 kilograms in Fiji, 35.5 kilograms in Congo). Moreover, regional distortions are also frequent. In India, 95 per cent of all fish is consumed in the coastal zones. These markets are little open to imports, accounting for only 12.8 per cent of world fish and shellfish imports in 1990. Besides Hong Kong (22.1 per cent), the major importers remain Thailand (15.8 per cent), Republic of Korea (7.3 per cent) and Singapore (7.2 per cent). However, the imports of China amount to less than 7 per cent of the imports of Spain, Latin America does not import more than Nigeria, and Africa imports less than Hong Kong. Half of the purchases are of fresh, chilled or frozen fish, and 20 per cent are crustaceans or molluscs (fresh, chilled, frozen, dried or salted). The last 33 per cent is equally distributed between industrial products, canned and dried, and salted or smoked products.

6. *Technological and ecological trends*

From catching to processing, the fish and shellfish industry involves a very high level of spoilage. Indeed, given the low selectivity in fishing, each year some 15 million tonnes of unwanted fish are discarded. To this spoilage, which constitutes an enormous threat to the environment, can be added losses resulting from transport (10 per cent) and processing (50 per cent). Discards are massive for some species (anglerfish, hogfish, scallops, crab, etc.) and some processes (fillets etc.). Some countries have already attempted to make a stand against these losses. In Norway, discarding is forbidden. In Japan, the remains (heads, fins, viscera) are processed to provide consumable products (pâtés, sausages etc.). In France, "false fish" (species in limited demand, fish of small height etc.) are used for making hydrolysate. In the United States, scraps are recovered to make fish concentrates.

Aquacultural companies often pollute the environment through different forms of discharges. In many countries and areas (Indonesia, Taiwan Province, Thailand etc.), shrimp-farming has already created heavy problems. Though numerous techniques allow for the treatment of discharge, in the case of the shrimp-farming, chemical methods remain ineffective and physical techniques (filtration) are still too expensive. However, new biological methods are being examined in, for example, Hawaii and Thailand with a view to the use of seaweeds and molluscs to fix wastes.

In many countries, Governments already regulate polluting activities in order to protect the environment. In 1990, Denmark decided to forbid new farms. In the medium term, the protection of the environment will probably become a priority for farms and processing companies, which continue to discharge their wastes on land and in water.

Another important ecological problem which is beyond the scope of this study is the overfishing of whales. Certain species like dolphins are important for the role they fill in the ecological chain. Overfishing simply results in the depletion of a stock and its eventual disappearance. Countries such as Japan and Norway need to develop educational programmes in this respect. While many natural species have provided food with interesting flavour, many of them have disappeared. The educational process helps in the decision to change eating habits in order to prevent the elimination of a species.

7. *Short- and medium-term outlook*

(a) *Consumption*

Given a yearly growth of 2 per cent, world fish and shellfish consumption could exceed 110 million tonnes by the end of the century. If the world population increases to 6.1 billion inhabitants by the year 2000, this means a demand of more than 100 million tonnes (including 25 million tonnes of fish-meal) more and more localized in developing countries, which account for 78 per cent of the world's population. Moreover, if income growth is taken into account, the consumption per inhabitant could increase by 1 kilogram each decade in developing countries (and probably more in developed countries). In this context, world fish and shellfish consumption could exceed 110 million tonnes in the year 2000.

(b) Production

With constant prices, production could easily meet consumption needs. But this depends on increased productivity and less wastage. In OECD countries, marine areas seem fully exploited, but in the Indian Ocean and the South Pacific, some new resources could be exploited. Some geographic areas present larger potentialities, and inland catches could increase heavily in Africa and Latin America.

Traditional crustaceans and demersal species are now fully exploited. Aside from pelagics, which are subject to fluctuations in catch, only krills and cephalopods seem able to support greater exploitation. Indeed, cephalopod resources have been estimated at 200 million tonnes. Their use could increase in human consumption, or they could be processed into fish-meal to substitute for pelagics, which are more useful for direct human consumption.

Technical progress in searching methods or in deep fisheries could also open new perspectives. Indeed, the bigeye tuna remains abundant down to 600 metres and deeper; down to 1,500 or 2,000 metres other usable species can also be found. In any case, catches will not increase without appropriate administrative policies. That implies a stricter definition of total admissible catches, a more careful knowledge of marine ecosystems, a stronger control of vessels, a real fight against pollution, an extension of restocking policies, more financial transfers in favour of developing countries etc.

The growth of the world supply will also require a better use of catches and especially a recovery of wastes. Only aquaculture allows a long-term increase in world seafood supply. A comparison of potential yields is revealing: 200 to 500 kilograms per hectare per year for bovines, compared with 3 to 8 tonnes for fish and shellfish. Aquacultural production could reach 20 million tonnes in 1995, and represent a quarter of the world supply (volume terms) in the year 2000. In the short term, government support will be necessary for aquacultural development, the management of fisheries, the fight against pollution, and the restructuring of processing industries. This support will require greater international coordination, which implies improved organization of markets, regulation of high-seas fisheries and further assistance to developing countries for fisheries projects.

C. Market pulp (ISIC 341101-341116)*

1. Recent trends and current conditions

Market pulp is an indicator of the cost of fibre, which is in turn the main factor cost for paper- and board-mills around the world, as shown in table IV.20. About 92 per

*UNIDO acknowledges the contribution of John Pearson, Pulp and Paper International.

Table IV.20. Production of market pulp by grade and region, 1991
(Thousand tonnes)

Grade	North America	Europe	Latin America	Asia	Africa	Oceania[a/]	Total	Percentage share
Bleached softwood kraft	8 695	3 489	734	91	75	122	13 206	38.30
Bleached hardwood kraft	3 152	4 203	1 789	1 168	171	-	10 483	30.41
Semi-bleached softwood kraft	319	141	30	-	-	28	518	1.50
Unbleached softwood kraft	564	522	382	268	160	140	2 036	5.91
Unbleached hardwood kraft	-	27	19	21	-	-	67	0.19
Dissolving, high-alfa kraft	628	23	13	-	-	-	664	1.93
Bleached softwood sulphite	542	1 256	22	26	-	-	1 846	5.35
Bleached hardwood sulphite	-	372	-	-	-	-	372	1.08
Semi-bleached softwood sulphite	-	12	-	-	-	-	12	0.03
Unbleached softwood sulphite	-	232	1	-	-	-	233	0.68
Dissolving, high-alfa sulphite	998	302	2	185	435	-	1 922	5.57
Stone groundwood	45	371	-	-	-	-	416	1.21
Refiner mechanical	80	34	-	-	-	10	124	0.36
Chemi-mechanical	-	70	-	-	-	-	70	0.20
Thermomechanical	112	45	-	-	-	-	157	0.46
Chemi-thermomechanical	870	338	58	-	-	116	1 382	4.01
Semi-chemical	-	213	-	40	-	-	253	0.73
Soda	-	-	49	-	-	-	49	0.14
Bagasse	-	-	25	48	3	-	76	0.22
Cotton linters	165	40	-	-	-	-	205	0.59
Esparto	-	-	-	-	41	-	41	0.12
Straw	-	12	-	-	8	-	20	0.06
Other non-wood	-	3	-	116	-	-	119	0.35
De-inking	106	85	-	-	-	-	191	0.55
Other recycled	12	2	-	-	-	-	14	0.04
TOTAL	16 288	11 792	3 124	1 963	893	416	34 476	100.00

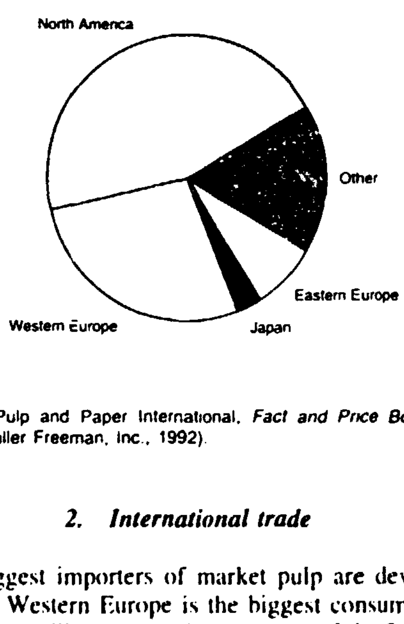
Source: Pulp and Paper International, *Market Pulp Survey 1992* (Brussels, Miller Freeman, Inc., August 1992).

a/ Excluding Australia and New Zealand.

cent of the 34.5 million tonnes of market pulp produced worldwide in 1991 was chemical wood pulp; or pulp manufactured by the chemical treatment of wood, rather than by grinding. Some 78 per cent is so-called kraft pulp, made by cooking wood in sulphate (alkaline) solutions; such pulps are prized for their high fibre strength. Sulphite pulps and semi-chemical pulps account for the rest of chemical pulp output. Most of these chemical market pulps are used for paper-making. Just 8.2 per cent of the pulp output is used in other applications such as textiles. Mechanical wood pulps, made by grinding, are a far less important input, accounting for only 6.2 per cent of total production. The dominant grade is chemi-thermomechanical pulp, in which woodchips are treated by heat and chemicals before grinding. The remainder of the market is made up of specialized fibres, such as non-wood pulps and some waste-paper pulps. The latter are becoming increasingly popular as environmental pressures for recycling grow in developed countries.

As shown in figure IV.11, Canada and the United States produced most (45.2 per cent) of the world output of pulp in 1991. The output of other countries appears in table IV.21. Among developing countries, Brazil, with 5.8 per cent of world output in 1991, is especially important, as is Chile with 2.1 per cent. More recently, the Indonesian industry has been increasing in both capacity and output.

Figure IV.11. World market pulp production, 1991



Source: Pulp and Paper International, *Fact and Price Book 1993* (Brussels, Miller Freeman, Inc., 1992).

2. *International trade*

The biggest importers of market pulp are developed countries. Western Europe is the biggest consumer, importing 12.9 million tonnes in 1991, out of the 24.3 million tonnes traded internationally. The largest exporters are also among developed countries. However, developing countries have been aided in their penetration of the pulp market by the availability of fast-growing plantation forests and low labour costs. Typically, wood accounts for 50 per cent of total operating expenditures; hence countries that can grow wood to maturity in short periods have an advantage over their competitors. Brazil has progressed most with the development of eucalyptus (hardwood) plantations with a cycle time of six to seven years. Similar growing conditions for this species exist in Argentina, parts of Chile, Indonesia, and parts of Africa.

Table IV.21. Production of market pulp, 1990-1991
(Thousand tonnes)

Region, country or area	Production 1991	Percentage share
Developed countries		
United States	7 982	22.9
Canada	7 789	22.3
Sweden	3 371	9.7
Former USSR[a]	2 000	5.7
Finland	1 575	4.5
Portugal	1 315	3.8
Japan	954	2.7
France	781	2.2
Spain	744	2.1
Norway	597	1.7
Developing countries		
Brazil	2 039	5.8
Chile	740	2.1
Taiwan Province	320	0.9
Argentina	250	0.7
China[a]	245	0.7
A. North America	15 771	45.2
Western Europe	9 577	27.5
Eastern Europe	2 785	8.0
Japan	954	2.7
Other	591	1.7
Total, A	29 678	85.1
B. Latin America	3 234	9.3
Asia		
Centrally planned economies (including China)	245	0.7
Market economies	888	2.5
Africa	815	2.3
Total, B	5 182	14.9
Total, A and B	34 860	100.0

Source: Pulp and Paper International, *Fact and Price Book 1993* (Brussels, Miller Freeman, Inc., 1992).
[a] Estimated.

Chile has been a pioneer in softwood production; its radiata pine plantations typically reach maturity in 24 years. Fast-growing trees are, however, only part of industry requirements. The fibre pulp produced must meet specific demands of the paper makers. Traditionally, softwood fibre of the Nordic and Canadian regions has been regarded as the highest quality available. None the less, developing countries possess an advantage with lower production costs, and there may well be a further drift of production capacity in that direction over the next few years. With high fibre costs, northern producers may seek higher-value applications for their fibre. Market conditions in 1992 were not favourable; demand became sluggish towards the end of the year, and oversupply weakened prices. In addition, environmental concerns led many producers to invest heavily in new technology at the end of the 1980s and the first two years of the 1990s, resulting in heavy debts and a weakened company structure. Despite these problems, output probably grew marginally in many countries. Table IV.22 shows small percentage increases for 1992 over 1991, although the final increases may be higher.

Prices for market pulp are notoriously cyclical. Table IV.23 illustrates the current downswing that has developed in the major consumer markets of Europe since 1989. Northern bleached softwood kraft pulp is considered the benchmark grade of the industry, but for completeness, the table includes three other grades, United States southern pine (softwood) pulp, northern birch (hardwood) and eucalyptus pulp (hardwood). At the end of the first quarter of 1993, a resolute attempt was being made by several suppliers to raise prices again to restore the profitability of the producers. Industry sources thought that the rise might be accepted by the market, although recessions in some of the major consuming countries, especially in Central Europe, Germany and Japan, threatened to keep demand and prices weak [5].

Table IV.22. Recent production estimates for market pulp, 1991
(Thousand tonnes)

Country	Production[a] 1991	Percentage share
Developed countries		
United States	8 980	29.4
Canada	6 985	22.9
Sweden	3 380	11.1
Russian Federation[b]	1 950	6.4
Finland	1 540	5.0
Portugal	1 300	4.3
Japan	930	3.0
Spain	810	2.7
France	800	2.6
New Zealand	656	2.1
Developing countries		
Brazil	2 173	7.1
Chile[b]	800	2.6
Argentina	253	0.8
TOTAL	30 557	100.0

Source: Pulp and Paper International, *Road to Recovery is no Easy Climb* (Brussels, Miller Freeman, Inc., 1993), pp. 33-41.

[a] Approximate figures.

[b] Estimated.

Table IV.23. Market pulp prices in Europe, 1989-1993
(United States dollars per tonne)

Quarter	Northern bleached softwood kraft	Southern pine	Birch	Eucalyptus
1989				
I	810	780	708	710
II	840	810	738	731
III	840	810	814	801
IV	840	810	895	868
1990				
I	840	680	767	772
II	840	650	748	753
III	800	650	703	697
IV	775	630	653	634
1991				
I	715	605	521	516
II	625	540	486	493
III	520	480	541	536
IV	490	450	594	590
1992				
I	530	480	551	547
II	550	520	629	631
III	600	560	639	615
IV	500-540	460-490	508	436-472
1993				
I	425-440	380-400	487-493	373-400

Source: Pulp and Paper International, *This Week* (Brussels, Miller Freeman, Inc., 1992-1993).

The perspective is complicated by environmental pressure from consumers of paper in several major markets, which has forced producers to develop new grades of pulp, bleached without chlorine or chlorine chemicals. These pulps have higher production costs and carry a premium on the market. Typically this amounts to $71.6 per tonne in Germany, as will be explained later.

3. *Capacity utilization and expansion plans*

Again, because of the existence of swing machines and tied tonnage, it is extremely difficult to give an accurate capacity utilization figure. However, the industry is believed to have operated at only about 81 per cent of its total capacity in 1991 [6]. The period 1990 to the end of 1992 saw a number of new projects come on stream, but with weakening markets and low prices in that period, many plans for further expansion have been curbed until an upturn is foreseen. With so little definite new capacity coming on stream, there should be a chance for the market to recover its supply-demand balance. As shown in table IV.24, most of the new projects are being planned in developing countries.

4. *Manufacturing capacity of developing countries*

It is difficult to define precisely the production capacity for market pulp. Several mills have the ability to swing between production for the market and production for neighbouring paper machines. Some pulp is also tied to the operations of particular buyers and, strictly speaking, does not qualify as market pulp. Table IV.25 provides best the estimates of market pulp capacity of several developing countries in 1992. Thus capacity is small compared to the world total, which is estimated to be around 43 million tonnes [7]. The two leading countries in pulp capacity as reflected in figure IV.12 are Brazil and Chile.

5. *Restructuring and deployment*

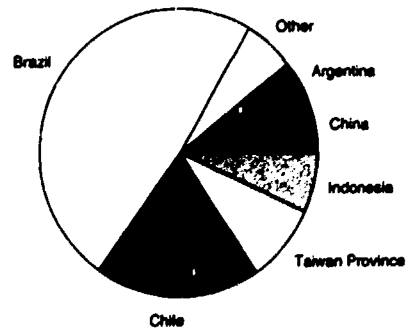
The tendency for mills in the North to move into higher-value added products will continue. Although currency devaluations have increased the competitiveness of these companies, in the longer term their fibre costs are likely to rise faster than those in developing countries. Some specialists and dedicated market pulp producers will continue to guard their positions, but many others will seek refuge from the pulp cycle in higher-value-added products. In developing countries, too, there may be some drift towards integration. Brazil-

Table IV.24. Some recent and proposed market pulp capacity expansions, 1992-1996

Country	Company	Additional capacity (thousand tonnes)	Status
Finland	Enocell, Uimaharju	150	Started up
	Metsä-Botnia, Rauma	400	Not before 1996
France	CDRA, St. Gaudens mill	120	Started up
	CDRA, Tarrascon mill	40	Started up
Portugal	Celbi, Figueira da Foz	360	Unlikely before 1996
Sweden	Södra Skogsägarna, Mönsteras mill	400	Unlikely before 1996
Canada	Alberta-Pacific, Alberta	500	Starting up in 1993
	Celgar Pulp, BC	220	Starting up in 1993
	Millar Western, Meadow Lake, Saskatchewan	200	Started up
	Shin Ho Canada, Ontario	150	Unlikely before 1995
	Tembec, Temiscaming	150	Started up
United States	Weyerhaeuser, Plymouth, North Carolina	125	To start in 1995
Argentina	Celulosa Puerto Piray Misiones	210	No date fixed
	Massuh, Paso de Libres, Corrientes	120	Not before 1995
Brazil	Bahia Sul, Mucuri, Bahia	250	Started up
	CVRD	500	Not before 1996
	Cenibra, Minas Gerais	350	To start in 1994
	Norcell, Bahia	420	Not before 1996
	Riocell, Guaiba	320	Not before 1995
Chile	Attisholz	80	To start in 1995
	Celulosa Pacifico	315	Started up
China	Qingzhou, Fujian	150	To start up in 1994
Indonesia	Indah Kiat, Riau	400	Starting up in 1993
	Inti Indorayon, Riau	500	To start up in 1996
	Riau Andalan, Riau	500	To start up in 1995
	Wira Karya Sambi, Jambi	350	To start up in 1995
	Tanjung Enim Lestari, Sumatra	410	To start up in 1995
Thailand	Phoenix Pulp & Paper Khonkaen	100	Starting up in 1993

Source: Pulp and Paper International, *Capacity Investment Survey* (Brussels, Miller Freeman, Inc., 1993).

Figure IV.12. Market pulp capacity in developing countries and areas, 1992



Source: Pulp and Paper International, *Market Pulp Survey 1992* (Brussels, Miller Freeman, Inc., 1993).

ian companies are already contemplating becoming major suppliers of uncoated wood-free papers to Europe and North America, based on their own eucalyptus pulp. Rather than build paper machines in their own country, some producers may seek partners in their major markets. Some pressure may also be felt by Indonesia as capacity in the Asian region grows.

Overall, however, it seems likely that the centres of market pulp supply will continue to move south. More companies from developed countries will buy shares in plantations and market-pulp-mills in the south as a means of protecting their fibre supplies. Examples of this are already occurring, Chile being the centre of attention so far. Around the turn of the century, New Zealand may also become a centre for investment in pulp capacity [8]. Its radiata pine forests, which will be maturing by then, will yield a quality of fibre similar to that of Chile. Another area with promise is Eastern Europe. Poland and the Czech Republic both have some potential to supply softwood kraft pulp to Germany, Europe's biggest mar-

Table IV.25. Market pulp capacity in developing countries, 1992

Country or area	Market pulp capacity (thousand tonnes)	Percentage share of world total
Brazil	2 500	5.81
Chile	1 000	2.32
Taiwan Province	460	1.07
Indonesia	350	0.81
China	285	0.66
Argentina	265	0.62
Swaziland	180	0.42
Thailand	130	0.30
World	43 000	100.00

Source: Pulp and Paper International, *Market Pulp Survey 1992* (Brussels, Miller Freeman Inc., 1993).

ket. However, the operational cost advantages of these countries may be outweighed for a long time by the heavy investment needed to rebuild their old and inefficient mills. It should also be recognized that recently developed solvent pulping methods could, if they prove successful, allow small but competitive market-pulp-mills to be built in many locations around the world.

Finally, the restructuring of the market pulp industry could also be given impetus by government action. In particular, if the European Community begins a subsidized programme to plant trees in order to take agricultural land out of production, the stimulus would exist to build new, competitive mills.

6. *Technological trends*

Besides the advances being made in the cooking procedures mentioned above, another new technological change involves the "closed" mill, that is, the closing of the water cycles of a mill so that no effluent is expelled from the production process. The process will take time to develop and may even prove impossible. Some commentators have seen chlorine compounds from the bleach plant as the main obstacle to closing the loops, but others say that this is not so [9]. At least two major projects, one of them on a six-month trial in Finland, have been conducted to assess future implementation.

7. *Environmental and energy considerations*

Producers of market pulp are having to react to the rapidly changing environmental concerns of their customers, the paper makers. The latter are, in turn, responding to pressure from paper users, often corporations seeking an environmentally clean image. Much of the environmental debate has been led by pressure groups such as Greenpeace, which have had considerable success in changing public opinion. The market pulp industry has been reactive rather than proactive throughout. It is worth noting that the changes demanded by environmentalists in manufacturing processes and product specifications are sometimes not based on engineering factors.

The level of environmental awareness also varies greatly from country to country. Central Europe, especially Germany, is acting as the trail-blazer, with North America and the United Kingdom also becoming more "green". Concern about such issues is more muted in developing countries.

Broadly, there are three main environmental concerns affecting this industry: forestry practices; bleaching and effluent management practices; and the demand for an increased level of paper recycling.

(a) *Forestry practices*

Forestry practices centre on the following environmental issues: the use of old-growth forest for pulp and paper-making; the clear-cutting of large areas of forest; the use of chemical fertilizers and pesticides; the sustainability of plantation forests of fast-growing species; and concerns for wildlife and the maintenance of a diversity of species in the forest.

For the pulp industry, these concerns have to be balanced against the need for cheap fibre. It seems certain that regulations restricting logging of old-growth forest will tighten in the United States. Similarly, laws and guidelines for protecting rare animals and birds will be introduced, making fibre from some regions (notably the Pacific Northwest) more expensive.

Elsewhere, pulp companies will need to submit their forestry procedures to more public scrutiny. Setting aside "islands" of untouched native forests as nature reserves within plantations is one way forward which is already practised by some of the largest companies in Latin America. Developing new disease- and pest-resistant trees by genetic manipulation is also to be a priority in avoiding the overuse of harmful chemicals.

Despite growing environmental opposition, plantation forests of fast-growing species will be a dominant source of fibre for the industry and will limit the industry's demand for land. Planting on unused wasteland, rather than replacing native forest, will make such plantations more acceptable.

(b) *Bleaching and effluent management practices*

The focus of environmental concern within the pulp-mill has fallen on the use of chlorine and its derivatives as bleaching agents. Ever since minute traces of dioxins were found in pulp-mill effluent in the mid-1980s, environmental pressure groups have been engaged in a public relations campaign to eliminate all chlorine compounds from the bleach plant. This is despite the fact that no solid evidence of harm to marine or land life resulting from chlorinated organic compounds has yet been confirmed.

Pulp producers responded to this criticism, first by introducing elementally chlorine-free grades, made without the use of molecular chlorine, but still using some chlorine dioxide as a bleaching agent. Lately, totally chlorine-free grades have been developed, using a range of alternative bleaching chemicals including hydrogen peroxide and ozone. Today, the brightness of these pulps is approaching that of chlorine-bleached pulp, and such grades sell at a premium to reflect their higher production costs.

It must be stressed that most of these changes have been driven by market forces. Whether they have had the effect of improving the environment is debatable. It is also unclear which bleaching chemicals will eventually supersede chlorine compounds in the future. Although ozone is currently showing promise, a number of other chemicals are under investigation.

It is equally important to notice that the demand for bleaching chemicals depends on the stages of the pulp line which precede the bleach plant. The initial cooking process, in which the lignin which binds together the fibres is dissolved in a chemical solution, is crucially important. It is the lignin that gives pulp its brown colour. The more lignin removed in cooking, the lower the demand for bleaching chemicals.

New cooking technology, both batch and continuous, is allowing more lignin to be removed early in the process without impairing the strength of the fibres. The installation of an oxygen treatment stage after cooking also permits more lignin to be removed, again reducing the bleaching chemical demand.

While the industry has reacted fast to the need for low-chlorine and totally chlorine-free pulps, new research is showing that some natural compounds present in the tree itself may be harmful to the environment if released with mill effluent. It seems essential that the research begun to solve the chlorine "problem" should eventually lead to effluent-free pulp production (see below). Unfortunately, the low profitability of the industry at present may hamper this development for several years.

(c) *Demand for increased recycling*

In developed countries, waste disposal is becoming a major problem because of the exhaustion of available landfill sites. Since paper can form up to 40 per cent by weight of the trash going to landfill in countries such as the United States, a movement to encourage more recycling has started. Potentially, this could change the role of the market pulp industry. The world currently recovers 37 per cent of the paper and board it consumes in recycling. Roughly 37 per cent of the materials used for paper making worldwide are made up of waste. But there are enormous differences among countries. In the United States in 1991, for example, just 30 per cent of the raw materials used in paper making was waste. In the Netherlands, it was 66 per cent.

The danger confronting market pulp producers is that Governments will mandate the use of recycled fibres to solve the landfill crisis. If legislation demanding minimum contents of recycled fibre for printing papers were to be passed, for example, the effect on the industry would undoubtedly be significant. It is not possible yet to offer precise figures.

Again, there is a concern that recycling legislation will not necessarily aid the environment. For example, the chemical pulp process is energy-self-sufficient, whereas energy has to be put into slush waste-paper, and this will often be generated from fossil fuels. Also, since fibres cannot be recycled indefinitely (the maximum is five times), a fresh flow of fibre will always be required. Legislation could tamper with that need and cause difficulties for paper makers in maintaining product specifications.

8. *Short- and medium-term outlook*

It seems that the bottom of the cycle has been reached, and that market pulp producers can expect a recovery in economic conditions over the next few years. Much will depend on how fast economic growth recovers in developed countries. A continuing recession in the European Community and Japan would mean that efforts to raise prices would not be successful. While full recovery is likely to arrive during 1994, the industry will continue to experience its boom and bust cycles. It is likely that developing countries will play a stronger role in this industry, and that Latin America and Indonesia will increase their importance as fibre suppliers in the medium term.

Pressures on the industry to respond to the concerns of environmental groups are likely to continue. It seems likely that totally chlorine-free pulps will eventually become the norm, but that the closing of the mill will not be achieved until the end of the decade. The focus for market-pulp-mills towards the management of fibre resources and the challenge of recycled fibre may well occur in the interim period.

D. Copper processing (ISIC 3720041-3720042)*

1. *Recent trends and current conditions*

Copper production can be defined in terms of mine production of copper ores and concentrates, smelter production or refinery production. A substantial proportion of total world production of copper in each of these forms enters international trade. While some countries may produce and consume similar quantities, many are either large net importers or large net exporters. Most copper is consumed in the production of semi-manufactures (wire, rod, bar, tube etc.) which are further processed before their ultimate exploitation in industrial applications. Some is used in the production of castings, and some in the production of copper compounds. A high proportion of copper is nominally unalloyed, though it may contain small quantities of other elements, but some is alloyed, mainly into brasses and bronzes that have engineering properties superior to those of unalloyed copper, for the applications in which they are used.

A range of highly specialized processes are involved in the production of copper. A brief summary is presented here. Ores mined by conventional methods are generally passed either to concentrators or leach circuits, according to their mineralogical composition. Sulphide concentrates, sometimes supplemented by cement copper obtained from the leaching of oxide ores, are smelted to produce blister. Subsequently, blister is refined to commercially pure metallic copper, usually by electrolytic refining to produce cathodes and, less commonly, by fire-refining. Ores treated by leaching processes yield liquors which can be processed in electrolytic cells to produce electro-won cathodes.

Mining and concentrating are usually undertaken at the mine site. Concentrates are often shipped over long distances to smelter and refinery operations, and substantial quantities enter international trade. While a high proportion of blister is refined at the same site, some quantities are shipped over long distances to distant refineries. The output of copper refineries is usually sold in the form of cathodes or other shapes to mills, foundries and

*UNIDO acknowledges the contribution of Kenneth Stanford, *Metallurgia*, FMJ International Publications Ltd.

chemical plants for the production of semi-manufactures, castings and copper compounds.

There is considerable vertical integration between the producers of refined copper, semi-manufactures and fabricated products, especially in developed countries. Tariff barriers designed to protect fabricating industries in countries that historically import unwrought refined copper are said to have inhibited the development of copper fabricating industries in less developed countries where refined copper is produced.

(a) Production of copper ore

Mine production of copper contained in ores and concentrates increased from 2.53 million tonnes in 1950 to 7.67 million tonnes in 1974, the peak year of production before the steady growth of production and consumption of copper was halted by the effects of the first oil-price increase. For almost a quarter of a century, production of copper increased at a compound annual rate of 4.7 per cent. Since 1974, the rate of increase has fallen, but mine production has nevertheless continued to rise. By 1989, it rose to 9.10 million tonnes, but in 1990 it fell to 9.02 million tonnes, before recovering to 9.17 million tonnes in 1991. An important factor contributing to the relative stability of total world production has been a reduction in the estimated production in the former USSR and Eastern Europe. Some of this reduction accurately reflects the industry disruption resulting from the difficulties faced by those countries since the late 1980s. Since the peak level of production of 7.67 million tonnes in 1974, despite three severe recessions in the economies of the major developed countries, the production of copper has risen at a compound annual rate of 1.1 per cent.

Production of copper in all major countries where copper ore is mined is shown in table IV.26. While the total reported may indicate a fairly steady progression in most countries, it also reflects the impact of a number of notable changes that have taken place in individual countries. In the United States, for example, the 1970s and 1980s were an extremely difficult period for copper mines. In 1970, production was over 1.56 million tonnes; and although this total was almost reached again in 1973 and in 1981, it was not exceeded until 1990. Whereas in 1970, the United States produced more copper in ores and concentrates than any other country, by 1989 its level of output had been overtaken by Chile, where production much more than doubled since 1970. Production in Chile fell slightly in 1990, but by 1991 it had risen strongly to 1.81 million tonnes, exceeding United States production by 180,000 tonnes. The level of production of copper in Chile increased by over 450,000 tonnes since 1985 as a result of the introduction of a much more enlightened system of regulation.

(b) Production of refined copper

World production of refined copper rose from 3.19 million tonnes in 1950 to 8.90 million tonnes in 1974. Like mine and smelter production, its growth rate has slowed down since then, but nevertheless shown a substantial increase. As shown in table IV.27, total production of refined copper in 1989 was estimated at 10.8 million tonnes, which reflected an average annual rate of increase of 1.3 per cent since 1974. This increase took place between the peak of one cycle of economic growth and the peak of another subsequent cycle. Figure IV.13 provides a glimpse at refined copper consumption in individual regions.

(c) Production of semi-manufactures

Principal consumers of copper refinery products are wire-mills and brass-mills, where cathodes or other refinery shapes are remelted, either alone or with alloying elements, cast to shape, and hot- or cold-worked into semi-manufactures, including wire, rod, tube, plate, sheet and strip. Wire-mills consume principally cathodes and

Table IV.26. World mine production of copper ore, 1987-1992
(Thousand tonnes)

Economic grouping, region or country	1987	1988	1989	1990	1991	1992
Africa						
Algeria	0.2	-	-	-	-	-
Botswana	18.9	24.4	21.7	20.6	20.6	21.1
Congo	1.3	1.0	-	-	-	-
Morocco	14.3	13.9	14.1	15.3	14.2	15.6
Mozambique	0.2	0.1	0.4	0.1	-	-
Namibia	36.7	39.4	30.8	32.5	35.0	33.6
South Africa	197.1	192.1	196.6	196.8	193.0	190.6
Zaire	500.0	465.1	440.6	355.5	291.5	174.9
Zambia	527.0	476.1	510.2	496.0	412.4	432.6
Zimbabwe	18.8	16.1	15.7	14.7	13.8	10.7
Total, A	1 314.5	1 228.2	1 230.1	1 131.5	980.5	879.1
Asia						
Cyprus	0.1	0.3	0.7	0.5	0.2	0.1
India	54.1	51.5	53.3	51.6	50.4	61.3
Indonesia	105.3	125.9	148.6	169.5	211.7	291.5
Iran (Islamic Republic of)	40.0	51.0	68.0	60.3	83.4	105.4
Japan	23.8	16.7	14.7	13.0	12.4	12.3
Malaysia	29.9	22.0	23.6	24.3	25.6	28.4
Myanmar	10.6	4.7	5.0	4.4	5.0	4.8

Table IV.26 *(continued)*

Economic grouping, region, country or area	1987	1988	1989	1990	1991	1992
Oman	16.9	18.1	16.6	13.7	13.5	13.5
Philippines	216.3	218.1	193.1	182.3	148.3	123.3
Republic of Korea		1.7	0.1	-	0.1	-
Turkey	25.8	36.2	45.4	39.8	35.5	36.0
Total, B	524.5	544.6	569.0	559.5	586.0	676.6
North America and Latin America						
Argentina	0.4	0.5	0.7	0.3	0.4	-
Bolivia	-	0.2	0.3	0.2	-	-
Brazil	40.3	44.8	44.4	36.5	37.0	37.2
Canada	802.2	776.5	723.1	793.8	797.6	816.4
Chile	1 418.1	1 451.0	1 609.3	1 588.4	1 814.3	1 920.7
Colombia	1.4	-	-	0.3	3.3	2.1
Mexico	230.6	279.4	249.3	291.3	267.0	275.1
Peru	406.4	298.3	364.2	317.6	375.3	368.1
United States	1 243.6	1 416.9	1 497.8	1 587.2	1634.4	1 757.9
Total, C	4 143.0	4 267.6	4 489.1	4 615.6	4 929.3	5 177.5
Oceania						
Australia	232.7	238.3	295.0	327.0	320.0	309.8
Papua New Guinea	217.7	218.6	204.0	170.2	204.5	193.4
Total, D	450.4	456.9	499.0	497.2	524.5	503.2
Western Europe						
Federal Republic of Germany[a]	1.5	0.7	0.1	-	-	-
Finland	19.8	20.2	14.5	12.6	11.7	10.3
France	0.3	0.3	0.2	0.3	0.3	0.2
Greece	1.0	-	-	-	-	-
Norway	22.0	15.9	16.5	19.7	17.4	12.3
Portugal	1.1	5.2	103.7	159.7	157.3	146.6
Spain	16.3	18.1	27.7	15.4	10.0	10.8
Sweden	84.7	74.4	69.5	73.5	80.5	88.7
United Kingdom		0.8	0.7	0.5	0.9	-
Yugoslavia	111.0	88.0	118.7	119.0	113.4	88.9
Total, E	257.7	223.6	351.6	391.5	390.8	357.8
Total, A, B, C, D and E	6 690.1	6 720.9	7 138.8	7 204.5	7 411.8	7 594.2
Monthly average	557.6	559.6	595.0	600.4	617.6	632.9
Former centrally planned economies						
Albania	14.9	14.9	16.7	13.2	8.0	..
Bulgaria	54.0	50.0	38.8	32.9	47.3	..
Czechoslovakia	5.2	4.8	4.4	3.6	2.6	..
German Democratic Republic	10.0	6.4	4.5	3.6	..	..
Poland	438.0	441.0	385.0	329.3	320.3	..
Romania	38.0	40.0	46.9	31.7	27.0	..
USSR	1 010.0	990.0	950.0	900.0	..	..
Centrally planned Asia						
China	350.0	370.0	380.0	360.0	..	..
Mongolia	120.0	121.6	123.4	123.9	120.0	..
Other						
Cuba	3.5	3.0	2.8	2.0	2.0	..
Other	12.0	12.0	12.0	12.0	14.0	..
Total, F	2 055.6	2 053.7	1 964.5	1 812.2	..	..
World, A, B, C, D, E and F	8 745.7	8 773.9	9 103.3	9 016.7	..	..

Source: World Bureau of Metal Statistics, *World Metal Statistics*, various issues (London).

a/ Data given for unified Germany after 1990.

Table IV.27. World production of refined copper, 1987-1992
(Thousand tonnes)

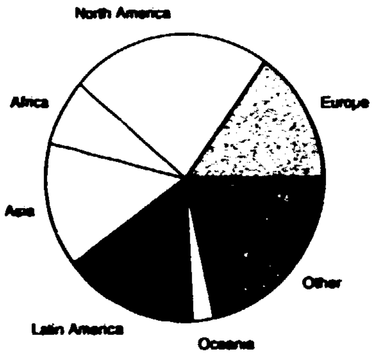
Economic grouping, region, country or area	1987	1988	1989	1990	1991	1992
Africa						
Egypt	4.0	4.0	4.0	4.0	4.0	1.8
South Africa	146.5	136.7	144.2	133.2	127.0	63.5
Zaire	210.2	202.8	203.8	173.2	139.7	90.0
Zambia	508.6	447.9	470.1	478.6	423.7	231.9
Zimbabwe	23.0	27.5	24.0	24.4	23.8	12.0
Total, A	892.3	818.9	946.1	813.2	718.2	679.3
Asia						
India	30.8	40.1	41.8	38.7	47.2	43.9
Iran (Islamic Republic of)	30.0	32.0	40.0	43.3	81.1	86.0
Japan	980.3	955.1	989.6	1 008.0	1 076.3	1 163.9
Oman	15.5	16.3	15.3	122.0	11.4	14.1
Philippines	132.1	132.2	132.2	125.9	115.5	122.0
Republic of Korea	157.9	170.4	178.7	187.0	198.4	209.2
Taiwan Province	47.0	43.3	43.2	16.1	-	-
Turkey	75.6	76.4	84.4	84.2	80.0	80.0
Total, B	1 469.2	1 465.8	1 525.6	1 515.2	1 609.9	1 719.1
North America and Latin America						
Canada	491.1	528.7	515.2	515.8	538.3	539.3
United States	1 541.7	1 852.5	1 953.7	2 017.4	1 995.1	2 141.7
Argentina	13.0	12.5	11.0	11.9	12.0	12.0
Brazil	147.0	147.2	166.5	156.8	141.4	143.6
Chile	970.3	1 012.7	1 071.0	1 191.6	1 228.3	1 317.4
Mexico	130.0	137.3	143.9	151.9	153.9	152.2
Peru	224.8	174.7	224.3	181.8	244.1	254.4
Total, C	3 517.9	3 865.6	4 085.6	4 227.2	4 313.1	4 560.6
Oceania						
Australia	207.8	222.7	255.0	274.0	279.0	281.1
Total, D	296.8	222.7	255.0	274.0	279.0	281.1
Western Europe						
Austria	32.9	38.4	46.3	49.7	52.8	54.3
Belgium	407.5	354.3	329.2	331.9	297.6	306.1
Finland	59.5	53.9	55.7	65.1	64.5	69.6
France	40.2	44.4	49.3	51.9	55.7	59.1
Germany, Federal Republic of[a]	399.8	426.4	475.2	476.2	521.7	571.6
Italy	65.0	75.4	83.3	83.0	83.4	83.5
Norway	29.4	31.7	35.0	36.5	38.4	38.9
Portugal	5.3	5.4	-	0.1	0.3	-
Spain	151.4	158.8	165.7	170.6	189.9	180.8
Sweden	91.9	90.3	94.6	97.3	96.6	100.0
United Kingdom	122.3	124.0	119.0	121.6	70.1	50.0
Yugoslavia	138.9	145.4	151.0	151.4	134.2	110.0
Total, E	1 544.1	1 548.4	1 604.3	1 635.3	1 605.2	1 623.9
Total, A, B, C, D and E	7 631.3	7 921.4	8 316.6	8 464.9	8 525.4	8 864.0
Monthly average	636.0	66.0	693.0	705.4	711.7	738.7
Former centrally planned economies						
Albania	13.0	15.0	15.0	10.9	4.4	..
Bulgaria	52.8	50.0	55.8	24.1	12.6	..
Czechoslovakia	27.2	27.1	26.9	24.6	25.3	..
German Democratic Republic	95.0	95.1	93.6	56.7	..	..
Hungary	10.4	6.9	6.1	6.0	4.4	..
Poland	390.2	400.6	390.3	346.1	376.8	197.4
Romania	40.0	41.0	33.0	35.0	15.0	..
USSR	1 410.0	1 380.0	1 345.0	1 260.0	..	..

Table IV.27 *(continued)*

Economic grouping, region, country or area	1987	1988	1989	1990	1991	1992
Centrally planned Asia						
China	450.0	460.0	470.0	550.0	570.0	..
Other	40.0	40.0	40.0	30.0	32.0	..
Total, F	2 528.6	2 515.7	2 475.7	2 343.4	..	..
World, A, B, C, D, E and F	10 159.9	10 437.1	10 792.3	10 808.3	..	..

Source: World Bureau of Metal Statistics, *World Metal Statistics*, various issues (London).
[a] Data given for unified Germany after 1990.

Figure IV.13. World production of refined copper, 1990



Source: World Bureau of Metal Statistics, *World Metal Statistics*, various issues (London).

wirebars mainly in the manufacture of unalloyed copper wire. Brass-mills principally use cathodes, but are also major consumers of ingots and cakes in the manufacture of copper alloy rods, bars, sheet, strip and plate. Tubing extruded from billets is mainly manufactured in brass-mills, but is predominantly of unalloyed copper.

Wire manufacture has been revolutionized in the past 15 years by the successful introduction of new technology to produce continuous cast rod, an intermediate in copper wire production. Whereas wire was mainly extruded from wirebars, continuous cast rod is made by starting from cathodes, and this has altered the pattern of production and sales of refinery shapes. First developed in the 1950s, continuous cast rod experienced rapid capacity expansion in the 1970s to reach about 5 million tonnes per year by the end of the decade, concentrated in Western Europe, the United States and Japan [10].

The production of copper components by casting from the molten metal is small in relation to the production of wrought semi-manufactures, including wire, tube, rod, plate, sheet, strip, bar and sections. Copper used in this way is almost exclusively alloyed, often with small but essential proportions of other elements. Total production of copper-base castings is not as well documented as the production of copper semi-manufactures, but one source reports that production in 1990 was 841,433 tonnes, of which a high proportion would have been copper [11]. In addition these data indicate that the production of copper castings was greatest in the United States, followed by Japan, which produced about half as much as the foundries in the United States. The next largest producers were Italy and the Federal Republic of Germany. Total production of copper-base castings, worldwide, therefore is likely to have consumed over 1 million tonnes of copper in 1990.

Brasses, and particularly red brass, appear to account for almost 70 per cent of United States castings but only about 45 per cent of German castings. All but 5 to 10 per cent of the rest are bronzes, particularly tin and leaded tin bronze; the remainder are mainly low-alloyed copper and an expanding group of copper-nickel alloys.

(d) Consumption of refined copper

Since around 1910 consumption of copper refined from primary materials, with some supplementary feed from scrap, increased from an average of less than 1 million tonnes per year to an average of almost 10 million tonnes per year in the 1980s. Consumption first exceeded 10 million tonnes in 1986, and by 1989 rose to nearly 11 million tonnes. Since then, the effects of the recession in major market economies, combined with the downward revision of estimated consumption in the former USSR and Eastern Europe, have reduced the estimated total consumption of copper in 1990 and 1991 to 10.79 and 10.87 million tonnes respectively. Further information on consumption in these and other countries is summarized in table IV.28.

Since 1950, consumption of refined copper rose by an average annual rate of 3.18 per cent, while consumption of scrap rose by only 2.3 per cent per annum. In the future, as increased supplies of scrap become available from the recycling of obsolete equipment, consumption of scrap may increase faster than the consumption of copper, which has been refined mainly from primary materials. Overall, copper consumption rose slightly in 1992, with declining demand in Japan and Europe being offset by recovery in North America and continued growth in other emerging economies. Japanese markets, however, have suffered following the fall in industrial demand.

As 1993 progresses, recovery is expected to gain momentum and an overall increase of 3 per cent is forecast in 1993. The Japanese financial rescue package and

Table IV.28. World consumption of refined copper, 1987-1992
(Thousand tonnes)

Economic grouping, region, country or area	1987	1988	1989	1990	1991	1992
Africa						
Algeria	-	-	-	-	-	-
Egypt	6.3	6.5	6.0	4.2	4.0	4.0
South Africa	72.2	75.5	71.8	67.6	63.0	61.6
Zaire	2.1	2.0	2.2	2.3	2.0	2.4
Zambia	8.0	11.0	9.0	8.0	10.7	9.2
Zimbabwe	10.0	10.0	10.4	13.7	112.0	12.0
Other Africa	1.0	0.1	0.1	0.2	1.1	1.1
Total, A	99.6	105.1	99.5	96.0	92.8	90.3
Asia						
India	100.0	113.0	130.0	135.0	157.0	157.0
Iran (Islamic Republic of)	20.0	34.0	31.0	40.0	52.0	50.9
Japan	1 276.6	1 330.7	1 446.6	1 576.5	1 613.2	1 415.8
Philippines	10.3	10.3	12.6	9.8	11.0	9.6
Republic of Korea	259.0	266.3	251.6	324.2	343.2	351.5
Taiwan Province	207.8	214.9	315.3	264.7	399.1	415.7
Turkey	75.3	93.7	101.0	108.9	98.1	98.0
Other Asia	120.2	137.0	195.6	241.1	276.9	277.0
Total, B	2 069.2	2 199.9	2 483.7	2 700.2	2 950.5	2 775.5
North America and Latin America						
Canada	232.3	236.3	218.6	184.5	185.1	175.0
United States	2 126.7	2 205.9	2 203.5	2 150.4	2 067.8	2 383.7
Argentina	63.9	44.4	26.1	23.0	24.9	24.9
Brazil	239.2	176.2	187.5	128.7	170.8	187.0
Chile	47.8	42.7	42.9	45.2	47.6	62.8
Mexico	123.6	120.4	133.6	127.2	131.3	127.0
Peru	45.7	31.2	33.0	30.0	29.0	28.8
Other	30.0	27.2	12.8	16.0	24.6	24.8
Total, C	2 909.9	2 884.3	2 858.0	2 706.0	2 671.1	3 013.5
Oceania						
Australia	124.0	128.8	129.7	120.0	101.2	114.1
New Zealand	1.4	1.8	0.9	4.7	2.6	3.7
Total, D	125.4	130.6	130.6	124.7	103.8	117.8
Western Europe						
Austria	26.0	26.9	22.3	22.0	24.0	24.0
Belgium	291.8	317.8	376.0	389.5	372.0	329.8
Denmark	-	0.1	0.3	0.9	0.1	-
Finland	77.0	73.7	86.0	87.0	87.4	82.3
France	399.0	408.9	458.8	477.6	481.2	472.0
Germany, Federal Republic of[a]	800.1	797.5	854.7	896.9	994.8	1 022.6
Greece	39.0	44.0	51.0	53.7	45.5	24.4
Ireland	-	0.3	0.1	0.1	0.2	-
Italy	420.0	445.0	458.4	474.9	470.7	525.0
Netherlands	21.9	20.4	17.9	23.1	17.6	18.2
Norway	8.0	10.0	12.0	8.0	8.0	10.2
Portugal	26.0	28.0	21.7	24.5	26.0	20.5
Spain	131.4	135.0	145.9	146.1	156.0	154.6
Sweden	98.3	104.6	109.9	117.2	113.2	108.4
Switzerland	9.5	11.0	6.2	3.5	4.3	4.6
United Kingdom	327.7	327.7	324.7	317.2	269.4	308.2
Yugoslavia	127.1	119.2	118.8	92.9	80.0	64.0
Total, E	2 802.8	2 870.1	3 064.7	3 135.0	3 150.4	3 166.8
Total, A, B, C, D and E	8 006.9	8 190.0	8 636.5	8 760.9	8 968.6	4 643.4
Monthly average	667.7	682.5	719.7	730.1	747.4	766.2

Table IV.28 *(continued)*

Economic grouping, region, country or area	1987	1988	1989	1990	1991	1992
Former centrally planned economies						
Albania	12.8	14.2	13.9	10.1	4.3	..
Bulgaria	56.0	57.0	56.0	32.1	17.7	..
Czechoslovakia	92.1	83.9	77.5	76.2	44.9	..
German Democratic Republic	170.0	170.0	178.0	130.9	..	..
Hungary	25.8	23.6	13.8	34.0	17.9	..
Poland	246.4	248.8	284.0	170.7	154.1	..
Romania	40.0	41.0	33.0	35.0	15.0	..
USSR	1 270.0	1 210.0	1 140.0	1 000.0	..	..
Centrally planned Asia						
China	470.0	465.0	528.0	512.0	..	..
Other	24.0	27.0	27.5	32.5	34.0	..
Total, F	2 407.1	2 340.5	2 351.7	2 033.5	..	..
World, A, B, C, D, E and F	10 414.0	10 530.5	10 988.2	10 794.4	..	..

Source: World Bureau of Metal Statistics, *World Metal Statistics*, various issues (London).
[a] Data given for unified Germany after 1990.

an easing of the monetary policy in Europe and the United States should boost demand, especially in public works programmes, which should prove metal-intensive. Although domestic copper consumption in some developed countries may take time to recover, Western Europe, which consumes 40 per cent of Western copper, and the emerging markets of Latin America, South-East Asia and Western Asia are expected to provide a strong market for North American, Japanese and Latin American copper exports.

China has already shown its strength as a copper consumer. With industrial production growing by up to 19 per cent in the first half of 1992, GDP growth in developing countries is expected to reach 4 per cent in 1993, and a higher rate is likely in parts of Asia and Western Asia, as living standards and infrastructure are improved. In the long term, it is estimated that as per capita copper consumption in Eastern Europe approaches Western levels, demand should increase by an annual rate of 500,000 tonnes by the year 2000.

The long-term prospects for the industry as a whole are also encouraging. Intensity of copper use per capita in the Western world is once again climbing, having fallen in the early 1980s. Between 1973 and 1983, per capita consumption fell from 3.9 to 3.2 kilograms, but has now recovered to 3.8 kilograms. Consumption data for other regions appear in table IV.29. Overall, therefore, consumption is expected to remain positive as an increasing number of new countries join the expansion phase of development. This should lead to robust growth during the mid-1990s, which should begin to be seen in 1993. With such a positive medium-term outlook, investment interest is expected to remain high.

(e) Copper prices

As the major world economies start to recover from recession, the demand for copper will strengthen, though this process is likely to be gradual. It is not expected to lead to any large increase in the copper price. In 1993, the outlook is still very much dependent on a pick-up in economic recovery in the developed economies. But strong and increasing consumption in emerging countries, as mentioned above, is expected to underpin demand. Supply disruptions combined with limited spare smelting capacity are expected to push copper prices higher as demand recovers.

Table IV.29. Per capita copper consumption in selected countries, 1992

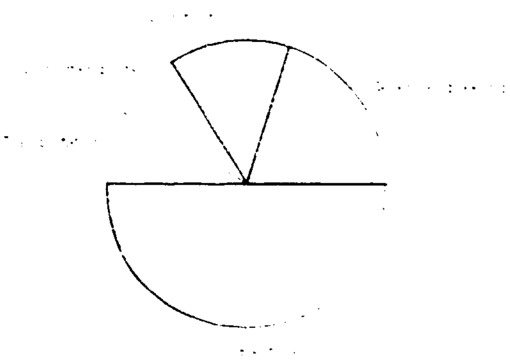
Country	Per capita copper consumption (kilograms)
Japan	12.26
United States	8.68
Russian Federation	3.47
China	0.47
India	0.15
Western market economies	3.78

Source: *The Outlook for Base Metals in 1993* (London, Rudolf Wolff, 1992).

2. *Major copper end-uses*

Total copper consumption in developed market economies in 1990 was about 9 million tonnes. The distribution among different industries is given in figure IV.14. The main consumption sector is electrical engineering, followed by the general engineering and construction sectors, with consumer goods and transportation being equal. The most important properties of copper, as shown in table IV.30, are its high electrical and thermal conductivity; of the two, electrical conductivity is by far the more important. In the United States, for example, wire accounts for about 55 per cent of the total consumption of copper. Since brass is also used for a wide range of electrical applications, total consumption of copper by

Figure IV.14. Refined copper distribution among different industries, 1991



Source: Copper Development Association, London.

Table IV.30. Relative electrical and thermal conductivities of some metals including copper

Metal	Relative electrical conductivity	Relative thermal conductivity
Silver	100	100
Copper	96	94
Gold	76	76
Aluminium	59	57
Magnesium	41	40
Beryllium	40	40
Tungsten	2[illegible]	30
Zinc	27	27
Cadmium	22	22
Iron	16	17
Platinum	15	17
Tin	13	16
Lead	8	8
Titanium	3	4
Mercury	2	2

Source: R. A. Higgins, *Engineering Metallurgy* (London, Hodder & Stoughton, 1993).

the electrical industry is estimated to be over 70 per cent in the United States.

The excellent thermal conductivity of copper led to its use for heat exchangers of all types, of which motor vehicle radiators are among the most important. Large quantities of copper are also used in heat exchangers in a wide range of other industrial equipment.

Other properties of copper which are particularly important are its corrosion resistance, which leads to its use in shipbuilding and in chemical and other process plants. Its malleability, ductility and good tensile strength are also useful attributes in relation to its consumption in a wide range of engineering applications. Its attractive appearance encourages its use where technical properties are supplemented by aesthetic appeal.

The predominance of electrical applications is likely to become even more marked in the near future; growing industrialization in developing countries requires the establishment of electricity generation, transmission and distribution networks and of light industry. The establishment and expansion of telecommunications networks may be less important as an outlet for copper as a result of competition from optical fibres.

(a) *Electrical industry*

Copper has the highest electrical conductivity of the commonly available metals, and is used in all forms and sizes for cabling and for busbars. Copper alloys are used for switches, connectors and contacts. Copper wire and cable is used in the transmission of electrical power and telecommunications signals. It is also employed in motor and generator windings, electromagnets and other components. These, in turn, have applications in electricity generating installations and in industrial, commercial and domestic electrical machinery, ranging from generators to consumer appliances. General electrical machinery is estimated to account for about 50 per cent of all electrical uses, power transmission for about 20 to 25 per cent, and consumer goods and communications for 10 to 15 per cent each. In developing countries the pattern of consumption is different because the power transmission and telecommunications networks are less highly developed, and because light industries may or may not be centred on the production of electrical and electronic equipment, and there is less copper use in the production of heavy electrical equipment.

The most important issue affecting the market for copper is the adoption of fibre optic cables in preference to copper cables for the transmission of telecommunications signals. The competition between the two materials is complex, but there still is extensive demand for copper cable.

(b) *General engineering equipment*

This category covers a very wide range of industrial applications and includes brasses for connectors and fittings of all types, bronzes for bearings and gears, aluminium bronzes and copper nickel alloys for marine pumps and propellers, and high-conductivity coppers for welding apparatus, moulds, heat exchangers and condensers. Copper and its alloys are also used in vessels, piping and a variety of hardware, such as connectors and fasteners.

(c) *Construction industry*

The largest quantities of copper are consumed in the construction of buildings, mainly in the form of copper tubing, and in the taps, valves, tanks, connectors and fittings used in conjunction with it. Copper tube systems are used for domestic water supply systems, both hot and cold, and for central heating systems. Copper tube may also be used in buildings for piping gas between the intake and the appliances in which it is used as fuel. Air conditioning systems also make use of copper tube. It was estimated that the consumption of copper tube in Japan almost doubled between 1982 and 1991, from 98,000 to 191,000 tonnes.

The use of copper in buildings depends on the fashion and preferred practice in a particular country. In the United Kingdom, for example, copper pipes are used for all plumbing applications including water and gas supplies, and central heating; in continental Europe large amounts of copper sheet are used for roofing. This cat egory also includes considerable quantities of brass that is used for builders' hardware such as locks and hinges.

New uses for copper tubes in buildings include fire sprinkler systems which are being introduced in residential buildings. Unlike sprinkler systems used in commercial buildings, systems for residential buildings are low-pressure and use water from the domestic water system. Another new use for copper is in cooling coils used by direct-coupled heat pumps which are being developed to provide heating and cooling for buildings from ambient sources.

A very wide range of architectural, decorative trim and builders' hardware is made of copper alloys, mainly brasses and bronzes. Hinges, locks, catches and stays for windows and doors, and fasteners such as screws, washers, nuts and bolts are all made of brass or bronze.

The move towards enhanced energy-efficiency in buildings could mean an increased use of copper, for example, in higher-efficiency boilers, radiators and heat exchanger systems.

(d) Transport industry

Copper is used in automobiles for all electrical components and radiators. Some manufacturers use copper-nickel pipes for brake and hydraulic suspension systems. Copper chromium is often used for brake discs. Railways use large amounts of copper in overhead and trackside electrical cables. New copper-aluminium alloys provide improved wear resistance and are expected to be used in airframe construction in the future. Transport applications, including electrical uses, probably account for over 5 per cent of the total consumption of copper. For example, it has been estimated that the copper content in passenger cars in the United States increased from an earlier 11.8 to 15.9 kilograms per vehicle in 1975, and to 22.2 kilograms per vehicle in 1990.

(e) Consumer goods

Consumer goods, like general engineering, form a very wide category, and include cookware, clocks, decorative ware, clothing and a wide range of consumer electronics.

(f) Ordnance

Total consumption of copper for ordnance worldwide is estimated at between one quarter to one half million tonnes per year, but obviously not all of this is documented by producing countries. In the United States, consumption for this purpose has fallen currently to around 20,000 tonnes per year, around 1 per cent of total United States consumption. An increasing proportion of copper used in armaments is being used for purposes such as wiring and connectors for increasingly sophisticated guidance control and communications systems currently being developed, rather than for more traditional applications such as brass for shell cases.

3. Structural change

(a) Latin America

Mine production of copper in Chile is now the largest worldwide, though the margin by which production in Chile exceeds that of the United States is very small. Production increased considerably in 1991 by 1.8 million tonnes, from less than 1.6 million tonnes in 1990. The rise in production has been impressive; in 1970, total production of copper in concentrates in Chile was less than 700,000 tonnes per year. Much of Chile's copper ore enters international trade. In 1990, it exported 256,500 tonnes out of a total of 1,672,700 tonnes recorded as having been exported. A large increase in production in 1991 led to an increase in exports from Chile at 508,000 tonnes. The main destinations were Brazil, East Asia, mainly Japan and the Republic of Korea, and Western Europe. Exports to the United States rose from 100 tonnes in 1987 to 20,800 tonnes in 1989, but then ceased. Smelter production of copper in Chile, like mine production, rose to a new peak of 1,328,500 tonnes in 1990, although, as the increase in exports of concentrates shows, it fell to 1,296,100 tonnes in 1991.

The production of refined copper in Chile has increased by about 30 per cent since 1986, from 942,000 tonnes to 1.2 million tonnes per year. Some of the increase has been accounted for by increased production at solvent extraction and electro-winning facilities. Reported consumption of refined copper in Chile is small at 45,200 tonnes in 1990, similar to the level consumed in the previous five years. A very high proportion of the refined copper produced in Chile is thus exported, with over 40 per cent of shipments going to a number of countries in Western Europe and a high proportion of the remainder going to countries and areas in East Asia, notably Japan, Republic of Korea and Taiwan Province. Exports to the United States fell from 150,000 tonnes in 1987 to about 50,000 tonnes in 1991, while substantial quantities are exported to Argentina and Brazil.

Substantial increases in production of copper in Chile are expected, even though the most optimistic forecasts may not be met, partly because of production difficulties at the major national copper corporation, Codelco. Mines will have to curtail their output, and some of the projects announced by other companies will not be brought into production as soon as hoped. Copper accounts for a high proportion of export earnings in Chile, and is vital to the country's trade balance. Its importance is such that increases in production and exports are as likely to be sought when prices are low as when they are high, since the total quantity of foreign exchange earned by exports of copper may be more important to the Government than the average price obtained per kilogram. In 1990, Codelco contributed $1,505 million to the Chilean treasury.

(b) North America

About one quarter of the copper in concentrates produced worldwide is mined in North America. Smelter production is several hundred thousand tonnes per year less than mine production, since copper-mining companies in the United States and particularly in Canada export large tonnages of concentrates for smelting in other countries. Production of refined copper in the United States is roughly the same as consumption, but in Canada refinery output is much higher than consumption, and large quantities are exported, mainly to the United States, the United Kingdom and other countries of Western European.

After Chile, the United States is the second largest mine producer of copper, with production of copper in concentrates reaching nearly 1.6 million tonnes in 1990, its highest level since 1970 when it was 1.56 million tonnes. Output rose again to 1.64 million tonnes in 1991. Production declined sharply during the recession in the early 1980s, and many mines closed down because of low prices, high operating costs, and prospects of high expenditures on compliance with stricter environmental control standards. The industry produced 500,000 tonnes less copper in 1983 than it had done only two years earlier in 1981, as the maximum effects of the closures were felt. Since then, however, increased efficiency, reduced costs and restructuring have led to a recovery which has pushed production to its highest level in over 20 years.

Smelter production is rather less than the copper content of concentrates produced, at about 1.45 million tonnes in 1991, compared with 1.64 million tonnes in concentrates. This relatively small difference, however, disguises a large import and export trade in concentrates. Exports of copper in concentrates rose to 360,500 tonnes in 1989, but were only 250,000 tonnes per year in 1990 and 1991. Imports rose to 153,500 tonnes in 1990, but were much lower in 1991 at around 62,000 tonnes.

Exports of blister and anode copper from the United States have been a few thousand tonnes per year in the 1980s, but in 1988 they rose to no less than 125,000 tonnes. They then fell to about 5,000 tonnes in 1989 and 1990, before rising to over 20,000 tonnes in 1991. Imports of blister and anode copper have been generally higher than exports, ranging from 46,000 tonnes per year in 1986 and 1987 to 128,100 tonnes in 1988. In 1991 they were over 90,000 tonnes, leaving a net import requirement of about 70,000 tonnes of unrefined copper.

Production of refined copper mainly from primary materials in the United States rose to over 2 million tonnes in 1990 and 1991, the highest recorded since 1973. In addition, a further 441,000 tonnes of refined copper were produced in 1990 from re-refined scrap, and 944,000 tonnes of scrap were reused directly, without re-refining, in the production of copper products. The United States has a substantial trade in refined copper, but its export-import balance has fluctuated substantially since the mid-1980s. In 1986, imports of 491,700 tonnes greatly exceeded exports, which were only 12,500 tonnes. By 1991, imports fell to 295,100 tonnes, while exports increased to 271,300 tonnes. The possibility has been raised that the United States could become a net exporter of refined copper.

Most of the copper consumed in the production of semi-manufactures in the United States is in the form of copper rather than copper alloy. Copper wire is the major semi-manufacture produced. Copper-alloy semi-finished products include rods, bars and sections, followed by flat products, plate, sheet and strip, with production of tubes much smaller.

Mine production of copper in Canada rose to 802,200 tonnes in 1987, which was the first year since 1973 and 1974 in which it had exceeded 800,000 tonnes per year. After falling in 1988 and 1989, it again rose to 802,000 tonnes in 1990, and was 776,900 tonnes in 1991. In recent years, over 300,000 tonnes per year of copper in concentrates have been exported from Canada, and smelter production has been between 450,000 and 550,000 tonnes per year. Some copper concentrates are also imported by Canada from the United States and other countries; the total has fallen from the peak level of 76,200 tonnes recorded in 1985, though it rose from 33,800 tonnes in 1990 to 68,300 tonnes in 1991.

Production of refined copper in Canada has been about 500,000 tonnes per year since 1984. About 60 per cent of this is exported, and consumption of refined copper in Canada is about 200,000 tonnes per year. In addition, a further 70,000 tonnes per year are recovered by the re-refining of copper scrap, or are consumed directly as scrap, without re-refining, in the manufacture of copper products.

(c) Africa

African countries account for approximately 11 per cent of the world production of copper in concentrates, 10 per cent of smelter production, but only 7 per cent of refinery production. A high proportion of the concentrates produced in Africa are smelted in countries in which they are produced, but substantial quantities of unrefined blister and anode copper are exported to refineries elsewhere. As the small volume of consumption of refined copper in Africa indicates, most of the output of copper refineries in the continent is exported to other regions.

Copper mining in Africa is dominated by two countries, Zaire and Zambia, which in 1991 accounted for 703,900 tonnes out of the 989,100 tonnes of copper produced in Africa. South Africa accounted for 200,200 tonnes, leaving only 85,000 tonnes produced in other countries. In both Zaire and Zambia, copper-mining and -smelting, including copper-refining in Zambia, are the dominant industries, accounting for large proportions of industrial output, employment and foreign exchange earnings.

(d) Australia

Mine production of copper in Australia rose above 200,000 tonnes per year in 1973 and has remained comparatively steady since then compared with the large fluctuations which have occurred in other countries. From 1973 to 1988, production was never lower than the 218,500 tonnes recorded in 1976, nor higher than the 261,500 tonnes produced in 1983. In 1990 it rose to a new peak of 327,000 tonnes, before falling to 311,000 tonnes in 1991.

Production of unrefined copper at copper smelters in Australia is lower than mine production, as some concentrates are exported. Since 1977, the largest quantity of copper in concentrates exported in any year was 84,600 tonnes in 1985, when the production of concentrates rose and production of unrefined copper fell. Exports of concentrates rose again to 67,300 tonnes in 1990, when smelter production fell even though mine production rose to its highest-ever level. Small quantities of blister and anode copper are exported from Australia, but production of refined copper is higher than production of unrefined copper, partly because it includes copper refined by electro-winning, and partly because it includes some copper recovered from scrap in primary refineries.

Production of secondary refined copper from scrap fell to 24,000 tonnes in 1991 from 36,000 tonnes in 1987. In addition a further 40,000 tonnes of scrap were used directly, without re-refining, in the production of copper products.

Consumption of refined copper in Australia is lower than production, and substantial quantities are exported. Consumption of refined copper lay in the range of 120,000 to 130,000 tonnes per year between 1987 and

1991. Exports of refined copper from Australia have risen to a succession of peak levels since 1987, when exports were 81,600 tonnes, to 173,900 tonnes in 1991. Further increases in exports may follow in the 1990s.

Until 1982, production of copper in the Philippines was dedicated to the export of concentrates for smelting in other countries. In 1983, smelting and refining facilities were brought into operation in the Philippines, and exports of concentrates fell accordingly. From 250,000 to 300,000 tonnes per year between 1977 and 1982, exports of concentrates fell to less than 100,000 tonnes per year in 1985; the highest that they have reached since then was 119,700 tonnes in 1988. From 1989 to 1991 they were only around 100,000 tonnes per year. Since the start-up of the PASAR smelter and refinery, exports of refined copper from the Philippines have kept pace with production. Consumption of refined copper in the Philippines is estimated at only about 10,000 tonnes per year, and the output of the refinery is mainly exported to yield foreign exchange.

(e) Western Europe

Production of copper ores and concentrates in Western Europe accounts for less than 5 per cent of the total production worldwide. Since the same region accounts for over 25 per cent of worldwide consumption of copper refined mainly from primary raw materials, there is a large flow of copper in various forms into Western Europe from other regions. Copper is imported into Western Europe in the form of concentrates, which are smelted in Europe and subsequently refined. Large quantities of copper which have previously been consumed in Europe are also recycled by being either re-refined or used directly as scrap, without re-refining, in the production of new copper products. There is a small net export trade in copper semi-manufactures and copper alloy semi-manufactures from Western Europe.

In 1990, Portugal became the largest producer of copper concentrates in Western Europe following the start-up of operations at Neves-Corvo. Prior to 1990, production was largest in Yugoslavia, followed by Sweden and Spain, but production in all three countries has declined in recent years.

The largest smelter production is in the western part of Germany where total production has been in the range 200,000 to 250,000 tonnes per year since the early 1980s. Over the same period, production in Yugoslavia doubled to almost 146,000 tonnes in 1988, but it has fallen since then as a result of civil unrest. Smelter production of copper in Finland, Spain and Sweden have also increased.

Refinery production of copper in Western Europe is almost twice that of smelter production. The largest production is in the western part of Germany where 476,200 tonnes were produced in 1990, and output rose to 522,500 tonnes in 1991. The next largest production was in Belgium, where output fell to less than 300,000 tonnes in 1991, continuing its gradual decline from over 400,000 tonnes in the mid-1980s. Production in Spain, which recorded 189,900 tonnes in 1991, showed a further increase.

(f) Asia

Mine production of copper in Asian countries, including China, was about 1 million tonnes in 1991, about 10 per cent of the world total. This proportion has not changed substantially since the late 1970s. The distribution of production between countries has, however, shown marked changes. Production in the Philippines fell to almost half its previous level in the mid-1980s, while production in Japan fell from over 50,000 tonnes per year to less than 13,000 tonnes per year. Over the same period there has been a large increase in production in Indonesia, and production in China and Mongolia has also risen.

Smelter production of copper in Asia is about double the production of copper in concentrates, mainly because concentrates for smelting in Japan are drawn largely from sources outside Asia, including Australia, Canada, Chile, Peru and the United States, as well as other countries in Asia. Production of refined copper in Asia is similar to smelter production. Consumption of refined copper is about 1 million tonnes per year higher than production, reflecting the large imports from other regions of refined copper made by countries in Asia.

Production of copper in concentrates in China was estimated to have risen fairly slowly from the late 1970s to 1986 from 170,000 to 200,000 tonnes. In 1987, production rose sharply to 350,000 tonnes, and it has remained between 350,000 and 380,000 tonnes per year since then. Estimates for smelter and refinery production have shown corresponding increases since 1986, and in 1990 were 425,000 and 490,000 tonnes, respectively, compared with estimated mine production of 360,000 tonnes. In addition to local production, China depends on imports of concentrates, blister and refined copper to meet its growing industrial requirements.

Reserves of copper in China are estimated to be at least 350 million tonnes of ore, but the low average grade of 0.6 to 1 per cent copper makes rapid expansion of production difficult. Nevertheless, arrangements are in progress for a steady increase in production at some selected sites. The largest producer of copper is the Jiangxi Copper Corporation. Its operations produced 71,000 tonnes of copper in 1989, and output is scheduled to double by 1993, and to double again by the year 2000.

(g) Former USSR

For many years, the copper industry in the former USSR was estimated to be the second largest in the world after the United States, but the decline of operations in the former USSR and the growth of production in Chile has changed the picture, so that the former USSR is probably the third largest producer of copper after the United States and Chile [12]. Production of copper in concentrates, which was estimated at over 1 million tonnes per year up to 1987, has since fallen to an estimated 900,000 tonnes in 1990 and 1991. Smelter production has been estimated at about 100,000 tonnes per year higher than mine production over the same period. Refinery production is estimated to have declined from 1.4 million tonnes in 1986 to 1.25 million tonnes in 1991 with most of the fall occurring in 1990 and 1991. Consumption of refined copper in the former USSR is also estimated to have fallen, from 1,300,000 tonnes in 1986 to 980,000 tonnes in 1991, with most of the decline, again, taking place in 1990 and 1991.

According to the trade statistics of developed market economies, the former USSR imported small quantities of copper in concentrates in 1986 and 1987, and then exported 1,300 tonnes in 1988. In 1990 exports rose to 17,700 tonnes, but fell to 9,600 tonnes in 1991 Small exports of blister to developed market economies were recorded in 1988 and again in 1990, but in 1991 exports of blister increased to about 7,000 tonnes. Most international trade in copper involving the former USSR is in refined copper. A small quantity of refined copper was imported from developed market economies in 1987 but most of the trade consists of exports of refined copper to those economies. From 29,400 tonnes in 1986, these more than doubled in 1987 and have continued to increase to reach 178,200 tonnes in 1990, a level which was maintained in 1991.

In the Russian Federation copper is produced in the Kola Peninsula, in the Urals, in western Siberia and in the far east of the country. Copper reserves in the Kola Peninsula are estimated at 295 million tonnes grading 0.35 per cent copper. Although it produces relatively small quantities of copper, the region is regarded as having a good potential for development. There are reported to be at least 22 nickel-copper deposits around Pechenga, Allerechen, Monchegorsk and Lovnoozersk. Copper deposits are also reported in the Imandra and Varzuga areas. The principal mines producing copper in the Kola Peninsula are listed as Nittis Kamuzk, Zhdanov C and Zhdanov W.

4. *Growth prospects in developing countries*

Growth in the demand for copper in the developing countries of China, India, Latin America and South-East Asia should be a major factor in the future of the copper industry [13]. Although accounting for only 18 per cent of copper consumption in Western economies, over 60 per cent of the expected increase in demand will come from the above-mentioned developing countries. Refined copper consumption in those countries is expected to grow at nearly 5 per cent per year up to the period 2005, compared with only 1.0 per cent in developed countries, and a trend rate of 2.1 per cent for Western economies. Most of the growth is expected to come from the construction sector, where net demand is forecast to rise faster than the average. Demand for copper from the electrical and transport sectors is expected to rise slower than the average, and to decline in telecommunications.

5. *Capacity utilization and expansion plans*

Recent forecasts anticipate a shortage of smelter capacity worldwide, as new smelter projects have failed to keep pace with new mine projects, assuming some growth in demand. Several large greenfield smelter projects have been investigated and deferred while new mines and mine expansion projects continue. Nevertheless, fears of a shortage of smelter capacity appear to be exaggerated. Although some smelter projects have been deferred, others are being investigated and, perhaps more important, smelter capacity is being increased by the refurbishment and replacement of existing smelters. Furthermore, not all the increased production of concentrates will require smelter capacity, as a growing tonnage is dedicated to solvent extraction and the production of cathode copper by electro-winning. Now that major terminal markets have started to approve a wider range of electro-won copper grades for delivery against their contracts, further increases in the production of electro-won copper will be encouraged.

To illustrate the nature of the expansion plans now in progress, several recent contracts awarded to Techpro Mining and Metallurgy may be mentioned [14]. Among these is a 23.4 million contract in the Islamic Republic of Iran, won by a consortium of contractors including Klockner INA Industrial Plants Ltd, the United Kingdom subsidiary of the German industrial group, together with Techpro. The contract, awarded by the National Iranian Copper Industries Corporation (NICICO), is for the design, supply, construction, supervision and commissioning of a heap-leach solvent extraction electro-winning plant at Sar Cheshmeh, the centre for copper production in the Islamic Republic of Iran. This is the fourth contract to be won by Techpro in the past year at Sar Cheshmeh, where NICICO ultimately plans to produce 200,000 tonnes of copper per annum, doubling current production volumes. The new plant will treat 27 million tonnes of oxide ore over the next decade, producing 41 tonnes per day of London Metals Exchange Grade A cathode copper.

Techpro is also currently preparing engineering and procurement specifications for the purchase of equipment for the rehabilitation of the BCL copper and cobalt mine and surface plant at Selebi-Pikwe, Botswana. The contract is funded by the European Investment Bank. Work continues on another large contract, the $30 million turnkey project in Zaire for La Générale des carrières et des mines (Gecamines) for the recovery of copper and cobalt from current leach tailings. Techpro is undertaking a series of projects for Zambia Consolidated Copper Mines. At Nkana division, the installation of oxyfuel burners to the reverberatory furnaces has been commissioned.

In Peru, Techpro has assisted International Mining Consultants in the technical and cost evaluation of the La Oroya Complex and Hydropower plants in preparation for the privatization of CENTROMIN, the Peruvian State-owned copper industry.

In the former USSR, Techpro has provided consulting services to several copper smelting and sulphuric acid plant producers in the Russian Federation and Kazakhstan. Techpro has provided metallurgical consultancy services involving auditing of smelter operations to a number of operations in Eastern Europe, including the Baia Mare flash smelter in Romania, and the MDK Pirdop flash smelter in Bulgaria.

Worldwide, incremental smelter expansions in Australia, Chile, Philippines and United States, and increased capacity utilization throughout the industry should provide additional capacity of around 200,000 tonnes in 1993. However, no new greenfield smelters are likely before the mid-1990s. The most likely projects are now the 120,000-tonnes-per-year smelter of Padaeng Industries in Thailand, and a 150,000-tonnes-per-year smelter in Indonesia, but neither of these are likely to be on stream until at least 1995 [15].

6. *Technological trends*

In the United Kingdom, the Copper Development Association is engaged in initiatives to maintain and increase the consumption of copper in end-uses in which it is subject to competition from alternative materials, and to create demand in new applications. The defensive initiatives involve maintaining demand in the construction industry for both water distribution and building wiring, in the transport industry for automobile radiators, and in the electrical industry for power cables and connectors [16]. The market creation initiatives include fire sprinklers, roofing systems and waste-heat recovery systems in the construction industry, nuclear waste containers and energy-efficient transformers for the electrical industry, and components for offshore industrial structures.

In addition to the work undertaken by the Copper Development Association, Codelco, the world's largest copper producer, has announced substantial increases in its budget for promoting copper. From $900,000 in 1986, this budget was increased to $3.4 million in 1991. Part of the expenditure is devoted to education and training programmes in large copper-consuming countries in order to increase consumption in the construction industry by making specifiers and installers better aware of the advantages offered by copper.

Copper is one of the major constituents of a new brazing alloy developed for joining metals to ceramics. The copper content is between 35 and 50 per cent, with 40 to 50 per cent silver and smaller quantities of tin and titanium. The new alloy can be used at temperatures below 850° C, and can therefore be used to braze thermally sensitive materials such as nodular cast iron or partially stabilized zirconia. Ultra-fine copper powder, with particles having an average diameter of 0.5 microns, is produced by Mitsubishi Gas Chemical Company for use in the manufacture of electronic components and for powder metallurgy. Some is also used in the production of anti-fouling paints.

The principal technical innovation which has been adopted by the copper industry over the past decade is the production of copper by leaching, solvent extraction and electro-winning. The technique is not new, since copper has been produced by such means for over 20 years, but it gained prominence in the 1980s as a low-cost method of producing copper, instead of, or in addition to, the conventional methods of mining, concentrating, smelting and refining. The process makes possible the production of copper from oxide ores which were previously discarded, and from tailings. Its exploitation makes it possible to extract copper from poorer ores or from waste material which has been mined and dumped over periods of 50 years, or longer, at some mines [17].

Major developments in the processing of refined copper in recent years have been in response to the availability of consistently high-quality copper from continuous-cast-rod mills. This has allowed the use of high-speed tandem wire-drawing machines and of in-line annealing, rather than the previous inter-stage batch process. Although conventional hot-rolling mills are likely to remain more suited to the production of very large- or very small-diameter rod, continuous cast rod accounts for about half the total of copper rod production, and its technical and economic advantages (uniform quality of large rolls of rod and low operating costs) will undoubtedly ensure further penetration.

A wide variety of copper alloys already are available, and the range has broadened as consumer specifications have become more demanding and copper has had to compete with other materials. Copper producers have founded the International Copper Research Association to sponsor research into and development of copper and copper alloys. The Copper Development Association is responsible for market development.

7. *Environmental considerations*

The mining and subsequent processing of copper still pose major problems of environmental degradation. Apart from the tremendous effects of land ecology disturbances caused by massive open-cast mining operations, severe atmospheric pollution problems stem from the sulphurous emissions from copper smelting, causing acid rain and consequent ecological and health effects. For example, around 750 tonnes per day of sulphurous vapours, including arsenic and particulate material, are released from the giant Codelco-owned Chuquicamata mine complex in Chile, the world's largest. Codelco is about to embark on a $300 million clean-up programme to comply with environmental regulations governing sulphur dioxide and dust emissions.

Already, investment in new process furnaces has reduced sulphur dioxide emissions at Chuquicamata to 50 per cent of the levels of the 1980s. Electrostatic precipitators have decreased arsenic and dust emissions, and old furnaces will be replaced by new blast-ovens that are more efficient in trapping dust. More vats will be installed to store sulphuric acid which, in turn, is used to leach copper from previously discarded waste material.

Another significant environmental impact of copper production involves solid waste products and liquid effluents, particularly thousands of tonnes of sludge and toxic waters generated by the copper extraction process. Again in Chile, Codelco is trying to reduce this formidable problem. The national copper corporation has developed an elaborate new treatment system for the giant El Teniente mine to produce non-toxic water from the process sludge by-product [18]. A massive 87-kilometre conveyor chute delivers water from the mine through the treatment system via the specially constructed Caren Dam in the Melpilla province of Chile. Clean water is exploited in a new experimental agricultural station, producing cereal crops and vegetables and rearing livestock.

8. *Short- and medium-term outlook*

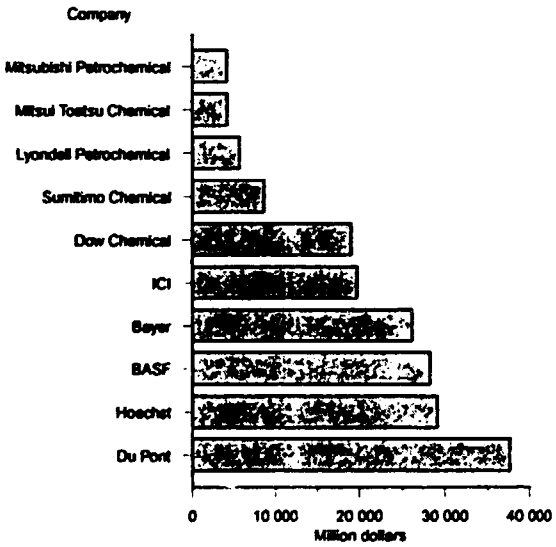
The copper market is poised to benefit from world economic recovery and should receive an additional boost from strong restructuring growth in emerging countries. As economies in Asia, Eastern Europe and Latin America develop, the gap in per capita metal consumption should narrow considerably. Relative per capita measures of metal consumption between developed and developing countries have been discussed in relation to table IV.29. With significant production located in regions where political, economic and geographical stability is not assured, the probability of disruptions in supply will continue to be high. With the possibility of a smelter bottleneck restricting output, the market is expected to remain fluid. The net imports going to the former centrally planned economies remain a major point of concern; a sustained increase in exports, or sales by China, could quickly reverse a relatively positive market outlook. Overall, a moderate growth in supply is forecast to be matched by a slight growth in consumption, and this should result in steady prices.

E. Petrochemicals (ISIC 351103-351131)*

1. *Recent trends and current conditions*

The chemical industry is an important part of the world economy, with output accounting for 7 per cent of global income and 9 per cent of international trade. Unfortunately, the global recession has dampened demand growth in developed countries, where industry performance is closely related to economic conditions, and typically lags behind any recovery. Major petrochemical producers in Japan, United States, Europe and new arrivals like the Republic of Korea, are still experiencing the cyclical downturn that began in late 1989. Some idea of the sales of the major producers is reflected in figure IV.15. What is different from previous downturns is that possibilities for industry revitalization are slim. This is chiefly because Western producers in developed market economies face not only the loss of important traditional export markets in Asia and the Pacific as the region develops an indigenous production base, but also the longer-term competition of lower-priced petrochemical products. This area was previously the target for about 50 per cent of all traded petrochemicals and plastics. A further problem is that companies in developed market economies similarly cannot effectively compete in Western Asia, where producers have a clear cost advantage based on cheap feedstocks.

Figure IV.15. World chemical company sales, 1991 and 1992



Source: Paper presented at the Business Outlook Conference of the United Kingdom Chemical Industries Association, held in London in January 1993, and company data.

Excess capacity, the dominant factor depressing the main petrochemical-producing regions, has not been overcome even by demand growth in the expanding Asian markets. However, some improvements have occurred. In Western Europe, about one third of the 34 crackers and downstream units operated at a loss during the last quarter of 1992. Like the early 1980s, average return on capital employed was negative, but average operating rates are 80 per cent as compared with 65 per cent previously. Margins at even the most efficient naphtha crackers were estimated at 27.1 dollars per tonne of ethylene, a massive 64.6 dollars per tonne less than in 1991. Petrochemical operating rates in the United States are even higher, averaging around 90 per cent, and operating rates in the Republic of Korea have been maintained at around the same level.

In regional terms, the profitability of the industry in Western Europe is very depressed, and is unlikely to rise in 1993 after a massive drop from the heady days of the late 1980s. As shown in table IV.31, many firms ended 1992 with lower profitability for petrochemical operations. Market shares are also under pressure. Both these factors along with a declining domestic economy have adversely affected the German industry. The United Kingdom is emerging only very slowly from a prolonged and deep recession. Turmoil on the Italian political scene is having a negative effect on an already-depressed domestic chemicals sector. France has performed better than most countries in the region, but its outlook for petrochemicals is rather pessimistic. The largest producers in Spain are under enormous financial pressures.

The chemicals sector in Western Europe has been forced into one of the most fundamental realignments of its $10 billion polyolefins sector for a decade. This is because even though volumes are basically strong, the industry is finding it impossible to survive since it is operating on very weak margins. Some plants have temporarily been put on short-time operation or closed in order to tighten the market and try to improve pricing. Some new plants have been completed but not brought on stream, because markets are already saturated or the products sold cannot even cover manufacturing costs.

Western Europe is the highest-cost region in the world for petrochemicals production. Even compared with the United States, producers in Europe are generally less competitive because of smaller plant size, leading to higher unit fixed costs for many operators; producers also face higher costs in terms of labour and feedstocks as well as exit barriers. The latter include the reluctance to close plants in areas of high unemployment and attempts to maintain vertical integration.

In the United States, the downturn is still evident; the trade balance of the United States chemical industry slid by $2.5 billion in 1992, and is expected to fall again in 1993. However, a few optimistic signs have appeared [19]. While industry returns are below those of 1981, 1983 and 1984, and operating rates are about 10 per cent higher, the weak global economy has not been a major factor in the United States downturn. The production of petrochemical derivatives was relatively strong in 1992, raw materials production was higher, and petrochemical prices reversed an 18-month decline. But new capacity elsewhere in the world forced down exports after record levels in 1991. Output of commodity plastics rose 6.2 per cent in 1992, to an estimated 30.2 million tonnes [20].

In Asia and the Pacific, the profitability of the industry in Japan has recently dropped sharply, particularly because of the domestic recession and fierce price competition from the Republic of Korea. The Japanese petrochemical industry is facing serious excess capacity as a result of the downturn. The recession is considered more serious than the one the country faced 10 years ago. In particular, user industries are likely to draw on invento-

*UNIDO acknowledges the contribution of Lynn Tattum, *Chemicalweek International*.

Table IV.31. Performance of selected chemical companies, 1991 and 1992 (Million dollars)[a/]

Region or country and firm	Sales 1991	Sales 1992	Percentage change 1991-1992	Net profit 1991	Net profit 1992	Percentage change 1991-1992
Japan						
Mitsubishi Kasei	4 490	4 225	-5.9	211	84	-60.2
Sumitomo Chemical	8 724	8 185	-6.2	162	131	-19.1
Mitsui Toatsu Chemical	4 244	4 254	0.2	125	58	-53.6
United States						
Du Pont	38 570	37 799	-2.0	1 413	975	-31.0
Dow Chemical	19 163	18 971	-1.0	952	276	-71.0
Union Carbide	5 720	4 805	-16.0	217	26	-88.0
Europe						
BASF	29 698	28 358	-4.5	662	392	-40.8
Hoechst	30 055	29 217	-2.8	864	753	-12.8
Bayer	27 006	26 239	-2.8	1 180	996	-15.6
ICI	19 822	19 144	-3.4	860	905 [b/]	-5.2

Source: Paper presented at the Business Outlook Conference of the United Kingdom Chemical Industries Association held in London in January 1993, and company data.

a/ Exchange rates based on end-1992 rates of 124.4 yen to the dollar and 1.57 deutsche mark to the dollar.

b/ 1992 net income figure includes an exceptional charge of $598 million.

ries longer this time, and consumer demand appears fairly well saturated. Plastics output in the first half of 1992 dropped by 2.8 per cent, to 6.2 million tonnes, and a decline is expected for the entire year [21]. Producers are struggling with a domestic recession that has stifled demand, and many have been forced to slash output by as much as 15 to 20 per cent to keep inventories under control.

Industry prospects are better in other parts of Asia, with demand in newly industrializing and developing countries continuing to show strong growth. This is particularly true of China, which has re-entered the market as a major importer of petrochemicals and plastics during the past two years. Demand from China has helped to absorb huge excess capacity in countries like the Republic of Korea, where producers have been prepared to sacrifice profits in order to generate sales.

2. *Industry restructuring*

(a) *Western Europe*

In Western Europe, recession is forcing producers to economize simply in order to return to acceptable levels of profitability. The industry expected an economic upturn, but its failure to materialize has forced companies to closely examine their portfolios. In addition, low-cost imports from Western Asia and the anticipated rise in imports from the Republic of Korea over the next two years have dampened any prospect of a respite when conditions do improve. Restructuring is a key theme for the sector; all major producers have agreed that it is needed, and several have taken initial steps towards it. There are two main routes available: closure of high-cost production plants; and merger or acquisition to reduce the number of firms in individual sectors. Restructuring in order to focus on fewer businesses, and on those in which a company has a dominant position, is increasingly evident. This has typically led to non-core businesses being sold or swapped. The toll on jobs has been heavy, and even countries traditionally resistant to cutting their workforce, such as Germany and Italy, have been forced to do so.

Western Europe has yet to see its first cracker closure, but it is strongly believed that this could happen in 1993. Small, older and land-locked units are the most likely candidates. Resistance to plant closures is strong and is often politically linked, but some downstream units have already been shut down, particularly when producers have brought new capacity on line. The most obvious trend during 1992 has been the move to merge businesses to achieve cost savings and rationalization of combined production capacities. For example, ICI is exchanging its polypropylene operation for BASF acrylics, and its nylon operations for Du Pont acrylics. Possible mergers still under negotiation but worth particular mention include Shell and Himont in polypropylene, BP Chemicals and EniChem in styrenics, and PCD and Huls in polyolefins.

(b) *Japan*

Under the umbrella of the Ministry of Trade and Industry (MITI), the restructuring of the petrochemicals sector in Japan in the early 1980s removed much excess capacity. In the current downturn, the market has deteriorated without any decrease in operating rates, and price degradation is the main factor blamed for current problems. Some companies have postponed expansion plans, and inter-company alliances have been formed to share operations that are slated for continuance. Producers are struggling with a domestic recession that has stifled demand, and many have been forced to slash output by as much as 15 to 20 per cent to keep inventories under control.

(c) Eastern Europe and the former USSR

The petrochemical industry in this region still suffers from the political and economic changes that have taken place in recent years. Recession in Western Europe and subsequent curbs on investment have held back privatization and development of the industrial base of the region, most of which is still unmodernized and suffering from environmental problems. In general, the petrochemicals and plastics sectors are still in a state of flux, with little hope of any short-term turnaround in the hardest-pressed countries such as the Russian Federation, or even of development of the best-placed industries, such as those in the territory of the former German Democratic Republic. Sectors that are witnessing progress in many countries include more downstream, consumer-oriented operations, such as those involving detergents and paints. The Government of the Russian Federation stated that in 1993 industrial output will reach only 90 to 93 per cent of 1992 output. Following a 34-fold increase in the price of oil in Russia during 1992, a further 450 per cent rise is expected in 1993. Privatization, which is proceeding only very slowly, is virtually non-existent in the petrochemicals industry.

In Poland, however, measures instituted in 1989 to increase privatization are becoming a reality. A study of restructuring in the heavy chemicals industry has been completed, and major soda-ash producers in developed market economies are already showing interest in buying Polish plants. The chemical industry of the former Czechoslovakia on the contrary has a much bleaker outlook, following the separation of the country into two sovereign states. In petrochemicals, Slovakia is being supplied by Slovnaft (Bratislava) and the Czech Republic by Chemopetrol (Litvinov). Chemical sales increased in the second half of 1992, and in 1993 a small increase in profits is envisaged. Privatization suffered a setback when Dow Chemical Europe did not proceed with a previous negotiation to acquire Sokolov.

Despite optimistic forecasts, the year 1992 was not the turning point for the Hungarian economy. Following a decline of 10 to 12 per cent in industrial production for 1991/92, a further drop of up to 3 per cent is envisaged in 1992/93. On the positive side, inflation decreased sharply, after having reached 35 per cent in 1991; exports have risen, and $1.5 billion of foreign investment were received in the first nine months of 1992. In 1993, petrochemical production is expected to regain 1991 levels. The Government has announced a new industrial strategy to safeguard companies of key importance, including plastics maker Borsod-Chem, fertilizer producer Pet Nitrogen Works, plastics and pesticides producer Nitrokemia, and the Taurus rubber works.

(d) Central America and Latin America

With the advent of the North American Free Trade Agreement and the freeing of the petrochemicals sector by State-owned Pemex, restructuring in Mexico has moved forward. Chemicals production in Mexico was worth nearly $14 billion in 1991, a 3 per cent rise over 1990. Industry competition from the United States is also stimulating productivity and environmental improvements. A new wave of investment is expected by domestic and foreign producers. Some expected domestic changes include the acquisition of smaller firms and even the closure of some uncompetitive producers.

Restructuring and regional market integration is the focus for most Latin American countries with significant petrochemical industries. Privatization is progressing slowly in Brazil, and the country is opening up to international competition at a difficult time, burdened by production surpluses because of recession. In Argentina, overall economic growth is favouring the chemicals sector, but imports account for much of the increased demand. Privatization is also moving ahead slowly. Restructuring moves have resulted in mergers and joint ventures, workforce cuts of 27 per cent, closure of 11 plants and the start-up of five new ones. Nevertheless, industry-wide losses reached $236 million over the 18 months ending January 1993, spurred by high energy costs, high taxes and financing charges. Since 1988, prices have been cut by 30 per cent.

3. *Manufacturing capacity of developing countries*

The Asia and Pacific region is the main focus for current and future growth in manufacturing capacity, notably China, together with Taiwan Province and the ASEAN countries. As domestic markets are already oversupplied, United States and Western European investors are diverting increasingly large proportions of total capital investment to the Asia and Pacific region where both State and private sector businesses are looking for overseas funding for petrochemicals expansion. As shown in tables IV.32 and IV.33, the petrochemicals expansion in the Republic of Korea recently peaked when the Hanyang ethylene cracker came on stream in late 1992. The balance of the petrochemical manufacturing base of the region has shown a marked shift. A decade ago, 76 per cent of all Asian ethylene capacity was based in Japan, as compared with 46 per cent today. Styrene, in Japan, declined from 89 to 53 per cent; polyolefins from 69 to 40 per cent; and polyvinyl chloride from 62 to 37 per cent.

Table IV.32. Ethylene production capacities in the Republic of Korea

Firm	Location	Capacity (thousand tonnes)	Completion date
Yukong	Ulsan	155	March 1973
Daelim	Yeochon	400	October 1979
Daelim	Yeochon	300	November 1989
Yukong	Ulsan	450	December 1989
Samsung	Daesan	350	June 1991
Lucky	Yeochon	350	July 1991
Hyundai	Daesan	350	October 1991
Daehan	Onsan	300	November 1991
Honam	Yeochon	350	March 1992
Hanyang	Yeochon	350	October 1992
TOTAL		3 355	

Source: Paper presented at the Business Outlook Conference of the United Kingdom Chemical Industries Association held in London in January 1993.

(a) Republic of Korea

Unlike the ASEAN countries or China, the Republic of Korea is at the end of a sizeable expansion phase. The challenge it now faces is dealing with the overcapacity its petrochemical expansion has created. Domestic de-

Table IV.33. Polyolefin production capacities in the Republic of Korea

Product	Number of producers	Number of plants	Capacity (thousand tonnes)
Low-density polyethylene	4	5	535
Linear low-density polyethylene	4	5	535
High-density polyethylene	4	5	320
Polypropylene	7	8	1 230

Source: Paper presented at the Business Outlook Conference of the United Kingdom Chemical Industries Association held in London in January 1993.

mand continues to show robust growth; the consumption of plastics grew another 11.7 per cent in 1992 to nearly 3 million tonnes, following a 5.4 per cent rise in 1991; it is expected to grow by another 6.1 per cent in 1993. But this increase has been swamped by capacity growth. Plastics production in the Republic of Korea rose almost 40 per cent in 1992 to 4.7 million tonnes, and is forecast to climb another 8.7 per cent in 1993. Plastics exports of the Republic of Korea grew by 98 per cent to 1.9 million tonnes in 1992, with an increase of 11.5 per cent forecast for 1993 [22]. Some 350,000 tonnes were exported to China in the first six months of 1992, or over 15 per cent of the total plastics production. Demand from China has undoubtedly helped absorb a huge amount of Republic of Korean output, and is expected to do so for another three to five years. Ethylene expansions have taken capacity to 3.3 million tonnes per year. The company, Daelim, is also commissioning polypropylene and low-density polyethylene plants during the first half of 1993, and a linear low-density polyethylene plant in mid-1994. Construction of new crackers currently is banned by the Government until 1995, as are polymers, aromatics or styrene projects, except as a means of absorbing output from existing crackers. But profitability is so low that recovery is probably a long way off. Domestic prices remain depressed, and prices in export markets have been slashed to maintain market shares. On the basis of a profitability index of 1984=100, the petrochemicals sector of the Republic of Korea as a whole is estimated to have fallen from 200 in 1989 to just 5 at present [23].

(b) China

Booming economic growth and improving living standards in China are fuelling a massive increase in imports, including petrochemicals. That is expected to continue, and domestic manufacturing capacity is not expected to be able to meet demand during the 1990s, despite the extent of the expansion programme in China as reflected in table IV.34. China has been strengthening its economic links with other Asian countries. Many firms in developed market economies are also seeking to participate in Chinese expansion, particularly downstream petrochemicals and plastics projects, and companies prepared to offer new technology are being encouraged. The majority of foreign investment is currently taking place in smaller, niche sectors. At end 1991, there were over 1,500 overseas chemical investments, but only 33 were valued at over $5 million, according to the Ministry of Chemical Industry [24]. Sinopec, producer of most of the petrochemicals of China, hopes to expand ethylene capacity from about 2.2 million tonnes per year to 3 million tonnes per year by 2000. In total, there are 14 projects planned for the period 1991-1995. Even if all these go ahead, ethylene imports are still expected to remain at around 1 million tonnes per year. The Ministry of Chemical Industry is pursuing an aggressive goal of export growth of 15 per cent per year, to reach a value of $10 billion by 2000 [25]. Chemical exports in 1992 were 59 per cent above the 1991 level, and imports rose 40 per cent over the period concerned. At $9.6 billion in

Table IV.34. Planned ethylene capacity expansion in China

Firm	Location	Capacity expansion (thousand tonnes)	On-stream date
Yanshan Petrochemical	Beijing	150	1995a/
Shell/Chinese consortium	Huizhou	450	b/
Provincial/Sinopec	Guangzhou	115	a/,b/,c/
Sinopec	Maoming	300	a/,b/,c/
China Natural Gas	Dushanzi/Xinjiang	140	a/,b/,c/
Dongfong Chemical	Beijing	115	a/,b/,c/
Formosa Plastics	Xiamen	450	b/
Local/Sinopec	Tianjin	140	a/,b/,c/
	Chengdu	115	b/
Yueyang Complex	Hunan	140	b/
Zhongyuan Complex	Puyang/Henan	140	1995a/,c/
Shijianzhuang Complex	Hebei	140	b/

Source: Chem Systems (Tarrytown, New York, February 1993).

a/ Likely expansion, approved.

b/ Planned.

c/ Included in eight-year plan.

1991, imports were more than double the value of exports. None the less, some 43 per cent of the State chemical enterprises of China experienced losses in 1990.

(c) Indonesia

As a result of the efforts of the Government of Indonesia to reduce borrowing by requiring projects to be privately funded, development of the chemicals sector has slowed somewhat. BP Chemicals and its Japanese partners have become the first polyethylene producer in Indonesia, with the commissioning of its unit of 200,000 tonnes per year. Start-up of the Chandra Asri complex at Cilegon, West Java, comprising an ethylene cracker of 450,000 to 550,000 tonnes per year and a polyethylene unit of 300,000 tonnes per year, is scheduled for 1995. The Golden Key Group is building up a styrenics complex worth $300 million and a polyethylene/polypropylene unit worth $500 million at Serang, West Java, scheduled to come on stream in mid-1995. In addition, the complex will produce 200,000 tonnes per year of polyethylene and 140,000 tonnes per year of polypropylene.

(d) Philippines

The most significant plan to develop the Philippines petrochemicals sector involves the State-owned Philippine National Oil Company. The firm is interested in participating in a $1 billion complex at Limay, Bataan Province, including a 350,000-tonnes-per-year naphtha cracker. Realization of the project is still distant, with cracker construction delayed to 1997 or even beyond. Downstream polymer plants for polyethylene, polypropylene, polyvinyl chloride and ethylene glycol are planned to come on stream between 1995 and 1997. About 30 companies from Europe, Japan, the United States and Taiwan Province have been approached as potential joint-venture partners.

(e) Taiwan Province

The petrochemicals expansion in Taiwan Province has enjoyed healthy development, despite the need to import the majority of the raw materials used. It accounted for 32.8 per cent of the total output of the manufacturing sector in 1990, with exports valued at $18.8 billion. Production value grew from $54 billion in 1990 to $61 billion in 1992, covering acrylonitrile, caprolactam, methanol, acetic acid and pure terephthalic acid. Ethylene output is driven by the State-owned Chinese Petroleum Corporation, which operates three crackers and has another under construction. Ethylene capacity in 1994 will be over 1 million tonnes per year, and the private-sector Formosa Plastics will add a further 450,000 tonnes by 1997. For the future, high labour costs are likely to prompt the redeployment of downstream projects, probably to mainland China.

(f) India

The liberalization of the Indian economy and the progressive opening-up to free trade has resulted in massive cuts in petrochemical tariffs, leading to significant increases in imports of plastics and fibre intermediates at competitive prices. At the same time, the devaluation of the Indian rupee has put a question mark over the viability of petrochemical projects in India, as costs increase for machinery, equipment and technology from overseas. Development has therefore slowed in most of the petrochemical projects in India. However, the State-owned Indian Petrochemicals Corporation, is pressing ahead with its $19.1 billion investment for a complex based on a 300,000-tonnes-per-year gas cracker. In the private sector, Reliance Industries is also building a 400,000-tonnes-per-year cracker.

(g) Western Asia

In Western Asia, the key player is Saudi Basic Industries Corporation (SABIC) at Riyadh. It has the only substantial export-oriented petrochemicals industry in the region, and has managed to remain profitable during the downturn because of its cost-competitive feedstock base, which is lower than that of any other exporting region. Despite the 1991 war in the Persian Gulf and the potential political instability it highlighted, capacity expansion in the Persian Gulf region continues. Over the next two years, a number of SABIC affiliates will be completing their current round of projects, while Saudi Arabia plans further investments worth $15 billion over the next 10 years. Eleven of SABIC manufacturing complexes are undertaking expansion projects aimed at raising capacity to 20 million tonnes per year by 1995. Other Gulf Cooperation Council countries such as Abu Dhabi, Bahrain, Iran, Islamic Republic of, and Kuwait are also pressing ahead with expansion plans. The Petrochemical Industries Co. of Kuwait plans a $2 billion petrochemical complex, even if it cannot find a foreign partner.

4. *Technological trends*

There have been few major technological developments in the petrochemicals sector, still led by the United States, Western Europe and Japan. One major advance currently being commercialized is the development of metallocene catalysts to improve polymer yields for polyethylene, polypropylene and polystyrene. Most companies have diversified downstream from petrochemicals, and tend to focus efforts on core businesses. The exception is in growth areas like methyl tert butyl ether, where developments can still be expected as the industry grows. Refinements of existing technologies continue to be introduced, resulting in lower production costs, higher-quality product grades, or materials with additional properties.

5. *Environmental and energy considerations*

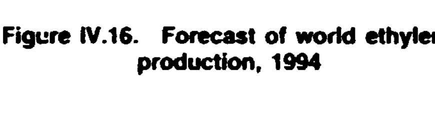
The chemicals industry remains under pressure, increasingly because of problems such as environmental pollution and global warming. Most regulatory issues are driven by environmental concerns, such as the Clean Air Act in the United States which, while focusing on refineries, also has major implications for the chemicals industry. It curbs petrochemical emissions coming from refineries, and has increased the demand for octane enhancers such as methyl tert butyl ether. The growing movement towards the imposition of an energy tax being discussed in Japan, the United States and Europe will place additional financial pressures on the petrochemicals industry. Another major issue is the excessive solid waste resulting from plastics, mainly because of their high content in consumer goods from toys to automobiles, and heavy applications in packaging. Companies, particularly in the United States and Western Europe, are investing increasing amounts of time and money in recycling efforts, but the financial returns on material recycling have been low, and collection and separation is still fragmented, except where Governments have stepped in, as in France and Germany. European legislation on recycling plastics waste is forecast to depress polymer growth rates by about 2 per cent throughout the 1990s. Despite improved techniques, incineration with energy recovery is still widely unpopular with the public. Incineration technology still has to be improved.

Industry initiatives are spreading worldwide through the introduction of self-imposed standards to keep ahead of government restrictions. International firms are setting the pace, and most impose uniform standards at manufacturing plants worldwide, in the hope that others will be forced by public and government pressure to follow suit.

6. *Short- and medium-term outlook*

Current attempts to increase capacity in developing countries will continue to erode United States and European petrochemical export markets. Constraints on funding at the government level and cutbacks on capital spending within private-sector firms in developed market economies could slow down developments in Asia and the Pacific, as well as privatization programmes in Central and Eastern Europe. Political instability in parts of Europe and Asia and the Pacific will also be a factor in speeding up petrochemicals expansion. The forecast for world ethylene production in 1994 is some 76.3 million tonnes; the breakdown by region is given in figure IV.16.

Figure IV.16. Forecast of world ethylene production, 1994



Source: Trichem Consultants Ltd., *Annual Review and 5-year Forecast* (London, 1992)

There are few signs that the petrochemical industry in Europe will pick up in the short term; mergers and alliances will help profitability, and a more balanced supply and demand situation is expected by 1996 or 1998, depending on the success of the rationalization moves being discussed. In terms of ethylene, it is reckoned that 2 million tonnes per year of capacity needs to be closed, equivalent to three or four big plants. Restructuring will be the main focus of activity for companies in the region. Cost-cutting will also result in job losses, especially in Germany.

Despite forecasts for an economic recovery in 1993, growth in United States production is expected to be limited, with exports experiencing further declines as new overseas capacity continues to come on stream. Lower feedstock prices will probably result in price decreases, leading to inventory reductions. However, prospects for commodity plastics are improving in North America; United States output jumped 6.2 per cent in 1992, to an estimated 30.3 million tonnes, and some price increases have held [20].

World ethylene production forecasts are given in table IV.35. In 1993, Japanese ethylene demand is expected to remain constant, with no growth from 6 million tonnes in 1992. On the other hand, capacity is set to increase from 6.7 million to 7.3 million tonnes. Little help is expected from the public spending programme of the Government of Japan and its 1993 budget, which is aimed at stimulating the economy of the country. Economic performance in ASEAN countries is expected to remain robust, with commensurate growth for petrochemicals. With the exception of Singapore, the per capita consumption of petrochemicals in the ASEAN countries is still low, compared with that of developed countries. Per capita plastics demand in Indonesia, for example, was just 3 kilograms in 1991, and 12 kilograms in Thailand, against 50 kilograms in Japan

Petrochemical imports from developed market economies are likely to fall in the Asia and Pacific region, from 3.4 million tonnes in 1991 to 2.8 million tonnes in 1996 [26]. The Republic of Korea and ASEAN countries will switch from being net importers of petrochemicals to net exporters. The Republic of Korea imported 400,000 tonnes of petrochemicals in 1991, but will have an export surplus of 700,000 tonnes by 1996. Corresponding figures for ASEAN countries are imports of 600,000 tonnes in 1991, with expected exports of 100,000 tonnes by 1996. In China and Taiwan Province, import deficits are expected to increase over the period, from 800,000 tonnes to 1.5 million tonnes, and from 1.1 million to 1.4 million tonnes, respectively [26]. Japan, which imported 200,000 tonnes of petrochemicals in 1991, should see a trade balance by 1996.

The high cost of privatization and restructuring is dampening progress in Eastern Europe. In the territory of the former German Democratic Republic, for example, the Treuhandanstalt privatization agency will spend $7.7 billion in 1993 on the chemical industry, split roughly equally between paying off debts, covering operating losses and new investments. The toll on jobs is huge, falling from 80,000 employers before reunification to roughly 15,000 by the end of 1993. Potential investors in petrochemicals are rare throughout the region, often discouraged by environmental problems and the lack of basic infrastructure. Privatization programmes have been slow to attract substantial interest from developed market economies, although some successes in the more developed countries like Hungary and Poland are evident.

Finalization of two planned free trade agreements, one focused on North America between the United States, Canada and Mexico, and the other between the European Community and the Gulf Cooperation Council, will be significant for the world's leading petrochemical producers. It is likely that the protracted GATT negotiations

Table IV.35. World ethylene summary and forecast by region, 1989-1997
(Million tonnes)

Type of data and region	1989	1990	1991	1992	1993	1994	1997	Percentage change 1989-1992	Percentage change 1993-1997
Ethylene capacity									
North America	19.9	21.0	22.2	23.5	23.9	24.7	25.5	18.09	6.69
Western Europe	15.0	15.4	16.4	17.5	18.5	19.2	19.3	16.67	4.32
East Asia	9.6	11.0	12.0	13.7	14.6	15.8	19.5	42.71	33.56
Western Asia and Africa	3.5	3.8	3.8	3.9	4.3	5.1	5.7	11.43	32.56
Latin America	3.3	3.6	3.6	4.0	4.4	4.5	4.7	21.21	6.82
World excluding Eastern Europe and former USSR	51.3	54.8	57.9	62.7	65.7	69.4	74.7	22.22	13.70
Eastern Europe and former USSR	6.9	6.9	7.0	6.7	6.9	6.9	7.0	-2.90	1.45
World	58.2	61.7	64.9	69.4	72.6	76.3	81.7	19.24	12.53
Ethylene production									
World excluding Eastern Europe and former USSR	48.2	51.1	53.2	56.4	57.9	60.3	68.2	-17.01	17.79
Capacity utilization									
World exluding Eastern Europe and former USSR[a/]	94	93	92	90	88	87	91	-4.00	3.00

Source: Trichem Consultants Ltd., *Annual Review and 5-year Forecast* (London, 1992).
[a/] Percentage.

will eventually implement tariff reductions on most chemicals, and this will lessen any possible trade shifts that might result from these or any other regional free trade agreements.

F. Fine chemicals (parts of ISIC 3512, 3522, 351102)*

1. *Recent trends and current conditions*

The world fine chemicals industry is a highly important science-based manufacturing business with strong growth prospects. It provides the important chemical building blocks for a range of products, including pharmaceuticals, agrochemicals, specialized plastics, industrial chemicals, food flavourings, photographic and electronic chemicals, dyes and pigments. Most fine chemicals are organic, carbon-based compounds made in low volumes by complex production routes and selling for high prices. A typical fine chemical sells for above $5 a kilogram. For some particularly complex intermediates, such as pharmaceuticals, the selling price can be $100 a kilogram. In contrast, a bulk petrochemical produced in high volumes, for example, a commodity plastic such as polyethylene, often sells for less than $1 a kilogram.

The industry is characterized by an extremely fragmented supplier base, with hundreds of important companies each having a relatively small portion of the overall market. There seem to be more than 10,000 important fine chemical products, with most compounds having relatively small sales of some $10 million a year or less. Typically, each product area is served by several competing companies [27].

Usually suppliers in this industry are relatively little involved in the final applications of the product. Exceptions are likely where divisions of individual companies supply to other divisions of the same business, as is often the case for big pharmaceutical and agrochemical industries. Similar arrangements are also often seen for large integrated chemical companies that may have their own specialized fine chemical divisions.

Even in instances where the supplier-customer relationship involves different parts of the same company, it may be possible that details of product application are kept hidden from the producer of the chemical. Other instances in which sharing of information between different parts of the same company is minimized concern cases where the customer investigates rival sources of supply, including outside firms as well as other divisions of the same company. That could happen in an effort either to force suppliers to bring down costs or to increase the quality of their products.

The range of final product markets and the high-value and low-volume aspects of the industry make it an attractive one for newcomers. However, the high R and D costs and the complexity of many of the production procedures constitute barriers to entry.

In the fine chemicals sector virtually all the production and an overwhelmingly large proportion of consumers

*UNIDO acknowledges the contribution of Peter Marsh, *Financial Times*.

are in the developed countries. The recession has caused industry sales to decline in recent years, but sales should expand later in the 1990s. During the late 1980s, real inflation-adjusted growth was 5 to 10 per cent per year. In the early 1990s it decreased to only about 2 per cent, but growth could again rise to 3 to 6 per cent per year by the late 1990s [28].

Putting a value on the global output of the fine chemicals industry is difficult. This is partly because definitions over exactly what constitutes a fine chemical vary widely. Also, a large proportion of the output is controlled by big chemical companies which use the materials in a variety of products sold to industrial customers. Such companies rarely divulge the value of the intermediate products used in their internal production processes. That adds to the problems of coming up with an overall figure for the output of the world fine chemical industry. However, the best guess is that in 1991 the fine chemical sector was responsible for sales of $30 billion; thus, it is only a small part of the world chemicals industry, with overall sales of $1,206 billion in 1991 [29]. The main geographic markets and production bases are Western Europe, the United States and Japan; together they account for about 90 per cent of world sales and output.

The industry is technology-oriented, in that many of the advances in the industry relate to new products with specific chemical properties that can do particular jobs. For instance, a fine chemical that ends up in a new pharmaceutical may have had to be designed in a research laboratory with a specific property in mind in terms of the way it affects a physiological process in the human body. That is one reason why the industry is more important in developed countries with strongly developed traditions in R and D and in technical skills.

More particularly, process innovation is probably still more important than the expertise required to devise new chemical entities for specific jobs. The production processes involved in the sector are often extremely involved, requiring perhaps 10 to 20 discrete production steps under exacting chemical conditions. The combination of chemical routes chosen to make a particular fine chemical will often be crucial to the quality of the final material and the costs of its production. These aspects are often vital to the success of a particular company in fine chemicals.

Even though the main producers are in the leading developed countries, some NICs are starting to make headway in the industry, either through the efforts of established international companies or indigenous businesses. The NICs concerned include Brazil, India, Malaysia, Pakistan, Republic of Korea and Taiwan Province. However, these countries and areas start with a handicap in that they need specialized skills in manufacturing techniques required to produce high-value, highly complex chemical ingredients in an extremely pure form. These levels of capability cannot be created overnight, or even in several years. They need many years, often decades, of laboriously developed training infrastructures based on universities and other research organizations. Thus for the foreseeable future, the NICs will probably have to be content with playing only a cooperative role in this particular business.

The part played by NICs is likely to be based either on selling chemicals that are less technically advanced than those made in developed countries; or on selling under licensing agreements new products invented by large transnational corporations; or on acting as strategic marketing and manufacturing centres for major companies headquartered in developed countries.

2. *Industry structure*

The fine chemicals industry is a subsector of the world chemicals industry; as noted above, sales of the latter stood at $1,206 billion in 1991. A geographic breakdown of sales for the chemicals industry as a whole can be seen in table IV.36.

Table IV.36. Sales of the world chemicals industry, 1989 and 1991
(Billion dollars)

Economic grouping region or country	Sales 1989	Sales 1991	Percentage share of world output in 1991
Western Europe	340	411	34.1
North America	275	287	23.8
Japan	190	183	15.2
Rest of world, of which	325	325	26.9
Other East Asia excluding China	39	..	..
India	25	..	..
Western Asia	12	..	..
Africa	15	..	..
Central America and South America	54	..	..
Eastern Europe	170	.	..
Total	1 130	1 206	100.0

Sources: United Kingdom Chemical Industry Association, *Chemical Industry Main Markets* (London, 1990) and private correspondence.

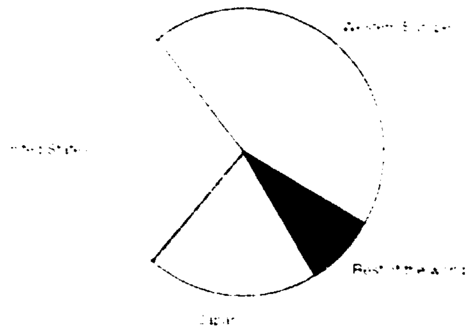
While Europe, the United States and Japan are similarly positioned in the fine chemicals branch as in the larger chemicals industry as a whole, the relative position of developed countries is much less important. This is explained by the high-value specialized characteristics of most fine chemicals, which are aimed mainly at markets in developed countries.

(a) *Major companies in the industry*

As is evident from figure IV.17, the proportion of the output of the fine chemical industry in Western Europe is slightly higher than the market for fine chemicals in the region. For the United States the position is reversed. This results from the particularly large markets in the United States for specific applications to which fine chemicals lend themselves, for example in pharmaceuticals and agrochemicals. Western Europe is a significant net exporter of fine chemicals, with some large suppliers of chemicals such as Ciba Geigy and Sandoz (Switzerland), ICI (United Kingdom), and Rhône-Poulenc Rorer (France) being among the main beneficiaries of this trend. Output and sales for the new growth regions is given in table IV.37.

Major companies in fine chemicals include many of the largest groups in the chemicals business as a whole. Often these have specialist divisions which are responsible for the manufacture of fine chemicals, and which produce materials solely for the use of other departments of the same company. Specifically, many of these chemi-

Figure IV.17. World production of fine chemicals, 1991



Sources: Estimates derived from Arthur D. Little, *Chemical Marketing Report* (London, 7 September 1992), and Peter Pollak, "Fine chemicals outlook for the year 2000", paper presented to the meeting of the European Chemical Market Research Association held in London from 14 to 16 October 1991.

Table IV.37. Output and sales of fine chemicals, 1991
(Billion dollars)

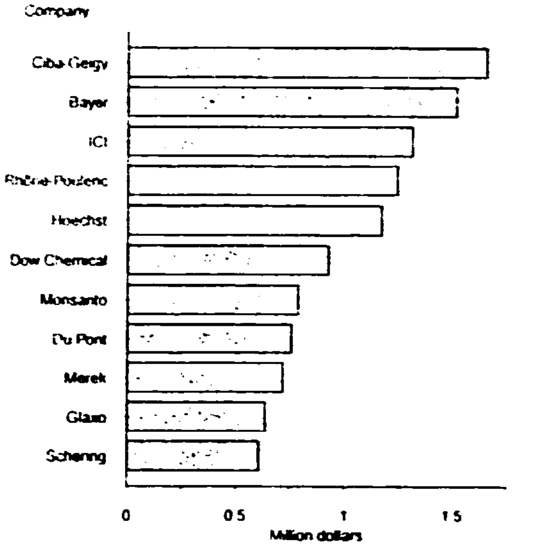
Economic grouping or region	Output	Percentage share	Market sales	Percentage share
Western Europe	13.2	44.0	11.1	37.0
United States	8.4	28.0	11.4	38.0
Japan	6.0	20.0	5.4	18.0
Rest of the world	2.4	8.0	2.1	7.0
TOTAL	30.0	100.0	30.0	100.0

Sources: Estimates derived from Arthur D. Little, *Chemical Marketing Report* (London, 7 September 1992), and Peter Pollak, "Fine chemicals outlook for the year 2000", paper presented to the meeting of the European Chemical Market Research Association held in London from 14 to 16 October 1991.

cal companies manufacture fine chemicals that are used by their own subsidiaries making pharmaceuticals or agrochemicals. There are also some important independent producers of fine chemicals which are not integrated into other areas of chemical manufacturing. Rankings of the major fine chemical producers are difficult to establish, because only rarely are details published about their own fine chemical activities. None the less, an estimate can be made of the world's biggest fine chemicals manufacturers, on the basis of published information about sales volumes of the large chemical-pharmaceutical-agrochemical groups. The production levels of the 11 major companies are compared in figure IV.18. The production of a wider group is given in table IV.38.

Other major companies that have significant fine chemicals divisions include Shell, DSM and Enichem. Specialized supplies of fine chemicals include Lonza, Omnichem, Andeno and ISC [27]. These companies generally have fine chemicals sales of less than $100 million a year. The fine chemicals output of the 32 companies shown in table IV.38 account for sales totalling $17.6 billion, or roughly half the world output of fine chemicals. This provides only a limited description of the world fine chemicals industry on the grounds that the industry is highly fragmented, with many small companies too small to be included in a table showing only the

Figure IV.18. Production of selected major fine chemicals companies, 1991



Sources: Estimates based on Peter Pollak, "Fine chemicals outlook for the year 2000", paper presented to the meeting of the Chemical Market Research Association, held in London from 14 to 16 October 1991, and Barclays de Zoete Wedd Investment House, *Outlook for Wellcome Drugs Company* (London, May 1992).

large firms. For many of the smaller groups, annual output is low. In the United States there seem to be 900 companies in the fine chemicals industry [30], while in the United Kingdom there are around 100.

Of the top 10 companies in the fine chemicals industry listed in table IV.38, 6 of them (Bayer, Hoechst, ICI, Dow Chemicals, Du Pont and Ciba-Geigy) are among the top 7 companies in the world chemicals industry. That underlines the degree to which the fine chemicals industry is dominated by the major chemical transnational corporations (the other member of the top 7, BASF, is ranked number 14 in fine chemicals). Of the other 4 companies in the leading 10 fine chemicals groups, Monsanto and Rhône-Poulenc are also integrated chemicals companies producing a relatively wide range of chemical materials. The others, Merck and Glaxo, are much more specialized companies concentrating almost entirely on pharmaceuticals. Of the 10 major companies in fine chemicals, the United States accounts for 4 companies, Germany and United Kingdom 2 each, and France and Switzerland 1 each. Out of all the 32 major companies listed in table IV.38, the United States accounts for 14, Japan 5, Germany 4, and the United Kingdom and Switzerland 3 each. France, Sweden, the United States and the United Kingdom (SmithKline Beecham) have 1 each.

Among the companies listed above which produce fine chemicals in a different technical range (for example, ICI, Hoechst, Bayer, Rhône-Poulenc, Dow Chemicals, Ciba-Geigy, Du Pont), many are trying to move further into fine chemicals to reduce their exposure to the bulk chemicals business. The current recession has produced massive overcapacity, poor prices and low profitability in that industry. In general many of the fine chemicals groups that are part of large integrated chemicals producers offer a relatively limited product and service range. However, they are increasing their efforts to upgrade their products. Many of the chemicals companies in this category shifted to fine chemicals from com

Table IV.38. World's major fine chemicals companies, 1991

Firm	Production (million dollars)	Firm	Production (million dollars)
Ciba-Geigy (Switzerland)	1 660	Johnson & Johnson (United States)	380
Bayer (Germany)	1 520	Pfizer (United States)	370
ICI (United Kingdom)	1 310	Takeda (Japan)	280
Rhône-Poulenc[a] (France)	1 240	American Home Products (United States)	270
Hoechst (Germany)	1 170	Schering Plough (United States)	260
Dow Chemicals (United States)	930	Upjohn (United States)	260
Monsanto (United States)	790	Wellcome (United Kingdom)	240
Du Pont (United States)	760	Sankyo (Japan)	210
Merck (United States)	720	Astra (Sweden)	210
Glaxo (United Kingdom)	640	Warner Lambert (United States)	200
Schering (Germany)	610	Shionogi (Japan)	200
Bristol-Myers Squibb (United States)	590	Fujiwawa (Japan)	180
Sandoz (Switzerland)	440	Yamanouchi (Japan)	180
BASF (Germany)	440	American Cyanamid (United States)	160
SmithKline Beecham (United States/United Kingdom)	430	Syntex (United States)	140
Eli Lilly (United States)	410		
Roche (Switzerland)	410		

Source: Estimates based on Peter Pollak, "Fine chemicals outlook for the year 2000", paper presented to the meeting of the European Chemical Market Research Association, held in London from 14 to 16 October 1991; and Barclays de Zoete Wedd Investment House, *Outlook for Wellcome Drugs Company* (London, May 1992).

[a] Including sales by Rhône-Poulenc Rorer and by Marion Merrill Dow.

modity chemicals to extract value from products made from mainstream processes. These include, for example, the production of oxime derivatives from caprolactam production or the manufacture of benzaldehye from the conversion of toluene to phenol.

The more specialized producers of fine chemicals tend to be smaller companies. For example, Lonza of Switzerland consider fine chemicals to be its main business [27]. It tends to concentrate on specific niches of the business, such as fluorinated intermediates or diketenes. They are often not integrated into "upstream" businesses, but rather sell their products to other chemicals groups which use them in making final products sold to a consumer or industrial user. Often such companies make a strong point of being independent and not competing with their customers. Frequently these companies compete by working closely with customers and providing high quality, reliability and good service.

The third main group of companies are the ones that mainly make specialized end-products, such as pharmaceutical or agrochemicals. These companies include mostly the major drug companies, namely Merck, Glaxo and Pfizer.

A useful distinction relates to the proportion of the industry as a whole that is taken up by "in-house" or "captive" markets, where a division of a company makes its product for use by another division of the same firm, and the proportion that is "merchant", where the chemicals are sold on the free market. The breakdown of these markets shown in table IV.39 indicates a 58 per cent share for "captive" compared to 34 per cent for "merchant" markets.

Table IV.39. Fine chemicals marketing network, 1991
(Percentage)

Type	Output
Captive	
In-house production of large chemical/pharmaceutical firms	58
Merchant	
Independent fine chemical companies	13
Small pharmaceutical groups	21
Other[a]	8

Source: Estimates based on correspondence with ICI, London.

[a] Including fine chemicals departments of small chemical firms.

(b) Product differentiation

It is helpful to define the ways in which fine chemicals differ from other parts of the chemicals industry, such as bulk chemicals and specialty chemicals (see box IV.1). In some ways fine chemicals can be thought of as having characteristics between those of the other two segments of the industry. Bulk chemicals are made in very large volumes which are sold at high prices with very little differentiation between the same basic product sold by different companies. Specialty chemicals are made in low volumes, with a specific material targeted at an individual product application. There is also a high degree of production devoted mainly to markets for chemists [27].

In terms of volumes in which different kinds of chemicals are made worldwide, bulk chemicals are normally produced in volumes of 10,000 tonnes a year or more, while fine chemicals are made in smaller volumes. Volumes of specialty chemicals can vary widely. Bulk chemicals are sold almost exclusively on a price basis, because a specific bulk chemical is unlikely to vary in

Box IV.1. Industry characteristics by chemical sector

Industry characteristics	*Bulk chemicals*	*Fine chemicals*	*Specialty chemicals*
Product life cycle[a]	Long	Moderate	Short/moderate
Product range (number of products)	Hundreds	Thousands	Tens of thousands
Product volumes[a]	More than 10,000 tonnes per year	Less than 10,000 tonnes per year	Highly variable
Product prices per kilogram	Less than $5	More than $5	More than $5
Product differentiation	None	Very low	High
Value added	Low	High	High
Capital-intensity	High	Moderate	Moderate/low
R and D focus	Process improvement	Process development	Application/product
Customer focus	Non-chemist	Chemist	Non-chemist
Importance of key success factors[b]			
Cost position	High	Average	Low
Technical service	Not relevant	Average	High
Close links with the customer	Not relevant	High	High

Source: Ennics Polastro, ***The Fine Chemicals Industry: the Challenges at the Turn of the Century*** (Brussels, Arthur D. Little, 1992).

[a]Typical examples, though exceptions may occur.

[b]Relative importance.

quality characteristics by more than a small amount from one supplier to another. However, a fine chemical is likely to be sold partly on the basis of its price and partly in relation to quality and specification. A specialty chemical, on the other hand, will be sold almost exclusively on the basis of its quality or the particular application for which it is tailored, with less emphasis on price.

A rough rule is that fine chemicals, along with bulk chemicals, are sold on the basis of what they are. Customers know better how to use them than suppliers. Specialty chemicals, on the other hand, are sold on the basis of what they do. In other words, the specific details of their performance are what matters. It would appear that it is not always very easy to categorize fine chemicals differently from bulk chemicals. Even so, some general guidelines apply. These are illustrated in figure IV.17, which gives the main characteristics of the fine chemicals industry in relation to both specialty chemicals and bulk chemicals.

The various demarcation lines shown can be best illustrated by some specific examples of what is normally construed as a commodity or bulk chemical, such as the material called oxylene. This material has more than 20 applications, sells at around $0.50 per kilogram, and has about 100 producers and 100 suppliers around the world [31]. It is fairly simple to make, requiring just one manufacturing step. Total world production is quite high, at 2.5 million tonnes per year. As an example of a fine chemical, a 3-amino-2-carboxyl-4-chloro-benzophenone could be considered. This has just one application, its use in the production of a specific drug. It costs more than $10 per kilogram, is made in volumes of just 100 tonnes per year, and has only one supplier and one customer. The production procedure is fairly complex, requiring five discrete steps.

(c) *Marketing and technology*

Among the most important characteristics of the fine chemicals industry from the point of view of marketing and technology are a high rate of invention of new products and relatively low-volume production with high sales value. Competition is largely (as with bulk chemicals) based on price, but with factors such as technological sophistication of the production route and availability of product also important. R and D is focused on the manufacturing aspects of the business, though product innovation can also be important. The industry possesses a wide product and customer range, which makes the sector not as affected as bulk chemicals by changes in world economic cycles [27]. Finally, the sector is driven by emerging applications in diverse customer areas, such as drugs, food flavourings, electronic and photographic chemicals and water treatment compounds [30].

3. *Main types of fine chemicals*

A few of the specific types of fine chemicals as categorized by basic chemical type are as follows: acyclic alcohols, not including plasticizers, detergent alcohols and propylene glycol; aldehydes and their derivatives; amide function compounds; amines, excluding methylamines, hexamethylene diamine aniline and salts of these compounds; carbolic acids; cyclic alcohols and their derivatives, excluding phenol Diazo, azo and azoxy compounds; enzymes; heterocyclic compounds, excluding lactams, hydrazine and hydroxylamine derivatives; imide and imine function compounds; inorganic esters; monocarboxylic acids, esters and salts, excluding acetic and methacrylic acids; organometallic compounds; organo sulphur compounds; oxygen function amino compounds; and sultones and sultams. The degree of complexity of these materials both from the point of view of their chemical structure and the ease with which they can be made often varies widely. Some fine chemicals can easily be confused with bulk chemicals because they are made in relatively large volumes and have a wide range of applications. Some fine chemicals are also quite hard to tell from specialty chemicals because they are made in very low volumes for which the number of different applications is limited. Questions of definition can often be confusing.

A specific compound, 2-chloro-5-(1-hydroxy-3-oxo-1-isoindolinyl) benzene sulphonamide provides an example. This is normally categorized as a fine chemical. It is sold for only one application, the manufacture of a specific drug. It costs about $100 a kilogram. However, once it is turned into a tablet and marketed as a drug to lower the water content of the body (this specific pharmaceutical is called chlorthalidone), it becomes a specialty product. At this point it also commands 10 to 20 times the initial price [31].

At the same time, fine chemicals can be usefully categorized into three broad classes [32]: standard intermediate ingredients; standard bulk active ingredients; and custom-synthesized molecules. In general, standard intermediate ingredients have a relatively large number of applications, as compared with the other two types which normally have only one application. The standard intermediate ingredients also generally stay in production for a relatively long time, because the chemicals for which they are used as a raw material are produced over a period of time owing to the nature of their applications. The other two types, in contrast, are often in production for only a relatively short time before they are superseded by another chemical that turns out better on grounds of either quality, cost, ease of use in production or greater applicability in terms of the final use of the end-product. The different characteristics of each, as summarized in figure IV.19, are further explained below.

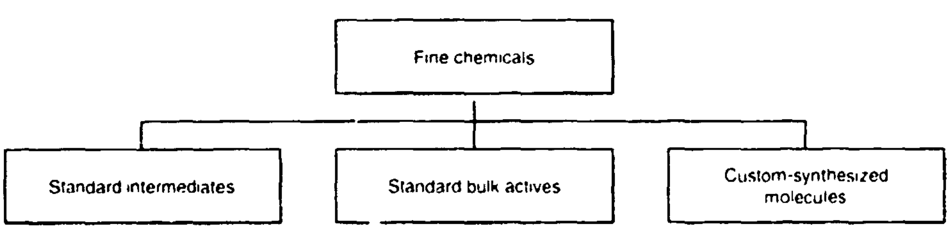
(a) Standard intermediates

Standard intermediates are represented by a great many chemicals used as building blocks in the construction of other materials. Examples are D-phenyl-glycine, malonitrile, 5-nitroisophthalic acid and dialkylthiophosphates. They are used in the synthesis of other molecules, such as ampicillin, triamteren and iopamidol, with applications in areas like health care and agrochemicals.

These products share several characteristics. They have a relatively long life cycle of 20 years or more, that is, the period during which sales can be made at a profit [32]. Their synthesis often involves a special technical step, such as nitration or hydrogenation or access to a key raw material, including hydrofluoric acid or hydrogen cyanide.

For instance, the synthesis of benzo-trifluoromethyl, an important intermediate in the production of herbicides such as trifluorin, requires access to chlorine and hydrofluoric acid. Moreover, there are often a range of

Figure IV.19. Principal segments of the fine chemicals industry



	Standard intermediates	Standard bulk actives	Custom-synthesized molecules
Types of structures:	Very broad range	Very broad range	Relatively few
Applications:	Often several	Single	Single
Life cycle:	Typically long	Relatively short	Unpredictable
Basis of competition:	Low delivered price	Low delivered price	Commercial flexible
Impacts of raw materials costs:	High	Highly variable	Limited

Source: Enrico Polastro, Jennifer Stahr and John Nystron, *Production Strategies for Leadership in Fine Chemicals* (Burlington, Massachusetts, Decision Resources, 1991).

suppliers of these kinds of materials. This means that producers have to watch costs and often compete in terms of final price, not much different from the situation for commodity chemicals. Finally, the costs of raw materials are an important factor determining the final price. Typically, the raw materials can account for 40 per cent of the final price a customer has to pay.

It is not possible to generalize the volumes in which standard intermediates are made. These can range from very low to very high, depending on the specific material and its final application.

(b) *Standard bulk actives*

These materials are mainly seen in the pharmaceutical and agrochemical industries, where they are used at various stages in the manufacture of products. Generally, their life cycle is short because of the relative ease with which they can be replaced by other chemical building blocks that do a better job. They are often synthesized in a number of steps involving starting materials that may belong to the class of standard intermediates (or possibly chemicals derived from these products). As with the standard intermediates market, specific products of this kind may be supplied by a number of rival producers. Hence, pricing strategies are extremely important to the ultimate survival of a particular supplier of a standard bulk active.

An example of a standard bulk active is the starting material for products such as analgesics or painkillers. Here the bulk active may need to be turned out in a large volume of perhaps thousands of tonnes a year. At the other extreme, a bulk active could be made in much lower volumes, such as for use in the production of relatively specialized drugs, for example, those which combat rare blood disorders.

(c) *Custom-synthesized molecules*

Custom-synthesized molecules cover a smaller product range. Their chemical characteristics depend entirely on what the customer requires. They are the equivalent in the chemical industry to designer clothing in the garment industry. They are tailored to a specific application; once that application is no longer relevant, or the specific customer no longer has a need for the end-product for which the raw materials are made, then the production of the custom-synthesized molecule will probably cease. This is another way of saying that the life cycle of these substances is exceedingly short. Often custom-synthesized molecules are made by suppliers who are very quick in meeting customer demands. They will have had to invest in sophisticated plant that is capable of making complex chemicals in small production runs, and then altering them to make other substances for which an application has become apparent.

In many ways, custom-synthesized molecules are the most interesting type of fine chemical. They are characterized by the following:

(a) They have an unpredictable life cycle, which is related to the fate of a single end-product;

(b) Their production often involves long, complex stages of synthesis. As a result, manufacture is usually left to specialist suppliers with the necessary expertise in terms of hardware, technology skills etc.;

(c) Price plays only a limited role in determining the success of the supplier. Commercial flexibility, back-up services and relationships with the user chemical company are also fundamentally important;

(d) The price of raw materials for these compounds is relatively unimportant in determining the final selling price. Frequently, the price of the raw materials accounts for 40 per cent or less of the price of the final custom product.

4. *Production technology*

Production technology plays a more important role in fine chemicals than for most other sections of the chemicals industry. While in many other subsectors such as commodity plastics or much of the basic petrochemicals area, the production routes are based on extremely well-known processes, often invented decades ago. Even though in these cases chemicals suppliers need to keep abreast with new trends and ways of updating the production route through new catalyst-assisted steps, or of varying reaction conditions, the manufacturing process itself barely changes from year to year. In fine chemicals a very different situation prevails. Here suppliers devote considerable time and attention to production improvements or finding new and different kinds of chemicals that have not been made in the past in anything beyond prototype volumes. Suppliers have to hire the kind of skilled chemists and engineers who are able to devise new production routes, to make specific tailored compounds depending on the applications chosen by a customer. They also have to invest large sums in modern production hardware, in which control by computers is becoming increasingly important.

As shown in box IV.2, there are two basic production systems for the fine chemicals industry, single purpose or multi-purpose. Single-purpose units are also seen in production of other types of chemicals in the commodity area. However, multi-purpose units are seen mostly in the fine chemicals part of the industry, and to some degree in the specialty subsection of chemicals manufacture. The production strategies for particular kinds of fine chemicals are linked to the range of ways in which single- and multi-purpose plants may be used in combination.

(a) *Single-purpose systems*

Single-purpose units can handle only one technology in a single step, for example hydrogenation or nitration. This makes the technology vitally important to the successful manufacture of the final product. The company that spends tens of millions of dollars in building such a single-purpose plant has to be sure that it is going to have a large amount of use in terms of delivering useful products. Even so, the investment required to install single-purpose plants is typically lower than that required to construct more flexible multi-purpose plants capable of making volumes of material of a corresponding amount. This is because of the streamlined, well-defined nature of a single-purpose plant, which reduces hardware requirements. Single-purpose systems are typically based on a batch process or a continuous process; in other words they normally turn out chemicals in relatively long production runs at high volumes. Good examples are fermentation systems that produce high volumes of antibiotics used in the drugs industry.

BOX IV.2. Characteristics of basic production set-ups for fine chemicals

Item	*Single purpose*		*Multi-purpose*
	Monoproduct	*Multiproduct*	*Multiproduct*
Operating mode	Continuous	Continuous or batch	Batch
Operating strength	Process efficiency	Process efficiency and some flexibility	Process flexibility
Applications	Large-volume standard intermediates and actives	Small-volume standard intermediates	Small-volume bulk activities and custom-synthesized molecules

Source: Arthur D. Little, Inc., Cambridge, Massachusetts (1993).

There are two types of single-purpose systems: monoproduct units and multiproduct units [32]. Monoproduct units are generally based on a continuous process making a single chemical entity. Typically these systems are used to make relatively simple molecules, such as standard intermediates or possibly slightly more complicated bulk actives. Often the volumes in which these materials have to be made are relatively high, perhaps in the order of tens of thousands of tonnes a year. It can be seen that there is an analogy here with the kinds of plants used to make bulk petrochemicals. These units have high process efficiency and limited flexibility; they cannot normally be altered to make different kinds of chemicals without a great deal of difficulty.

Multiproduct systems can produce related molecular structures with little or no change to the hardware configuration. Typically these units make ranges of closely related standard intermediates whose individual demand would not warrant the use of a dedicated unit. Systems of this type are particularly useful when performing key steps in the multi-stage synthesis of complex molecules.

(b) *Multi-purpose systems*

Multi-purpose systems can handle a range of different production processes, depending on the control procedures to which the equipment is subject. These systems can handle the large number of the different production stages required to make a specific, relatively complicated chemical. In such cases, total production time is quite slow, since the plant has to be stopped and restarted again between different stages of the synthesis. Between the different stages, new control regimes may have to be implemented; aspects of the hardware may have to be changed or new programmes may have to be brought to bear, if the systems are subject to a large amount of computer control. However, in cases where the tonnages of the final product being made are relatively small, and where the chemical being synthesized is of a particularly high value, then the relatively inefficient aspects of production may not matter very much. It can be seen that optimal use of these types of hardware depends very much on a trade-off between operating flexibility and efficiency.

Most low tonnage bulk active ingredients and custom-synthesized molecules are made in multi-purpose units, firstly because of the multi-stage production procedures which are normally relevant for such molecules, and also because of the relatively short product life cycles of these chemicals, which would make dedicated hardware obsolete relatively quickly.

Operating a multi-purpose unit successfully is not an easy job. It is quite different from single-purpose systems, which are normally seen in most other facets of the chemicals industry. In some senses the management aspects of operating multi-purpose systems are analogous to those required in many kinds of engineering plants where hardware has to be switched frequently to make a wide range of discrete manufactured products (often heavily customized) in short production runs. The difficulties of successfully operating multi-purpose units include balancing production schedules to minimize changes in the operating routines for the plant and keeping inventories of both finished chemicals and raw materials low. A second difficulty involves having a workforce that can handle different production routes to a wide range of different final products. Finally, the company involved with these techniques probably needs advanced knowledge of modern computer control procedures.

Because of the special nature of much of fine chemicals manufacturing, particularly the use of sophisticated multi-purpose units of the kind just mentioned, a large number of specialized producers of fine chemicals have become prominent in recent years. Many of these companies have relatively low annual sales, and so do not figure in the league tables of the largest companies in fine chemicals, such as those listed in table IV.38. The importance of these companies in the sector as a whole, however, is relatively large. This is because a great many of the larger companies in the sector rely on them for specific stages in fine chemicals production. Typically, a large company may contract out specific steps in the synthesis of a particular chemical, leaving this to a specialized producer. In the United States, there are several hundred specialized custom producers of fine chemicals, including Grant Chemicals, Morflex, Pressure Chemicals, Cambrex, Angus Fine Chemicals, ChemDesign, Ruetgers-Nease, Ricerca [33].

Often a key to whether a large fine chemicals producer decides to contract a specific stage of manufacturing to one of these smaller groups will be not just the complexity of the production step involved, but also the degree of environmental risk. With pollution regulations in most developed countries becoming more vigorous, the types of anti-pollution systems (for example containment vessels, special apparatus for recycling waste and specialized health and safety equipment to protect workers) needed for particular parts of complex production processes will be too difficult or expensive for most fine chemicals companies. This is leading them increasingly to contract out some of their stages of chemical manufacture mainly on environmental grounds [33].

In the United States the custom synthesis market catering for contract manufacture of particular fine chemicals, either because of their complexity or their environmental impact, came to $1.3 billion in 1991. This market is likely to grow at between 8 and 12 per cent a year during the early to mid-1990s.

In the area of production technology, computers play a key part, especially for systems that have to be capable of being switched from one production regime to another. To make a range of different chemicals during the frequently difficult and complex stages of manufacture of a final finished product, the choice of the control system is often extremely important. In this both hardware and products from a specific chemical reaction are brought into contact with each other. In addition, different computers are frequently linked by data networks which send computer code from one system to another to provide overall coordination.

5. *Application areas for fine chemicals*

(a) *Pharmaceuticals*

Table IV.40 shows that the production of fine chemicals for pharmaceutical applications was almost one half of the world market, or $13.2 billion, in 1991. The magnitude of fine chemicals production in this particular area is roughly one tenth of the total production of the world drugs industry [31]. It can be seen from table IV.41 that many of the world's biggest drugs companies are also highly important in fine chemicals manufacture. This indicates that to a large degree the drugs industry produces its own fine chemicals, used generally as intermediates in the manufacture of the finished product suitable for use as a medicine. It also is an important purchaser of fine chemicals from specialist fine chemical contractors.

Table IV.40. Application areas for fine chemicals, 1991

Final product	Fine chemical sales (billion dollars)	Percentage share
Pharmaceuticals	13.2	44.0
Plastics/industrial chemicals	4.5	15.0
Agrochemicals	4.2	14.0
Vitamins	2.1	7.0
Dyes	2.1	7.0
Flavours	0.9	3.0
Other[a]	3.0	10.0
TOTAL	30.0	100.0

Source: Estimates derived from Arthur D. Little, *Chemical Marketing Report* (London, 7 September 1992); and Peter Pollak, "Fine chemicals outlook for the year 2000", paper presented to the meeting of the European Chemical Market Research Association held in London from 14 to 16 October 1991.

[a] Including electronic chemicals, specialist materials, cosmetics and animal feed.

The pharmaceutical industry stands at a crossroads, with its future dependent on several diverse factors which are difficult to quantify. On the one hand, there are the pharmaceutical demands from ageing populations in many developed countries, increasing interest in personal health care, generally rising wealth, and the growing incidence (especially in developed countries) of hard-to-combat diseases like cancer, heart ailments and acquired immunodeficiency syndrome (AIDS). Set against this trend are several other factors which would lower any expectations about fast growth in the drugs industry. They include increased cost-consciousness on the part of government health agencies, which in many countries are the main customers for pharmaceuticals, the difficulties inherent in developing new formulations for diseases with complicated modes of attack and causes such as AIDS, and increasing costs of R and D. There is also the problem of ensuring that drugs do not cause unnecessary side-effects and so infringe the health and

Table IV.41. World's major pharmaceutical companies: ranking by non-prescription drug sales, 1991

Rank in 1991	Firm	Sales (million dollars)	Rank in 1991	Firm	Sales (million dollars)
1	Merck	7 223.0	16	American Home Products	2 727.0
2	Glaxo	6 638.4	17	Marion Merill Dow	2 711.0
3	Bristol-Myers Squibb	5 908.0	18	Schering-Plough	2 614.0
4	Hoechst	5 427.7	19	Upjohn	2 670.0
5	Bayer	6 304.8	20	Wellcome	2 354.1
6	Sandoz	4 454.5	21	Schering AG	2 614.0
7	SmithKline Beecham	4 371.9	22	Sankyo	2 125.2
8	Eli Lilly	4 145.0	23	Astra	2 066.8
9	Hoffmann-La Roche	4 131.5	24	Warner-Lambert	2 014.0
10	Ciba-Geigy	4 063.6	25	Shionogi	2 008.7
11	Johnson & Johnson	3 800.0	26	Fujisawa	1 933.7
12	Pfizer	3 771.0	27	Yamanouchi	1 775.1
13	Rhône-Poulenc Rorer	3 420.0	28	American Cyanamid	1 642.0
14	ICI	2 286.6	29	Syntex	1 386.0
15	Takeda	2 762.1	30	Monsanic	1 303.0

Source: Barclays de Zoete Wedd Investment House, *Outlook for Wellcome Drugs Company* (London, May 1992).

safety regulations underlying the consumption of medicines [30].

A specific factor which should help production of fine chemicals for pharmaceuticals is the growing interest in substituting cheap "generic" drugs for their branded equivalents in cases where medicines are off-patent. Generic drugs, which include a number of common analgaesics and heart medicines, require in many cases the production of substantial volumes of fine chemicals in the shape of specific intermediates, which are then used to make the final product.

The production of the necessary fine chemicals in the overall, often complex process of producing a medicine has to be seen against the background of the large amount of regulations in the drugs field. The drugs industry is one of the world's most highly regulated. Companies developing new drugs are subject to intricate controls and rules that have to be met to ensure that the products are safe and that they work more or less as advertised. Most developed countries have government health departments which include large drug regulatory divisions. It is the job of companies to manage their drug development work in such a way that the products pass through the regulatory process relatively smoothly and without too much time or money being wasted. None the less, it often takes 10 years and up to $100 million in R and D efforts to take a new drug from the laboratory to the marketing phase. The rules devised by these drug regulatory departments mainly involve hundreds, if not thousands, of tests which the chemicals in new drugs have to pass before they can be certified as safe and efficacious.

The tests involve several different regimes: laboratory experiments on the basic chemicals in drugs to find 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. In short, sufficient evidence has to be amassed that the product is both safe and effective in fighting a particular ailment or localized condition. Only after the drug in question has passed all these regulatory stages will it receive a product licence to enable doctors to prescribe it to patients in a general way, or (in the case of over-the-counter medicines that do not require a prescription) to allow pharmacists to stock the product on their shelves so that it can be bought by the public.

Important subsectors in the world drugs industry include preparations for brain or central-nervous-system disorders involving many common painkillers such as aspirin, anti-arthritis compounds, anti-infectives, heart and skin preparationms and cancer treatments.

Increasing R and D costs are an important aspect of the industry, partly because of the purely scientific difficulties of coming up with new formulations to treat diseases such as heart disorders. There is also the extra work involved in gathering huge amounts of data, either needed to satisfy safety regulations, or related to how new drugs affect the physiological processes of the human body. The industry worldwide spent about $26 billion on R and D in 1991. That accounted for about 17 per cent of total sales, an extremely high proportion by the standards of other manufacturing sectors [34].

(b) Plastics and industrial chemicals

Plastics and industrial chemicals represent an extremely large application area for fine chemicals, the total fine chemicals being used in this sector accounting for sales of $4.5 billion worldwide in 1991. It also encompasses a range of materials, for example, specialist additives used in engineering plastics such as nylon, inorganic and organic salts used for specialist industrial reactions, and enzymes [30]. End-products in this sector which use fine chemical preparations in their manufacture include not only specialist plastics, but reagents, cleaning agents, diagnostic materials and household chemicals.

An important market in this general area of fine chemicals represents the various additives used in the $20-billion-per-year world engineering plastics industry. Engineering plastics are tough, strong substances used in industries such as cars, aerospace and factory machinery. They are both more expensive and more complicated to make than conventional bulk plastics such as polyvinyl chloride. Examples include polycarbonate, acrylonitrile butadiene styrene, and various engineering grades of polypropylene.

Highly important in this industry are the organic substances added in small quantities to plastic to change its properties in some way, for example, in altering its texture, colour or ease with which it can be moulded or formed.

Another major market for fine chemicals in this branch involves industrial enzymes, used as catalysts in specific reactions in food-processing, paper-bleaching and other industries. Other areas of industrial fine chemicals include water-soluble polymers used in applications including paint production and sewage treatment. These water-soluble polymers often based on the bulk chemical acrylonitrile are in many developed countries replacing volatile organic compounds (used in paints, for example), which are associated with health problems because of the way they are propagated in the atmosphere and inhaled by humans and animals.

(c) Agrochemicals

Fine chemicals used in the production of agrochemicals accounted for sales in 1991 of $4.2 billion. The overall agrochemicals market totalled $24.7 billion in 1991. The market breakdown for herbicides, insecticides and fungicides is provided in table IV.42. In the agrochemicals business many of the biggest companies are also large suppliers of fine chemicals. As shown in table IV.43, the biggest company is Ciba-Geigy of Switzerland with just over 10 per cent of the world market. The next biggest is Imperial Chemical Industries (ICI) of the United Kingdom with 9 per cent. Then comes Bayer of Germany and Rhône-Poulenc of France, both with about 8 per cent of the world market.

In terms of specific types of agrochemicals, there are four main categories, as described below.

(i) Herbicides

The total world market for herbicides in 1990 was $11.6 billion. The main types are as follows:

(a) Triazines. These had an estimated market of $1.7 billion, are generally applied directly to the soil, and are relatively old, established materials. Key products

Table IV.42. World agrochemical sales by major sector, 1991
(Billion dollars)

Economic grouping or region	Herbicides		Insecticides		Fungicides		Total	
	Value	Percentage share	Value	Percentage share	Value	Percentage share	Value	Percentage share
United States	3.7	31.9	1.3	17.3	2.7	49.1	7.7	31.3
Western Europe	3.1	26.7	1.7	22.7	1.5	27.3	6.3	25.6
Western Asia	1.7	14.7	2.2	29.3	0.3	5.5	4.2	17.1
Latin America	1.1	9.5	0.6	8.0	0.4	7.3	2.1	8.5
Eastern Europe	1.1	9.5	0.5	6.7	0.2	3.6	1.8	7.3
Rest of world	0.9	7.8	1.2	16.0	0.4	7.3	2.5	10.2
TOTAL	11.6	100.0	7.5	100.0	5.5	100.0	24.6	100.0

Source: *Financial Times*, industry database.

Table IV.43. World's major agrochemical companies, 1990

Firm	Rank in 1980	Rank in 1990	Sales in 1990 (billion dollars)	Agrochemicals as a percentage of group sales in 1990
Ciba-Geigy (Switzerland)	2	1	2.8	18
ICI (United Kingdom)	5	2	2.3	9
Bayer (Germany)	1	3	2.2	8
Rhône-Poulenc (France)	6	4	2.0	13
Du Pont (United States)	9	5	1.7	4
Dow Elanco (United States)	8 a/	6	1.5	100
Monsanto (United States)	3	7	1.5	17
Hoechst (Germany)	10	8	1.4	5
BASF (Germany)	7	9	1.3	4
Schering (Germany)	-	10	0.9	24

Source: County NatWest WoodMac, "Agrochemical Service" (Edinburgh, 1991).
a/ Refers to sales of Eli Lilly alone, as Dow Elanco was formed only on 1989.

include 1,2,4-triazine derivatives, such as Lexone (Du Pont), and Sencor and Lotiz (both Bayer). These products are extensively used to control weeds affecting crops of maize, sorghum, sugar cane, sugar beet and pineapple. While Bayer, Du Pont and Shell are important in this field, Ciba-Geigy is the main manufacturer, being responsible for ametryne, prometryne and simazine;

(b) Amides. With a market of $1.2 billion, they are sprayed on soil for control of grasses and broad-leaved weeds. Most of the main products are covered by patents, and so profitability has been high. However, many of the patents have run out in recent years, and sales are expected to contract in the 1990s. The main markets are in the United States and South-East Asia, and include more than 20 products, half of which are important commercially. Dominant chemicals are propachlor (Ramrod, made by Monsanto), Machete (also Monsanto), and alachlor (Lasso, Monsanto);

(c) Carbamates. The United States accounts for about a third of a total market of $1.1 billion. Japan and Eastern Europe also are important. The introduction of new products in the 1980s increased the importance of this group, many of which are off-patent. ICI is one of the main companies, selling products such as EPTC (Eptam) and buylate (Sutan). Another large-selling chemical is diallate (Avadex, Monsanto);

(d) Ureas. With a market of $840 million, ureas have a wide application range and are fairly inexpensive. The earliest members of the family were invented by Du Pont in the 1960s. Hoechst and Ciba-Geigy are also important. Key products include diuron, monuron, fluomeuron, chloroxuron, methabenzthiazuron and chlorotoluron;

(e) Toludines. These are used mainly for soy bean and cotton crops, especially in the United States (60 per cent of the market), Brazil and Europe. With sales in 1990 of $380 million, the main outlets are the producers of cotton, soy bean, and peanuts. Main manufacturers include Dow Elanco and Treflan. The two largest-selling products are the generic trifluralin, and also Sonalan. Prowl, sometimes marketed as Stomp, and with the generic name pendimethalin, is also important;

(f) Hormone-acting products. With sales at $660 million, hormone-acting products interfere with the hormonal balance of plants. They can be extremely selective (interfering with only specific types of weeds), because of the way products can be targeted at particular hormonal structures;

(g) Diazines. These are relatively new entrants, with high profitability and recent sales of $750 million. Used for rice, soy bean, cotton, cereals, vines and nuts, the markets are mainly in the United States, Japan and Brazil. Four main products appear in this branch: bentazone (BASF), methazole (Sandoz), oxadiazon (Rhône-Poulenc) and pyrazolate (Sankyo);

(h) Diphenyl ethers. Their sales of $590 million are rapidly growing as a result of their relative newness; they are applied particularly to soy bean and rice crops.

About seven major products have annual sales of $20 million or more, including Blazer (BASF), X-52 (Nihon Nohyaku), MO (Mitsui Toatsu) and Hoelon (Hoechst). Many of these products are protected by patents and so are relatively expensive and profitable;

(i) Sulphonyl ureas. These constitute a broad spectrum of activity against weeds appearing with cereals, soy beans and rice. The market of $530 million is mainly in the United States (soy beans and cereals), Western Europe (cereals), Australia (cereals), and East Asia (rice). Important products include Glean or chlorsulfuron (Du Pont) and Logran or triasulforon (Ciba-Geigy). Other relatively new products are Beacon (Ciba-Geigy) and Gratil (Hoechst);

(j) Imidazolinones. Sales of $405 million have been recorded for imidazolinones. Sceptre, the first of this class, was introduced in 1984, used largely for soy bean crops. The maker was American Cyanamid, and it continues to dominate the market for the products; others made by the same company include Pursuit and Assert.

(ii) Insecticides

Total sales of insecticides in 1990 amounted to $7.7 billion. The main types are as follows:

(a) Organophosphates. This is an old established type of chemical with about 70 major products and sales in 1990 of $2.8 billion. However, its use has been reduced because of worries about toxicity. Old and off-patent products (sold by many manufacturers) include parathion, malathion and dimecron. More recent products are Counter (American Cyanamid), Bolster (Bayer), Karphos (Sankyo) and Curacron (Ciba-Geigy);

(b) Pyrethroids. First introduced in 1976, pyrethroids now face heavy competition as a result of a large number of companies entering the market. With sales of $1.4 billion, the products are based on synthetic chemicals that replicate the insecticidal properties of naturally occurring flower heads;

(c) Carbamates. With sales of $1.7 billion, carbamates are used for a wide range of crops. They are important in that they can often be used against insects that have acquired resistance to other insecticides such as organochlorine and organophosphate products. Major products include Sevin and Temik (Rhône-Poulenc), Furadan (FMC) and Lannate (Du Pont);

(d) Organochlorines. Use has been affected by worries about long-term persistence in soil and possibilities of the chemicals entering the food chain. However, their sales still amount to $500 million, and they are very cheap, and therefore still used extensively in developing countries. Most products are off-patent, and they include toxaphene, DDT, lindane, chlordane, endrin and aldrin.

(iii) Fungicides

Total sales of fungicides in 1990 amounted to $5.5 billion. The main types are as follows:

(a) 1,2,4 Triazloles. Only recent entrants to the market, these attack a broad variety of fungal types; their sales have already reached $1 billion. The most successful products include Tilt (Ciba-Geigy), Punch (Du Pont), Baycor, Baytan and Bayfidan (all Bayer);

(b) Dithiocarbamates. These are all mature chemicals and have many off-patent producers, with sales of $890 million. The growth of 0.2 per cent a year in recent years may result in a decline of 5 per cent a year in the 1990s. Major producers include Bayer, BASF, Rohm and Haas, Rhône-Poulenc and Du Pont;

(c) Inorganics. Elemental sulphur is a large-selling product, as are copper-based fungicides, and have sales of $600 million. However, their market growth can be considered limited because of associated toxicity problems.

(iv) Other fine chemical applications

The rest of the market for fine chemicals consists of a diverse range of product areas, including electronics, food chemicals, research, cosmetics, and photographic chemicals. An indication of the relative importance of these market areas is given table IV.44, which applies only to the United States and reflects demand for fine chemicals in some key product applications.

Table IV.44. Application areas for fine chemicals in the United States, 1980, 1991 and forecast for 1996
(Million dollars)

Type of chemicals	1980	1991	Forecasts for 1996
Electronic	753	2 125	2 660
Food based	294	1 530	1 955
Research	601	1 225	1 515
Photographic	479	1 145	1 485
Cosmetic	369	735	990
Pharmaceutical (fine)	1 791	3 945	5 000
Pesticide	497	820	930
General industrial	2 877	5 890	7 765
Total	7 661	17 415	22 300

Source: Freedonia Consulting Group, *Study on World Industry in Fine Chemicals* (Cleveland, Ohio, 1992).

In the area of electronics, the production of integrated circuits, semiconductors and related devices is likely to be a fast-growing chemical sector in the 1990s. Manufacture of these products requires the use of several types of fine chemicals including substrate and plating chemicals and high-purity gases [30]. Another important application area in electronics concerns advanced ceramics which are used when adding layers of material to a metal substrate in order to influence the electrical and chemical properties of an integrated circuit. These ceramic compounds, one of the relatively few types of material in the fine chemicals world which are inorganic as opposed to organic or carbon-based, involve a number of complex compounds based on materials including zirconia, alumina, silica and beryllium.

The cosmetics industry employs fine chemicals in the production of items such as toothpaste, fragrances, deodorants, soaps and shampoos. Often these materials can offer key properties important to the commercial success of the product, such as the degree of lather, smell, smoothness or taste. Similar links with the world of "consumer tastes" are evident in product areas involving food and drinks, where fine chemicals can act as flavourings, acidulents, emulsifiers, vitamins, sugar or fat substitutes and preservatives. A key aspect is that many relatively new fine chemicals will be required to fit in with trends in consumer preferences in developed countries. These include producing foods that offer fewer calories, that last for relatively long periods on the shelves of supermarkets without deteriorating, and that fit in with the increasing consciousness about healthy eating.

There are also uses for fine chemicals in the research world, for example as blood substitutes and catalysts in medical diagnosis systems.

6. *Short- and medium-term outlook*

Several important strategic issues confront the future of the fine chemicals industry. NICs including China and India are starting to enter the sector, mostly offering large-volume simple molecules and competing mainly in price. These countries are starting to commercially threaten some fine chemicals producers in developed market economies in particular product areas [32]. Another issue is the general world economic slow-down at the beginning of the 1990s, which is dampening growth prospects in some of the commercial application areas for fine chemicals. In addition, the rate of innovation in fine chemicals from both a product and process point of view is starting to decline. This factor could hamper the industry later in the 1990s [31].

However, some technological challenges that lie ahead could be wholly positive for the growth of the industry. Biotechnology is starting to make an impact in the industry, by presenting new possibilities for products and also by making some production processes more efficient. Also, there are opportunities to capitalize on the relatively new "optical active" or chiral compounds, which offer specific chemical and physical properties, and which can be used in areas such as medicine and crop protection.

For existing producers of fine chemicals, one of the important issues ahead concerns maintaining some form of competitive advantage, given the greater degree of commercial risk that may occur in the 1990s [27]. For those companies seeking entry into the industry (most usually from a position of strength in the bulk chemicals sector), the main challenge is how to choose the correct segment of the industry from a process and product point of view, and how best to confront the stiff competitive challenge of existing companies.

G. Higher-value-added steel (parts of ISIC 3710 and 3819)*

1. *Recent trends and current conditions*

At first sight, a drop in world crude steel output of just 3 per cent in 1992 compared with 1991 would not appear to be substantial. However, in commercial terms, 1992 was widely acknowledged as being one of the worst years for steel makers, with most experiencing a huge decline in profits, and many reporting losses. The general explanation for this is that while volumes (tonnages) were adequate, prices were far from being so. The degree of overcapacity in the EEC at the beginning of 1993 was estimated at 30 million tonnes of crude steel capacity and 20 million tonnes of rolled steel capacity. In Eastern Europe and the former USSR, different authorities have suggested figures as diverse as 20 to 50 per cent overcapacity. These excess capacities have put pressure on steel makers in regions such as China, South-East Asia and Western Asia to export to the few undersupplied regions in the world. Although Japan remains the biggest net exporter of steel, lower prices have caused profits to fall.

The year 1993 was one in which all the efficiency gains made during the late 1970s and 1980s to combat the far-reaching effects of the oil price shocks and the subsequent trade changes proved to be insufficient to cope with a new global recession in developed countries. Previous rationalizations and cost-cutting, closure of outdated plant and reduction of workforces were inadequate to deal with yet another steel market crisis. In developed countries, firms merged or went into receivership or out of business, as no further belt-tightening could be achieved.

2. *Regional adjustments in crude steel*

Steel production in the 11 newly independent States of the former USSR, when combined, remains the world's largest, despite yet another large annual reduction in output. As shown in table IV.45, despite a 16.3 per cent decline since 1991, it is estimated that over 111 million tonnes of steel were produced. As recently as 1988, production peaked at 163 million tonnes, hence the 1992 figure represents a staggering reduction of 32 per cent. Even taking into account the recession, such declines reflect the huge excess capacity and inefficiency that prevailed in steel plants and their consuming industries under the previous regime. If the States were to be listed separately, then estimates suggest that the Russian Federation would account for between 65 and 70 million tonnes, Ukraine for 35 to 40 million tonnes, and Kazakhstan for around 5 million tonnes. This would place the Russian Federation in fourth place, ahead of Germany, with Ukraine probably just after Germany. Figure IV.20 shows the relative market shares of major producing countries.

Despite a 10.5 per cent decline in output in Japan, it is still the dominant steel-making country, a position it is likely to retain for some time to come. Government plans to revive the domestic economy through public infrastructure expenditure should have already improved steel demand, but in March of 1993 industry leaders again called on the Government to take further steps. On the other hand, it may only be a matter of a few years before China takes the top position, leap-frogging the United States on the way. China's 13 per cent increase in output from the previous year was the biggest of any of the significant producers, and plans are well under way to build at least two new greenfield steel plants.

In Europe, the EEC had an unsatisfactory year with reductions in output being the norm. Germany, the market leader, experienced a 5.7 per cent drop from its 42.2 million tonnes of output in 1991, which included the output of the former German Democratic Republic; it

*UNIDO acknowledges the contribution of Brian Cooper, Editor, *Steel Times International*, FMJ International Publications Ltd.

Table IV.45. Major world steel producers, 1985-1992
(Million tonnes)

Economic grouping, region, country or area	1985	1986	1987	1988	1989	1990	1991	1992[a]	Percentage change 1991-1992
Former USSR	154.7	160.5	161.9	163.0	150.1	154.4	132.8	111.2[b]	-16.3
Japan	105.3	98.3	98.5	105.7	107.9	110.3	109.6	98.1	-10.5
United States	80.1	74.0	80.9	90.7	88.8	89.7	79.7	83.2	4.3
China	46.8	52.2	56.3	59.4	61.6	66.3	71.0	80.2[c]	13.0
Germany	40.5	37.1	36.2	41.0	41.1	38.4	42.2	39.8[d]	-5.7
Republic of Korea	13.5	14.6	16.8	19.1	21.9	23.1	26.0	27.8	7.1
Italy	23.9	22.9	22.9	23.8	25.2	25.5	25.1	24.8	-1.3
Brazil	20.5	21.2	22.2	24.7	25.1	20.6	22.6	23.9	5.7
India	11.9	12.2	13.1	14.3	14.6	15.0	17.1	18.1	5.8
France	18.8	17.9	17.7	19.1	19.3	19.0	18.4	18.0	-2.6
United Kingdom	15.7	14.7	17.4	19.0	18.7	17.8	16.5	16.1	-2.6
Canada	14.6	14.1	14.7	14.9	15.5	12.3	13.0	13.9	7.2
Spain	14.2	11.9	11.7	11.9	12.8	12.9	12.9	12.6	-2.5
Czechoslovakia	15.0	15.1	15.4	15.4	15.5	14.9	12.1	10.9	-9.6
Taiwan Province	5.2	5.5	5.8	8.3	9.0	9.7	11.0	10.8	-1.5
Belgium	10.7	9.7	9.8	11.2	10.9	11.4	11.3	10.3	-8.8
Turkey	4.9	5.9	7.0	8.0	7.8	9.3	9.3	10.2	9.6
Poland	16.1	17.1	17.1	16.9	15.1	13.6	10.4	9.9[e]	-5.1
South Africa	8.5	8.9	9.0	8.8	9.3	8.6	9.4	9.2	-2.2
Mexico	7.4	7.2	7.6	7.8	7.9	8.7	7.9	8.4[c]	5.9
Democratic People's Republic of Korea	6.5	6.6	6.7	6.8	6.9	7.0	7.0	7.0[b]	-
Australia	6.6	6.7	6.1	6.4	6.7	6.7	6.1	6.9	11.8
Netherlands	5.5	5.3	5.1	5.5	5.7	5.4	5.2	5.4	4.8
Romania	13.8	14.3	15.0	14.3	14.4	9.8	7.1	5.3[c]	-25.1
Sweden	4.8	4.7	4.6	4.8	4.7	4.5	4.3	4.4	2.5
Austria	4.7	4.3	4.3	4.6	4.7	4.3	4.2	3.9	-5.7
Venezuela	3.1	3.4	3.7	3.6	3.2	3.0	3.1	3.4[c]	7.9
Indonesia	1.4	1.7	2.1	2.1	2.4	2.9	3.0	3.1[b]	3.3
Finland	2.5	2.6	2.7	2.8	2.9	2.9	2.9	3.1	6.5
Luxembourg	3.9	3.7	3.3	3.7	3.7	3.6	3.4	3.1	-9.2
Iran (Islamic Republic of)	0.8	0.8	0.8	1.0	1.1	1.4	2.2	2.9	33.3
Argentina	2.9	3.2	3.6	3.7	3.9	3.7	3.0	2.7[e]	-10.3
Egypt	1.0	1.0	1.4	2.0	2.1	2.2	2.6	2.5	-1.7
Saudi Arabia	1.1	1.1	1.4	1.6	1.8	1.8	1.8	1.9	4.7
Hungary	3.6	3.7	3.6	3.6	3.3	2.8	1.9	1.6[c]	-16.4
Others	28.3	29.2	30.0	30.9	30.4	26.4	19.8	19.7	-0.5
TOTAL	718.9	713.5	736.5	780.1	786.0	770.0	735.9	714.3	-3.0

Source: International Iron and Steel Institute, Brussels, press release, 19 January 1993.

a/ Provisional.

b/ Estimate.

c/ Estimate based on 11 months.

d/ Including the former German Democratic Republic in 1991 and 1992 only. Data for other years are those of the Federal Republic of Germany.

e/ Estimate based on 10 months.

also suffered the most spectacular of the European rationalizations with the merging of Krupp and Hoesch, and the bankruptcy of Klöckner and Saarstahl. Belgium and Luxembourg, which rely heavily on exports, both suffered reductions of around 9 per cent.

The Braun Plan approved by the EEC in 1993 recommended a cutback in crude steel capacity of 30 million tonnes, and of 20 million tonnes in rolled steel products. This was to be financed by a certain amount of EEC funding supported by an equal amount from participating Governments, but the amount proposed by the Braun Plan far exceeded that which would have been made available through this mechanism. The EEC shied away from a suggested published price list for steel in an attempt to support prices. However, it was generally agreed that some control over the import of steel from Eastern European countries would be imposed until 1995, although certain countries had already made unilateral restrictions of their own.

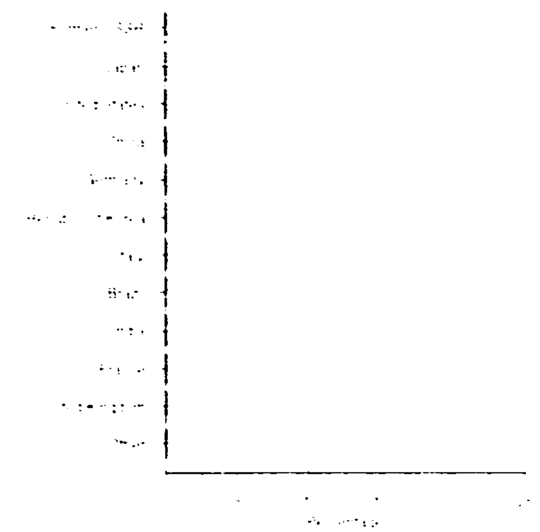
Non-EEC Europe fared slightly better, with only Austria experiencing a reduction as a result of its economic circumstances. The territory of the former Yugoslavia suffered dramatically from its internal problems, with Croatia and Slovenia not included in the 1992 statistics.

Output in the United States actually showed a 4.3 per cent increase, but this was largely due to the further growth of the minimill sector, while the major integrated plants experienced severe market competition both from the domestic minimills and from imports. The Government of the United States, having failed to reach a multilateral steel agreement to control imports, imposed tariffs on certain imports early in 1993.

Of the other developed countries, Australia was able to benefit from more buoyant demand in South-East

Asia, and increased output to 1991 pre-recession levels, but margins remained small on both exports and home market steel. Canada also saw a respectable 7.1 per cent growth, but this was compared to a very poor showing in 1991.

Figure IV.20. World market shares of the major steel-producing countries, 1992



Countries of Eastern Europe managed to achieve more penetration into the markets of OECD, causing disruption in the importing countries, but internal reordering still spelled reductions in output which are likely to continue for a few more years, as the readjustment to free market economies gains momentum.

A comparison of the production of crude steel in developing and developed countries appears in table IV.46. In Latin America, an overall growth in output of 5.1 per cent is largely accounted for by the dominance of Brazil, where output was up by 5.7 per cent to 23.9 million tonnes, although consumption showed a 6.6 per cent decrease. This is explained by a 10.1 per cent growth in exports to 12 million tonnes. Latin American steel exports represent 10 per cent of total international steel trade.

The Republic of Korea continued to produce more steel, up 7.1 per cent on 1991, although the growth rate is down from the levels of the middle to late 1980s.

India continues to grow steadily, but unspectacularly, although the promise of accelerated growth has been made possible by the lifting of government restrictions on integrated steel plant ownership. Private investors may now build and operate integrated steel plants, and at least one project is being considered. The control of steel prices has also been removed, as have punitive tariffs on imported raw materials and capital plant.

Western Asia is likely to become a potential growth area for steel production. The Islamic Republic of Iran experienced a 34.5 per cent increase in crude steel output in 1992, and new facilities were commissioned in Saudi Arabia and the Islamic Republic of Iran. Also, the Syrian Arab Republic has announced its first minimill-steel plants.

Table IV.46. World production of crude steel, 1985-1992
(Million tonnes)

Economic grouping region or country	1985	1986	1987	1988	1989	1990	1991	1992	Percentage change 1991-1992
Developed countries[a] of which	374.2	351.9	360.9	391.3	395.3	391.1	380.5	369.5	-2.9
EEC (12)[b]	136.6	125.7	126.5	137.8	140.1	136.8	137.4	132.5	-3.6
United States	80.1	74.0	80.9	90.7	88.8	89.7	79.7	83.2	4.4
Japan	105.3	98.3	98.5	105.7	107.9	110.3	109.6	98.1	-10.5
Developing countries[c]	76.8	81.6	87.8	97.9	102.6	102.0	111.2	116.9	5.1
Total market economies[d]	451.0	432.6	448.6	489.2	498.0	493.1	491.7	486.4	-1.1
Economies in transition[e]	214.1	221.8	224.4	224.3	219.2	203.3	165.9	140.3	-15.4
China and centrally planned Asia	53.7	59.2	63.4	66.6	68.8	73.6	78.2	87.4	11.8
World	718.9	713.5	736.5	780.1	786.0	770.0	735.8	714.1	-2.9

Source: International Iron and Steel Institute, Brussels, press release, 19 January 1993.

Note: In 1992, the 48 member countries of the IISI produced 506 million tonnes of crude steel, equivalent to 70.9 per cent of total world crude steel production.

[a] Developed countries comprise Western Europe, Canada, the United States, Japan, South Africa and New Zealand.

[b] Including the former German Democratic Republic in 1991 and 1992 only.

[c] Developing countries comprise Africa (excluding South Africa), Asia (excluding China and other Asian centrally planned economies and Japan) and Latin America.

[d] Total market economies exclude the former USSR and the countries of Eastern Europe, China and other centrally planned economies.

[e] Economies in transition comprise the former USSR and the countries of Eastern Europe.

3. *Increasing trade in higher-value-added products*

(a) *Changing nature of products*

Steel has an image problem which has a negative effect on its popularity as a material. While production processes in developed countries have improved environmentally, following two decades of applying pollution-control technologies and new clean steel-making processes, there are still many locations where steel-making poses a major environmental problem. In States of the former USSR (particularly Kazakhstan, Russian Federation and Ukraine), in the former centrally planned economies of Eastern Europe, in China and, to a lesser extent, India and Latin America, the pollution problems of iron- and steel-making have not been fully addressed. The reality of an environmentally unfriendly industry persists and continues to damage the image of steel itself. Even in countries that have cleaned up their production processes, steel has a long way to go to achieve a better image, and this problem is currently being addressed by bodies such as the International Iron and Steel Institute at Brussels [35]. Steel competes with many other materials in a wide variety of industries, the most notable being construction, automotive parts, packaging and electrical appliances, industries in which concrete, plastics, aluminium and composites are all fighting for market shares, in many cases with deserved success.

To maintain the usability of steel, the industry is thus developing the new steels required to produce improved consumer goods such as cars and washing-machines. This trend has become increasingly visible over the past decade, particularly in developed countries, as steel makers compete with alternative materials and with other steel makers to meet more sophisticated consumer needs. In developing countries the need is not so severe, demands on steel makers are not so high, and the requirement for more basic products is being met by less sophisticated production processes. In developed countries, the increasing production of improved steels has been due to the efforts of the leading steel makers.

During the 1950s and 1960s, steel makers produced more or less their own production requirements, dictating conditions on the market. If customers wanted something special, little attention was given to them. The oil shocks of the 1970s, followed by the environmentally aware 1980s, introduced a hitherto unknown level of competition which transformed the steel industry from a complacent and largely old-fashioned smokestack industry into an efficient and market-aware industry. In short, it changed from a production-led sector to a market-led one, and despite the trauma of rationalizations that occurred throughout Europe and North America, it was definitely for the better.

Steel-making companies started paying attention to customer needs and working with them to develop materials that would be needed for the next generation of products. Recent changes in the output of major steel-producing companies are given in table IV.47. This new attitude has resulted in the production of steels that are to all intents and purposes new or "advanced materials". Steel, being an alloy of iron and other elements, can be transformed according to an almost infinite different number of "recipes", all with different properties. And those properties can also be tailored by the metallurgy of the production process. Properties of steel can be custom-designed to meet a wide range of needs, giving it remarkable flexibility and attractiveness as a material. And steel is completely recyclable; this has become an increasingly important factor as manufacturers of consumer durables are having to take on responsibility for the total life cycle of their products.

Because of the extraordinary range of steel grades, forms and products, no attempt will be made in the present survey to consider them all. Instead, the focus will be on those recent developments which qualify as higher-value-added steels for applications in thermal power generation, automobile manufacturing, electric appliance manufacturing, construction, electricity supply, oil and gas extraction and packaging. An idea of the range of these products can be obtained from table IV.48.

(b) *Thermal power generation*

High-temperature strength, pressure resistance and corrosion resistance are prerequisites for steels used in thermal power generation. Stainless steel comprises a range of highly alloyed steel grades, all having chromium as the main alloying constituent. Though stainless steel itself is not a recently developed material, new grades are continually being developed.

To some extent stainless steel consumption remains an enigma. Over the last 15 years annual cumulative growth in consumption for the 20 main developed countries was 5.8 per cent. In 1950, consumption was a mere 1 million tonnes, but by 1990 had grown to 8 million tonnes. The enigma is twofold. Stainless steel has been less affected by recessionary forces than carbon steel, and the per capita consumption varies dramatically in comparable economies. In 1990, annual per capita consumption of stainless steel in Japan was 17.3 kilograms, while the European average was only 7.75 kilograms and that of the United States was less than 6.4 kilograms. Meanwhile, annual per capita consumption of 15.9 kilograms in Taiwan Province and of 10.45 kilograms in the Republic of Korea suggests that NICs can support high consumption rates for stainless steel.

In Europe, Germany leads the way with a rate of 11.8 kilograms; Italy is close behind with 10 kilograms, and has the fastest growth rate in Europe. The large discrepancies in consumption, supported by market research, indicate that stainless steel has a huge potential. Why it has not been taken up more widely is open to conjecture. Life-cycle costing has shown in many applications that stainless steel is superior.

For thermal power generation plants the conventional pressure resistance requirement at high temperature has been 24 megapascals and 566° C for boiler tubes. Ultrasupercritical-pressure power generation systems are being developed to improve generation efficiency with steels capable of handling 31 megapascals at 593° C being produced, and steels able to operate at 34 megapascals and 650° C are under development.

Conventional austenitic stainless steels are based on the 18-8 formula (percentages of chrome and nickel), but their temperature operating range has been expanded by the addition of small amounts of further alloying elements. The 15-15 series has a stabilized austenitic composition and high-temperature strength enhanced by other alloy additions, and the 20-25 chrome and 20-35 nickel series of stainless steels with greatly enhanced

Table IV.47. Output of major steel-producing companies, 1991-1992
(Million tonnes)

Company and country or area	1991 Rank	1991 Output	1992 Rank	1992 Output
Nippon Steel (Japan)	1	28.63	1	25.10
Usinor Sacilor (France)	2	22.80	2	21.10
Posco (Republic of Korea)	3	19.09	3	20.01
British Steel (United Kingdom)	4	12.94	4	12.39
NKK (Japan)	5	12.45	5	10.89
Ilva (Italy)	7	11.00	6	10.60
Thyssen (Germany)	6	11.13	7	10.13
Kawasaki (Japan)	8	10.91	8	10.00
Sumitomo Metal (Japan)	9	10.90	9	9.97
Sail (India)	11	9.38	10	9.70
Bethlehem (United States)	12	9.09	11	9.57
USS (United States)	10	9.55	12	9.47
Iscor (South Africa)	13	7.59	13	7.74
LTV Steel (United States)	14	6.94	14	7.52
BHP (Australia)	17	5.72	15	6.68
China Steel (Taiwan Province)	16	5.86	16	6.25
Kobe Steel (Japan)	15	6.50	17	5.75
National Steel (United States)	19	4.76	18	4.88
Hoogovens (Netherlands)	18	4.94	19	4.85
CSN (Brazil)	34	3.52	20	4.36
Cockerill Sambre (Belgium)	20	4.43	21	4.35
Inland (United States)	21	4.24	22	4.30
Stalco (Canada)	38	3.36	23	4.25
Nucor (United States)	31	3.82	24	4.22
Hoesch (Germany)	22	4.19	25	4.18
Huta Katowice (Poland)	32	3.69	25	4.18
Preussag Stahl (Germany)	23	4.14	27	4.09
Usiminas (Brazil)	24	4.13	28	4.03
Tokyo Steel (Japan)	33	3.66	29	3.95
Riva[a/] (Italy)	36	3.50	30	3.90
Voest Alpine (Austria)	25	4.11	31	3.77
VSZ Kosice (Czechoslovakia)	29	3.90	32	3.60
Ensidesa (Spain)	26	4.06	33	3.49
Dofasco (Canada)	34	3.52	34	3.42
HKM (Germany)	30	3.84	35	3.41
Nisshin Steel (Japan)	37	3.47	36	3.37
Klöckner (Germany)	39	3.35	37	3.25
CST (Brazil)	40	3.30	38	3.18
Sidmar (Belgium)	26	3.93	39	3.15
Nova Hut Kuncice (Czechoslovakia)	42	3.10	40	3.11
Arbed (Luxembourg)	40	3.30	41	3.10
Armco Steel LP (United States)	45	2.80	42	3.08[a/]
SSAB (Sweden)	43	2.96	43	2.96
Cosipa (Brazil)	47	2.76	43	2.96
Nisco (Iran, Islamic Republic of)	59	2.20	45	2.94
Sidex SA (Romania)	27	4.00	46	2.91
Krupp Stahl (Germany)	44	2.90	47	2.74
Sidor (Venezuela)	45	2.80	48	2.67
Gerdau (Brazil)	60	2.10	49	2.65
Ahmsa (Mexico)	48	2.66	50	2.55
Rouger Steel (United States)	58	2.23	50	2.55
Tata Iron and Steel (India)	52	2.40	52	2.49
Inonon Iron and Steel (Republic of Korea)	66	1.90	52	2.49
TDCI (Turkey)	49	2.48	54	2.43
Trinecke Zelezamy (Czechoslovakia)	51	2.47	55	2.36
Toa Steel (Japan)	56	2.30	56	2.31
Weirton (United States)	60	2.10	57	2.26
North Star (United States)	55	2.32	58	2.19
Huta Sendzimira (Poland)	53	2.38	59	2.13
Acominas (Brazil)	62	2.09	59	2.13
Wheeling-Pittsburgh (United States)	63	2.02	59	2.13
Co-Steel (Canada)	64	1.95	62	2.12
Nakayama Steel (Japan)	57	2.29	63	2.11
Rautaruuki (Finland)	49	2.48	64	2.09

Source: *Metal Bulletin*, 11 February 1993, p. 21.

Note: Country shown is the country of origin of the company; output figures may include company plants elsewhere.

[a/] Estimate.

Table IV.48. Higher-value-added steel products

Type of steel	Description and applications
Stainless steel	Severe corrosive environments - process plant, thermal power stations, vehicle exhaust systems Decorative end-use with corrosion-resistant requirement - rail and road vehicles, catering equipment, constructional
Engineering steel	Engine and automotive transmission components, aerospace, general engineering, machine tools
Tool steel	Manual and automated tools; high hardenability
High-strength low-alloy steel	Automobile outer panels
Super-deep-drawing grades	Complex automotive applications requiring high ductility, can-making
Bake hardenable	Automobile outer panels where heat curing paint systems are used
Coated steel	Metallic - automotive, construction Organic - automotive, construction, appliances Tin-plate packaging Tin-free packaging
High-yield strength at elevated temperature	Fire-resistant constructional long products - beams, columns
Ultra-clean steel	Extra-deep-drawing applications, low-temperature welding applications, sour gas (oil-country-tubular-goods) applications
Constant-web-height beams	Constructional and building
Electrical steels, high-silicon	Electrical transformers and motors
High-strength bar	Impact resistance in automobiles
Vibration-damped	Alloy - shipbuilding, appliances, automobiles Sandwich - automotive, construction materials, such as roofs
Clad steel	Plate and tube - for improved economy in corrosive environments, where the corrosion resistance of stainless steel is required, and a substrate of carbon steel provides the strength.

Source: Steel Times International, London, 1993.

high-temperature strength reach beyond ferrous categorization because of their high non-ferrous content.

The cost and price fluctuations of nickel have stimulated the development of lean alloy stainless steels, typified by the 9-12 chrome series of heat-resisting ferritic grades, containing no nickel, and martensitic stainless steels with less then 1 per cent of nickel. These can offer corrosion resistance comparable or superior to austenitic steels in most environments, and are 200 times superior to mild steel in respect of corrosion resistance. These steels are referred to as lean alloy dual phase. The 9 chrome-1 molybdenum and low-carbon 9 chrome-2 molybdenum steels are examples, and additional carbide-forming elements such as vanadium and niobium have been used to enhance high-temperature strength. However, product development is being focused on the range of 12 per cent chrome grades for superior corrosion resistance at elevated temperatures. Where corrosion conditions are very high, such as in coal combustion boilers, excellent corrosion resistance can be achieved without excessive use of alloying elements by using chromized or clad pipes. Chromized pipes have a chrome-rich layer diffused into the inside and outside surfaces, while clad pipes have a layer of stainless steel metallurgically bonded onto the surface. The advantage of this system is that it can combine an inner layer of high temperature strength with a highly corrosion-resistant outer layer.

Flue gas desulphurization of oil- and coal-fired power stations has become a crucial issue, as this effluent has been identified as the major source of acid rain. Consequently, flue gas desulphurization equipment is being retrofitted onto existing plants, and new generating plants must have such environmental protection measures designed in from the outset. The highly corrosive nature of flue gas means that stainless steel is the only answer for systems whose costs are measured over the product life cycle.

(c) *Automotive applications*

Automobiles represent one of the most visible examples of the challenge to steel arising from alternative materials. The main driving force has been weight reduction to achieve reduced fuel consumption and hence lower running costs and environmental impact. Corrosion resistance is a battle which has been largely won, thanks to the development and use of coated steels.

To automobile manufacturers, both plastics and aluminium are obvious alternatives to obtain weight reduction in structure and body panels, but there is no real competition with engineering steels for power train and mechanical components. Recyclability is a major factor favouring the use of steels as the professional dismantling of "time-expired" cars becomes more commonplace in developed countries. Predictions for the future choice of materials' for automobiles show a gradual reduction in weight for ferrous materials, but not a reduction in application, because of improvements in steel properties allowing less material to be used for the same function. Today, steel comprises around 73 per cent of the gross weight of a car body.

Forecasts made just a few years ago predicted rapid reductions in steel usage as plastics and aluminium gained ground, but expanded research and development in steel-making has generated new products to meet their challenge. Led by Japan, a new supplier-customer relationship has been established between steel makers and car manufacturers, which has enabled expected needs for materials to be addressed by both parties working in concert on product development.

For car body panels a balance has to be found between high-yield strength, stiffness, deep-drawing properties and thickness (reflecting weight). Outside body panels require high-yield strength for dent resistance, although problems with surface deflections probably limit the maximum to 240 newtons per square millimetre (N/mm^2). Super-deep-drawing qualities can be achieved by ultra-low-carbon content, and the controlled addition of phosphorus provides the appropriate solute carbon for bake hardenability. Body panels using this technology are highly formable for stamping, and are subsequently hardened by baking on the paint line, providing an additional 30-50 N/mm^2 after baking. The use of high-strength low-alloy ultra-low-carbon sheet for super-deep-drawing has also enabled the use of larger one-piece panels replacing welds and flange connections, where previously more than one panel was used.

For inside body panels and structural materials, the same problem does not exist with surface deflections; cold-rolled sheet with a yield strength of 340 to 440 N/mm^2 has thus been used. This is achieved by the addition of solid solution elements to control the microstructure through chemical metallurgy. Physical metallurgical techniques are used to further increase the strength and formability of cold-rolled sheets with high levels of retained austenite, by continuous annealing to improve formability and subsequently to capitalize on the transformation of ductile austenite into higher-yield-strength martensite by plastic deformation during forming.

For chassis members, hot-rolled steel sheet, precipitation-hardened and solution-strengthened to 490 to 540 N/mm^2, has been used together with a dual-phase structure of fine ferrite and bainite. Thermomechanically controlled hot-rolling has enabled these steels to achieve tensile strengths of up to 780 N/mm^2.

Safety is always a major concern for car makers, and enhanced-strength reinforcing materials are required for use in bumper bars (fenders) and internal door guard bars. Cold-rolled, high-strength steel sheet with 980 N/mm^2 tensile strength have been used commercially, and a combination of steel chemistry and continuous annealing has enabled ultra-high strength of up to 1,470 N/mm^2 to be reached.

None of these properties would have been achieved without developments in production technology which have enabled the making of very low-residual clean steel with accurately controlled chemistry. By processing these steels through continuous casting, cleanliness has been maintained. Subsequent thermomechanically controlled hot-rolling and continuous annealing of cold-rolled strip has enabled physical metallurgy to achieve the desired qualities for the steels demanded.

Corrosion problems with motor car bodies is now more or less a thing of the past. It used to be that the body of a car would not last the lifetime of the mechanical components, but now the balance is more even. This is partially due to better-detailed panel design and painting systems, but more influential has been the use of galvanized steel sheet.

Traditional steel cladding material for buildings has been metamorphosed into a high-technology material for both external and internal body panels. The resulting finish is now suitable for cosmetic external use, where previously electrogalvanizing was the only route available to reach an adequate substrate for visible paintwork. Metallic coating can be done on one or both sides of the sheet, electrolytically or by dipping, and a range of coating alloys can be used. These are usually based on zinc, nickel and aluminium, and offer far greater corrosion protection than standard zinc galvanizing. Organically coated strip (painted) is used to a limited extent in automobile manufacture, but the problems associated with joining prepainted materials have restricted its use.

Corrosion remains a factor in exhaust systems (mufflers), and ferritic stainless steels can provide life-cycle economies. The introduction of environmental controls on exhaust emissions and the increasing use of catalytic converters on exhausts has changed the perception of the exhaust system from a disposable low-cost item to a higher-cost, long-life item which should last the lifetime of the car.

As steel lacks the noise-attenuation properties of plastics or aluminium, sound-proofing becomes necessary in motor cars. Ways to avoid this have been found with the development of vibration damping sheet. Since the 1960s, efforts have been made to impart damping qualities on steel sheet through the use of alloying, but the results have been too expensive for general use. The design characteristics required can be classified into dislocation, twinning, composite and ferromagnetic types, depending on the damping mechanism. For general use the ferromagnetic damping alloys based on an iron-aluminium-silicon composition would appear to have the best future, since costs can be kept lower, and their damping characteristics do not depend on temperature or frequency.

The other route to vibration damping is through resin-sandwiched sheets, which comprise a thin layer of visco-elastic resin between two thin steel sheets. Any vibration bends and deforms the entire steel sheet, and the resulting slip formation of the resin layer resists bending and deformation, reducing the vibration. These are formable, and the addition of metal powder to the resin has resulted in a weldable grade being available. In Japan, commercial lines now exist for the production of resin damped sheet, and one automotive application has been in engine oil sumps. As there is a temperature restriction on sandwich sheets, the choice between types of vibration damping technology depends on its application.

Although the ceramic engine now exists, it is still in the development stage. Ceramics are unlikely to replace engineering steels as a commercial proposition for most engine components. An interesting development for small and complex steel components has been the increasing use of powder metallurgy rather than casting or forging. Powder metallurgy offers densities and strengths approaching that of solid material, but without the expense of intricate machining. The resulting products have a consistent and repeatable structure, without the possibility of internal voids and flaws.

(d) Electrical appliance manufacturing

As discussed, the use of metallic coated steels in the automobile industry is widespread, whereas organic coil-coated (painted) sheet finds fewer applications. However, in the production of cabinets for electrical appliances, the use of prepainted sheet is widespread. The advantages to the manufacturer are obvious. It eliminates the need to have any painting facilities, thereby doing away with an environmentally hazardous operation. As cabinets are usually fastened by riveting or screwing, there is no welding operation to destroy the coating, and advances are being made in the use of thermosetting adhesives which result in a join as strong as spot welding. Coil-coated material can be press-formed without damaging the paint film, and it remains a very versatile material. New precoated sheets with linear polyester resin paints can even be folded double without damaging the film. There is an enormous range of colours and textures that can be applied by coil coating to satisfy not only the practical aspects of functionality, but also the aesthetic qualities required for domestic use.

Coil-coated material is also widely used for office equipment and furniture and in cladding panels and roofing for buildings. Coated steel for buildings has become particularly well established in Australia, and consequently BHP Steel has become a world leader in the supply of prepainted coil, both for domestic use and for export to East-Asian countries.

In Japan, the use of vibration-damped sheet in washing-machines is finding favour. Japanese households tend to be small, and washing-machines are usually installed in kitchens, where it is important that noise be kept to a minimum.

Electrical appliances usually include at least one electric motor for which a special range of so-called electrical steels, containing up to 6.5 per cent silicon, have been developed, divided into grain-oriented and non-grain-oriented types. For small electric motors, non-grain-oriented silicon steels of up to 3.5 per cent silicon are commonly used, providing high magnetic flux density with acceptable core loss. New steels are being developed to meet the high magnetic flux density required for torque characteristics, while reducing core losses through control of steel composition, higher purity and control of grain size and orientation. Eddy current losses, which comprise 70 per cent of total core loss, can be reduced by using thinner sheets, even as low as 0.2 millimetres thick. Lower core loss will be achieved through the production of even thinner sheets, but the silicon steels are hard to roll because of brittleness, and alternatives to conventional rolling are being sought. One approach is to cast thin strip directly, thereby reducing the need for finish rolling to a minimum. This technology is being applied to the production of stainless steel on a pilot scale, and is expected to go into commercial production in Japan.

(e) Construction

Steel has been vying with reinforced concrete as the prime building medium for high-rise buildings, and has met with considerable success in the United Kingdom, following a very active marketing campaign by British Steel. The construction boom of the 1980s saw steel take an increasing share of the market until it finally took over the leading position from reinforced concrete. While this trend has not been so apparent in other countries, steel makers all over the world have taken note of the United Kingdom success and are attempting to capitalize on the innovation. The current recession has obviously caused a spectacular reduction in building projects, but arguments for steel-framed buildings remain strong. Speed of erection is the main factor in favour of steel, keeping costs down during construction and enabling the building to become a revenue earner at an earlier date. For high-rise buildings, steel had previously suffered from its inability to maintain its strength at the elevated temperatures experienced during fires. It was looked upon as inherently unsafe. The making of steels with increased yield strength at elevated temperatures has helped to alleviate this problem, as has the design of structures themselves and improved fire-resistant, protective insulation.

Constructional steels for the inner structure in high-rise buildings are in the form of beams and sections. Large beams which were previously fabricated by welding are now being rolled integrally, and in Japan beams of fixed outer dimension have been introduced. This development makes construction much easier for the structural steelworker, since he does not have to accommodate beams of different overall height. This may seem a small and simple achievement, but for the beam-mill designer it has been a considerable challenge, due to the actual nature of beam-rolling technology.

Precoated steels are also widely used for exterior wall cladding panels and roofs in industrial buildings, and in some countries for domestic housing as well. The maintenance requirement for these materials are minimal, an important factor when making life-cycle costing estimates. Prepainting is always done onto metallic coated strip, so that even if the paint layer is damaged, corrosion resistance remains high. Base coatings of hot-dipped zinc-aluminium alloys are normal for high durability and corrosion resistance. Fluorine-containing resin paint maintains coating performance and discolouration resistance. Whereas the normal procedure today is for a two-coat, two-bake process, improved performance will be achieved by developing better paint qualities and applying three-coat, three-bake systems. As with electrical appliances, the range of finishes which can be applied is designed to satisfy all needs, to match the surroundings, or to draw attention to the building.

Stainless steel cladding is also being used on prestige buildings, and enjoys the advantage of complete freedom from maintenance, except perhaps for the occasional cleaning.

(f) Electricity supply

It has been estimated that the world consumes some 12 billion megawatt-hours of electricity annually. Small increments in generator efficiency would, therefore, have a considerable impact on costs. Even as the search for superconductivity at ambient temperatures proceeds, steel can still help to lower the cost of generator production.

Grain-oriented silicon steels are used in transformer cores and static electrical equipment. The size and orientation of the grains influence the magnetic performance, and hence core loss. Steel makers have been able to make grain-oriented sheet since the 1930s, when the technique was developed in the United States. This has improved vastly since its inception, in that the magnetic flux density has increased, thinner sheets have been produced, and by using laser irradiation to subdivide magnetic domains core loss has been reduced. It is recognized that steel containing 6.5 per cent silicon provides the best characteristics for core loss and magnetic permeability, but the brittleness of this material precludes the normal rolling procedure for production. Thin strip casting is one way around this problem, as mentioned above, but chemical vapour deposition has been shown to be a revolutionary way of siliconizing, after the sheet has been rolled to the required final thickness (down to 0.2 millimetres and below).

(g) Oil and gas production

The demand for steels which could cope with the extreme conditions experienced in the harsh environment of oil and gas extraction platforms in the North Sea, and in other extreme weather locations such as Alaska and Siberia, caused a flurry of steel development. Not only do oil-country-tubular-goods steels and offshore structural steels have to remain ductile and weldable at low temperatures, they need to have high-impact toughness at low temperatures; in the case of pipes and tubes, they must resist the acidic and sulphurous materials which are being extracted. The oil extraction industry, therefore, has been a major force in developing ultra-clean steels with very low levels of sulphur and other residuals.

Technologies widely adopted for making clean steels in bulk have previously been the domain of special orders only, but they have now been commonly adopted for bulk steel-making. These include: hot metal pretreatment to remove silicon, phosphorus and sulphur; slag-free tapping of arc furnaces and converters; secondary steel-making: stirring, temperature control, alloying and degassing; shrouded casting; and strand stirring during casting. Once clean steel is made, various physical metallurgical techniques are applied to reach the required tensile strength combined with toughness and weldability.

(h) Packaging

For the steel industry, packaging steels are usually associated with steel cans made of tin-plate. Although tin-plate accounts for barely 3 per cent of world steel production, steel cans are a widely used form of steel packaging. However, aluminium cans are becoming increasingly competitive. In fact, aluminium is the biggest rival of steel packaging. Following years of aggressive expansion, plastics materials now appear to have reached the limits of their capabilities in view of increased demands for recycling. Glass is restricted mainly to liquids and reopenable lid containers, and has an inherent breakage problem. The aluminium industry has been very active in marketing its material to the packaging industry with considerable success, and it has been gaining a share of the steel market. But recently, steel makers have begun to fight back by working closely with container makers to meet their needs and those of the end-user.

The arguments over the comparative degrees of recyclability of aluminium and steel are well aired and not entirely conclusive. Aluminium has a high level of latent energy since it takes considerable energy to extract aluminium from bauxite. Recycling this latent energy clearly makes sense, but recycling aluminium cans is more difficult than recycling steel ones, simply because steel cans can be magnetically separated, whereas aluminium needs to be manually selected, a job which usually relies on the consumer at a collection point.

Recyclability apart, the factors that affect the material choice are weight, cost, ease of forming, longevity, consumer appeal and ease of opening. Steel is fighting an active campaign on these fronts, and is currently doing well in the food market, but less well in beverages. Tin-plate is cold-rolled steel strip which is subsequently plated with tin and protected with an organic film of lacquer or plastics on the inside surface. The cost of tin has driven the development of the so-called "tin-free steel" which is a chromium-plated material, and it has also caused the use of ever thinner tin coatings. In 1970, a typical tin coating was 2.8 grams per square metre, whereas today the figure is less than 1 gram per square metre. Meanwhile the minimum tin-plate thickness has been reduced from 0.20 millimetres in 1970 to 0.14 millimetres today, a reduction of over 30 per cent in 20 years. Manufacturers today are aiming to reach 0.12 millimetres. These reductions have resulted in the weight of a two-piece beverage can (without the end) being reduced from 42 grams to 28 grams, or by almost 33 per cent. Current research is working on bringing this weight down to 19 grams, with a resultant wall thickness after drawing of only 0.05 millimetres.

Super-deep-drawing steels have enabled the development of the two-piece can, with the base and walls in one piece, and a separate top. This reduces the welding operations needed for the conventional three-piece can, and speeds up production. Two-piece cans can be painted with the final label design before forming, removing the need for separate paper labels.

Application of the lacquer or film laminate has been developed from a sheet process into a continuous coil process, greatly reducing costs and increasing flexibility of coating choice. The traditional can-opener could become redundant as peel-off tops are developed for food cans. Already the beverage can is universally opened without a tool, although most two-piece steel beverage cans have aluminium tops which are easier to manipulate. Recent research has led to the production of a steel easy-open top with two push-in buttons sealed on the inside with plastisol, and another company is working on a film-laminated, chromium-coated steel top of a high-tensile, deep-drawing quality which relies on scoring technology similar to that used for aluminium lids.

A further interesting development is the use of shallow trays for food packaging with peel-off, heat-sealed lids. Pet-food manufacturers were the first to use these containers, which are now being considered for human foods and ready meals. It has been shown that such trays can be used in microwave ovens; the potential for tin-plate in the packaging of ready-to-serve meals is thus an extremely interesting development.

The tin-plate industry needs these new ideas in order to expand. Although 13.7 million tonnes of tin-plate packaging was used worldwide in 1991 (of which 25 per cent was recycled), the predicted growth rate for the product is not more than 1 per cent per annum up to 1995. There will be growth areas in the world where this figure will be far exceeded, but overall growth in tonnage terms is restricted. However, with the drive for thinner gauges and lighter cans, tonnage is not the best parameter with which to measure the growth of steel in packaging. The figure which best reflects the true performance of tin-plate is surface area, but this is far less easily measured.

4. *Short- and medium-term outlook*

Forecasting production and consumption in the steel industry still involves much uncertainty. At the beginning of 1993 the trade restrictions being applied in the United States were still in a state of flux, and could have a major effect on import and export flows.

(a) North America

Improving economic conditions in the United States and Canada at the beginning of 1993 have been generally interpreted as reflecting the end of the global recession in developed countries. The anticipated consumption level of 99 million tonnes for 1993 should provide a benchmark for consumption to the year 2000 [36]. Stabilization at this level is considered to be the likeliest scenario.

(b) Europe

Consumption of steel products within the EEC in 1995 will maintain its trend with a value of 115 million tonnes, that is, about the same level as in 1990, which was quite a good year in the European steel market. In the second half of the decade, one source suggests that very slight growth will take the total to 117 million tonnes. Non-EEC countries of Western Europe comprise a relatively small percentage of overall steel production, although there are important producers and markets in Scandinavia. Consumption in this region was in the doldrums in early 1993, with little change expected in the short term.

The future of Eastern Europe and the former USSR is largely unknown and wide margins of error should be allowed for. Consumption at the beginning of the decade was estimated at around 150 million tonnes, and since then the fall has been dramatic. By 1995, it has been suggested that the worst should be over, and that a figure of 100 million tonnes might be sustained until the year 2000 [35].

(c) Japan

Despite government action on increasing infrastructure spending in Japan, major steel-producing companies are consolidating their iron and steel activities and looking for expansion in other areas. Steel-consuming industries in Japan are expected to decline as automotive transplants continue, and Japanese steel makers look overseas for joint-venture production opportunities. As a result, consumption is forecast to decline by about 0.7 per cent annually to around 85 million tonnes of products by the year 2000. The overall picture in developed countries is essentially stagnant till the end of the decade, apart from short-term fluctuations.

(d) Developing market economies

Latin America experienced a slight upturn at the beginning of 1993, although Brazil, the dominant economy in the region, failed to recover as hoped. However, consumption in the region is predicted to rise by around 4.6 per cent annually to around 35 million tonnes [36]. Developing Asia will also show growth to a level of 105 million tonnes by the end of the decade, with particular optimism in the South-East Asian countries of Indonesia, Malaysia, Philippines and Thailand.

Reconstruction and development in Western Asia, particularly in the Islamic Republic of Iran, should lead to increasing steel use in that region. Little change is forecast for Africa, and the political situation in South Africa is unlikely to spell growth for the economy.

Altogether, consumption in developing countries should grow quite strongly, by about 5 per cent per year to 1995, and then by 3.4 per cent per year to 2000 [36].

(e) China

Demand in mainland China should easily reach 80 million tonnes by the end of the decade, and the authorities hope that domestic production will reach that level at the same time. At the current rate of expansion this will possibly make China the second biggest steel-producing country in the world after Japan, and almost certainly the third after Japan and the United States.

In summary, total world steel consumption in 1995 will still be below the 1990 figure, mainly because of restructuring in the formerly centrally planned economies. But from 1995, an annual 1.1 per cent growth rate to the year 2000 should result in a global consumption figure of 686 million tonnes of finished steel products.

H. Advanced materials
(parts of ISIC 3513, 3610, 3620, 3710 and 3720)*

1. *Recent trends and current conditions*

The current global recession has generally restrained any increases in sales revenues for advanced materials in the past two years, except in the communications and computer industries. The monetary and industrial policies of the past decade for most countries in the North have adjusted to the recent economic downturn together with the end of the cold war. Developing countries in the South which export conventional raw materials also have experienced declining sales. In general, the potential exists to expand advanced materials sales in the automotive, aerospace, electronics, heavy equipment and machinery, and other materials-related industries.

(a) Nature of advanced materials

Just as there is no unified definition of advanced materials, there is no single, all-purpose classification.

*UNIDO acknowledges the contribution of Walter C. Labys, Professor of Resource Economics, West Virginia University.

Some advanced materials have also been termed structural materials, or in some cases engineered materials. Requirements for definitions and classifications must be tailored to specific purposes [37]. If the primary concern is materials availability, for example, the classification will be based on the commodity minerals used in manufacturing. If the concern is the actual or potential substitution of one material for another, the classification will be based on materials types, for example metals, polymers, ceramics and composites. Scientists and engineers may classify materials according to chemistry, properties or function. Industrial managers may be concerned with materials needs and developments in this industry or in market shares, and will develop appropriate classifications. Product manufacturers, on the other hand, may devise a classification based on processing technologies for which capabilities exist or may be developed.

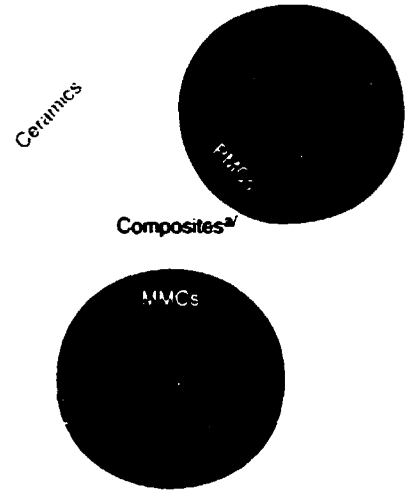
One approach to achieve unity among the above classifications, as shown in figure IV.21, reflects the fluidity existing among the basic materials types: ceramics, polymers and metals. Composites reflect a combination of two or more of these materials to obtain a raw material that has properties superior to those of its constituents [38]. As an example of how these properties can be modified, figure IV.22 compares the maximum use temperatures of three of these basic types. Organic materials such as polymers are shown to melt or char above 316° C; most refractory metals lose their useful strength above 1,038° C; ceramics, however, can retain their strength above 1,649° C and can be potentially useful up to 2,760° C. In applications such as heat engines and exchangers, in which efficiency increases with operating temperature, ceramics offer potential energy and cost savings due to simpler designs than would be possible with metals.

Figure IV.23 compares the "specific" strength and stiffness (per unit weight) of some advanced materials with those of conventional metals. The specific stiffness of aluminium can be increased by a factor of 3 by mixing the metal with 50 per cent by volume of silicon carbide fibre to form a metal matrix composite. Even more impressive are polymer matrix composites such as graphite fibre-reinforced epoxy (graphite/epoxy), which may have specific strengths and stiffness of up to four times that of steel and titanium (measured along the direction of fibre reinforcement). Such properties make it possible to build composite structures having the same strength and stiffness as metal structures, but with up to 50 per cent less weight, a major advantage in aircraft and space applications.

Although the above properties of ceramics and composites are impressive, the main advantages of advanced materials is that they are "tailored" materials, fabricated from constituents to obtain the properties required for a given application. The development of advanced materials has opened a whole new approach to engineering design. In the past, designers started with a material and selected discrete manufacturing processes which transformed it into the finished structure. Applying the new tailored materials, designers now start with final-performance requirements and literally create the necessary materials and structure in an integrated manufacturing process. Thus, with tailored materials, old concepts of materials, design and fabrication processes are merged with new ones of integrated design and manufacturing, and as a result, new materials can be categorized in the four groups described below.

Metals and alloys. Most advanced metals are structural materials, that is, materials used in human-made structures and machines primarily because of their mechanical properties. These are distinguished from magnetic, electrical and electronic, photonic, refractory, abrasive and other functional types of materials. They possess properties often superior to those of traditional met-

Figure IV.21. Classification of advanced materials

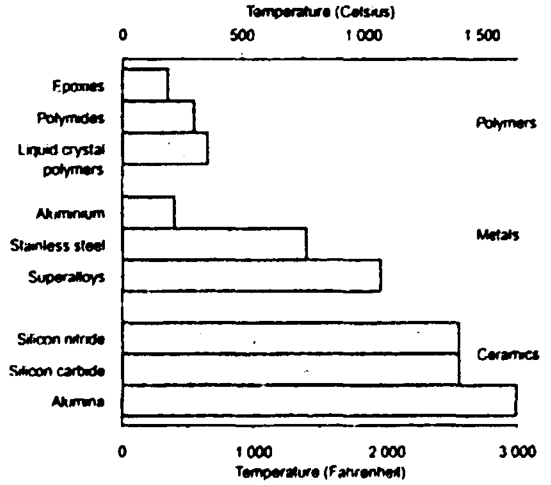


Key
CMCs = Ceramic matrix composites
PMCs = Polymer matrix composites
MMCs = Metal matrix composites

Note a Includes ceramics, polymers and metals. Reinforcements added to these materials produce ceramic matrix composites (CMCs), polymer matrix composites (PMCs) and metal matrix composites (MMCs).

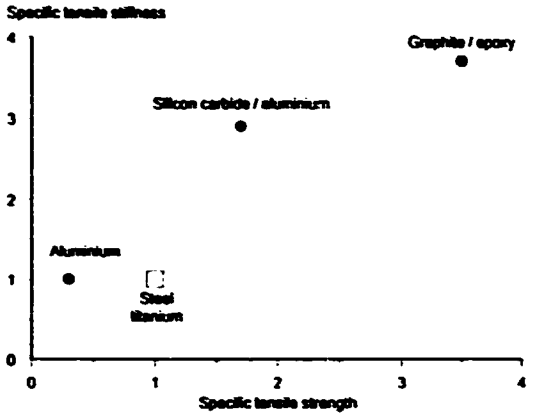
Source Office of Technology Assessment, Advanced Materials by Design, (Washington, D.C., Government Printing Office, 1988).

Figure IV.22. Maximum use temperatures of various structural materials



Source Bureau of Mines, *The New Materials Society* (Washington, D.C., Government Printing Office, 1991).

Figure IV.23. Comparison of the specific strength and stiffness of various composites and metals



Source: Bureau of Mines, *The New Materials Society* (Washington D.C., Government Printing Office, 1991).

als, such as strength at elevated temperatures, lightness, microstructural stability, and resistance to corrosion, to creep and to fatigue failure. The aerospace industry is by far the most important market for these metals. Metals which are of grave concern today are high-technology or special metals, that is, beryllium, gallium, germanium, niobium, platinum, titanium, zirconium and the rare earths. Also important are special alloys which constitute microstructural variants of conventional metals. Examples are amorphous metals produced by one of the rapid solidification techniques, metastable alloys produced by mechanical alloying, oxide-dispersion-strengthened metals produced by powder metallurgy, and directionally solidified alloys.

Ceramics. These materials encompass all solids that are neither organic nor metallic and are important for electronic, optical and magnetic devices. They are formulated from earth materials, formed into useful shapes, and transformed into solid bodies using heat-emerge. Compared with metals, ceramics possess superior wear resistance, high-temperature strength and chemical stability; they also generally have lower thermal conductivity, thermal expansion, and lower toughness, that is, a tendency towards brittleness. Conventional ceramics, such as refractors, glass, brick, abrasives, porcelain, enamels and pigments have been in use for some time; so have structural ceramics. New advanced structural ceramics include alumina, silicon carbide, silicon nitride, sialons (Si_3N_4-AL_2O_3 compounds), boron carbide and boron nitride.

Polymers. Though plastics such as polyethylene, polypropylene, polystyrene and polyvinyl chloride have constituted a major industry for many years, and fibre glass-reinforced plastics have found broad applications, a new class of polymeric materials with exceptional strength and heat resistance is emerging and being increasingly used in automotive, aircraft and many other applications, replacing metals. These materials are classified as "engineering polymers" and "performance polymers". Among the former are polyphenylene oxide, polybutylene terephthalate, polyethylene terephthalate, polyacetal, polycarbonate, and alloys and blends of these polymers. Among the new performance polymers (with decomposition or glass transition temperatures as high as 275° C), are fluoropolymers, polyamide, polyamide-imide, polyarylate, polyetheretherketone, polyetherimide, polyethersulphone, polyphenylenesulphide and polysuphone. These materials, which are reinforced with a variety of fibres, are being applied to both exterior and interior components of aircraft, evaluated for use in automobiles to replace sheet steel in the body, and considered for structural components.

Composites. These materials generally consist of fibrous or particulate reinforcements held together by a common matrix. Continuous fibre reinforcement enhances the structural properties of the composite far more than particles do. However, fibre-reinforced composites are more expensive and difficult to fabricate. Composites are classified according to their matrix phase. Thus, there are ceramic matrix composites, polymer matrix composites, carbon fibre or carbon-carbon composites and metal matrix composites. Ceramic matrix composites contain dispersed ceramic particulates and whiskers, or continuous fibres used principally for toughening ceramics. Another type involves the application of a thin ceramic coating to a metal substrate; this yields a component with surface properties of a ceramic combined with the high toughness of metal in the bulk. Polymer matrix composites consist of high-strength, short or continuous fibres held together by a common organic matrix. The composite is designed so that the mechanical loads which the structure is subjected to in service are supported by the fibre reinforcements. Polymer matrix composites are often divided into two categories: "reinforced plastics" and "advanced composites." The distinction is based on the level of mechanical properties (usually strength and stiffness); however, there is no clear-cut separation. Among advanced composites, carbon fibre composites employ carbon fibres as the reinforcing component in a number of organic or inorganic carbon matrices. Combinations of carbon matrix and carbon fibre make carbon-carbon composites attractive, because of low density, high strength, high stiffness and superior thermal properties (such as high-temperature stability in a non-oxidizing atmosphere). Metal matrix composites usually consist of a low-density metal, such as aluminium or magnesium, reinforced with particulates or fibres of a ceramic material, such as silicon carbide or graphite.

Compared with unreinforced metals, metal matrix composites have a significantly greater stiffness and strength, as indicated in figure IV.23. However, these properties are obtained at the cost of lower ductility and toughness. Composites within these categories are often referred to as "advanced" if they exhibit properties such as high-temperature strength or high stiffness per unit weight, which are significantly better than those of more conventional structural materials, such as steel and aluminium.

(b) World production and consumption

The global value of all products made entirely or in part from advanced materials is estimated at $170 billion for advanced polymers, $90 billion for advanced metals, $35 billion for advanced carbon and $13 billion for advanced ceramics [37]. Such values are not uncommon, when considering the large size of the more important end-use markets. For instance, if metal matrix composites were used in automobile engines to make cars lighter and hence more fuel efficient, the worldwide market for metal matrix composites could reach billions of dollars.

Growth of advanced materials has been cited as adversely affecting the demand for some major metals; although the more important factor behind the recent slump in metals has been the global downturn [39]. With the recent recovery of growth in developed countries, the demand and prices of most metals (nickel, copper, aluminium etc.) have started to rise again. Whether this rise will continue in the long run depends on two factors in particular:

(a) One is a change in the kinds of products consumed. With the rise in the standard of living in developed countries, demand for consumer goods (household appliances, cars etc.) is becoming saturated. Since these goods possess a high conventional materials content (steel, aluminium, conventional alloys etc), the derived demand for the latter also is affected. The increased recycling of materials also reduces this derived demand;

(b) The other is a change in the materials used to produce output. The rise in basic materials prices after 1973 induced technological changes which have resulted in substantial savings on materials in manufacturing. The development and use of more efficient advanced materials also contribute to the process. This industrial transformation has been termed "transmaterialization", and refers to technological progress whereby production based on conventional minerals is being replaced by "high-technology" minerals and advanced materials [40]. Examples of this substitution process include greater use of plastics, thermoplastics and organic matrix composites in cars instead of steel, use of optic fibres in telephone cables instead of copper, and use of aluminium-lithium alloys instead of conventional alloys in aircraft manufacturing.

At present, however, the scale of substitution of advanced materials for conventional materials remains limited, implying that growth in the industry will evolve slowly in an incremental fashion. Such a pattern is reflected in table IV.49, which reports a levelling off in global sales of advanced materials since 1990.

Metals and alloys. The production of advanced metals is typically divided into five groups. Two of the groups, intermetallic alloys and metal matrix composites, are advanced materials. The other three groups, which include aluminium alloys, superalloys and titanium alloys constitute both advanced and engineering materials. Table IV.50 features recent estimates of consumption of advanced metals and metal matrix composites in the United States. Data on advanced aluminium-lithium alloys are the only data available for the aluminium group. At least two of the advanced metals groups, aluminium-lithium alloys and metal matrix composites, are beginning to emerge from the development stage. Consumption of these materials, although starting from a small base, is expected to grow rapidly in the 1990s, assuming substantial commercialization. The use of superalloys should grow at a modest rate of about 5 per cent per year, while the use of unreinforced titanium alloys is likely to remain essentially unchanged throughout 1995, after which it is expected to decline somewhat as these alloys are displaced by advanced materials. The intermetallic alloys are not expected to see major use until the end of the 1990s.

Ceramics. Advanced ceramics are consumed in: electronic and structural applications in vehicular, stationary and aircraft engines; cutting tools; wear parts; capacitors and integrated circuits packages; resistors, seals and nozzles; and bioceramic medical products. Traditional or conventional ceramics used in making pottery, bricks, abrasives, refractories, plumbing fixtures and ceramic tile floors, for example, normally do not meet the demanding environments of advanced applications. These various end-uses are generally divided into electronics and structural or engineered segments. The former represent a mature business of which the first products gained commercial acceptance in the 1950s. The latter is an infant industry with great, although uncertain, potential. Superior physical properties such as high strength and corrosion resistance have enabled advanced ceramic products

Table IV.49. World sales of advanced materials, 1990-1992
(Millions of pounds sterling; millions of dollars)

Materials	1990	1991	1992[a]
Advanced polymer composites			
Shipments	35.0	31.1	31.0
Revenue	4 000	4 500	4 530
Advanced ceramics			
Revenue	13 594	15 341	15 400
Engineered ceramics			
Revenue	1 359	1 688	1 700
Metal matrix composites			
Shipments	1.2	0.98	1.0
Revenue	60	54	54
Carbon-carbon composites			
Shipments	0.68	0.52	0.53
Revenue	200	175	175
Polymer composites[b]			
Shipments	2 575	2 360	2 490

Source: Bureau of Mines, *Mineral Commodity Summaries* (Washington, D.C., Government Printing Office, 1993).
Note: Shipments are in millions of pounds sterling; revenue is in millions of dollars.
[a] Estimates.
[b] United States only.

Table IV.50. Estimated United States consumption of advanced metals and metal matrix composites
(Thousands of tonnes; millions of dollars)

Material	1985	1990	1995[a]
Aluminium-lithium alloys[b]	Small (Small)	Small (Small)	25.0 ($550)
Superalloys[b]	20.0 ($350)	30.0 ($600)	40.0 ($1 000)
Titanium alloys	20.0 ($650)	21.0 ($720)	20.0 ($870)
Intermetallic alloys	Small (Small)	Small (Small)	3.0 ($100)
Metal matrix composites	Small (Small)	5.0 ($220)	25.0 ($750)

Source: Bureau of Mines, *The New Materials Society* (Washington, D.C., Government Printing Office, 1991).
Note: Small implies less than 1,000 tonnes, or less than $100 million. Figures in parentheses are millions of dollars.
[a] Estimates.
[b] Unreinforced alloys only. Reinforced alloys are included in metal matrix composites.

to gain a place in markets previously dominated by more traditional materials. As more products emerge from the research phase and as material substitution problems are solved, sales may increase more rapidly.

The market data reported for advanced ceramics vary widely because of the lack of a standard classification system However, such data still reflect trends in market growth and the relative sizes of market segments. The global market for advanced ceramics was about $13.6 billion in 1991. This estimate refers to the value of the ceramic component of products containing advanced ceramics, as distinguished from the full value of advanced ceramic products, which includes the value of non-ceramic components [41]. In that total, about $3.2 billion can be attributed to electronics ceramics. These figures can be further evaluated using the tonnage sales data given in table IV.51. In 1991, the relative importance of market segments were: electronics, 88.7 per cent; cutting tools, 7.2 per cent; and others, 4.1 per cent. Regarding the regional breakdown, table IV.52 shows that out of a total for that group of 12,200 tonnes in 1991, the major sources were Japan with 48.3 per cent, United States with 36.8 per cent and Europe with 12 per cent. While table IV.51 features only a limited breakdown by product, it does reflect the major share of electronics ceramics.

Polymers. Most of the advanced and high-performance polymers have been available for less than two decades, but some of the general-purpose engineering resins were put on the market more than 20 years ago, and in the case of polyamides (nylons) nearly 50 years ago. About 25 per cent of advanced polymers are con-

Table IV.51. World advanced ceramics sales by product, 1977, 1986 and 1991
(Tonnes)

Product	1977	1986	1991[a]	Percentage change 1986-1991	Percentage share 1986	Percentage share 1991
Electronics	813	4 808	10 820	125.0	88.9	88.7
Cutting tools	58	433	855	104.4	8.0	7.2
Heat engines	-	-	80	-	-	-
Other	34	167	329	97.0	3.1	4.1
TOTAL	905	5 408	12 084	125.6	100.0	100.0

Source: Office of Technology Assessment, *Advanced Materials by Design* (Washington, D.C., Government Printing Office, 1988).

Note: Totals in tables IV.51 and IV.52 do not coincide because of the approximate nature of the reported data, each totalled separately.

[a] Estimates.

Table IV.52. World advanced ceramics sales by region and country, 1977, 1986 and 1991
(Tonnes)

Region and country	1977	1986	1991[a]	Percentage change 1986-1991	Percentage share 1986	Percentage share 1991
Japan	398	2 587	5 900	128.1	47.8	48.3
United States	362	2 024	4 500	122.3	37.4	36.8
Western Europe[b]	127	662	1 470	122.0	12.2	12.0
Germany[c]	42	254	550	116.5	4.7	7.5
United Kingdom	38	167	390	175.6	3.0	3.2
France	32	151	335	121.8	2.8	2.7
Other	15	90	195	116.7	1.7	1.6
Canada	10	72	170	136.1	1.5	1.6
Other	8	63	160	160.0	1.1	1.3
TOTAL	905	5 408	12 200	125.6	100.0	100.0

Source: Office of Technology Assessment, *Advanced Materials by Design* (Washington, D.C., Government Printing Office, 1988).

[a] Estimates.

[b] Percentage shares are totals for Western Europe.

[c] Data for 1977 and 1986 cover only the former Federal Republic of Germany.

sumed in electrical and electronic applications, usually in conventional circuit components, where their insulating and anticorrosive properties and their dimensional stability are valuable. In such uses, they tend to replace older polymers such as the phenolics. Metal-filled varieties are used for electromagnetic interference, shielding in housings for computers, and other sensitive electronic devices. The transportation industry accounts for nearly 25 per cent of the advanced polymers, employing them as small- to medium-sized structural, mechanical and electrical parts. From these uses, advanced polymers have tended to displace metals and other polymers. The remaining 50 per cent of applications can be found in a very wide variety of products, ranging from plumbing and builders hardware to home appliances, videotapes and photographic films.

Only sparse data are available concerning world sales and consumption of the advanced or engineering plastics. Table IV.53 provides estimates of world consumption in 1986 for the regions of major demand. The world total is 1.5 million tonnes; of this, United States accounted for 37.1 per cent, Western Europe for 34.8 per cent, Japan for 17.4 per cent and the rest of the world for 11 per cent. Table IV.54 provides consumption data for the narrower group of specialty plastics.

Composites. The construction of most composites depends on the combination of different kinds of fibres with different minerals or materials, as indicated above. Table IV.55 features estimates of the world market for five types of fibres used in the construction of composites: carbon, aramid, HS-glass, ceramic and others. Carbon fibres and the aramid polymer fibre (Kevlar-type) occupy 90 per cent of the $793 million market; these are used in aircraft, appliances, construction, electrical, marine and consumer products, and land transportation.

(c) The growing importance of composite markets

Polymer matrix composites are combinations of matrix materials, formed by polymerization of an organic resin and reinforcement of fibres into a variety of patterns and weaves or fibres. Generally, only continuous-fibre-reinforced polymers are considered engineered polymers. Advanced polymers are low-volume, high-cost materials that require specialized processing techniques. They can also be separated into two groups: reinforced polymer materials and polymer matrix composites. Reinforced polymer materials are single polymers, copolymers, blends or alloys. Their common feature is homogeneity; there is no other material within the polymer system except for the fibre added as reinforcement. Polymer matrix composites are advanced polymers reinforced with two or more short or continuous fibre types and single or commingled polymer matrix materials. The fibres are typically high-strength glass (HS-glass), carbon fibres, boron, ceramic, aramid or other organic fibres.

The value of advanced polymer-matrix-composite components produced in Japan, Western Europe and United States in 1985 was $2.1 billion. United States and European markets are dominated by aerospace applications. While in the United States, the driving forces are military and space programmes, in Western Europe the major influence is commercial aircraft applications. In contrast, the Japanese market is dominated by sports equipment applications.

Commercialization of advanced polymer matrix composites is an area in which the United States remains vulnerable to competition from abroad. United States suppliers of polymer matrix composite materials report that foreign commercial end-users (particularly those outside the aerospace industry) are more active in experi-

Table IV.53. World consumption of engineering plastics, 1986[a]
(Thousand tonnes)

Item	Western Europe	United States	Japan	Rest of the world	World	World percentage share
Polyamide	275	200	100	75	650	43.4
Polycarbonate (PC)	90	140	50	40	320	21.4
Polyacetal	68	50	70	22	210	14.0
Phenylene polyoxide	30	85	20	15	150	10.0
Polybuthyleneterephthalate (PBT)	25	45	10	10	90	6.0
Pclyethyleneterephthalate (moulding)	8	15	2	-	25	1.7
PC/ABS[b]	20	15	3	2	40	2.7
PC/PBT	5	5	-	-	10	0.7
TOTAL	521	555	255	164	1 495	100.0

Source: Bureau of Mines, *The New Materials Society* (Washington, D.C., Government Printing Office, 1991).

[a] Estimates.

[b] Acrylonitrile-butadiene-styrene.

Table IV.54. World consumption of specialty plastics, 1986
(Thousand tonnes)

Speciality plastics	Western Europe	United States	Japan	Rest of the world	World	World percentage share
Polyvinyl difluoride	2.0	5.0	2.0	1.0	10.0	12.2
Fluoroelastomers	1.5	3.0	0.5	-	5.0	6.1
Polyphenylene sulphide	1.0	8.0	1.0	0.5	10.5	12.8
Polysulphone	1.3	5.0	1.5	0.2	8.0	10.0
Polyether sulphone	0.7	2.0	0.2	0.1	3.0	3.6
Polyarylate	0.1	0.1	1.3	-	1.5	1.8
Polyimide (including film)	0.5	1.0	0.2	0.3	2.0	2.4
Polyamide-imide	0.2	0.2	0.1	-	0.5	0.6
Polyetheretherketone	0.1	0.1	0.1	-	0.3	0.4
Polyetherimide	0.2	0.3	0.1	-	0.6	0.7
Other	10.5	21.6	4.8	3.9	40.8	49.6
TOTAL	18.1	46.3	11.8	6.0	82.2	100.0

Source: Bureau of Mines, *The New Materials Society* (Washington, D.C., Government Printing Office, 1991).

Table IV.55. World market for raw material fibres used in composites, 1990
(Million dollars)

Fibre type	Polymer composites	Metal matrix composites	Mixed mode[a]	Total	Percentage share
Carbon	530	[b]	7	537	67.6
Aramid	160	-	25	185	23.3
HS-glass	25	-	-	25	3.1
Ceramic	20	3	-	23	2.9
Other	25	[c]	[c]	25	3.1
TOTAL	760	3	32	795	100.0

Source: Bureau of Mines, *The New Materials Society* (Washington, D.C., Government Printing Office, 1991).
[a] Including carbon-carbon and armour fabric uses.
[b] Including boron, ultra-high-molecular-weight polyethylene, and other polymer fibres.
[c] Minor.

menting with new materials than are United States commercial end-users. Currently, less than 2 per cent of polymer matrix composites are advanced composites of the types used in aircraft and aerospace applications. However, United States production of advanced polymer matrix composites is projected to grow by 15 per cent annually for the remainder of the decade, increasing from a 1985 value of $1.4 billion to nearly $12 billion by the year 2000. The industry continues to be driven by aerospace markets, with defence applications projected to grow even more over the next several years.

France is the dominant producer of polymer matrix composites in Western Europe, selling more than all other European countries combined. The United Kingdom, Germany and Italy are also important. The commercial aircraft manufacturer Airbus Industrie, a consortium of European companies, is the single largest consumer of polymer matrix composites. At the European Community level, significant expenditures are being made to facilitate the introduction of polymer matrix composites into commercial applications through the BRITE and EURAM programmes. In addition, the

EUREKA programme, "Carmat 2000", has proposed spending $60 million over four years to develop polymer-matrix-composite automobile structures.

Carbon-carbon composites differ from carbon-fibre-reinforced polymer matrix materials which utilize the fibre's high-tensile strength and high stiffness for many room-temperature applications. For example, carbon fibre is used for golf club shafts, tennis rackets, fishing rods in the sporting goods industry, and for pipe and concrete reinforcement in the construction industry. In contrast, carbon-carbon composites are used principally in aerospace and defence industries for applications such as aircraft brake pads, rocket nozzles and missile nose-cones; only a small fraction is used in sports equipment. The estimated worldwide market in 1990 for carbon-carbon composites was $202 million in four major applications: aircraft brakes ($50 million); rocket nozzles ($70 million); nose tips/ablatives ($66 million); and others ($16 million). Overall, the United States represents 75 per cent of the worldwide carbon-carbon composite market, primarily due to its dominance in military and aerospace technology. Western Europe and Japan account for the remaining 25 per cent of the market.

Metal matrix composites are metals or metal alloys reinforced with ceramic fibres, whiskers or particulates. Due to their superior mechanical strength and unique physical characteristics, such as low thermal expansion, metal matrix composites can be found in structural and non-structural components alike. They combine metallic properties (ductility and toughness) with ceramic properties (high-temperature strength and high modules), thus offering greater strength in shear and compression as well as higher service temperature capabilities. The principal markets for metal-matrix-composite materials in the United States and Western Europe are in the defence and aerospace sectors. The structures of the United States and European metal-matrix-composite industries are similar, with small, undercapitalized firms supplying the formulated metal-matrix-composite materials. Currently, the matrix is supplied by large aluminium companies, which are considering integration into the field of composite materials. There are also in-house efforts by major aircraft companies to develop new composites and new processing methods. Many analysts feel that the integration of metal-matrix-composite suppliers with larger concerns having access to more capital and research will be a critical step in producing reliable, low-cost metal matrix composites that could be used in large-volume commercial applications.

Unlike the situation in the United States and Western Europe, companies involved in the manufacture of metal matrix composites in Japan are largely the same as those involved in the supply of polymer matrix composites and ceramics, that is, the large, integrated materials companies. Another difference is that Japanese metal-matrix-composite producers focus primarily on commercial applications, including electronics, automobiles, aircraft and aerospace. One noteworthy Japanese development is Toyota's introduction of a metal-matrix-composite diesel-engine piston consisting of aluminium locally reinforced with ceramic fibres.

The estimated global market in 1990 for metal matrix composites was $60 million in four major applications: automotive ($15.6 million); aerospace ($42 million); recreation ($1.2 million); and others ($1.2 million). The United States accounts for 60 per cent of the worldwide market value because of the high cost of prototype materials used by the aerospace industry. The Japanese share is only 20 per cent. It is estimated that the average cost of metal-matrix-composites for aerospace applications is 10 times higher than the cost of automotive and other applications. Japan is the leading consumer of automotive metal-matrix-composite components, mainly because of its production of metal-matrix-composite engine pistons.

Ceramic matrix composites are produced by adding particulates, whiskers or fibres to a ceramic matrix. Ceramic matrix composites have high fracture toughness and improved mechanical shock resistance compared to monolithic ceramics. But unlike polymer matrix composites, ceramic matrix composites are still at the embryonic stage. Their development is severely hampered by inadequate fabrication techniques. Lower fracture toughness of ceramic matrix composites compared with metal matrix composites further limits their application as structural components. Currently, ceramic matrix composites find major applications in cutting tools, wear-resistant components and, to a lesser extent, aerospace and defence technologies. The worldwide market for advanced ceramics has been estimated to be $13.6 billion; of this, between 1 and 3 per cent is for ceramic matrix composites. Most of the latter composites are used in ceramic whisker cutting-tool bits in the machine tool industry and in making aluminium beverage containers for the canning industry.

2. *Materials substitution patterns*

An examination of the rates at which advanced materials are substituted for minerals and agricultural raw materials could provide insights into the present and future growth of advanced materials consumption. Important factors underlying this substitution process include quality (performance), technology (design) and economics (relatively lower prices and costs) [42].

(*a*) *Quality*

Superior performance properties rather than lower materials costs appear to be the principal consideration in the early stages of substitution. If the cost of a new material eventually becomes competitive as production volumes increase, the substitution process will be difficult to reverse. Thus, it may often be too late for conventional producers to react to competition from a new material that has already eroded their market share.

(*b*) *Technology*

While the inherent properties of basic materials are important in substitution, other factors also matter. First, new materials must have a "proven track record", that is, firms are reluctant to incorporate a new material into their product until the performance record of the material in other uses has proved its reliability. Thus, superior performance in laboratory testing could involve years or even decades (as in aerospace applications where risks are high), before a new plastic is accepted as a substitute for a metal proven reliable by long use. Hesitancy to introduce a new material also results if a potential user is not aware of its advantages, lacks assembly line experience with it, or incurs high retooling costs by converting to the material. The cautious "wait-and-see" stance is an attitude that favours conventional materials already in place. This phenomenon has been observed regardless of whether the new use of the material in question was for high-technology aerospace parts or for common plumbing fixtures in the building trade.

(c) Economics

The only relevant cost consideration in materials substitution today is the "total package cost", which includes not only the price of the material itself, but also all other costs involved in using the material to manufacture a product, for example, labour. While many new materials are priced higher than the conventional materials they displace, these new materials may be preferred because they offer the opportunity to reduce manufacturing costs sufficiently to offset their higher prices. For example, a one-piece plastic unit that replaces an item built from several parts could reduce assembly costs. Because total package costs are so important, materials producers now must work closely with parts designers and other manufacturing system specialists to develop a product that is competitive.

(d) Materials displacement

Major implications of the above substitution factors are not only an improvement in product performance, but also the somewhat detrimental effect of the displacement of conventional mineral and raw material commodities [43]. An example of this displacement is provided in table IV.56 which estimates the extent of substitution of advanced polymers for other materials in the United States. Plastics have made the strongest competitive advances of all materials against metals and glass in many markets, and will continue to do so in the 1990s. Calculations underlying table IV.56 indicate that at least 25 per cent of all plastics and resins domestically produced compete directly with mineral materials. These computations do not include those markets where plastics compete with so many other materials in addition to non-fuel minerals that displacement of the latter could not be measured with sufficient precision. If those markets were added to the estimates of plastic consumption, the total would probably indicate that well over 35 per cent of United States plastics production competes with metal and non-metal minerals.

As suggested by table IV.56, the 1990s will be a period of more intense competition between metals and polymers [41]. Steel and aluminium are the major metals most likely to be affected. Polymer materials have already replaced some 7 to 9 per cent of steel consumed in domestic motor vehicle production and may displace more than twice that amount by the year 2000. In the construction industry, it is estimated that polymers have replaced slightly less than 10 per cent of the iron and steel consumed, and by 1995 could displace up to 13 per cent. In aerospace applications, polymer composites are displacing aluminium utilized for the "skin" of many new military aircraft, and are expected to make large inroads in passenger airliner manufacturing during the next decade. Composites currently account for less than 3 per cent of passenger airframe weight, but are forecast to account for as much as 65 per cent during the 1990s. As a result, the proportion of passenger airframe weight composed of aluminium may decrease from the current 80 per cent to as little as 20 per cent by the year 2000.

Table IV.56. Forecasts of identified substitution of advanced plastic materials in five major United States industries, 1985, 1990, 1995 and 2000[a]

Industry	1985	1990	1995[b]	2000[b]
Motor vehicles				
Steel displaced by plastics				
Million short tonnes	1.3	1.8-2.4		2.7-7.3
Percentage	7-9			8-19
Passenger airliners[c]				
Aluminium displaced by polymer composites				
Thousand short tonnes	0.5		..	4.0-11.0
Percentage	3			20-60
Building and construction[d]				
Iron and steel displaced by plastics				
Million short tonnes	2.5	..	4.3-6.1	..
Percentage	9		10-13	
Aluminium displaced by plastics				
Thousand short tonnes	37		64	..
Packaging (bottling and canning)				
Glass displaced by plastics				
Million dollars	..	386		..
Metal (aluminium and steel) displaced by plastics				
Million dollars	..	223		..
Heavy machinery and equipment				
Metal displaced by plastics				
Thousand short tonnes	700	800	..	..
Percentage	5	5	..	..

Source: R. F. Balazik and B. W. Klein, *The Impact of Advanced Mineral Markets* (Washington, D.C., Bureau of Mines, 1987).

[a] Data are not cumulative.

[b] Estimates.

[c] Excluding military and private civil aircraft. For 1985, it is estimated that over 23,000 short tonnes of aluminium were displaced by plastic composites in the entire aerospace industry.

[d] Displacement in pipe, tube, siding and window markets.

3. International trade

The increased domestic production and consumption of advanced materials affects two important areas of international trade: trade and transfer of technology; and trade in conventional materials or primary commodities. Growing markets in advanced materials are associated with a shift in the competitive position of different countries producing high-technology products and other manufactured goods. There is also evidence of a link between technological performance and trade competitiveness, although the size and scale of countries as well as their level of development affects this relationship. While the United States was once dominant in technology, Western Europe and Japan have narrowed the lead. Aided by the acquisition of imported technological know-how as well as their own efforts, the NICs have become increasingly competitive technologically. However, in the trade in advanced materials and processes, a technology gap does exist between developed and developing countries.

The medium- and long-term implications of the gap are not at present known. However, it can be witnessed in the above explanation of the increased substitution of advanced materials for conventional minerals and raw materials. Since a large portion of these conventional materials originate in developing countries, the previously high export volumes and revenues of those countries could be reduced. An example of such a decrease can be seen in the substitution of fibre optic cable for copper wire [42]. Because of the recent diffusion of fibre optic technology in public telecommunications and in other information transfer networks, demand for copper in insulated wire and cable is being increasingly satisfied by advanced glass-fibre composites. Some advantages of this substitution include: large band width allowing many voice channels; Low loss of frequency power; technological superiority for digital transmission; upgradability to higher wave lengths; small size, light weight and small cable diameter; no electromagnetic radio-frequency interference, or crosstalk; greater difficulties of "eavesdropping" or "tapping" without a high degree of skill; lack of conductivity, eliminating ground loop problems; easier installation with fewer repeater stations and splices, requiring less maintenance; no performance degradation due to moisture, corrosion or high temperature; and rapidly declining production and installation costs.

Table IV.57 provides forecasts of total copper consumption in the telecommunications industry by major countries and regions as well as the proportion of consumption expected to be displaced by fibre optic technology. Although telecommunications represent only a small portion of global copper consumption, the projected copper displacement is not minor. Major developing-country copper exporters that could be affected include Chile, Mexico, Papua New Guinea, Peru, Zaire and Zambia.

The above example reflects similar substitution findings for aluminium, iron ore and other minerals [43]. This lends further confirmation to the "transmaterialization" process, that is, a reduction in the demand for products of more raw-material-intensive industries due to an increased use of special minerals and advanced materials [40]. The acceleration of transmaterialization may mean that even as world economic growth recovers, demand for major raw materials, particularly by developed countries, may not resume pre-recession levels. This would have far-reaching implications on the export performance of developing countries whose foreign exchange earnings depend, to a large extent, on the exports of a few raw materials. As will be explained later, several developing countries and groups of countries have reacted against possible adverse effects of technological change on their exports of raw materials by setting up programmes for the development of new domestic and foreign end-uses for commodities of export interest to them [44].

Apart from the effect of transmaterialization on trade, the diffusion of new materials technologies would accelerate technological change and increase obsolescence of existing materials processing techniques. This explains why in the face of declining materials consumption, growing overcapacity and massive closures of conventional materials industries in developed countries, new plants continue to be built to increase the competitiveness of their products on world markets. A good example of this is the expansion of higher-value-added steel manufacturing and alloy mini-mills in Japan, the United Kingdom and the United States.

4. *Manufacturing capacity of developing countries*

The main challenge developing countries face is not simply that of experiencing the above suggested decline in traditional materials. The production capacity now in place, which is very heavy, horizontally designed and planned to produce, transport and commercialize huge amounts of raw materials and processed goods, shows a tendency of becoming obsolete. Such capacity will be superseded by new capacity which is more efficient as well as more capable of producing goods which embody greater amounts of technological innovation. The passage from the first stage to the second will not be easy, as far as developing countries are concerned. The basic endowments of these countries, such as abundant raw materials, cheap labour and energy, are not as important as technological know-how. Moreover, as new materials technologies increasingly rely on more complex and so-

Table IV.57. Forecasts of copper consumption and fibre optic displacement in telecommunications, 1994, 1997 and 2000
(Thousands of tonnes; percentage)

Region or country	1994	1997	2000	Region or country	1994	1997	2000
France				United Kingdom			
Consumption	46.7	47.2	47.8	Consumption	30.9	31.3	31.7
Displacement	59.5	67.0	73.1	Displacement	60.5	67.5	73.2
Germany				United States			
Consumption	82.1	83.1	84.1	Consumption	220.0	226.5	289.0
Displacement	60.4	67.8	73.8	Displacement	62.9	67.3	73.2
Italy				EEC			
Consumption	86.6	87.6	88.7	Consumption	282.2	285.5	289.0
Displacement	60.0	67.3	73.2	Displacement	60.0	67.3	73.2
Japan				World			
Consumption	150.1	157.4	165.1	Consumption	927.9	973.2	1 020.6
Displacement	65.5	72.6	78.1	Displacement	61.6	68.9	74.8

Source: M.J. Hannon and W.C. Labys, "Measuring Material Substitution" in *Papers and Proceedings of the American Mining Society* (Littleton, Colorado, Society of Mining Engineers, 1990), pp. 70-90.
Note: Consumption is in thousands of tonnes, and displacement in percentages.

phisticated knowledge, necessary efforts to develop and absorb such technologies will be substantially augmented.

There is evidence that developing countries are accepting this challenge [44]. Materials science and technology institutions are evolving from and are integrating in areas of applied chemistry, geology, mining, metallurgy and ceramics. Materials advisory boards and commissions, using quantitative and normative forecasting and assessment techniques, are emerging as institutional mechanisms to provide direction to materials research and production and to technology transfer. This process is prompting developing countries to develop a coherent long-term strategy for materials and a capability to participate in the evolution of international materials policy. Such policies would cover imports and exports of raw materials or finished materials, stockpiling, materials substitution, international trade, research and development, production, standards, distribution, pricing, conservation and recycling of materials. In addition to national materials policy, regional and local materials policies are being expanded to complement international, national and regional resources and needs.

As an example of this phenomenon, the Ministry of Sciences and Technology of Brazil created a commission in 1986 to establish a national materials programme. Such a programme was justified because of Brazil's extensive mineral reserves, including quartz (95 per cent of known reserves), niobium (86 per cent), titanium, beryllium, rare earths and others. In addition, some scientific and technological capabilities already exist in Brazilian universities and research centres; the Brazilian market is also likely to be one of the most promising for high-technology products [44]. The programme defines the achievement of four main targets: a considerable expansion of human resources by increasing the number of scholarships in the country and abroad; consolidation of the research and development infrastructure; establishment of immediate opportunities both in research and development; and the setting-up of productive units.

These are only initial activities which can be reinforced by other mechanisms and the establishment of long-term strategies. Such strategies, of course, should be coupled with broader industrial and trade policies. Similar progress in other regions can be found in India, Republic of Korea and Thailand, including the development of an Asian and Pacific Regional Centre for Advanced Materials [45]. As per capita incomes rise in developing countries, there is no doubt that their conventional minerals and materials consumption will increase. However, the increase in technological innovation in all sectors of industry suggests that greater use will be made of advanced materials. To meet this need, manufacturing capacity in these advanced products will probably expand.

5. Technology and industry structure

Advanced materials technologies are becoming markedly more international in character [38]. Through acquisitions, joint ventures and licensing agreements, firms are seeking access to growing world markets as well as ways of lowering their production costs. Governments around the world are investing large sums in multi-year programmes in collaboration with industry to facilitate commercial development, and critical technological advances continue to come from a number of countries, for example, carbon fibre technology from the United Kingdom and Japan, composite technology from the United States, weaving technology from France, and hot-isostatic-pressing technology from Sweden. Several global trends are apparent in evolving advanced-materials industries. These include a shift towards larger, more integrated companies, the growing transnational character of these companies, and increasing government support for the development of advanced materials technologies.

In the long run, large integrated materials companies are likely to dominate the high-volume markets for advanced materials. One reason is that capital costs of scale-up production are higher than most small companies can afford. Also, the close relationships between design, manufacturing and quality control demanded by advanced materials are more consistent with the capabilities of a large, vertically integrated company. Because most of the value added in advanced materials businesses lies in the production of components and shapes, there is an economic incentive for suppliers of powders, resins or fibres to integrate vertically into the downstream businesses.

Nevertheless, small companies will also be an important force in advanced-materials technology developments. Indeed, because current demand is primarily for research services or limited production of specialty materials for military use, small companies are playing a major role in advanced materials development, especially in the area of metal matrix composites. Even among the large companies involved, their advanced materials divisions are typically on a very small scale. In future, small companies will continue to be a source of innovative materials and processes, and will continue to supply niche markets small enough to attract the large integrated companies. Table IV.58 lists the major companies involved in the production of advanced materials.

(a) Ceramics

The most important United States participants in the advanced ceramics industry tend to be medium- or large-sized corporations that have experience with traditional ceramics or that are diversifying from other structural materials areas. These include Norton Company, Champion Spark Plug, Standard Oil Engineered Materials, Coors Ceramics, GTE and Alcoa. Major United States companies that manufacture structural ceramics products are listed in table IV.58. Most of these products are wear parts, refractories, cutting tools or military items such as armour and radomes.

Japan has been the leader in the production of structural ceramic products for both industrial and consumer use. Japanese consumers exhibit a commitment to use domestically produced materials. Although the Governments of Japan and the United States spend comparable amounts on ceramics research and development (roughly $100 million annually), the total spent by Japan far exceeds that of the United States. Among the many Japanese companies participating in the advanced ceramics industry are roughly 100 powder suppliers, 250 suppliers of finished components and 150 equipment suppliers. Table IV.58 also lists the major manufacturers of finished ceramics components. Recent entrants into this field include steel, cement and petrochemical companies. Japanese ceramics companies are far more vertically and

Table IV.58. Major companies in the world ceramics industry, 1986

Structural ceramics	Finished ceramics
United States	**Japan**
Advanced Refractories Technologies	Asahi Glass
Alcoa	Asahi Optical
Ceradyne	Figaro Engineering
Champion Spark Plug Company	Hitachi
Coors Ceramics Company	Hitachi Chemical Ceramics
Corning Glass Works	Hitachi Metals
E.I. Du Pont de Nemours and Company	Koh's Metals
GTE Products Corporation	Koransha Insulators
W.R. Grace and Company	Kurosaki Re-factories
Kennametal, Incorporated	Kyocera
Norton Company	Matsushita Electronic Components
Standard Oil Engineered Materials Company	Mitsubishi Heavy Industries
Solar Turbines, Incorporated	Mitsubishi Metals
3M Company	NGK Insulators
Union Carbide Corporation	NGK Spark Plug
	Narumi China
	Nippon Denso
Europe	Nippon Tungsten
Céramiques et composites (France)	Noritake
Cookson (United Kingdom)	Shinagawa Refractories
Desmarques (France)	Showa Denko
ESK Spark Plug Company (Germany)	Sumitomo Electric
Feldmuehle (Germany)	Toshiba Ceramics
Friedrichsfeld (Germany)	Toshiba Tugaloy
Haldenwanger (Germany)	
Hoechst-Ceram Tech (Germany)	
Hutschenreuter (Germany)	
Norton (Germany)	
Société europeene propulsion (France)	
Stettmer (Germany)	

Source: Office of Technology Assessment, *Advanced Materials by Design* (Washington, D.C., Government Printing Office, 1988).

horizontally integrated than United States companies, a fact that probably enhances their ability to produce higher-quality ceramic parts at lower prices.

Alcoa and ESK are the two largest manufacturers of ceramic powders in Europe, accounting for about 50 per cent of the European merchant market. Alcoa is the leading supplier of high-purity alumina, while ESK is the leading supplier of various grades of silicon carbide. Some companies, including Philips, Siemens, Norton and Magnesium Elektron manufacture powders for captive consumption of ceramic parts, often electronic components. Manufacturers also import ceramic powders from Japan and the United States. Overall, about 40 European companies manufacture ceramic parts for sale in the merchant market. Another dozen or so, mainly electronic companies, produce components for captive consumption. A modest trend exists among powder suppliers to further integrate into the production of parts.

(b) *Polymer matrix composites*

The United States is the largest producer and consumer of advanced composites in the world. The structure of the United States advanced composites industry is largely a result of its orientation towards aerospace applications. Segmentation has occurred largely along product lines (fibres, resins, prepregs and shapes). Other important industry characteristics include limited production volumes and a cost structure commensurate with the high value of the end-uses. Hercules, Hexcel, Fiberite and Boeing are the most important companies in the United States composites industry. All produce lines reflecting the aerospace industry, the largest and most technology-driven market segment. The United States market for finished composite structures in 1985 was valued at approximately $1.4 billion, of which about one half was consumed by the aerospace industry. The structure of this industry is fairly complex, with a significant overlap among the activities of individual firms. Companies such as Hercules, for example, produce carbon fibre, prepregs and finished shapes for the merchant market, and use them captively as well. Table IV.59 provides a list of United States companies that produce base resins, prepregs and shapes.

Although Japan is the largest producer of carbon fibre in the world, it has been only a minor participant in the advanced composites industry. One reason is that Japan has not developed a domestic aircraft industry, the major user of such composites. Instead, the Japanese industry was initiated to supply aircraft and space industries in the United States, while most of the Japanese domestic growth has been in the recreational markets. The composition of the Japanese advanced composites market is currently: recreational, 55 per cent; industrial, 35 per cent; and aerospace, 10 per cent. Table IV.59 includes a list of major Japanese companies in the industry.

The polymer matrix composite business in Western Europe is concentrated in four countries: France,

Table IV.59. Major companies in the world polymer-matrix-composites industry, 1986

Resin, prepreg and shape suppliers	Fibre and prepreg suppliers
United States	*Japan*
American Cyanamid	Asahi Glass
Amoco Performance Products	Asahi Nippon Carbon
Avco	Hitachi Chemical
BASF	Kasei Fiberite
Boeing	Kureha Chemical
Ciba-Geigy	Mitsubishi Chemical
Dow Chemical	Mitsubishi Rayon
Du Pont	Mitsui
Ferro	Nippon Carbon
Grumman	Nittobo
Hercules	Nitto Electric
Hexcel	Sakai Composite (Toray)
HITCO	Somar
Hysol Grafil	Teijin
ICI	Toho Rayon
Fiberite	Toray
Lockheed	Ube
LTV	Vacuum Metallurgical
McDonnel Douglas	
Northrop	*Europe*
Phillips 66	Hysol Grafil
Rohr Industries	Soficar
Shell Chemical	RK Carbon Fibers
United Technologies	Enka (Akzo)
	Du Pont
	Vetrotex
	Société nationale des poudres et explosifs
	Bekaert NV
	Sigri
	Specmaat
	Ten Cate Glas
	American Cyanamid
	BASF
	Bristol Advanced Composites
	Ciba-Geigy
	Bonded Structures
	Brochier et fils
	Fiberite Europe
	Fibre and Mica
	Fothergill and Harvey
	Gividi
	Hexcel
	Stevens-Genen
	Interglas-textil
	Krempel
	LNP (ICI)

Source: Office of Technology Assessment, *Advanced Materials by Design* (Washington, D.C., Government Printing Office, 1988).

Germany, Italy and United Kingdom. Together, these countries account for about 90 per cent of the business. France dominates the advanced composites business in Western Europe, with a 55 per cent share of sales. Substantial involvement by the Government of France in major aerospace, automotive and energy-producing companies makes the French industry by far the most heavily State-subsidized in Western Europe. At the European Community level, significant expenditures have been made to facilitate the introduction of polymer matrix composites into commercial applications. Significant amounts of advanced composites products are fabricated in the United States and exported to Europe either for assembly in European aircraft or for production of components for United States aircraft.

Table IV.59 also lists companies involved in the European polymer matrix composite industry. Among resin suppliers, large transnational chemical companies dominate the supply of high-performance thermosets and thermoplastics to the European market. Major producers of epoxies include Shell, Ciba-Geigy, and Dow Chemical. The most important suppliers of high-performance fibres in Western Europe include Hysol Grafil, a joint venture between Dexter (United States) and Courtaulds (United Kingdom); Soficar, a joint venture between Elf Aquitaine (France) and Toray (Japan); and Enka (Netherlands). Total production capacity of carbon fibres in Europe is estimated at over 1,100 tonnes. Capacity in the United Kingdom is the largest, followed by Germany and France. Overall, four suppliers (Ciba-Geigy, American

Cyanamid, Hexcel and Krempel) control about three quarters of European prepreg production. The commercial aircraft manufacturer Airbus Industrie is the single largest consumer of shapes in Western Europe.

(c) *Metal matrix composites*

The principal markets for metal matrix composite materials in the United States and Western Europe are also in the defence and aerospace sectors. At present, suppliers of metal matrix composite materials in the United States are small undercapitalized companies with limited technical resources, because the current market is not big enough to attract large companies. In fact, several experts have characterized the industry as a "cottage" industry. Research and development programmes have been initiated by larger firms, including major aluminium suppliers such as Alcoa and Alcan. However, companies actually supplying metal matrix composite materials, structural shapes and components to the industry are either small entrepreneurial firms or small subdivisions or subsidiaries of large corporations. Integration of these smaller producers into concerns having greater capital and research and development resources is considered an important step in the diffusion of technology into commercial applications. Primary suppliers of matrix, reinforcement and finished metal matrix composite materials in the United States are given in table IV.60.

The principal companies supplying metal matrix composites in Japan are the traditional metal suppliers and suppliers of fibres and particulates for polymer matrix composites and ceramic matrix composites. These include Toho Rayon, Toray, Mitsubishi Aluminium, Kobe Steel and Nippon Steel. Major organizations involved with metal matrix composite materials in Japan are listed in table IV.60. Companies experimenting with metal matrix composite products include Hitachi, Ishikawajima-Harima Heavy Industries, Honda and Toyota. The metal matrix composite industry in Japan differs significantly from that in Western European and the United States, in that the same companies involved with ceramics and polymer matrix composites also produce metal matrix composites. End-user industries in Japan interested in metal matrix composites are the automotive, electronics and aerospace industries. Japan does not have a large defence industry, and is more interested in developing commercial materials for industrial applications. The domestic market for these metal matrix composite materials is small, but a few products are made in limited quantities. One noteworthy metal matrix composite development in Japan has been the introduction by Toyota of a diesel engine piston consisting of aluminium locally reinforced with ceramic fibres. This suggests the future possible use of metal matrix composites in low-cost, high-volume applications, creating interest among potential international commercial users of such products.

The structure of the Western European metal-matrix-composites industry is similar to that in the United States. Current metal-matrix-composites research and development is primarily funded by defence ministry contracts. Among end-users, aerospace companies have made the highest research and development investments in metal matrix composites. No automobile companies appear to have plans to use metal matrix composites in the near future, although nearly all have conducted preliminary investigations. The principal countries involved in metal-matrix-composites research and development are France, Germany and the United Kingdom. Table IV.60 identifies the principal organizations involved in those countries and others.

6. *Short- and medium-term outlook*

The advanced materials industry is characterized by three features that distinguish it from the past [41]. First, new materials are being developed at a more rapid pace, and technological and competitive pressures are accelerating the role of substitution. Secondly, by working at the molecular level, scientists can now create new materials for specific properties and uses rather than modify existing materials; parts are redesigned and manufacturing processes are changed to accommodate these new materials. Thirdly, advanced materials development now requires a much wider range of expertise and scientific knowledge; as a consequence, plant design engineers and assembly line specialists must work with materials scientists to reduce total product costs. The development of these materials has caused conventional materials, especially metals, to suffer competition in substitution, particularly from reinforced plastics and fibre optics. Light and durable plastics and polymer composites are also used as substitutes for metals and glass in the motor vehicle, aerospace and packaging industries. Optical fibres may one day supplant copper as the premier materials used in telecommunications, and electrically conductive plastics now under development eventually may displace metal wire in electronic circuits. In addition, advanced ceramics are being developed for high-temperature environments that were previously the sole domain of metal alloys. The impact of such developments is expected to grow substantially over the next decade.

(a) *Automotive applications*

Car and truck manufacturing constitutes an immense market for advanced polymers, because the industry produces a great number of motor vehicles that could incorporate sizeable quantities of these materials. The utilization of additional plastics under the hood (some plastics are already being used for parts such as radiator headers and master hydraulic cylinder reservoirs) is expected to trail their use for outer body panels for several reasons. To design and manufacture firewalls, floor pans and sidewalls with plastics rather than metal requires composite materials that have high-temperature resistance, low flammability etc. Excluding the engine block, which will remain predominantly metal into the twenty-first century, the frame and other structural parts will probably be the last area where plastics will substitute for metals [41].

Actual substitution of plastics in cars involves: costs of both the plastics and the steel that they replace, and in addition the cost of other materials, such as aluminium and magnesium, that compete with plastics in replacing steel; costs of designing and manufacturing plastic car parts versus steel, aluminium, or in a few cases, magnesium; prices of oil and gasoline; ability of plastics to meet high-performance requirements (high-temperature resistance and high strength) for under-the-hood and frame parts, which is a safety issue as well; changing

Table IV.60. Major companies in the world metal-matrix-composites industry, 1986

Suppliers of metal-matrix-composites materials in the United States	Organizations involved in metal-matrix-composites research in Western Europe	Organizations involved in metal matrix composites in Japan
Matrix	*Germany*	*Company*
Alcan	Batelle-Frankfurt	Art Metal Manufacturing Company
Alcoa	Berghof GmbH	B&W Refractories
AMAX	Dornier	Daia Vacuum Engineering Company
Avco/Textron	Messerschmitt-Bolkow-Blohm	Hiroshima University
Dow Chemical	Sigri	Honda Motors
	France	Japanese Society on Materials
Particulates	Aerospatiale	Science
Norton	CDF Chimie	Mitsubishi
Standard Oil Engineered Materials	Ecole des mines (Paris)	Nippon Carbon
	Elf Aquitaine	Okura Laboratory
Whiskers	Institut Saint-Louis	Sumitomo
Arco Chemical	Société nationale des	Tokai Carbon
American Matrix	poudres et explosifs	Tokyo University
J. M. Huber	Thomson-CSF	Tokyo Institute of Technology
Versar Manufacturing	Université de Bordeaux	Toyota Motors
	Vetrotex - Saint-Gobain	
Fibres	*Italy*	
American Cyanamid	Aeritalia	
Avco/Textron	Fiat	
Du Pont	Siai Macheti	
Standard Oil Engineered Materials	*Netherlands*	
	Fokker	
Composites	*Norway*	
Advanced Composite Materials	Central Institute for	
Amercom	Research - Oslo	
Arco Chemical	*Sweden*	
Avco/Textron	Chalmers University of	
Cordec	Technology	
Dural Aluminium Composites	Kockhoms Shipyard	
DWA Composite Specialties	SAAB	
Materials Concepts	Sweden Defence Laboratory	
Novamet	Sweden Institute for Metals	
Sparta	Research	
	United Kingdom	
	Harwell	
	Bristol Composites	
	British Aerospace	
	Courtaulds	
	Dunlop	
	Fothergill and Harvey	
	Hepworth and Grandage	
	Imperial Chemicals	
	Lagstall Engineering Company	
	Rolls Royce	
	Royal Aircraft Establishment	
	Wellworth Limited	
	Westland Helicopters	

Source: Office of Technological Assessment, *Advanced Materials by Design* (Washington, D.C., Government Printing Office, 1988).

consumer tastes and preferences; and the economic feasibility of recycling automotive plastics.

The thermal strength and hardness properties of advanced ceramics have given these materials significant potential for their application in car and truck engines. However, ceramic coatings and parts are only now being introduced by the motor vehicle industry, and will not seriously compete with conventional materials in this sector for a decade or more. The most near-term uses likely for advanced ceramics are items such as turbocharger rotors, piston rings and pistons, cylinder liners and small stationary parts. Coatings and smaller parts will be introduced first.

(b) *Aerospace applications*

Aerospace manufacturing also represents a future major market for advanced materials. The lower production rate of aircraft versus motor vehicles permits greater use of longer-cure composites in aircraft manufacturing. The much higher prices of and much longer processing time permitted for aircraft composites allow them to be used more frequently than motor vehicle composites. It is in the aerospace sector that the new state-of-the-art composites will be developed, rather than in the motor vehicle sector where the goal is largely to increase the plastic parts production rate and reduce the cost of existing plastics.

Composites such as graphite-epoxies have several advantages over the aluminium they replace in the airframe. Probably the most significant of these is the lighter weight of composites: aluminium parts generally weigh about 1.3 times as much as the composites that substitute for them. The lighter weight enables the aircraft to have a longer range and bigger payload, and increases manoeuvrability and speed. Relatively little experience in the use of composites compared with metals in aircraft means that composites will initially be used mainly in secondary structures, that is, doors, flaps, slats and part of the tail. Unlike the airframe, where composites have already substituted for aluminium in sizeable quantities (at least in some military aircraft), the engine area presents technical and performance problems which are more difficult for composites to overcome. With regard to engineered ceramics, it is expected that with the exception of their possible application as coating, ceramics will not be employed in jet aircraft engines until well into the next century. However, because of this, they offer advantages that almost ensure their eventual use.

(c) Construction

The construction industry, although a traditional consumer of metal, has been increasing its demand for plastics. Important consumers are firms that manufacture pipes and conduits, siding for buildings, and windows for residential housing. Other building trade applications in which plastics are competing with conventional mineral materials include interior and exterior moulds, doors, plumbing fixtures and insulation. Less weight, lower fabrication costs, better design flexibility and ease of maintenance are features that have increased the demand for plastics in construction materials and will continue to spur its use by builders over the next decade.

Steel and ductile iron for conduits and drain and sewer pipes account for most of the metal that is expected to be replaced by plastics in construction during the early 1990s. Most of the gains against metals will be made by plastic piping (predominantly polyvinyl chloride) within buildings and as underground water and drain lines in urban areas. Plastic pipes already account for a large portion of all rural mains laid today (replacing cast iron and vitreous clay pipe). In the siding business, aluminium is the metal that faces the greatest competition from plastics (primarily vinyl). Steel currently accounts for only a very small share of the market, a share that is not expected to change much in the next decade. Aluminium faces a strong challenge from plastics as a material used to fabricate window frames for houses and other residential structures. Plastics (primarily vinyl) have a growing share of the residential replacement window business and the total residential window market.

(d) Machinery and equipment

The heavy machinery and equipment industry consumed about 158.2 kilograms of plastics per year between 1980 and 1985, primarily to replace metals. Although a small portion of plastics substitute for rubber in hoses and gaskets, most polymer materials are used to manufacture parts such as casings, shields, instrument panels and housings formerly made from steel, cast iron, or aluminium. Plastics are used to achieve lower costs based on lighter weight and ease of fabrication. The total impact of substitution by plastics in this sector could be estimated, but the information available is not detailed enough to permit much differentiation among the types and quantities of metal displaced. As the competition of plastics in the industry, steel reportedly is the metal most affected by the substitution trend.

I. Semiconductor industry (ISIC 383228)*

1. Recent trends and current conditions

In 1992 the world semiconductor market reached some $59.9 billion, a 9.6 per cent increase over 1991 [46]. This growth rate is commendable, given that the increase for 1990/91 was 8.5 per cent, and that increases for earlier years averaged only 3 per cent. The recovery occurred during the first quarter of 1991 in Asia, the second quarter in the United States and the third quarter in Europe. However, no such recovery took place in Japan, where the market declined. Concerning growth rates in these countries and their regions, table IV.61 shows that for 1991/92 growth rates were 29.6 per cent in Asia and the Pacific, 19.7 per cent in the United States, 15 per cent in Europe and –7.4 per cent in Japan. In Europe, the rates varied between 14.3 per cent in Germany, 13.3 per cent in France, 7.1 per cent in the United Kingdom and 24.5 per cent in the rest of Europe. The high growth rate enjoyed in Asia and the Pacific is due mainly to sales of personal computers, with the electronic industry in Taiwan Province responsible for much of the growth. Other Asian countries showing rapid growth in table IV.61 are the Republic of Korea and China. In terms of market share, figure IV.24 shows that Japan, which previously accounted for more than 38 per cent of the global market is down to 32 per cent. The market share of Asia and the Pacific is close to that of Europe, about 18 per cent. Figure IV.25 provides market shares by major product sector.

(a) Underlying market forces

In Europe as well as in Japan, poor household demand has led to a decrease in the consumption of consumer goods; in the United States the slight recovery of the economy is unable to reverse this decline. The consumption of computers, however, has increased, and this has caused semiconductor sales to grow by 26 per cent in 1991/92. Also creating semiconductor demand in Europe has been increased anti-pollution regulations on the one hand, and growing security requirements on the other. Demand arose in the automobile industry as a result of growth in enhanced engine management systems, air bags and anti-skid braking systems; semiconductor sales thus rose by 15 per cent over the level of 1991. Other market segments such as telecommunications and industrial applications grew moderately by 5 per cent, but the military segment decreased by 3 per cent [46].

These growth patterns are roughly the same in different regions of the world, except in Japan, where nearly all product sectors experienced strong negative growth. The computer sector now accounts for more than 45 per cent of the total world semiconductor market, with one

*UNIDO acknowledges the contribution of Jean-Philippe Dauvin, SGS-Thomson Microelectronics.

Table IV.61. World semiconductor sales, 1991 and 1992

Region, country or area	1991 (million dollars)	1992 (million dollars)	Percentage change 1991-1992	Percentage share 1991	Percentage share 1992
Japan	20 935	19 384	-7.4	38.33	32.38
United States	15 376	18 410	19.7	28.16	30.75
Europe	10 115	11 470	15.0	18.52	19.16
Germany	3 280	3 750	14.3	6.01	6.26
United Kingdom	2 176	2 331	7.1	3.98	3.89
France	1 280	1 450	13.3	2.34	2.42
Other	2 268	2 823	24.5	4.15	4.72
Asia and the Pacific	8 182	10 600	29.6	14.98	17.71
Republic of Korea	1 805	2 410	33.5	3.33	4.03
Taiwan Province	1 834	2 600	41.8	3.36	4.34
Hong Kong	1 351	1 600	18.4	2.47	2.67
China	353	500	41.6	0.65	0.84
ASEAN	2 673	3 300	23.5	4.89	5.51
South Africa and New Zealand	166	190	14.5	0.30	0.32
Total	53 497	58 748	9.8	97.97	98.14
World	54 607	59 864	9.6	100.00	100.00

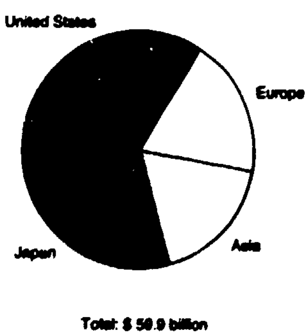
Sources: World Semiconductor Trade Statistics, *Blue Book* (San José, California, January 1993), p. 34; SGS-Thomson Microelectronics; and estimates based on presentations to the French Integrated Circuit Club (Paris, February 1993), German Notary Statistics (Stuttgart, December 1992), Anie Semiconductor Club (Milano, January 1993), and Electrics Companies Industry Federation-United Kingdom Club (London, February 1993).

half of that due to the personal computer. The automotive segment represents 6 per cent of the world total. This approximately equals the share of the market for colour television sets [46].

(b) Underlying technological trends

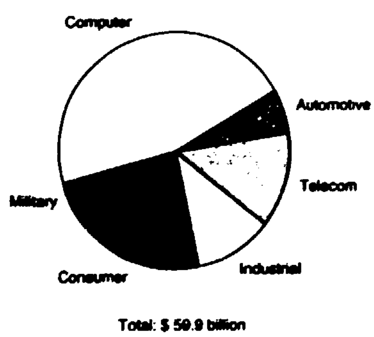
The strong growth in the personal computer industry as well as its emphasis on adopting the newest generation of chips has dramatically increased the demand for the 32-bit microprocessor (86 series from Intel mainly). As shown in table IV.62, growth increased by 22.1 per cent between 1991 and 1992. Demand for volatile memories (dynamic random access memory (DRAM) and static random access memory (SRAM)) mainly employed in the motherboard of a personal computer has also increased significantly. At the same time, the very depressed demand for mainframe computers has lowered the growth to 2.4 per cent for semi-custom semiconductors (application-specific integrated code). Other product applications experienced very moderate growth (Analog) or even negative growth (bipolar digital). Microcomponents (microprocessors, microcontrollers, microperipherals) shared 23.24 per cent of the total market, while total memories (volatile and non-volatile) occupied 25.49 per cent [46].

Figure IV.24. World semiconductor market, 1992



Source: J.-P. Dauvin, SGS-Thomson Microelectronics, Paris (1993).

Figure IV.25. Total semiconductor market share by sector, 1992



Source: J.-P. Dauvin, SGS-Thomson Microelectronics, Paris (1993).

Table IV.62. World semiconductor market growth, 1991 and 1992

Type of device	1991 (million dollars)	1992 (million dollars)	Percentage change 1991-1992	Percentage share 1991	Percentage share 1992
Micro processors	11 388	13 910	22.1	20.85	23.24
Memories	12 233	14 840	21.3	22.40	24.79
Semicustom	4 405	4 510	2.4	8.07	7.53
Analog	8 336	8 730	4.7	15.27	14.58
Bipolar digital	3 420	3 150	-7.9	6.26	5.26
MOS logic	4 852	4 820	-0.7	8.89	8.05
Optoelectronics	2 421	2 300	-5.0	4.43	3.84
Discrete semiconductors	7 552	7 604	0.7	13.83	12.70
TOTAL	54 607	59 864	9.6	100.00	100.00

Source: World Semiconductor Trade Statistics, *Blue Book* (San José California, January 1993), p. 34.

(c) Prices

Prices of a semiconductor device depend on three factors in particular: technological progress (for example, level of integration, size of the wafer and package), which in the past has been responsible for an annual decrease of 30 per cent of the cost of elementary components (such as transistors); the complexity of a chip (computing power for microcomponents, size of memory, number of gates for a full logic circuit), and changes in international business cycles. In 1992, technological progress intensified in microprocessors as well as in the memory segment. The microprocessor segment has witnessed the very rapid replacement of the Intel 386 by the 486; in the memory segment the 1 megabyte DRAM has been replaced by the 4 megabyte DRAM, and 4 UV-Eprom has been replaced by the first generation of Flash Eprom. The supply of semiconductors, which has exceeded demand over the past two years, has now come closer to equity.

In general, semiconductor prices increased by 10 per cent between 1991 and 1992. This total reflects price rises for microprocessors of 40 per cent, DRAM memories of 35 per cent, microcontrollers of 16 per cent, and analog integrated circuits of 8 per cent. However, discrete semiconductor prices did not grow at all; in fact prices of digital bipolar integrated circuits fell by 10 per cent, largely due to replacement by newer complementary metal-oxide semiconductor technologies. Underlying the overall price increase has been the demand exerted on two groups of semiconductors, microprocessors and DRAM memories. This phenomenon occurred previously in 1974, in 1984 (TTL bipolar logic), and again in 1988 (DRAM memories).

(d) Performance of major companies

In 1992, for the first time since 1986, Intel of the United States has displaced NEC of Japan as the world's leading semiconductor producer. The fastest growth experienced by a company in 1992 was that of Samsung of the Republic of Korea, which has had a growth rate of 54 per cent since 1983. Companies in Japan have shown very little growth, partly because of the depressed domestic market (about 7 per cent), and partly because of very tough competition from Samsung in the DRAM memory segment. In addition to Intel, table IV.63 shows that most United States companies experienced higher profits in 1992 than in 1991. Particularly high gains were experienced by Atmel, Cypress and Motorola.

European companies as a whole have shown moderate growth averaging about 5 per cent, this is well below the world average, and also well below the total growth of the European semiconductor market. Philips suffered from the collapse of demand for consumer products, and Siemens failed to place any new major products on the market. An exception was the good portfolio positioning and the good regional sales split of SGS-Thomson (22 per cent of sales in Asia, 21 per cent in the United States). This allowed the Franco-Italian company to grow by some 13 per cent.

2. *Industry restructuring*

(a) Market shares

Taking advantage of both a downturn in the Japanese economy and a heightened emphasis on the semiconductor trade agreement between the United States and Japan, the market share of North American companies grew significantly by 41.1 per cent between 1991 and 1992, compared with 38.4 per cent in 1990/91. Table IV.64 provides the share of the top six United-States-based companies (Intel, Motorola, Texas Instruments, National Semiconductor, Advanced Micro Devices, and AT&T). All of these companies experienced strong growth between 1983 and 1992. Overall, the market share of Japanese companies dropped by 3.6 per cent in 1992, representing a global share of 42.8 per cent. However, Japanese companies still managed to perform well in many areas. NEC retained its top ranking in the Japanese market, and Toshiba experienced strong sales in the logic and memory areas. In Europe, only SGS-Thomson recorded strong sales growth; two other major European companies experienced a very moderate growth or decrease, well below the market average. The top 20 semiconductor manufacturers are all suppliers of a broad range of products operating on a worldwide basis, covering between 25 per cent of the market in the case of Intel (which can be considered as an exception) and 88 per cent of the market in the case of NEC, Toshiba, Mitsubishi and Matsushita.

Table IV.63. Financial results of selected semiconductor-producing companies in the United States, 1991 and 1992

Company	Profit before tax 1991 (million dollars)	Profit before tax 1992 (million dollars)	Percentage change 1991-1992	Percentage share 1991	Percentage share 1992
AMD	128.0	195.0	52.3	14.20	9.37
Aanalog	17.8	11.5	-35.4	1.98	0.55
Atmel	10.2	13.9	36.3	1.13	0.67
Brooktree	12.2	10.6	-13.1	1.35	0.51
Burrs Brown	-10.0	1.0	a/	-1.11	0.05
Chips & Technologies	-48.0	-55.0	14.6	-5.33	-2.64
Cypress	20.0	27.0	35.0	2.22	1.30
Dallas Sc	15.0	18.0	20.0	1.66	0.86
Intel	818.0	1 066.0	30.3	90.77	51.23
IRC	26.0	7.0	-73.1	2.89	0.34
LSI Logic	8.0	-110.0	a/	0.89	-5.29
Motorola b/	454.0	583.0	28.4	50.38	28.02
National	-152.0	99.0	a/	-16.87	4.76
VLSI Technology	10.0	-33.0	a/	1.11	-1.59
Texas Instruments b/	-408.0	247.0	a/	-45.27	11.87
TOTAL	901.2	2 081.0	130.9	100.00	100.00

Source: Database of J.-P. Dauvin, SGS-Thomson Microelectronics, Paris.

a/ Not applicable.

b/ Total group.

Table IV.64. World's major semiconductor-producing companies, 1983-1992

Rank	Company and country	Sales 1992 (million dollars)	Percentage change 1983-1992	Market share 1992 (percentage)
1	Intel (United States)	5 064	20.0	7.7
2	NEC (Japan)	4 976	15.0	7.6
3	Toshiba (Japan)	4 765	19.0	7.3
4	Motorola (United States)	4 635	12.0	7.1
5	Hitachi (Japan)	3 902	13.0	5.9
6	Texas Instruments (United States)	3 052	7.0	4.7
7	Fujitsu (Japan)	2 583	16.0	3.9
8	Mitsubishi (Japan)	2 307	18.0	3.5
9	Philips (Netherlands)	2 109	10.0	3.2
10	Matsushita (Japan)	1 929	14.0	2.9
11	Samsung (Republic of Korea)	1 902	54.0	2.9
12	National Semiconductor (United States)	1 797	3.0	2.7
13	SGS-Thomson Microelectronics (France, Italy)	1 605	18.0	2.6
14	Advanced Micro Devices (United States)	1 502	10.0	2.3
15	Sharp (Japan)	1 388	19.0	2.1
16	Sanyo (Japan)	1 369	16.0	2.1
17	Siemens (Germany)	1 220	16.0	1.9
18	Sony (Japan)	1 150	28.0	1.8
19	Oki (Japan)	976	17.0	1.5
20	AT&T (United States)	924	19.0	1.4
	TOTAL	49 155	14.0	75.1
	World	65 453	..	100.0

Source: Dataquest, *Market Share Report* (San José, California, February 1984 and January 1993).

In general, United States subsidiary companies, except AT&T, have very little or no integration with their parent company. However, Japanese companies are fully integrated, and their internal transfer payments represent between 25 and 35 per cent of their total revenues. As a percentage of their corporation semiconductor purchases, this represents between 80 and 85 per cent, certainly the highest of any major world company. Companies such as Samsung, Goldstar and Hyundai in the Republic of Korea exhibit the same integration profile, the *chaebol* in the Republic of Korea behaving exactly as the Japanese *keiretsu*. Semiconductor companies in Europe possess a degree of integration somewhere between the United States companies (none or very little) and the fully integrated companies in Japan and the Republic of Korea. Internal transfers of semiconductors by Philips cover 55 per cent of all Philips semiconductor purchases; this percentage is lower at 35 per cent for Siemens and at 15 per cent for SGS-Thomson.

This global view can be disaggregated to the national and the regional level, as shown in table IV.65. In the United States, the major domestic companies possess a 55 per cent market share. The remaining 45 per cent belong mainly to companies in Japan, Republic of Korea and Europe. The high level of penetration by Japan and the Republic of Korea results from the fact that the United States electronic industry is heavily specialized in personal computer production. The latter requires heavy use of DRAM memories, a "specialty" of Japan and now of the Republic of Korea. In recent years the United States share of their domestic market increased as a result of the very strong position of Intel, based on its 32-bit microprocessor used in personal computers. A slight but definite recovery of the domestic market share of United States companies is expected to increase as a result of the relocation of personal computer production from countries of the Asian and Pacific rim towards Mexico and several other Latin American countries.

The European market has the greatest share of foreign firms. Indigenous producers such as Philips, Siemens, SGS-Thomson, Temic and GEC-Plessey possess 38 per cent of the domestic market. This small share is due to the displacement of Japanese companies closer to customers in Ireland, Germany and the United Kingdom.

The Asia and Pacific region seems to be divided between Japanese companies (with a 25 per cent to 30 per cent share) and United States companies (25 per cent). Companies of the Republic of Korea such as Samsung are increasing their share quickly, given their production of DRAM and SRAM memories. The Japanese market is dominated by Japanese semiconductor companies, mainly because of the high level of market restrictions faced by foreign companies. The presence in the Japanese market of some United States companies such as Texas Instruments and Intel is mainly due to the presence of IBM in Japan (purchasing microcomponents from Intel) and to specialty products (like bipolar TTL) produced by Texas Instruments and not by Japanese semiconductor manufacturers. Despite continuous political pressure from the United States Government to open the Japanese market, foreign penetration has not progressed much above 10 to 12 per cent of the total Japanese domestic market.

(b) *Changes in concentration*

The semiconductor industry has been in place only since the 1960s. During the past 30 years, the concentration ratio of the industry intensified; in 1992, the top 20 manufacturers represented 70 per cent of the global industry. This movement towards concentration has not been continuous, some years witnessed increased con-

Table IV.65. Market shares of the top 10 semiconductor-producing companies by region, 1992

Company	Sales (million dollars)	Percentage share	Company	Sales (million dollars)	Percentage share
Japan			*Europe*		
NEC	3 354	15.9	Philips	1 125	9.2
Hitachi	2 386	11.3	Intel	1 109	9.1
Toshiba	2 341	11.1	Motorola	976	8.0
Fujitsu	1 790	8.5	Siemens	980	7.4
Matsushita	1 538	7.3	SGS-Thomson	895	7.3
Mitsubishi	1 314	6.2	Texas Instruments	705	5.8
Sharp	1 080	5.1	NEC	481	3.9
Sanyo	879	5.2	National	415	3.4
Texas Instruments	858	4.1	AMD	346	2.8
Samsung	682	3.2	Hitachi	333	2.7
United States			*Asia*		
Intel	2 246	13.0	Toshiba	960	8.1
Motorola	2 317	11.4	Intel	885	7.4
Texas Instruments	1 192	5.9	Motorola	839	7.0
Toshiba	988	4.9	Samsung	835	7.0
National	823	4.0	Hitachi	488	4.1
AT&T	757	3.7	Texas Instruments	473	4.0
Hitachi	695	3.4	Philips	467	3.9
NEC	687	3.4	NEC	454	3.8
AMD	680	3.3	National	421	3.5
Samsung	614	3.0	Sanyo	417	3.5

Source: Dataquest, *Market Share Report* (San José, California, January 1993).

centration, and others relaxed concentration. During 1988 and 1989, for example, such an increase occurred. However, in 1992 the rate among the top 20 manufacturers declined to 71 per cent, down from 75 per cent in 1989.

The major causes of concentration have been the increasing cost of new technology and of manufacturing equipment. In the 1970s, total expenditure on R and D and capital spending did not exceed 20 per cent of the total sales of the industry leaders. Today this percentage has jumped to 40 per cent, equally distributed between R and D and capital spending. In 1992, the most advanced factory launched by Samsung to produce 16 megabyte DRAM memories required expenditures of $890 million. In 1985, the cost of an equivalent unit producing 256 kilobyte DRAM memories was about $250 million. Economies of scale have now become very important; a semiconductor company must reach a critical size estimated for a broad range of semiconductor companies to be 5 per cent of the world market. This would mean a lower share for the specialist and niche companies.

During the past 10 years, more than 12 semiconductor companies have disappeared or have merged. None of them had sales beyond the critical 5 per cent level. Companies which have been bought by their competitors are as follows: Mostek (bought in 1985 by Thomson-Semiconducteurs); Fairchild (merged with National Semiconductor in 1987); and General Electric (RCA merged with GE RCA and Harris Semiconductor in 1989). In Europe, SGS Microelectronics merged with Thomson-Semiconducteurs in 1987; and Matra Harris, Telefunken and Siliconix were merged in 1992 under the Daimler-Benz flag to build Temic, a $470 million sales company.

(c) Future mergers

More than 150 semiconductor companies are now operating on the worldwide merchant market. An additional 15 are manufacturing semiconductors for their own use. An exception is IBM, which has an estimated production value close to $5 billion, but which embodies captive transfers. As a result, IBM is not ranked among the semiconductor manufacturers. There are three categories among the 150 merchant semiconductor companies . The top 10 with an average of 5 per cent market share by company are all suppliers of a broad range of products. Their size, broad portfolio of products and technology allow them to be in a relative "safe zone" in terms of continuing to exist on their own. Semiconductor companies which are not as large, with an average world market share of 2 per cent, but which are also broad-range companies are considered in an "unstable zone". That is, they could disappear quickly. To survive, they have to grow very fast; otherwise they will be obliged to sell part of their portfolio in order to become specialists. The remaining semiconductor companies are specialist or niche companies, operating on a very small portion of the total semiconductor market, whether by region, country or product. A typical example of these companies is Cypress semiconductor, which holds the second position in very fast SRAM manufacture, but numbers 30 in overall manufacturing. The specialists can be considered as being in a "relatively quiet zone". In fact, during the past 15 years practically none of the companies belonging to this group has disappeared.

(d) Government research support

National Governments have been historically very active in helping the semiconductor industry. Today the major support programmes are semiconductor machinery and technology (Sematech) in the United States, the Joint European Submicronic Silicon Initiative (JESSI) in Europe, and the Taiwan Submicron Consortium in Asia and the Pacific.

Semiconductor machinery and technology. Sematech is moving ahead with its R and D strategy to make software technologies such as modelling, simulation and computer-integrated manufacturing available for chip production. One goal is to reduce the process technology development cycle by some 25 per cent. Sematech also has focused its efforts on the needs of high-volume, integrated circuit manufacturing with broad product portfolios. This satisfies larger member companies. At the other end, firms such as Micron, which need advice for a much narrower product line, do not receive much help. This may have contributed to the decision by Micron to reconsider its membership in Sematech. This group is also trying to become more open about the knowledge of improvements it has fostered. The organization, funding and goals of Sematech are summarized in table IV.66. Although Sematech receives half of its budget of $200 million per year from Washington, it faces uncertain funding for 1993. About $80 million was allocated on a preliminary basis for Sematech in the fiscal year. However, in late June, the United States House Defense Appropriations Subcommittee awarded as much as $100 million in funding.

Sematech partnership for its total programme involves an industry-wide effort designed to alter the way companies interact. The programme is based on the following objectives: to make semiconductor companies aware that they are dependent on every other company in the supply chain and that partnering is essential to save the infrastructure; manufacturing excellence must be achieved to ensure survival; and partnering for total quality is a hands-on, step-by-step process that formalizes an industry commitment to improve the semiconductor infrastructure and regain the leadership of United States industry in semiconductor manufacturing.

Joint European Submicronic Silicon Initiative. Formed in 1989 to strengthen Europe's semiconductor position and to accelerate research in submicron technology and manufacturing, JESSI varies greatly in its structure and purpose from that of Sematech. The structure and goals of JESSI revolve around four programmes: manufacturing and technology for engineering samples of 16 and 64 megabyte DRAMs, 4 and 16 megabyte SRAM, and erasible programmable read only memory; design and technology to improve the presence of European materials, back-end processes and production equipment in world production; an application program that encourages usage of European computer-aided, design software; and basic and long-term research projects (including 0.25-micron complementary metal-oxide silicon technology), circuit design methodology, lithography and other processing methods.

JESSI has been encumbered with funding problems since its inception. Originally, national Governments and the EEC were each to support JESSI with 25 per cent of the necessary funding. As shown in table IV.67, EEC and national Governments have fallen well short of their

Table IV.66. Development of Sematech, 1987, 1992 and 1993

Item	1987	1992	1993 and beyond
Members	14 founding members including AMD, AT&T, Digital Equipment, Harris, HP, IBM, Intel, LSI Logic, Micron, Motorola, National, NCR, Rockwell, TI. Department for Research Programmes Associations, and SEMI/Sematech also sit on the board.	13 members remain. LSI left in January, citing lack of direct benefits and internal financial pressures. Harris and Micron have also reserved option to leave by year's end.	Membership should stabilize at 11, given Sematech's increased focus on needs of large integrated circuits companies.
Funding	100 million dollars per year from corporate members and $100 million from DoD, with DoD funding guaranteed through 1992.	$100 million each from members and DoD, but Congress to reconsider DoD funding. While DoD has requested $80 million for 1993, Congress is expected to provide the full $100 million.	Probably no change, but expected DoD funds to be allocated on project-by-project basis now that Sematech is achieving success.
Results	Attempt to develop next-generation chip-making processes meets with difficulty. Pressures among members reduces effectiveness.	Goals scaled back to improve United States integrated-circuit equipment-maker base, but increasing focus on needs of large chip companies causes some smaller members to depart.	Goals shift again. New five-year plan emphasizes use of software in integrated-circuit manufacturing systems. Even critics say Sematech's direction is better.

Source: *Electronics Business* (New York, McGraw-Hill, 1992).
Note: DoD = Department of Defense.

commitments to the consortium. The results are a budget that regularly falls $600 million short of its original proposal, and a majority of projects that have been slowed or stalled because of inadequate funding. Though research results are not expected from JESSI until 1996, many observers are unimpressed with what they have seen so far. However, judging how well the consortium has fared is difficult because JESSI is just completing its "start-up phase" and moving to the full research activities for which it was intended.

In Europe it has been claimed that JESSI is too weak to move ahead with its plans because of a growing dependence of many of its member companies on foreign cooperation and alliances. Others charge that the technological advances of JESSI are being compromised by unwarranted political interference. For example, JESSI ejected ICL Ltd from three computer-aided design projects after the United Kingdom company was bought by foreign-owned Fujitsu. Meanwhile, IBM Europe has been allowed to participate in two projects.

Taiwan Submicron Consortium. In July 1990, Taiwan Province took a big step forward in its attempt to move from imitator to innovator by opening the doors of the Taiwan Submicron Consortium. The goal of the Consortium has been to develop and to transfer leading-edge process technology to local semiconductor manufacturers. The programme is considered a highly ambitious project for Taiwan Province, as the area seeks to move from low-technology to high-technology electronics production. The Consortium has been organized to develop submicron technology, and has two full members: Taiwan Province Semiconductor Manufacturing Company and United Microelectronics Corporation. It also has five associate members: Elron Technology, Inc.; Holtek Microelectronics, Inc.; Macronix; Mosel-Vitelic, Inc.; and Winbond Electronics Corporation.

When the Consortium first started, the goal was to reach 0.5-micron technology by 1995. Some members now say that is not aggressive enough. TI-Acer, located in Hsinchu, has already started incorporating a 0.55-

Table IV.67. Proposed and actual funding levels for JESSI

Proposed funding (percentage by donor)		Actual funding (percentage by donor)	
European Community	25	European Community	8
National Governments	25	National Governments	22
Industry	50	Industry	70
Total dollar amounts (1989-1996)	$ 3 billion	Total dollar amounts (1989-1996)	$2.4 billion

Source: JESSI, *Annual Report* (New York, January 1992).

micron process in its 4 megabyte DRAM manufacturing process. TI-Acer also plans to have a supershrink 4 megabyte DRAM in production in 1993 using the same 0.55-micron process, and will apply the same process technology to its 16 megabyte DRAMs when the market warrants.

With a few competitors in Taiwan Province already using half-micron technology, some consortium members are pushing for greater process-technology goals. The Electronic Research and Service Organization (ERSO), which oversees the Consortium, has a second phase of process technology development under consideration. It proposes that a 0.35-micron technology be the starting-point for advanced process development.

Another concern being raised by member companies is what will happen to the 12,000-wafer-per-month fabrication once the project is completed in 1995. Previous ERSO projects have spun off as competitors. Consortium members have received assurances from the Government of Taiwan Province that the 200-millimetre fabrication will not become a competitor, though no agreement has yet been reached.

3. *Capacity utilization and expansion plans*

The semiconductor industry has always been capital-intensive. On average the industry used to invest around 20 per cent of its total value of sales on an annual basis. A major part of these expenses have been devoted to new facilities (90 to 95 per cent of the total amount spent each year), and a minor part goes to equipment maintenance. A traditional rule in the industry has been that of "one dollar to one dollar". This means that to obtain an increase in sales of $1 for a given year, the industry has to invest $1 in capital in the previous year. In the early 1970s, the ratio was close to $2. To obtain $2 of additional sales, the amount of investment that had to be realized in the previous year was close to $1. However, increasing costs of technology, largely due to the increase in the level of chip integration, has dropped this ratio to 0.5. Today a $2 investment generates only $1 of additional sales in the following year.

An example of the increasing cost of the investment is provided by DRAM memories, the most advanced device. As shown in table IV.68, in 1984 the cost of investment necessary to produce 1 million pieces per month for the 256 kilobyte DRAM device was $35 million; the investment cost for a 16 megabyte DRAM device is now $210 million. This cost is likely to jump to $450 million for the 256 megabyte DRAM. For the moment, there are few factors that would suggest a slow-down in these rising investment costs. In addition, the necessity of a firm reaching a critical size to compete is likely to lead to further concentration between companies.

Levels of capital investment by individual companies in 1991 and 1992 are summarized in table IV.69. Those figures confirm a decline in spending in all major regions. However, as will be explained below, the decrease has been particularly profound in Japan.

(a) *North America*

Capital spending in North America also fell in 1992, but only by 8 per cent. For 1993, one source [47] expects North American capital spending to increase by 13 per cent. It is likely to reach $4 billion in 1993, and should continue to increase at a double-digit, or near double-digit growth rate through 1996. While capital expenditure in Japan outstripped that in North America from 1988 to 1992, the same source forecasts that spending in North America will be larger than that in Japan between 1993 and 1996.

Growth in capital spending in North America is not likely to spread evenly among all semiconductor companies. Rather, it will depend heavily on the product portfolio of the semiconductor company and the end-markets for its chips. Companies such as Intel are doing exceptionally well, and will make investments accordingly, while companies such as IBM will trail in capital spending, at least in the near term.

There are several downward pressures retarding the growth of capital spending in North America. These include: the decline in investment in North America by Japanese semiconductor manufacturers; and the pursuit by United States semiconductor companies of high-value-added niche applications that concentrate on the design and the use of overseas foundries to manufacture chips.

(b) *Europe*

Growth in capital spending in Europe continues to be unexciting. It declined by 18 per cent in 1991 and by another 12 per cent in 1992. One source [47] predicts that it will decline by 4 per cent in 1993. That source also forecasts 20 to 30 per cent growth for 1995 and 1996; however, this forecast is clouded with uncertainty. Capital spending in Europe was surpassed by capital spending in Asia and the Pacific in 1988, and currently European investment accounts for only about 10 per cent of global semiconductor investment. An interesting perspective is that in 1993 capital spending in Europe may be only $1 billion, which is considerably less than the $1.6 billion which Intel plans to spend in 1993.

(c) *Asia and the Pacific*

When looking at recent trends in capital spending, one immediately recognizes the big surge in Japan between the years 1987 and 1991; such spending rose to a peak

Table IV.68. Growth of DRAM memory investment cost
(Million dollars of investment for 1 million pieces per month)

Item	DRAM memory			
	256 Kilobytes	1 Megabyte	4 Megabytes	16 Megabytes
Generation	35	70	120	210
Year of market introduction	1984/85	1988/89	1990/91	1993/94

Source: SGS-Thomson Microelectronics, *Red Book* (Paris, January 1992).

Table IV.69. Capital spending estimates by semiconductor companies, 1991 and 1992

Company	1991 (million dollars)	1992 (million dollars)	Percentage change 1991-1992	Percentage share 1991	Percentage share 1992
Japan					
NEC	752	615	-18.2	8.72	8.42
Hitachi	650	516	-20.6	7.54	7.07
Toshiba	790	500	-36.7	9.16	6.85
Mitsubishi	665	476	-28.4	7.71	6.52
Matsushita	460	353	-23.3	5.34	4.83
Sony	520	377	-27.5	6.03	5.16
Fujitsu	700	520	-25.7	8.12	7.12
North America					
Intel	948	1 000	5.5	11.00	13.69
Motorola	763	650	-14.8	8.85	8.90
Texas Instruments	383	323	-15.7	4.44	4.42
AT&T	170	153	-10.0	1.97	2.10
National	120	130	8.3	1.39	1.78
LSI	130	100	-23.1	1.51	1.37
Republic of Korea					
Samsung	435	590	35.6	5.05	8.08
Goldstar	360	200	-44.4	4.18	2.74
Hyundai	160	150	-6.3	1.86	2.05
Europe					
Philips	146	170	16.4	1.69	2.33
SGS-Thomson	250	280	12.0	2.90	3.83
Siemens	220	200	-9.1	2.55	2.74
TOTAL	8 622	7 303	-15.3	100.00	100.00

Source: Database of J.-P. Dauvin, SGS-Thomson Microelectronics, Paris.

of $5.6 billion in 1991. In 1992, spending in Japan declined by almost 30 per cent to $4 billion, and is likely to fall even further in 1993 to $3.5 billion. Capital spending is likely to rebound in 1994, but capital spending is not expected to reach the 1991 peak of $5.6 billion, even by 1996. This slow-down in capital spending can be attributed not only to the troubled domestic economy, but also to the increasing overseas investment of Japanese semiconductor manufacturers. The latter divert the much-needed investment away from Japan.

Sales have weakened for Japanese IC manufacturers as well. Domestic rivalry among Japanese integrated circuit firms has led to the building of several fabrication units, each alleged to be able to produce more and more DRAMs. Realizing that the world cannot absorb excessive DRAM production, and given a worldwide economic slow-down, Japan now has many fabrication units running at less than anticipated capacity, and plans for additional facilities have been put on hold. However, it remains the world leader in capital spending, despite the 30 per cent reduction in such spending in 1992.

The forecast for capital spending in the Asia and Pacific region as a whole remains bright. Although capital spending in Japan, Europe and North America all decreased in 1992, spending in Asia and the Pacific in 1992 increased by a modest 2 per cent, despite the cancellation or "push-out" of plans for new fabrication units. Modest growth of 4 per cent is forecast for 1993 [48], rising to 9 per cent in 1994. Capital spending also is predicted to grow by 20 per cent in 1995 and 1996.

In the other areas of Asia and the Pacific, Governments are targeting the semiconductor industry as a cornerstone of their industrial policy. China, India, Malaysia and Thailand can be expected to win a larger share of the capital spending in the region. In 1991, capital spending in Asia and the Pacific accounted for 17 per cent of all worldwide semiconductor investment, and will reach 22 per cent in 1994. That is, nearly a quarter of all semiconductor equipment will be sold in this region in the near future. As shown in table IV.70, these regional changes have clearly modified the shares of capital spending according to the nationality of the manufacturers.

In retrospect, cumulative Japanese capital spending from 1989 to 1992 represents as much as 50 per cent of world spending. Clearly this shows the basic strength of Japanese companies on the worldwide scene, and hence shows the relative significance of their decline in investment in 1992. As shown in table IV.71 the average decrease of investment has been 4 per cent per year from 1989 to 1992. This trend contrasts with the period from 1980 to 1989, during which annual growth exceeded 20 per cent per year. These trends suggest that in 1993 capacity limitations could lead to an increase in semiconductor prices. In fact this situation started to develop in the last quarter of 1992, and has continued during the first quarter of 1993. This trend is further confirmed by the increase in the ratio of bookings to billings and by a rise in semiconductor inventories.

Assuming that the semiconductor companies will be extremely cautious all through 1993 in expanding their

Table IV.70. Breakdown of semiconductor capital spending by region, 1989, 1990 and 1992
(Percentage)

Region	1989	1990	1992
Japan	45	51	41
North America	35	31	40
Asia	8	9	10
Europe	12	9	9
TOTAL	100	100	100

Source: Dataquest, *Semiconductor Report* (San José, California, February 1993).

capacities, some increases are still likely to occur just to restore profits. An upward market adjustment should thus begin during 1994, which suggests a cyclical market decline at least by 1995.

4. *Technological trends*

The nature of semiconductor process technologies has changed considerably since the 1970s. Table IV.72 shows the product life cycle for the more popular technologies. For instance, the P-channel metal-oxide semiconductor (PMOS), a mainstream technology in 1970, is now obsolete. In fact, there are probably less than 10 suppliers in the world that still manufacture integrated circuits using PMOS technology. However, no technology of the past 21 years has dominated the market for integrated circuits as CMOS does at present. In fact, integrated circuits produced using CMOS are likely to represent 81 per cent of the total merchant market for integrated circuits (in dollar terms) in 1996. Bipolar complementary metal-oxide semiconductor (BiCMOS) integrated circuits are likely to show a 52 per cent growth rate between 1991 and 1996 (rising from $650 million to $5.3 billion) [49]. Even with such a high growth rate, BiCMOS integrated circuits will represent only 5 per cent of the total integrated circuits market, and will still be considered a niche technology. CMOS technology has been in the "maturity" stage of its life cycle since the mid-1980s, and is still likely to be in the maturity stage well into the twenty-first century. As of 1993, no new technology has appeared with the potential to dethrone CMOS as the mainstream process for integrated circuits in the foreseeable future. Cost-effectiveness, steadily increasing performance and consistently high levels of investment in R and D by the manufacturers of integrated circuits are likely to keep CMOS ahead.

It should be added that CMOS application-specific integrated circuits will continue to replace n-channel metal-oxide semiconductor (NMOS) DRAMs and microprocessor unit devices. The switch from one technology to another in the memory market for the metal-oxide semiconductor (MOS) (for example, 256 kilobyte DRAMs are primarily NMOS, whereas 1 megabyte DRAMs are all CMOS) can happen very quickly when moving from one generation to the next. The popularity of CMOS as compared with NMOS, PMOS, and BiCMOS is very evident. In fact BiCMOS and CMOS are likely to represent 99 per cent of the total MOS market in 1996. As was shown earlier, the recent dramatic shift from NMOS to CMOS is primarily due to memory devices. CMOS became the technology of choice as MOS memory density reached and surpassed 1 megabyte. All 1 megabyte DRAMs are produced using CMOS technology, and nearly all of the very large-scale integration (VLSI) and ultra-large-scale integration (ULSI) technology of the memory devices of the future will be CMOS or BiCMOS.

Japanese companies currently possess the majority of the market for MOS integrated circuits. This domination of major memory markets, coupled with their holding of a large portion of the gate array market, have propelled their market share to 50 per cent of the segment of MOS integrated circuits.

United States companies occupy the largest percentage of the bipolar market with a 43 per cent share. Some of the large United States companies are still heavily involved in bipolar digital technology, which may eventually prove to be advantageous for manufacturing BiCMOS devices. Those with expertise in emitter-coupled logic (Motorola, National etc.) may benefit the most initially.

Each of the major trends is reviewed in greater detail below.

Table IV.71. Regional growth of semiconductor capital spending by private companies, 1989-1992
(Million dollars)

	Spending by private companies				Percentage change	Percentage share	
Region	1989	1990	1991	1992	1991-1992	1989	1992
Japan	5 455	6 040	5 600	3 900	-30.4	11.19	6.51
United States	3 300	3 650	3 385	3 700	9.3	6.77	6.18
Europe	980	1 050	920	800	-13.0	2.01	1.34
Asia	920	1 050	975	994	1.9	1.89	1.66
Total	10 655	11 790	10 880	9 394	-13.7	21.85	15.69
World	48 763	50 519	54 607	59 865	9.6	100.00	100.00
Percentage of world sales	22	23	20	16	20 a/		

Source: World Semiconductor Trade Statistics, *Blue Book* (San José, California, January 1993).
a/ Average.

Table IV.72. Changes in market share of semiconductor process technologies, 1970-1996

Process technology	Characteristics	Market share 1970	1980 (percentage)	1991	1996[a/]
MOS					
PMOS	Slow, obsolete	31	5	1	-
NMOS/higher-frequency MOS	Becoming obsolete	2	37	5	1
CMOS	Mainstream technology, inherent difficulties resolved (latch-up, slow operation)	2	10	71	81
BiCMOS	Early in its life cycle, offers both MOS and bipolar advantages	-	-	1	5
Bipolar					
Emitter-coupled logic	Fastest silicon-based process, receiving increased attention while competing with gallium arsenide	3	3	3	2
Transistor-transistor logic	Slow, obsolete	29	8	1	-
Speed/large-speed TTL	Mainstream bipolar logic, under pressure from MOS application-specific integrated-circuits	7	13	3	1
Linear	Mainstream analog technology, some competition from CMOS, especially in analog/digital converters and amplifiers, and gallium arsenide	26	24	15	9
Galliun arsenide	Cost competitive with emitter-coupled logic	-	-	1	1

Source: World Semiconductor Trade Statistics, *Blue Book* (San José, California, January 1993).
a/ Forecast.

(a) CMOS

CMOS technology continues to be more popular than other technologies because of several important advantages, including: low power density; relatively good noise immunity and soft error protection; low-threshold bias sensitivity; design simplicity and relatively easy layout, especially for application-specific integrated circuits; and capability for lower power analog and digital circuitry on the same chip. Because of these advantages, CMOS is expected to be the technology of choice for the VLSI and ULSI products of the future. Just as NMOS replaced the slower and more power-hungry PMOS technology, CMOS has now supplanted NMOS. The speed and power characteristics of CMOS are major contributors to this increase in market share. In fact, CMOS will approach bipolar speeds as lithography techniques improve and smaller feature sizes are manufactured.

(b) BiCMOS

Because BiCMOS offers advantages over both bipolar digital and CMOS integrated circuits, it will eventually replace many bipolar and CMOS integrated circuits. These include microprocessor units, bus drivers, analog-to-digital converters, track/hold amplifiers, disk-drive controllers, memory controllers, SRAMs, DRAMs, video RAMs, programmable logic devices (PLDs), gate arrays, and standard cells. The movement to incorporate megacell functions on-chip is also helping to spur the acceptance of BiCMOS technology for gate array devices. Because of the high degree of flexibility of the circuit characteristics in BiCMOS technology (that is, the ability to use high-drive and high-performance bipolar and low-power-consumption CMOS) and the overall performance edge over pure CMOS, BiCMOS is one segment of the market for integrated circuits that is gaining in popularity.

(c) Integrated circuits

Integration levels have grown continually since the invention of the integrated circuit. The MOS integration levels have increased an average of 35 to 50 per cent per year for the past 21 years. MOS memory devices ULSI integrated circuits are expected to contain over 256 million transistors by 1996 and over 1 billion transistors per chip are forecast for the year 2000 [50]. As the number of transistors per die have escalated, the die area of new integrated circuits has increased by about 13 per cent per year from 1970 to 1992. The trend towards larger die sizes is forecast to continue at that rate into the mid-

1990s. The future sizes for a "tight production resolution" device have decreased from about 3-microns in 1980 to about 0.4-microns in 1992. This represents about a 15 per cent decrease every year. The trend is expected to continue, and feature sizes are forecast to be 0.2-microns by 1996 [51]. It is interesting to note that by 1996 1-micron feature sizes will be considered obsolete. Because of its relatively low cost and technical advances, optical lithography is now forecast to have a much longer life than originally expected. Optical techniques will be the mainstream of integrated circuit lithography for the rest of this century.

5. *Short- and medium-term outlook*

The world semiconductor market is expected to grow at more than 10 per cent per year, with 15 to 20 per cent anticipated for 1993. The regional growth rate should be uneven. Asia and the Pacific will exceed world average growth by a factor of two; meanwhile, the Japanese market is likely to remain stagnant. Sufficient quantities of semiconductors should be available to maintain market equilibrium. However, if the Japanese economy rebounds quicker than expected, the increased demand will upset the equilibrium and thus boost prices, as well as triggering a strong move to replenish inventories. The recent dramatic changes in regional growth rates should lead to a restructuring of the semiconductor market, and consequently that of the industry. Lack of domestic demand will affect the performance of Japanese companies and consequently their investment trends.

Strong growth of the computer segment should push its consumption close to 50 per cent of the total world semiconductor market. This very high percentage is due not only to the strong demand for personal computers, but also to the weak demand from the consumer sector. The automotive segment should continue to exceed the average growth of the whole market. More spectacular growth should come from the sales of microprocessors and of memories. The underlying forces here are the growth of personal computer production and also of portable phones and car electronics (anti-lock braking systems, air bags, injection). The bipolar digital categories should continue to decrease as a result of technological replacement by CMOS integrated circuits. The discrete market should grow only moderately.

(a) *Consumption*

During the past 30 years the world semiconductor market has developed with compound annual growth of sales close to 15 per cent. During the years 1987 to 1992 this growth rate declined slightly to 13 per cent. Table IV.73 shows a slightly lower annual rate of 10.1 per cent forecast for the period from 1992 to 1997. This perspective is based on the assumption of a general slowing-down of the world economy and declining consumer demand with the progressive saturation of the sales of electronic equipment and desk-top personal computers; newly emerging applications such as multimedia communication and high-definition video techniques (HDVT) are likely to have only a minimal impact on demand. The market cycles which occurred regularly during the past 30 years are now lessening in magnitude. If the market begins to decline in 1995, it should rebound by the end of the cycle.

Forecasts of changes in regional market shares can also be interpreted from table IV.73. It appears that the United States share has stabilized. The geographic dispersion of the electronics industry which contributed to the decline of the United States market should slow down and even change by the relocation of producers to Mexico. The European share of the world market should also remain constant. Here the delocalization process will be compensated for by production increases as a result of recovery and expansion in Eastern Europe. With regard to Japan, the constant increase in labour costs, a very high degree of saturation of the internal market and increasing competition from other Asian countries should clearly slow down the potential for growth in domestic electronics and semiconductor production. Most rapid growth should take place in the Asia and the Pacific region, with a growth rate of 14.7 per cent expected [51]. The future of those regions will depend on the permanent increase in domestic demand, which it is hoped will begin by 1997.

Table IV.73. Forecast semiconductor market growth by region or country, 1992 and 1997

Region	1992 (billion dollars)	1997 (billion dollars)	Annual percentage change 1992-1997	Percentage share 1992	Percentage share 1997
United States	18.4	29.5	9.9	30.72	30.41
Japan	19.4	27.5	7.2	32.39	28.35
Asia and the Pacific	10.6	21.0	14.7	17.70	21.65
Europe	11.5	19.0	10.6	19.20	19.59
TOTAL	59.9	97.0	10.1	100.00	100.00

Source: J.-P. Dauvin, *Semiconductor Market Forecast* (Paris, SGS-Thomson Microelectronics, 1993).

Product growth reported in table IV.74 suggests strong gains by memories and microcomponents, which are expected to represent more than one half of the total semiconductor market. Semi-customs should also continue to increase their share of the total market to 9.28 per cent.

(b) *Investment*

From the 1970s to the 1990s capital investment grew by 18 per cent per year, a growth rate exceeding that of sales. These trends led to permanent overcapacity, which clearly generated the 1985 and 1990 market slumps and

Table IV.74. Forecast semiconductor market growth by product, 1992 and 1997

Type of product	1992 (billion dollars)	1997 (billion dollars)	Annual percentage change 1992-1997	Percentage share 1992	Percentage share 1997
Microprocessorss	13.9	26.0	13.3	23.24	26.80
Memories	14.8	27.0	12.8	24.75	27.84
Semicustom	4.5	9.0	14.9	7.53	9.28
Analog	8.7	13.0	8.4	14.55	13.40
Bipolar digital	3.2	2.2	-7.2	5.35	2.27
MOS logic	4.8	6.7	6.9	8.03	6.91
Optoelectronics	2.3	3.1	6.2	3.85	3.20
Discrete	7.6	10.0	5.6	12.71	10.31
TOTAL	59.8	97.0	10.2	100.00	100.00

Source: J.-P. Dauvin, *Semiconductor Market Forecast* (Paris, SGS-Thomson Microelectronics, 1993).

continuous price decreases experienced by memories, such as DRAM, SRAM and erasable programmable read-only memory (EPROM). These production capacities were mainly built by semiconductor manufacturers in Japan, followed by those in the Republic of Korea that started to invest heavily in 1989. Since 1990, and especially in 1991 and 1992, the slump in the Japanese semiconductor industry and the general slowing-down of the world economy has led to a very sharp decrease in investment, leading to undercapacity in 1993 and probably during the first half of 1994. The Japanese semiconductor companies should continue to limit their efforts in building new capacity. However, companies in the Republic of Korea, mainly Samsung and Goldstar, will continue to invest heavily in their attempt to displace their Japanese competitors in the DRAM memories market. Overall, the investment of Asian semiconductor companies should amount to about 12 per cent of world capital spending. In Europe, the only semiconductor company that should continue to invest heavily is SGS-Thomson; Philips is suffering from the lack of demand in consumer goods; and the resources of Siemens are limited because of its continuing losses.

The expected heavy investment in the Asia and Pacific region will make it the third market for semiconductors, surpassing Europe in 1993; in particular, China, which has begun to invest in the semiconductor industry, offers low-cost labour as well as huge market potential. It could be that by 1995, 20 per cent of the world's $12 billion investment in the semiconductor industry will be made in Asia, 12 per cent of which will come from indigenous companies.

(c) Industry structure

The outlook can be viewed in terms of the role to be played by the major national producer companies. A slight increase in the share of United States companies in world semiconductor production is expected as a result of their strong presence in microprocessors. A slight decrease in share is foreseen for Japanese companies, which will concentrate on dedicated integrated circuits, leaving the DRAM segment to companies in the Republic of Korea. Expected strong investments in 1994-1995 in the DRAM and SRAM memories segment, and probably in the FLASH-EPROM segment should enable, the Republic of Korea to reach a possible 10 per cent of world production in 1995. The European companies should keep their share constant mainly as a result of the potential of SGS-Thomson, with the two other major companies regularly losing market share on a world basis. Up to 1995 and probably to 2000, no new semiconductor company sharing more than 2 per cent of the world market is likely to start up. This implies little shift in the role of companies in the global market structure.

J. Power-generating equipment (ISIC 3831)*

1. Recent trends and current conditions

Unlike many other engineering sectors, the world market for power-generating equipment is benefiting from a sustained period of steady growth. Historically, the market reached a peak in the mid-1970s, when more than 150 gigawatts (1 gigawatt = 1,000 megawatts) were ordered in 1974; it then fell to a low point of about 50 gigawatts in 1985. At present the world market is around the range of 60 to 70 gigawatts, and for the next decade major equipment suppliers expect that the level of annual orders will grow to reach between 80 and 85 gigawatts, or possibly more by the end of the century. To put these figures in perspective, 1 gigawatt would be a very common size for a new power station, although stations as big as nearly 3 gigawatts have been built by combining units, a practice which is becoming increasingly common in Japan.

The following new trends have emerged in the power-generating equipment market over the past three years:

(a) A booming level of demand for heavy-duty gas turbines and large combined-cycle power plants from a level of around 10 gigawatts a year to over 30 gigawatts a year, representing some 50 per cent of global thermal power demand;

(b) A depressed market for hydroelectric power orders, which are down from more than 10 gigawatts a year to less than 5 gigawatts. Many of the best sites for large-scale hydropower generation are already in use, and the remaining ones present environmental challenges;

(c) A new wave of orders in the United States and Western Europe, as older, coal-fired plants are replaced by cleaner, more efficient combined-cycle generation;

(d) An almost complete dearth of orders in Eastern Europe and the former USSR, with the exception of the former German Democratic Republic, now part of unified Germany;

(e) A continuous high level of orders in Japan;

(f) A stable level of orders in developing countries, limited as usual by financial constraints.

In fact, demand now appears to be shifting from the United States and Europe to the countries of the Pacific rim [52]. This is one of the most important recent trends in the industry, but there are a number of other significant influences. Across the world, from the United States to the United Kingdom and more recently in Asia, the customer market is changing, with independent power producers or non-utility suppliers in the United States and private power producers elsewhere taking the place of State-owned utilities. These customers are looking for a power plant that is quicker to build and cleaner, thus complying with stricter regulations on emissions. Power-generating equipment has always been politically sensitive; the large-sized orders have implications both for suppliers in terms of their ability to keep their factories working, and for clients, in terms of their ability to pay. Globally, supplier countries have won orders in regions where their political influence is strong, and such ties have continued long after the dismantling of colonial empires. There is evidence that some of the ties are now loosening, even in home markets, where Governments that owned utilities traditionally placed orders with domestic manufacturers. For major suppliers, the overriding effect of the market shifts has been globalization, in sales forces, service centres, manufacturing centres and local partners and licences. At the same time, suppliers have undergone significant restructuring to reduce their

*UNIDO acknowledges the contribution of Andrew Baxter, *Financial Times*.

overhead costs and retain the financial ability to respond to the new technological and market challenges. Since the current market is only about one half that of 1974, there was heavy restructuring of the industry in the late 1980s.

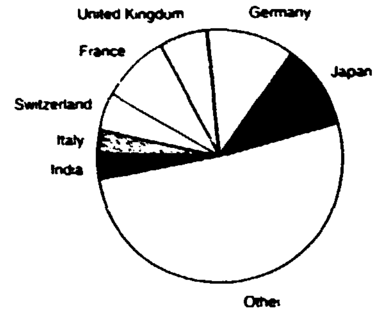
Recent trends in the main markets will now be reviewed, beginning with Asia. In north-east Asia there is a high level of activity, with China, Taiwan Province and the Republic of Korea all building up their power capacity to cope with their various industrial development programmes. China, which has an enormous development programme, is building coal-fired, combined-cycle nuclear stations. In addition, the country would need to invest at least $8.7 billion at 1993 prices in power plants up to the year 2000 to tackle energy shortages, and was ready to allow 100 per cent foreign ownership of power stations [53]. The South-East Asian market is growing dramatically from a small base, and countries such as Malaysia and Indonesia, which do not have a power-generating equipment industry, are importing heavily to ensure they have enough power to cope with the rapid economic growth. As such, new power capacity being added in Asia is an integral part of the building-up of the infrastructure of the region, along with transport links.

Western Asia remains an important market, with a solid base already installed. In some countries it has already become a replacement market, as the first generation of power stations are replaced by new gas- or oil-fired combined-cycle stations. The Islamic Republic of Iran has been growing most strongly in the past two years. Following the end of its war with Iraq the country has been expanding its power capacity to accommodate its plans for industrial development. In Europe the relatively new combined-cycle technology has virtually eliminated coal-fired generation from new orders, with the exception of generating equipment for lignite or brown coal now being installed in the eastern part of Germany, as utilities from the western part replace the highly pollutive, old brown coal plants. The European market, unlike its Asian counterpart, is not being driven by any strong demand for extra power capacity. Rather, it is being driven by technology, and by the availability of finance to build new, cleaner plants to replace old, coal-fired stations. The situation is similar in the United States, where available technology will replace old technology [52]. In Latin America, the market was depressed during the 1980s because of the debt crisis. But now there are signs of economic recovery, based on more disciplined macroeconomic policies, which could lead to the fulfilment of some of the pent-up demand for new power capacity.

(a) *Production*

As for the production of power-generating equipment, the main centres remain in developed market economies, where major generating equipment suppliers have their main factories. The market shares for major turbine-producing countries are given in figure IV.26. Eastern European countries still have important production capacity, at present underutilized because of the recent lack of orders. Developing countries have production capacities to satisfy an increasing portion of their basic needs (notably China, India, Mexico and Republic of Korea), but their aggregate capacities do not represent more than 20 per cent of world production [52].

Figure IV.26. World's major turbine-producing countries, 1985-1989



Source: Power plant database of the Science Policy Research Unit, Sussex University; *The World Market for Heavy Electrical Equipment* (Sutton, United Kingdom, Nuclear Engineering International, 1990).

Table IV.75 shows how the balance of production of turbine generators has changed since 1955, with production in North America dropping from 48.43 per cent of the total recorded between 1955 and 1964 to 16.21 per cent between 1985 and 1989. In contrast, the share of Japan has risen from 7.39 to 10.97 per cent over the same period, while that of India has climbed from zero to 3.14 per cent. Table IV.76, which lists the top suppliers over the periods considered, reflects these trends. It is noticeable, for example, that BHEL (Bharat Heavy Electricals Limited), the dominant Indian supplier, enters the 1985-1989 rankings in ninth position. These tables predate some of the large mergers of the late 1980s which created the United Kingdom and French company GEC Alsthom and the Swiss-Swedish Asea Brown Boveri. With regard to average market shares in gas turbines for 1989-1991, General Electric claims 22 per cent of its parent share, and another 34 per cent for its business associates and licensees. This is followed by the Westinghouse/Mitsubishi alliance, with 15 per cent of the world market, Siemens of Germany, with 11 per cent, and Asea Brown Boveri, with 10 per cent [52]. This leaves only 8 per cent for other producers. For steam turbines, market shares in recent years have been approximately as follows: Westinghouse/Mitsubishi, 14 per cent; General Electric, 13 per cent; Asea Brown Boveri, 10 per cent; GEC Alsthom, 9 per cent; and Siemens, 8 per cent. This leaves 48 per cent for other producers, showing how much more fragmented the more traditional, developed market for steam turbines is.

(b) *International trade*

Table IV.77 shows world export markets by region of generator installation, and with the exception of the United States, divides the world into country sizes, with or without a heavy electrical industry. It is noticeable that the United States market has become much more international over the periods covered. Between 1955 and 1964, only 2 per cent of its needs were covered by imports, but this rose to 19 per cent between 1985 and 1989. Conversely, the table shows how large countries with their own heavy-equipment industry have become

Table IV.75. World production of turbine generators, 1955-1989
(Megawatts)

Economic grouping, region or country	Production 1955-1964	Percentage share 1955-1964	Production 1965-1974	Percentage share 1965-1974	Production 1975-1984	Percentage share 1975-1984	Production 1985-1989	Percentage share 1985-1989	Production Total	Percentage share 1955-1989
North America	114 144	48.43	224 060	41.52	191 754	31.22	87 429	16.21	617 914	31.47
Japan	17 421	7.39	76 065	14.10	104 244	16.97	59 169	10.97	257 199	13.10
Germany	22 182	9.41	49 830	9.23	67 044	10.92	62 278	11.55	210 431	10.72
United Kingdom	31 322	13.29	57 295	10.62	38 904	6.33	34 369	6.37	162 014	8.25
France	11 132	4.72	28 490	5.28	46 829	7.62	47 470	8.80	136 160	6.93
Switzerland	8 085	3.43	21 693	4.02	21 752	3.54	25 406	4.71	77 834	3.96
Italy	5 668	2.40	17 730	3.29	22 745	3.70	17 060	3.16	64 764	3.30
India	-	-	1 744	0.32	20 729	3.38	16 909	3.14	39 382	2.01
Other Europe	4 389	1.86	14 347	2.66	11 629	1.89	4 084	0.76	35 853	1.83
CMEA[a/]	250	0.11	3 799	0.70	11 220	1.83	16 065	2.98	32 026	1.63
Other	6 597	2.80	18 562	3.44	20 034	3.26	8 516	1.58	53 709	2.74
Unallocated	-	-	2 571	0.48	6 436	1.05	19 710	3.65	31 216	1.59
Unknown	14 511	6.16	23 453	4.35	50 843	8.28	140 807	26.11	245 000	12.48
TOTAL	235 701	100.00	539 639	100.00	614 163	100.00	539 272	100.00	1 963 502	100.00

Source: Power plant database of the Science Policy Research Unit, Sussex University; *The World Market for Heavy Electrical Equipment* (Sutton, United Kingdom, Nuclear Engineering International, 1990).

a/ Former Council for Mutual Economic Assistance.

Table IV.76. World's major producers of turbine generators, 1955-1989
(Megawatts)

Company and country	1955-1964	Rank	Percentage share 1955-1964	1965-1974	Rank	Percentage share 1965-1974	1975-1984	Rank	Percentage share 1975-1984	1985-1989	Rank	Percentage share 1985-1989
General Electric (United States)	63 877	1	36.14	112 838	1	27.43	99 491	1	20.82	51 103	1	11.35
Siemens (Germany)	10 984	3	6.21	28 059	3	6.82	44 474	3	9.31	45 296	2	10.06
Alsthom (France)	5 401	10	3.06	18 521	9	4.50	39 222	4	8.21	40 374	3	8.96
Mitsubishi (Japan)	-	..	-	24 585	7	5.98	38 167	5	7.99	33 297	4	7.39
BBC (Switzerland/Germany)	9 005	5	5.09	27 936	4	6.79	32 885	7	6.88	31 834	5	7.07
Westinghouse (United States)	34 656	2	19.61	86 969	2	21.14	69 873	2	14.62	28 677	6	6.37
GEC (United Kingdom)	-	..	-	-	..	-	18 133	10	3.80	25 774	7	5.72
Toshiba (Japan)	6 579	8	3.72	26 777	5	6.51	37 740	6	7.90	25 018	8	5.55
BHEL (India)	-	..	-	-	..	-	20 269	9	4.24	16 348	9	3.63
Hitachi (Japan)	5 792	9	3.28	23 522	8	5.72	26 673	8	5.58	11 888	10	2.64
NEI (United Kingdom)	10 599	4	6.00	26 641	6	6.48	-	..	-	-	..	-
Allis Chalmers (United States)	8 240	6	4.66	-	..	-	-	..	-	-	..	-
English Electric (United Kingdom)	7 114	7	4.02	-	..	-	-	..	-	-	..	-
GE (Canada)	-	..	-	12 136	10	2.95	-	..	-	-	..	-
Unknown	14 511	..	8.21	23 453	..	5.70	50 843	..	10.64	140 807	..	31.26
TOTAL	176 758		100.00	411 437		100.00	477 770		100.00	450 416		100.00

Source: Power plant database of the Science Policy Research Unit, Sussex University; *The World Market for Heavy Electrical Equipment* (Sutton, United Kingdom, Nuclear Engineering International, 1990).

Table IV.77. World export market for power generation by region of generator installation, 1955-1989

Market category[a/]	1955-1964 Megawatts imported	1955-1964 Percentage of needs imported	1955-1964 Percentage of trade	1965-1974 Megawatts imported	1965-1974 Percentage of needs imported	1965-1974 Percentage of trade	1975-1984 Megawatts imported	1975-1984 Percentage of needs imported	1975-1984 Percentage of trade	1985-1989 Megawatts imported	1985-1989 Percentage of needs imported	1985-1989 Percentage of trade	Total Megawatts imported	Total Percentage of needs imported	Total Percentage of trade
I	2 214	2	4.71	14 862	7	10.64	25 679	14	12.20	15 239	19	8.06	57 994	10	9.70
II	7 220	11	15.35	8 070	5	5.78	4 931	3	2.34	3 640	3	1.93	24 261	5	4.06
III	2 680	29	5.70	4 250	23	3.04	3 240	20	1.54	1 496	43	0.79	12 210	25	2.04
IV	13 305	89	28.29	38 289	88	27.40	49 221	95	23.38	43 861	100	23.21	146 824	94	24.56
V	13 483	69	28.67	45 284	65	32.41	56 075	54	26.64	54 385	64	28.78	169 855	61	28.41
VI	8 132	100	17.30	28 975	100	20.74	71 384	100	33.91	70 352	100	37.23	186 748	100	31.23
TOTAL	47 034	21	100.00	139 730	27	100.00	210 530	37	100.00	188 973	47	100.00	597 892	35	100.00

Source: Power plant database of the Science Policy Research Unit, Sussex University; *The World Market for Heavy Electrical Equipment* (Sutton, United Kingdom, Nuclear Engineering International, 1990).

Notes: Totals column includes a small number of sets for which no commissioning date is available; and calculations of megawatts imported and percentage of needs imported include only capacity for which a supplier has been identified.

a/ I - United States
II - large countries with heavy electrical industries, excluding the United States
III - small countries with heavy electrical industries, such as Sweden and Switzerland
IV - developed countries with no heavy electrical industries, such as Australia and Belgium
IV - large countries with vertical heavy electrical industries capability, including Brazil, Canada and India
VI - developing countries with no heavy electrical industries

even more dependent on domestic suppliers than in the past. When so much depends on individual orders, therefore, it is hardly surprising that there are a number of trade issues in the power-generating equipment industry. United States suppliers have long complained that it is impossible for them to sell steam turbines in Europe, while some European suppliers say that Japan is a very difficult market to gain access to. Recently, there has been some opening-up in equipment markets. In the United Kingdom, privatization of the electricity supply industry led almost overnight to the internationalization of equipment supply, all of which had previously come from the old General Electric Company power business (now part of GEC Alsthom) and Northern Engineering Industries. Customers who now appear to be free to order internationally have given major contracts to Asea Brown Boveri (which has a United Kingdom joint venture with NEI for the United Kingdom market), Siemens and GEC Alsthom.

Similar developments are likely to occur to the same extent in continental Europe, and indeed markets are already opening up in Germany. The often close relationship between utilities and their suppliers may be swept away by the controversial EEC utilities directive, which came into force in 1993 as part of the single market programme. This obliges public utilities to hold open tenders for big power contracts. Non-EEC suppliers were worried about two so-called fortress-Europe provisions; customers can reject a bid with less than 50 per cent of European content, and must prefer a European bid where it is no more than 3 per cent higher than the best bid from overseas. In early 1993, however, a trade agreement between the United States and EEC waived these rules for United States power plant suppliers. It is worth pointing out, however, that the network of alliances and licensing agreements set up by companies such as General Electric provides a way of doing business in countries that might otherwise be closed. Similarly, the creation of companies such as Asea Brown Boveri provides national manufacturing presence in major EEC markets under a global umbrella, even though the company is technically based outside the EEC.

(c) *Profits*

As for the profitability of the industry, it is difficult to identify a clear trend on prices because almost all installations are tailor-made [52]. Global demand is growing and involves new requests for clean technologies, high-performance equipment and good reliability. At the same time suppliers have reduced their excess capacity and rationalized their facilities to allow for a better supply and demand balance, reducing employment in the developed countries. The consequence should be better productivity and profitability, even if stiff competition does not permit a large increase in the market price level.

2. *Markets and corporations*

The power-generating equipment industry has reached a crossroads, with markets in developing countries becoming the most important in the next decade. Attention is focused on the fast-growing economies of Asia, but it is important not to forget countries with ambitious industrialization plans such as the Islamic Republic of Iran. Elsewhere, the Latin American market for power-generating equipment is also reviving, as countries such as Brazil emerge from the financial difficulties of the mid-1980s. In short, the important countries and areas are those which are industrializing very quickly: Argentina, China, India, Indonesia, Mexico, Republic of Korea, Taiwan Province, Thailand, Turkey and others. Other countries with fewer growth perspectives have limited needs for power, and represent less than 3 per cent of the world power-generating equipment market.

The market for power-generating equipment in developing countries is dominated by producers in developed market economies, and the size of power plant orders puts financial strains on even the strongest economies. Consequently, the structure of the market is changing, with privatized power and schemes like build-own-operate or build-operate-transfer emerging in a number of countries. The market is also quite clearly becoming more open, with some of the historical ties that linked a country to an equipment supplier in a developed market economy now being loosened. This is happening because countries, particularly those in South-East Asia, have developed well beyond the category where they would be eligible for aid financing. Thus, more suppliers are encouraged to bid for contracts, which can be decided more on a technoeconomic basis than on political or financial considerations. A further factor creating a climate of change, as well as growth, is the environmental issue. Although public concern over issues such as the greenhouse effect is not nearly so strong in developing countries as in developed market economies, there has recently been a spate of orders in Asia for combined-cycle gas turbine power stations, albeit due as much to the availability of gas as to environmental issues.

Among the different markets in developing countries over the past 30 years, the Asian market has blossomed as the centre of demand for electric power in the countries of the Pacific rim has shifted southward from Japan to Indonesia, Malaysia, Republic of Korea, Taiwan Province and Thailand. Since the 1970s the rate at which new generating capacity is installed in Asia has tripled, whereas in western Europe and North America it is running at two thirds of the former levels [52]. The Asian Development Bank forecasts that a further 300,000 megawatts of generating capacity will be required during the 1990s, in addition to about 500,000 megawatts of installed capacity [54].

Japanese suppliers have taken a rapidly increasing share of the Asian market, and are now the dominant exporter to the region. Rapid economic growth in the Commonwealth countries has allowed the United Kingdom to regain some market share, and the adoption of combined-cycle technology, in which United States companies are strong, has expanded sales in that country.

Overall, it has been estimated that the three major Japanese companies (Mitsubishi Heavy Industries, Toshiba and Hitachi) have supplied about 25 per cent of power plant capacity exported to the region. But the highest individual share of the export market is held by General Electric, with 18 per cent, and GEC Alsthom, with 16 per cent. There are wide variations from country to country because of historical and political reasons, and also because of the availability of local suppliers. In China, for example, both GEC and Alsthom merged their power engineering industries, making their new company the leading developed-market-economy exporter of power plants, with China as its most important export market. However, at least 40 per cent of the installed capacity of China has been supplied in the past by its local State-owned industry, which maintained self-sufficiency in coal-fired generating equipment until the early 1980s. Since then, the country is becoming more open; it plans to install 12,000 to 15,000 megawatts of generating capacity a year, and needs assistance from developed market economies to achieve this. The four big suppliers in China are based at Beijing, Dongtang, Harbin and Shanghai. In the Republic of Korea, in contrast, the important historical market suppliers have been General Electric, GEC Alsthom, Asea Brown Boveri, Westinghouse and Hitachi. The biggest local producer, Korea Heavy Industries, has not been significant historically, but is growing fast, and has recently entered cooperation agreements with western suppliers. In Indonesia, there is no domestic producer of power-generating equipment, and the market leaders are Mitsubishi, Toshiba and General Electric.

Apart from China and the Republic of Korea, India is the only other country that is a significant producer of power-generating equipment. Indeed, China (with its exports of power equipment to Pakistan) and India (with exports to Cyprus) are believed to be the only Asian suppliers selling their equipment abroad. Chinese companies also participate with developed-market-economy suppliers in ventures overseas. An example is the Magellen project for two fossil-fuel steam plants in the Philippines, in which Westinghouse and Shanghai United Electric cooperated. The Indian industry is dominated by the State-owned Bharat Heavy Electricals Limited, which with 67,000 employees may be losing its competitive edge. Almost all of its production goes to the domestic market, but it is not in a position to supply the entire market. Because India still needs soft loans to finance much of its development, equipment has to be imported from the lending country. The only possibility to advance Bharat Heavy Electricals Limited has been linked to foreign investment.

The Latin American market is by far the most significant market for hydroelectric equipment in the world. With a rapidly expanding population, low per capita electricity consumption and a wide range of natural resources, these countries have considerable market potential. But chronic debt problems have made such a capital-intensive sector as power plant supply a difficult one in which to operate. According to one source, Japan made substantial inroads into the hydroelectric plant market in the 1960s and 1970s, but European producers have fought back strongly in international consortia and through local subsidiaries [55]. Producers from countries of the former Council for Mutual Economic Assistance have also gained a significant market share, and North American producers have maintained their presence. Generally, the local equipment industry is not at the forefront of technological capability. There was, until recently, a tradition for countries to deal directly with foreign suppliers. But both Siemens and Asea Brown Boveri have built power equipment factories in Brazil, and as the economic problems of that country ease, Asea Brown Boveri finds that it can import raw materials and export products such as hydroelectric generators to neighbouring countries such as Argentina, Colombia and Venezuela. In Mexico, the principal local manufacturer is Turalmexin. GEC Alsthom, which previously owned only 49 per cent, has taken full ownership of the firm.

The market in Western Asia is another important area for foreign equipment suppliers. There is no indigenous industry, apart from subsidiaries of developed-market-economy suppliers; for example, Asea Brown Boveri as a whole has about 2,000 employees in Saudi Arabia. Although oil-related income means that financing orders is not such a large problem as in most developing countries, politics influence the choice of suppliers. Since the Persian Gulf war of 1991, Iraq no longer has access to western equipment; However, the Islamic Republic of Iran is investing heavily in rebuilding its industries following its war with Iraq. No supplier has established a very strong position apart from Japan, and the main trend in recent years has been the decline of North American suppliers and the corresponding rise in producers in the former CMEA [55].

Equipment trends in developing-country markets are also changing as the markets themselves evolve. Coal-fired generation remains an important option in countries such as China. The Shajiao coal-fired power station in China reflects this phenomenon, and it can be found in other developing countries. In 1992, a consortium led by GEC Alsthom, which included Slipform Engineering and Asea Brown Boveri Combustion Engineering, won a turnkey contract to build the large 1,310 megawatt project in China, expanded only a few weeks later to 1,980 megawatts. The Shajiao site will supply much-needed power for the industrial development programme of Guandong province. When completed in 1995, the project will be the largest independent power plant in Asia. It will be managed by a joint venture between Guangdong General Power Company and Hopewell Energy, part of the Hong Kong property group Hopewell Holdings; the venture will own, operate and maintain the plant for 20 years.

But combined-cycle power is also making inroads. There has been a spate of orders for such equipment in Indonesia, Malaysia and Thailand due to the availability of natural gas, but combined-cycle gas turbine has also been selected because of its relatively short lead-time. In June 1992, the GEC Alsthom subsidiary European Gas Turbines won a turnkey order for a 110-megawatt combined-cycle power station at Shantou in China. The equipment will be ready for use by 1994, allowing the plant to meet the urgent need of Guandong province for additional electricity. Other suppliers such as Siemens, Westinghouse and Asea Brown Boveri have also benefited from the trend towards combined-cycle gas turbines, with orders from Egypt, India, Iran, Islamic Republic of, Philippines, Republic of Korea and Tunisia.

The hydroelectric market has been quieter recently, the largest contract of the past two years being the $1.25 billion order won by a consortium led by Asea Brown Boveri for the Karun III hydropower plant in the Islamic Republic of Iran. But there are also opportunities for overhauling and retrofitting. Asea Brown Boveri again was involved in a consortium which in 1991 won a contract of about $140 million to modernize the hydroelectric plant at the Aswan Dam in Egypt after three full decades of uninterrupted power generation.

As for the nuclear industry, developing countries and areas such as Taiwan Province and the Republic of Korea face the brightest immediate prospects. Taipower, the State utility of Taiwan Province, recently decided to go ahead with its long-delayed fourth reactor, a two-unit complex of 2,500 megawatts. In September 1992, the Republic of Korea placed a $950 million order for two 700-megawatt Canadian deuterium uranium reactors to be supplied by Atomic Energy of Canada and other companies in Canada and the Repubiic of Korea. China has also committed to adding more nuclear power, and longer-term prospects are improving in Indonesia and Malaysia.

Most of the generating strategies in developing countries and areas constitute evidence of increasing flexibility in financing arrangements as equipment suppliers put together international consortiums to bid for work. Many of the recent big contracts in South-East Asia have been largely Japanese-financed even though the most important pieces of equipment have come from European suppliers. There have also been some encouraging examples of cross-border cooperation. In October 1991, General Electric Power Generation won a $60 million contract with the United States branch of Sumitomo, the Japanese trading house, for the sale of three gas turbine generators for a plant in Indonesia. Financing came from EID/MITI of Japan and the United States Export-Import Bank.

Another related new development is private sector power. Apart from the above-mentioned Shajiao project, private-sector power generation is on the agenda in India, Indonesia, Malaysia, Pakistan (with its 1,292 megawatt Hab River project), Thailand and Philippines to provide an alternative financing source to that of national Governments, the World Bank or the Asian Development Bank. For the equipment industry, this is likely to mean a further boost for their combined-cycle business because of the shorter lead-times. In Malaysia the independent power producer Sekap Power reached a preliminary agreement in early 1993 to build a 1,300 megawatt combined-cycle power station at Lemut on the west coast of Malaysia at an estimated cost of $1.28 billion. YTL Corporation Berhad, in cooperation with National Power of the United Kingdom, has already reached a preliminary agreement to build two gas-fired power stations with a combined 1,000 megawatt capacity. Construction will follow on a build-own-operate basis. Private power is also emerging in Latin America; a company based in Washington, D.C., K&M Engineering and Consulting Corporation, is developing the continent's first private power project capitalized on a non-recourse project finance basis. The project is a 100-megawatt, gas-fired facility to be constructed at Cartagena, Colombia. Westinghouse also has been awarded contracts for more than $50 million to supply, operate and maintain a 100-megawatt power plant in Argentina. The plant, to be supplied to Compañías Asociadas Petroleras, is the first greenfield independent power project to be developed in Argentina.

The size of power plants and the consequent lumpiness of financing needs, makes it highly sensible for developing countries to allow alternative ownership structures. Private schemes, however, can present a dilemma for equipment suppliers. For instance, should they participate fully in build-own-operate schemes which could tie them to a project financially for 20 or 30 years? It is doubtful that an equipment industry would want to become a utility; a supplier may be asked to take an equity share in a plant while it is under construction, but it would want to sell its stake once the plant is in operation.

3. *Capacity utilization and expansion plans*

While major power equipment producers are seeking markets in developing countries, the majority of the capacity to produce equipment is in developed countries. The industry is one of the oldest engineering sectors, and over the past century most countries of Europe and North America have supported the industrialization effort of the power plant supply industries. However, domestic generating needs have diminished since the 1970s, and despite the recent limited recovery, excess capacity still exists in developed market economies. In particular, a relative decline in the use of very large steam turbines for conventional fossil-fuel power generation as well as nuclear power generation has caused plant closures in the equipment industry. It has not been considered practical or desirable to switch steam turbine factories to the manufacture of gas turbines. Excess capacity has been a particular problem in Europe, bringing on a series of major mergers in the late 1980s. The EEC has found manufacturing capacity utilization rates as low as 60 per cent, and in the boiler manufacturing sector capacity utilization averaged 20 per cent [56]. This situation appears to have improved more recently. Most equipment suppliers in Europe and the United States have drastically reduced their manufacturing capacity through consolidation, mergers and rationalization. However, in certain specific areas such as small steam or gas turbines and conventional boilers, there are still too many suppliers, and therefore overcapacity remains.

Naturally, the trend towards reducing production capacity is aimed at lowering the fixed costs of the industry and thus improving profitability in a sector where profit margins are traditionally tight. Conversely, however, another very important trend in the industry in recent years, a much needed improvement in productivity, has had the effect of increasing manufacturing capacity. Customers are requiring better and quicker service from the industry, which has responded by introducing new management and new manufacturing technologies to reduce cycle times (the time between the receipt of an order and delivery to the customer) and to increase product quality. For example, cycle times at General Electric for certain replacement parts have been cut by more than 80 per cent, and overall by 25 to 50 per cent [52]. These achievements are not only important from a competitive point of view, they also help cut inventory or stock levels and thus reduce working capital.

Asea Brown Boveri has also experienced profound changes in its manufacturing processes and in its use of factory automation. Information-based technology is the key to reducing working capital, and its so-called T50 strategy in Sweden is aimed at halving all lead-times. This is being done by decentralizing work activities and widening individual worker skills within teams, and has required close cooperation with trade unions. Although this programme covers the full range of Asea Brown Boveri activities, including non-power-related equipment, it is the power business which has the most to gain.

In the United Kingdom, too, recent developments have shown that raising productivity and product quality in older power equipment plants requires attention both to manufacturing methods and soft issues such as employee involvement. One of the best examples is GEC Alsthom Large Machines in Rugby. A site that has been producing electrical products since 1902, the company has doubled its sales per employee through an ambitious employee development programme that incorporates total quality management and multi-skilling. The project involved the complete redesigning of factory layout and introduction of new products and equipment. After 130 person-years of planning, lead-times and inventories have been halved and volumes increased by 60 per cent.

New demand for equipment has also appeared; one good example is the recent change in the world's largest gas turbine plant, namely the General Electric facility at Greenville, South Carolina. The dearth of orders in the mid-1980s persuaded General Electric to end gas turbine manufacture at its plant at Schenectady, New York, which now concentrates on steam turbines. At Greenville, it decided to concentrate on the core technologies of gas turbine manufacture, turbine blades, buckets, combustion hardware and nozzles. Basic unmachined castings, forgings and casings are sourced worldwide, including in Japan, and the worldwide business associates of General Electric supply many turbine parts. The company found that it could very quickly reduce the cycle time for a turbine blade from 26 to 13 weeks through the introduction of new technology, but better management has now reduced the cycle time closer to a target of two weeks.

The experience of General Electric illustrates some important aspects of current manufacturing strategy in the power equipment industry. The days when companies used to manufacture all but the tiniest components in-house, including their own forgings, have long gone. International equipment networks are already being used for component supply, and there is a worldwide trade in parts, although major companies still prefer to manufacture the critical components themselves. A dilemma exists because, on the one hand, there is a tendency to keep manufacturing in company plants in order to maintain a proper workload. However, on the other hand, for reasons of competitiveness, there is a growing curiosity about where to find lower manufacturing costs. GEC Alsthom, for instance, sources parts or materials from countries where it has no manufacturing facilities [52]. Low-wage countries may be considered, provided it can find the proper manufacturing and delivery quality.

The acquisition of Eastern European power equipment companies by companies such as Siemens and Asea Brown Boveri also opens the way to component supply arrangements. In the short term their purchases have involved the acquisition of at least temporary excess capacity, since the expected resurgence of local markets in these countries has not happened. But companies are already being used to supply parts to factories of Asea Brown Boveri and Siemens in Western Europe. GEC Alsthom, too, may be searching for new places to source parts, including some Eastern European countries. But it would not be sourcing complete units.

4. *Restructuring and redeployment*

Licensing agreements, joint ventures and mergers have been an integral part of the power-generating equipment industry, albeit within countries rather than across borders. The past five years have seen a sharp acceleration in the internationalization of the structure of the industry, as producers respond to sweeping changes in the market itself, to the ever-increasing costs of technical development and the need for access to the latest technology, to the demands of pan-European and global manufacturing, and to the problem of manufacturing overcapacity mentioned in the previous section. A further factor, which may have been a catalyst to the process of restructuring currently under way, has been the consolidation of pressures to liberalize world trade in power plants. Conversely, the continued existence of trade barriers is a powerful spur to the formation of manufacturing agreements and joint ventures, giving companies a presence in a market that would otherwise not be available.

Three main factors are considered important in restructuring the heavy electrical equipment industry [55]. First is the increasing effective size. Raising the minimum size and weight of a company brings sufficient resources and expertise to activities such as R and D and marketing to allow a company to be competitive. Secondly, access to markets is essential. For most companies, home markets can no longer be expected to provide sufficient business to sustain their capacity, even if it could be assumed that home suppliers would retain their privileged access to them. Companies are therefore looking for partners that will give them as a worldwide a presence as possible. In particular, companies outside the EEC regard a presence in the EEC as vital, given the potential threat posed to them by the single market reforms introduced in 1993. Thirdly, access to technology must exist. The rapid swing away from conventional steam plant and the declining popularity of nuclear plants has left a number of companies unable to compete in potential growth areas, particularly in gas turbines. Companies that lacked the capability to produce this equipment have sought agreements that enable them to offer it. The most important new capability appears to be large heavy-duty gas turbines and the associated technology for integrating them into combined-cycle power stations (see below). A summary will now be given of how these factors have worked themselves out in three major forms of restructuring.

(a) Mergers and agreements involving Western producers

The approach of General Electric of the United States represents the broadest and most diverse use of the various types of partnerships available between individual companies in this industry. The combination of strategic alliances and world-leading technology, especially in gas turbines, enabled General Electric and its partners to receive 61 per cent of the available orders worldwide for combustion turbines in 1991. The company has a worldwide network of 57 business associates and licensees, including 10 business associates in gas turbines. As a general rule, General Electric brings its technology to the agreement, and the other party manufactures the equipment for a local or regional market. But some of its agreements are on a much more equal footing, albeit designed partly to give General Electric access to otherwise closed markets. In East Asia, General Electric recently signed a new agreement extending a long-term manufacturing association with Hitachi that has been a key factor in introducing General Electric gas turbines to Japanese utilities. The new 15-year agreement establishes a joint development board and allows Hitachi to manufacture the newest and most advanced turbines of General Electric.

In Europe, General Electric has established three major alliances in the past three years to overcome trade barriers. First, it has signed a manufacturing and marketing agreement with Blohm and Voss, a German machinery manufacturer. The two companies will offer steam turbine and combined-cycle power plants for the European market. Secondly, it has made a series of agreements with Elin Energieversorgung of Austria, covering technology transfer, cooperative development and production of new generator models. Thirdly, General Electric took a 10 per cent stake in European Gas Turbines, a subsidiary of GEC Alsthom. This relationship has been particularly important for both General Electric and GEC Alsthom. The most powerful gas turbine in the world, the 50-hertz MS9001F, was designed by General Electric and developed in conjunction with European Gas Turbine.

The creation of GEC Alsthom in 1989, meanwhile, was one of two large and important mergers that have changed the face of the European power-generating equipment industry. The combination of the power and transport companies of the General Electric Company of the United Kingdom and Alcatel Alsthom of France was aimed at addressing all the key restructuring factors listed above. There was remarkably little overlap between the two companies in terms of product, and with the General Electric link, GEC Alsthom can offer a remarkably wide range of turbines. The only major area of overlap between the companies was in steam turbines, and the need for rationalization of excess capacity in this area was one of the key factors behind the merger.

It was also an element in the other big European merger in 1988 which created Asea Brown Boveri from Asea of Sweden and Brown Boveri of Switzerland. Asea Brown Boveri is now the largest electrical engineering company in Europe, and the merger became a blueprint for the restructuring trends in the industry. The size of the combined operations meant that product and manufacturing specializations can be developed in different centres to reduce overall costs. Asea Brown Boveri, for example, has rationalized turbine generator production between Switzerland and Germany. Sales marketing and distribution can be combined to become more cost effective, an important factor in developing target markets such as the United States. And a stronger financial base was created, necessary for supporting R and D and for handling larger turnkey projects.

Both mergers have been successful so far, although Asea Brown Boveri was able to move very quickly at first. Both companies have also participated in the further restructuring of the power equipment industry of developed market economies, notably Asea Brown Boveri, through its $1.6 billion acquisition of Combustion Engineering, a large United States boiler maker. Asea Brown Boveri has since put General Electric through a heavy restructuring and reorganization programme, which has improved its profitability.

Westinghouse, the second-biggest United States power equipment producer, has also been active in creating a comprehensive network of global alliances, ranging from service joint ventures through licensing agreements to joint development, marketing and manufacturing alliances. In 1992, a particularly significant deal was announced with Rolls-Royce, the power equipment producer best known for its aero-engines in the United Kingdom. Rolls-Royce will transfer its leading-edge, aero-engine technology to Westinghouse for incorporation into its industrial combustion engine designs, while Westinghouse will transfer selected technologies to Rolls-Royce for use in their product lines. The two companies will cooperate in marketing Rolls-Royce aero-derived gas turbine engines for power generation applications.

Overall, the mergers and other deals have created four leading groupings in the world power equipment industry: General Electric and its network of business associates (including GEC Alsthom); Asea Brown Boveri; Siemens of Germany with its Kraftwerk Union power subsidiary; and Westinghouse, whose main strategic allies are Mitsubishi Heavy Industries of Japan and FiatAvio of Italy.

(b) Joint ventures and licensing involving developing countries

It has been observed that power equipment markets are growing strongly in the NICs of Asia. Naturally, therefore, producers in developed market economies are forming joint ventures or entering into licensing deals as necessary to protect and develop their position in these markets. The attitude of Asian countries to the local manufacturing of heavy equipment differs widely. The Republic of Korea is keen on developing its heavy equipment industry, while Taiwan Province is more prepared to import equipment and concentrate its own efforts on other industries. Considering the market strength of the Republic of Korea, therefore, it is not surprising that it has been the centre of efforts of producers in developed market economies to forge cooperative agreements.

In 1992, General Electric of the United States and Korea Heavy Industries and Construction Company announced an agreement initiating the transfer of General Electric heavy-duty gas turbine technology to Korea Heavy Industries and Construction Company. The two companies will jointly manufacture gas turbines based on General Electric designs, and the agreement also allows General-Electric-designed gas turbines built solely by Korea Heavy Industries and Construction Company to be sold in the Republic of Korea. Korea Heavy Industries and Construction Company is already a business associate of General Electric in steam turbines, manufacturing jointly with General Electric units in the 550 megawatt range for fossil-fired plants, and 700 to 1,000 megawatt turbines for nuclear power plants. In 1991, meanwhile, the Siemens Power Generation Group concluded a long-term cooperation agreement with Halla Engineering & Heavy Industries of the Republic of Korea. Once again, the deal involves gas turbines, and allows Halla to make Siemens-designed gas turbines in the Republic of Korea and to market and service the machines in its home market and other countries. Both sides will provide reciprocal supplies of gas turbine components, and cooperate on gas-turbine power plant projects on a case-by-case basis for export markets.

In China, there are numerous arrangements between indigenous manufacturers and major non-Chinese suppliers, including General Electric, Westinghouse and Hitachi. GEC Alsthom, for example has developed industrial cooperation agreements that include the transfer of technology for turbine generator manufacture to BZD. The most recent joint venture to be announced was Asea

Brown Boveri Hefei Transformer Co., linking Asea Brown Boveri as the majority owner with Hefei Transformer Works. The venture will use part of the present manufacturing facilities of HTW in Hefei City, Anhui Province. These will be restructured, and Asea Brown Boveri will provide modern technology and training.

As for licensing contracts, the most significant market for producers from developed market economies is India. Bharat Heavy Electricals Limited, the major Indian power equipment company, has a long-standing gas and steam turbine licence from Siemens and a gas turbine deal with General Electric, and recently concluded a technical collaboration agreement with Asea Brown Boveri Combustion Engineering for the manufacture of circulating fluidized bed boilers, ideal for inferior grades of coal. These will be manufactured at Tiruchirappally in southern India with the assistance of Asea Brown Boveri. Such circulating-type boilers are also being made in India by Isgec John Thompson in collaboration with Ahlstrom of Finland and by Buckau Wolf in a tie-up with Deutsche Babcock of Germany. Cockerill Mechanical Industries of Belgium also recently strengthened its market position in India in heat recovery systems by entering into a technical collaboration with Bombay-based Larsen and Toubro. This involves the local manufacture of units used in co-generation and combined-cycle power plants. In 1993, GEC Alsthom and the Indian company Triveni Engineering, the country's leading supplier of small steam turbines, established a jointly owned company to manufacture small- and medium-sized steam turbines. The new company, of which 51 per cent will be owned by GEC Alsthom, will use the technology of the United-Kingdom-French company and have manufacturing facilities in Bangalore and Allahabad.

(c) Takeovers and joint ventures in Eastern Europe

Outside Asia, the dominant area of takeover and joint venture activity for major power equipment producers in recent years has been in Eastern Europe and in the territory of the former German Democratic Republic, which constitutes the eastern part of reunified Germany. The impetus for the takeovers differs somewhat. While both the eastern part of Germany and Eastern Europe offer opportunities for low-cost manufacturing of components that can be used across Europe, reunified Germany represents a current market opportunity, while takeovers in Eastern Europe require a down payment on future growth prospects.

In 1991 Asea Brown Boveri bought Bergmann-Borsig, based in Berlin and the leading manufacturer of power plant components in the former German Democratic Republic. Asea Brown Boveri agreed to invest about $30 million over the next three years in Bergmann-Borsig, which is already participating in Asea Brown Boveri's European power contracts. Asea Brown Boveri has also purchased Energiebau Dresden and Automatisierungsanlagen Cottbus. GEC Alsthom, which began with a relatively weak position in Germany, strengthened its presence in 1991 with the acquisition of Kesselbau Zeitz and Kesselbau Neumark from the Treuhandanstalt, the body in charge of privatizing the industry in the former German Democratic Republic. The companies are active in steam generator rehabilitation and manufacture. GEC Alsthom has also bought the TRO, a Berlin-based company which is the major supplier of high-voltage switchgear and instrument transformers in the eastern part of Germany.

In Eastern Europe and the former USSR, attention has been focused on the Czech Republic and Poland, partly because of their strong electromechanical traditions and the existence of relatively large companies which give a good local market presence. Siemens and, in particular, Asea Brown Boveri have been very active in these markets. In late 1991, Siemens signed a memorandum of understanding to form a joint venture with Skoda Plzen, the leading Czech Republic company in this sector, but since then negotiations have slowed down. Meanwhile in the former USSR, Siemens has set up a joint venture with Leningrad Metal Works, a respected steam turbine producer. The venture, Interturbo, will develop and manufacture gas turbines initially for the market of the Russian Federation, and eventually for export.

Asea Brown Boveri has 20,000 people working in more than 30 companies and joint ventures in Central and Eastern Europe. Not all of these are in power engineering; for example, Asea Brown Boveri has a stake in the Polish turbine firm Zamech. This firm has benefited from Asea Brown Boveri management and technological know-how, and also has direct access to the worldwide sales network of Asea Brown Boveri. In fact, companies such as Zamech are being kept busy with export orders as a short-term survival strategy because there is so little work at present from domestic markets. In 1993, Asea Brown Boveri also bought a 67 per cent interest in a new company created from the power engineering division of Prvni brnenska strojirna, of Brno in the Czech Republic. This is a business with 4,000 employees, and an annual turnover of $120 million, including a net profit of $13.2 million in 1993.

The European Gas Turbines subsidiary of GEC Alsthom, meanwhile, signed a cooperative agreement in 1991 with the Kirov Works in Saint Petersburg, which, like Leningrad Metal Works, makes steam turbines. The agreement covers the manufacture, assembly and packaging of 25-megawatt gas turbines for the market of the Russian Federation. European Gas Turbines is supplying parts and technical assistance to set up new manufacturing and testing facilities in Saint Petersburg.

5. *Technological trends and environmental considerations*

(a) Major trends and problems

Over the past decade, environmental and safety issues have become increasingly intertwined with technological developments in power-generating equipment. In different ways, most current product developments are linked to energy efficiency, energy conservation, pollution reduction and environmental improvement. Particularly in question are the emissions from traditional coal-burning power plants, while events such as the Chernobyl disaster in the Ukraine have led to increased security in nuclear power stations. At the same time, considerable investment is being made by developed market economies in renewable energy sources such as wind and wave power. The power equipment industry is proving successful in meeting these challenges. In particular, the rapid growth in popularity of combined-cycle gas turbine power stations has been possible because of investment by the industry in gas turbine development. A further influence on technical development has been the changing nature of the customer industry, which increasingly demands that plants can be ordered and completed in three years, rather than the traditional five or more years.

In addition to the traditional environmental concerns of plant suppliers and customers such as sulphur dioxide (SO_2) and nitrogen oxide (NO_x) emissions, thermal discharges, fly-ash storage, and radioactive waste treatment and storage, there is growing concern about broader issues such as the global environmental effects of power generation, acid rain, the greenhouse effect and hazardous materials. As the understanding of some of these issues is still developing, more environmental regulation of the pollutive effects of the power industry is expected. The implementation of an ecotax proposed by the EEC on carbon dioxide emissions is pending the outcome of similar pollution taxation being considered in other OECD countries. This presents additional challenges to power equipment suppliers to ensure that all environmental requirements, including the use of the most cost-beneficial system of fuel, plant and abatement facilities, are met in order to deliver clean electricity. The same issues are also likely to influence environmental requirements for existing stations and for the repowering or retrofitting of older stations.

Another important point, especially from the perspective of developing countries, is that organizations such as the World Bank have imposed strict environmental standards on projects which they finance. Even in developing countries, the costs of future remedial action in the event of environmental damage would be far greater than the original costs of equipment to minimize environmental problems.

(b) Main types of power-generating equipment

Large-scale, electricity-generating capacity generally falls into one of three main types, excluding the combined-cycle gas turbine which will be examined later. The first is conventional thermal generation, where fossil fuel (coal, oil or gas) is burned in a conventional boiler, creates steam and drives a turbine generator which, in turn, generates electricity. Table IV.78 shows how the mix of technologies in world power-plant orders has been changing in recent years. Unit sizes, meanwhile, have grown substantially since 1955 to gain economies of scale, as shown in table IV.79. In developed countries conventional thermal generation size grew from a maximum of about 100 megawatts, with a typical size of about 30 megawatts in 1955, to a maximum of 1,000 megawatts and a typical output of 600 megawatts in 1970. The use of even larger sizes can create problems. These include integrating such units into the electricity supply system, encountering intrinsic difficulties in their manufacture, and the economic risk of committing such a high proportion of investment into a single project. None the less, steam turbines of some 1,450 megawatts are now being produced.

Technological development has focused mostly on reducing fuel costs, which typically account for about 70 per cent of power station operating costs. The principal approach has been in improving the efficiency of the transformation from heat to electricity by raising the pressure and temperature of the steam sent to the turbine generator by the boiler. However, in most countries there has been a virtual standardization of steam conditions at a temperature of 540° Celsius and a pressure of 160 bar, just beneath the level where steam turns from being subcritical to supercritical. Supercritical steam brings efficiency gains but, until recently, the relatively small improvements have been insufficient either to justify the higher capital costs, or to offset the initially poorer reliability of such machines. But there is now increasing worldwide interest in supercritical steam. Both Japan and Germany have continued developing such units.

The second main type of power generation is nuclear plant, where a nuclear reactor replaces the conventional boiler as the source of heat and hence steam. As with fossil-fuelled plant, unit sizes rose rapidly in the 1960s in order to maintain a competitive position against conventional plant. Until recently, the unit size had levelled off at a maximum of about 1,350 megawatts, but in 1992, GEC Alsthom supplied a 1,500-megawatt machine. This is the world's largest single shaft turbine generator and was shipped to a nuclear power station in France. In nuclear stations, high thermal efficiencies have been a lesser priority than controlling capital costs. The low temperature of steam produced by the most widely used types of nuclear reactors, pressurized water reactors and boiling water reactors, have not been seen as a major drawback to their adoption.

The third main method of generating power is hydroelectricity, where a flowing water source is used directly to drive a water-wheel or turbine which is coupled to an electric generator. The size, technical characteristics and overall costs of hydroelectric stations are largely determined by the geography of the resource, notably the flow rate and volume of water available. In its simplest form, run-of-the-river, turbines are placed on a river bed. Such schemes are generally small and relatively cheap, but allow no flexibility to store water until an optimum time. Larger resources are usually utilized by damming a river or lake and allowing water to be stored. This gives more flexibility over time of use, but at the expense of higher capital costs.

Technological and environmental issues relating to combined-cycle generators, coal-fired equipment, nuclear power and renewable energy sources are dealt with below.

(c) Combined-cycle gas turbine-power generation

The most important technological development in power generation over the past 15 years has been the growing popularity of gas turbines, used in the so-called combined-cycle operation. Combined-cycle power plants use the exhaust gases of gas turbines, which are still at a temperature of at least 500° Celsius, to generate steam via a waste-heat recovery boiler, which in turn drives a steam turbine. This means that thermal efficiency, which is the amount of energy per unit of fuel used, is at about 54 per cent, much higher than that of simple-cycle gas turbines or steam turbine power plants, which currently achieve efficiencies of 35 and 40 per cent, respectively. Additionally, gas turbines emit very little sulphur dioxide, and have low nitrous oxide levels compared with coal-fired stations. Assuming that sufficient supplies of gas are available, a combined-cycle operation station provides efficient, flexible and clean power generation.

Most recent research in this area has been devoted to improving the reliability of the gas turbine, increasing its power output, raising the temperature of the exhaust gases (by increasing the combustion temperature), and enhancing the environmental profile of the turbines. In the early 1960s, the efficiency of combined-cycle plants in general was about 28 per cent, and by 1975 the 40 per cent efficiency level had been exceeded. Today, the most modern and largest gas turbine currently produced is the 212 to 226-megawatt 50-hertz General Electric MS9001F machine, which is manufactured jointly by General Electric and a subsidiary of European Gas Turbines. This has a combustion temperature of 1,2??° Celsius and an exhaust temperature of 583° Celsius. In combination with a 120-megawatt steam turbine in a VEGA 109F unit, efficiencies of about 55 per cent and an output of 335 megawatts can be achieved.

Further research is aimed at increasing firing temperatures and, hence, exhaust temperatures. However, to

Table IV.78. World electric capacity by region of installation, 1955-1989

Country, economic grouping and industry	Megawatts[a/]				
	1955-1964	1965-1974	1975-1984	1985-1989	Total
United States	109 640	216 302	189 911	85 684	601 537
	(47)	(40)	(31)	(16)	(31)
Percentage of which:					
Conventional	83	76	71	40	71
Nuclear	1	14	21	53	19
Hydropower	16	10	9	6	10
Large[b/]	68 013	153 059	151 683	167 373	547 492
	(29)	(28)	(25)	(31)	(28)
Percentage of which:					
Conventional	82	83	50	43	61
Nuclear	2	8	37	49	27
Hydropower	16	9	13	9	11
Small[b/]	10 177	19 682	17 210	7 041	60 983
	(4)	(4)	(3)	(1)	(3)
Percentage of which:					
Conventional	13	24	10	24	16
Nuclear	-	15	45	28	20
Hydropower	87	61	45	47	63
Developed countries[c/]	16 121	44 934	53 493	54 785	174 968
	(7)	(8)	(9)	(10)	(9)
Percentage of which:					
Conventional	83	78	74	84	79
Nuclear	-	1	13	5	6
Hydropower	17	20	12	11	15
Large[d/]	20 618	70 350	110 205	126 861	328 869
	(9)	(13)	(18)	(24)	(17)
Percentage of which:					
Conventional	35	47	44	32	40
Nuclear	-	6	14	21	14
Hydropower	65	47	42	47	46
Developing countries[c/]	11 132	35 312	91 661	97 528	249 655
	(5)	(7)	(15)	(18)	(13)
Percentage of which:					
Conventional	51	53	66	62	61
Nuclear	-	1	1	5	3
Hydropower	49	45	34	32	37
Total	235 701	539 639	614 163	539 272	1 963 502
Percentage of which:					
Conventional	74	71	59	47	60
Nuclear	1	9	20	30	17
Hydropower	25	20	21	22	22

Source: Power plant database of the Science Policy Research Unit, Sussex University; *The World Market for Heavy Electrical Equipment* (Sutton, United Kingdom, Nuclear Engineering International, 1990).

Note: Totals column includes a small number of sets for which no commissioning date is available.

a/ Figures in parentheses are percentage shares of period totals.

b/ With heavy electrical industry.

c/ Partly heavy electrical industry.

d/ No heavy electrical industry.

Table IV.79. Mean and maximum size of units installed in developed market economies and commissioned from 1955 to 1989
(Megawatts)

Period	Conventional			Nuclear			Hydropower		
	Mean	Maximum	Number of units	Mean	Maximum	Number of units	Mean	Maximum	Number of units
1955-1959	96	340	813	100	100	1	55	490	396
1960-1964	135	700	714	80	220	27	65	375	565
1965-1969	201	1 000	757	196	650	47	78	229	611
1970-1974	284	1 300	811	544	1 152	75	110	475	535
1975-1979	270	1 300	677	788	1 300	74	131	700	460
1980-1984	285	1 300	623	831	1 296	81	146	700	462
1985-1989	311	1 300	823	969	1 455	169	161	635	741

Source: Power plant database of the Science Policy Research Unit, Sussex University; *The World Market for Heavy Electrical Equipment* (Sutton, United Kingdom, Nuclear Engineering International, 1990).

achieve thermal efficiencies of 60 per cent by the end of the decade an elusive goal of a 1 per cent increase in efficiency each year would be necessary. At the same time, General Electric is hoping to raise its gas turbine efficiencies by two or more percentage points through a licensing deal with Exergy, a small Californian company that owns an innovative technology called the Kalina cycle.

Another research area is developing aero-engine gas turbines of increasing size. In particular, there have been some important recent developments in turbine blade technology, and their manufacture which owes a great deal to aerospace research. One promising area is directionally solidified and single-crystal turbine blades, which enhance the performance of aero-engines and could do the same in power generation, if the problems of manufacture of much larger sizes can be overcome.

Finally, research also is being directed to improving further the environmental performance of gas turbines by using the so-called dry low nitrogen (NO_x) systems. This technology has been in use for 20 years, but is now seen as particularly applicable, as it avoids the heat rate penalties of some other methods. There are further methods for reducing NO_x, such as selective catalytic reduction systems used in heat recovery steam generators, while another solution involves direct catalytic combustion in gas turbine combustors to achieve NO_x concentrations of less than 10 parts per million. In Japan, where NO_x emission regulations are among the toughest in the world, a 2,000-megawatt, combined-cycle plant at Futtsu has achieved NO_x emissions below 10 parts per million, the lowest in the world.

(d) Developments in coal-fired equipment

Apart from nuclear power, coal-fired power generation is the most politically sensitive area for equipment suppliers and customers. The environmental impact of coal-burning to produce electricity has become increasingly controversial. The process produces both solid wastes and flue gases. The gaseous emissions of concern are particulate (fine airborne ash), sulphur dioxide and nitrogen oxide. When coal is burned, it can produce about twice as much carbon dioxide per kilowatt-hour of electricity as gas, and about 20 per cent more than fuel oil. It is estimated that Governments, equipment suppliers and coal companies are spending more than $1 billion a year on research aimed at turning coal into a fuel that can match the cleanness and efficiency of natural gas. These efforts can be broadly divided into two, albeit overlapping, groups: technologies to improve the cleanness of conventional coal-fired generation; and completely new methods of burning coal.

With regard to the first group, one way to improve emissions is by coal-cleaning, a process that reduces the amount of pollutants in the coal feed. Advanced cleaning concepts are now being developed to increase the degree of cleaning that is economically feasible. These include thermal oxidation of sulphur in coal, removal of pyritic sulphur by bacterial oxidation, agglomeration of finely ground carbon-bearing particles by fuel oil, high-gradient magnetic desulphurization, and microbubble flotation. Low-sulphur coals also offer possibilities for major advances.

Another method is flue gas desulphurization, which takes a variety of forms, some of which result in a gypsum by-product that can be used in the building industry. The problem with some flue-gas desulphurization methods, however, is process complexity, high operating costs, and improvements in alternative technologies. Even so, new methods focused on calcium-based rather than sodium-based sorbents are being developed. Equipment suppliers of flue-gas desulphurization equipment see their biggest market opportunity in Eastern Europe and the former USSR where funds are restricted. Asea Brown Boveri, for example, is building two flue-gas desulphurization systems at a power plant in Pennsylvania which will remove about 95 per cent of the sulphur dioxide emissions of the facility.

A third approach is to improve the environmental performance of the pulverized coal-fired boilers which are the workhorses of worldwide coal-based power generation. Again, there are a number of methods, including sorbent injection, which introduces calcium-based sorbent directly into the boiler to reduce sulphur dioxide emissions by as much as 40-60 per cent; another is low-NO_x combustion, especially low-NO_x burners, which can reduce NO_x emissions by 50 per cent or more.

A minority of observers believe such developments will be enough to achieve the required environmental acceptability and efficiency. In Denmark, fuel conversion efficiency of 46 per cent is claimed for the latest ultra-clean, supercritical but conventionally fired coal plant. Mostly, however, the industry is putting its faith in a range of new or relatively new coal-burning technologies.

Fluidized-bed combustion power plants have generated considerable interest as a way to meet strict SO_2 emission regulations without requiring cumbersome flue-gas desulphurization systems. Most of the clean coal power stations developed so far use this system; it involves burning powdered coal in a bed of pulverized limestone, which acts as a chemical trap for any sulphur emitted from the fuel, and an upward flow of air keeps the bed in constant motion. A first turbine is driven by steam produced in boiler tubes in the fluidized bed, and a second by hot exhaust gases. The two most promising versions are circulating and pressurized fluidized bed combustion, where the whole chamber operates at between 5 and 20 bars. An Asea Brown Boveri consortium is currently building a 180-megawatt coal-fired cogeneration facility in Maryland which will include the world's largest operating fluidized bed combustion boiler. Asea Brown Boveri also has three fluidized bed combustion power plants successfully operating in Spain, Sweden and the United States, and is now ready to commercialize much larger systems offering 300-megawatt electrical output or 800 thermal megawatts. The company points out that fluidized bed combustion will take a wide variety of coal, and sees good opportunities for retrofitting, particularly for small- to medium-sized, coal-fired plants which, for various reasons, must continue to use coal.

Other suppliers, notably General Electric and Siemens, are putting much more faith in the integrated gasification combined cycle. In this process, coal is gasified by partial combustion in a pressurized furnace, and the gas is cooled, cleaned, and then used to fire a gas turbine, at which point the process ressembles that of the conventional gas-turbine combined cycle outlined above. Siemens has supplied turbines for two demonstration plants that have so far been awarded in Europe. These are the Demkolec project at Buggenum in the Netherlands, which runs on hard coal, and the KoBra lignite or brown-coal-fired combined-cycle plant near Cologne. Other projects are being prepared in Europe. In the United States, as early as 1984, General Electric joined with the Electric Power Research Institute, the United States Department of Energy and others to prove the feasibility of the integrated gasification combined cycle at the Cool Water pilot plant in California. This 120 megawatt plant serves 125,000 people, with emissions running well below current United States standards. General Electric is also involved in other integrated gasification combined-cycle projects.

The advantage of the integrated gasification combined cycle for the gas turbine producers is that it opens up another market beyond conventional gas combined-cycle generation. The integrated gasification combined-cycle has not yet met the efficiency levels of combined-cycle operation. However, with its latest turbines, General Electric is working towards efficiencies of 44 per cent, 10 points below combined-cycle operation, while a Siemens/Krupp Koppers coal gasification process called Prenflo will achieve 45 per cent efficiency at a new 300-megawatt plant to be built in Spain. However, the efforts of gas turbine producers to raise thermal efficiencies further should aid integrated gasification combined-cycle power generation, where efficiencies could reach 46 per cent in the next few years. From an environmental perspective, emissions of sulphur dioxide and nitrogen oxides in the integrated gasification combined cycle are now almost down to the levels achieved with natural gas. But there is now hope that even the emissions of carbon dioxide from coal-fired stations can be reduced. At a 320-megawatt cogeneration plant in Oklahoma, 200 tonnes a day of carbon dioxide (CO_2) are extracted chemically from the flue gases. As with flue gas desulphurization, however, it is a costly process.

(e) Nuclear power

In spite of the fact that commercial prospects for nuclear power are currently bleak with the exception of a handful of markets in Asia, major equipment suppliers are maintaining their product development plans in the hope of new interest in the next century. Two events have been crucial in undermining the nuclear power industry: the Three Mile Island accident in 1979 (since then no new nuclear plant has been ordered in the United States); and the Chernobyl disaster in Ukraine in 1986. Inevitably, perceptions of the safety of nuclear plants have become a critical issue in determining the future growth of the industry. The OECD Nuclear Energy Agency predicts that the total nuclear generating capacity for 24 wealthy industrialized countries will rise from 264 gigawatts in 1991 to 296 gigawatts in the year 2000, less than a quarter of the total predicted in a forecast made in 1977 [52]. But other issues have also dented the reputation of the industry, notably cost. The most efficient size for a nuclear plant is about 1,400 megawatt, and that requires an investment of about $2 billion and a lead-time of about 10 years.

Nuclear power does have two good attributes. The first is environmental; unlike the power-generating equipment mentioned above, nuclear power produces no polluting carbon dioxide, sulphur dioxide or nitrogen oxides. Theoretically, therefore, nuclear power ought to gain as emissions standards are tightened. The second is that nuclear power provides a security of supply against world events that could disrupt available fuel supplies.

Given that it can take 15 years for a new nuclear reactor design to come to fruition, product development has to continue now if companies are to have any hope of winning orders in the future. Present market conditions are bringing companies closer, allowing them to spread development costs. Two examples are the co-operation between Siemens of Germany and Framatome of France, and between Westinghouse Electric of the United States and Mitsubishi Heavy Industries of Japan. Two European companies have a jointly owned subsidiary, Nuclear Power International, which is developing the European pressurized water reactor. In France this will be the successor to the N4 series, and in Germany it will replace the Konvoi design. Emphasis is on safety, to facilitate public acceptance of nuclear power and thus the commercial prospects for the European pressurized water reactor. Nuclear Power International is working on reducing the chances of a core melt to less than one in one million for events internal to the nuclear plant. At the same time, it assumes the worst-case scenario, and then mitigates its effects so [illegible] releases can be limited to the plant [illegible]

If all goes well, con[illegible] begin in 1998, by which time Nuclear Power International hopes that the market will have revived. Westinghouse and Mitsubishi, meanwhile, signed a new 10-year agreement in 1992 to cooperate on developing commercial nuclear technology, deepening a relationship that began in 1958 by extending the range of joint development work.

Overall, the technology parameters for future nuclear stations are, by general agreement, as follows. They will have to be built and operated at relatively lower costs than current levels and be competitive with future fossil-fired plants; safety must be of paramount importance; licensing, construction schedules and costs must be predictable; and there must be an extremely low risk of severe accidents.

Most of the industry's efforts are devoted towards new versions of the pressurized water reactor and boiling water reactor, but other developments include the so-called high-temperature gas reactor cooled by helium, the heavy-water type as used in the Canadian deuterium uranium reactors, and liquid metal reactors. Perhaps the most exciting research area, however, is concerned with fusion power, which obtains energy from combining light atoms rather than splitting heavy ones. In 1992, EEC, Japan, Russian Federation and United States signed an agreement to cooperate in the engineering design of an international thermonuclear experimental reactor. The six-year $1-billion project will result in the completion of a test facility design that would, if built, demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes. Fusion energy has a long-term potential which is virtually limitless, environmentally acceptable and an economically competitive source of energy.

(f) Renewable and alternative fuel sources

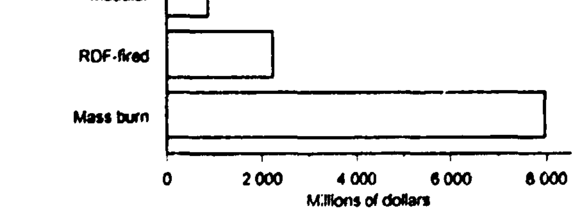
A growing interest in power generation has been the potential of renewable or alternative power generation, and its effect on the equipment industry. Strictly speaking, however, there is nothing new about renewable energy. Hydroelectricity has been in use for some 100 years, and is a technologically mature and proven method that accounts for about 20 per cent of world energy output. From an environmental perspective, hydroelectricity is very much a two-edged sword. It has no fuel costs or harmful emissions, yet it is intrusive on a large scale because of the need for big dams and reservoirs. Leading funding authorities such as the World Bank and the European Investment Bank require an environmental impact report for any new proposed hydroelectric power scheme. Even though the technology is well established, there is, however, still room for improvement. One equipment manufacturer is making substantial investments in improving the efficiency of large hydrogenerators, while automated control systems to run power stations virtually unmanned are also becoming increasingly important. In the next 10 years, the trend towards smaller, more environmentally friendly schemes will be met with more compact generating equipment.

Other renewable energy types include wind, tidal wave, solar power, biomass and industrial and municipal wastes. Since the first oil price shock of 1973, vast sums have been spent on research into alternative energies, and all these types of power generation have developed from concepts into reality. However, no alternative energy breakthroughs of a major scale have been achieved. In the United Kingdom, a study done in 1992 by the Renewable Energy Advisory Group, concluded that renewables could theoretically contribute as much as 45 per cent of 1991 electricity supply by around the year 2025. A more economically plausible figure, it suggests, would be about 20 per cent of 1991 supply, or about 60 terawatt-hours (60 million megawatt-hours) per day [57]. There are several reasons for this. First, conventional power technology has been advancing over the past 20 years. Secondly, subsidies are likely to be required for the alternative technologies to flourish, and these may not be forthcoming. Thirdly, the power that is generated, for example, from wind or waves, is highly dispersed, so that energy has to be gathered from a large space or volume.

The most developed of the alternative technologies, apart from solar panels in domestic use, is wind power. There are already an estimated 20,000 wind turbines in the world, with some producing more than 1 megawatt of power, but there are environmental costs, notably the visual obtrusiveness of wind turbines. Tidal power has been proved to work, and produces output that compares well with conventional power stations. A 240-megawatt tidal barrage has been operating successfully on the Rance estuary in France since 1967. But larger-scale schemes, such as the abandoned Severn Barrage in the United Kingdom, could cost as much as $9 billion and have negative environmental side-effects. Other technologies, notably solar photovoltaic cells, have benefited considerably from research spending, but are still not yet commercially practical, except in special circumstances.

A more practical approach to renewable energy may be the use of waste products as fuel as shown in figure IV.27. One study has predicted that the already robust European market for refuse-to-energy plant would grow strongly over the next decade or more, because of tightening legislation on the disposal of municipal solid waste [58]. A number of companies are also offering equipment for collecting the gas that collects on landfill sites and turning it into usable electrical energy. Biomass, a general term for natural waste products, is also being used as a power source, with one of its most promising fuels being poultry litter. In 1992, the world's first com-

Figure IV.27. Total European sales of refuse-to-energy plant equipment and services by plant type, 1992 to 2005



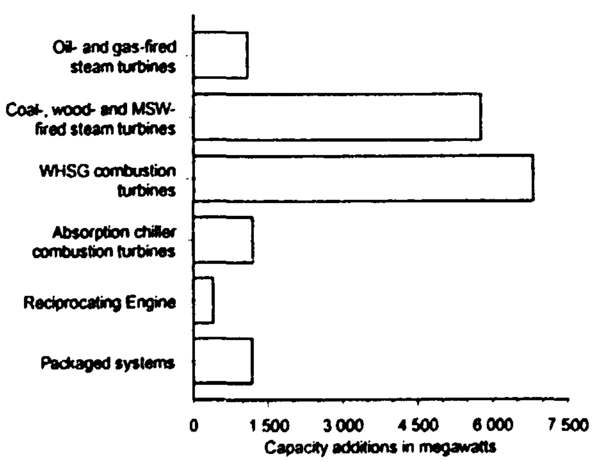
Note: RDF = refuse-derived fuel

Source: Frost and Sullivan International, The European Market for Cogeneration Systems, Reports E1603 and 1604 (London, July 1992).

mercial power station fuelled by poultry litter was opened in the United Kingdom. Although relatively small, with a power output of only 12.5 megawatt, the plant is environmentally attractive because it represents a relatively clean way to dispose of poultry litter. Sulphur dioxide and nitrogen oxide emissions are much less than for coal-fired power generation.

With regard to small-scale power generation, it is important not to forget the attractiveness of combined heat and power for many countries, or for industrial concerns big enough to consider their own power generation. Combined heat and power, known as cogeneration in the United States, turns the waste heat from the main power source into steam or hot water for use by industry or in the home, and can achieve thermal efficiencies of as much as 90 per cent. The systems can be powered by gas and steam turbines or by clean-burning diesel engines. Already hundreds of combined heat and power schemes are in operation in Europe, and more are planned, as forecast in figure IV.28. In the past, combined heat and power technology has been applied mainly as a cost-saving measure, but increasing environmental concerns are now starting to affect buying decisions for cogeneration equipment. Although the environmental performance of combined heat and power plants varies widely according to the power source, they are generally relatively pollution-free where they substitute for coal-fired generation, and they would reduce carbon dioxide emissions sharply [59].

Figure IV.28. Total European market for cogeneration systems, forecast capacity additions by equipment type, 1990 to 2000



Note: MSW = municipal solid waste
WHSG = waste-heat steam generator

Source: Frost and Sullivan International, The European Market for Cogeneration Systems, Reports E1603 and 1604 (London, July 1992).

6. *Short- and medium-term outlook*

The world power-generating equipment industry is likely to experience a period of steady growth over the next several years. Encouraging prospects in some regions of the world such as Asia, however, are balanced by uncertainties elsewhere. The factors listed above, environmental awareness, technology development, industrial restructuring, and changes in the nature of the customer base, will continue to be important influences over the next decade.

In terms of the annual growth in power-generating capacity, one estimate suggests that Asia will experience a 4.5 per cent growth per year in the 1990s [60]. That exceeds the projected capacity for Latin America and Western Asia at 4.2 per cent, and eclipses the anticipated 2 per cent for North America and the 1.8 per cent for Europe. In terms of the world market as a whole, it is expected to reach the range of 90 to 100 gigawatts by the year 2000 [52]. Roughly 40 per cent of the business over the coming decade should come from the countries of the Pacific rim, including China, and about 20 per cent each from Africa, Europe, Latin America, United States and Western Asia.

It is also important to look at the total market for power generation, transmission and distribution equipment to see how the regional mix will change. Asea Brown Boveri estimates that the Asian market, excluding Japan, currently accounts for about 15 per cent of the total, but by the turn of the century it will represent 30 to 33 per cent of a market that will have grown substantially [52]. Westinghouse estimates a potential for 620 gigawatts, and forecasts about 73 gigawatts of steam and combustion turbine orders a year by the end of the decade, 56 gigawatts of which will be outside the United States [52]. The order volume for the year 2000 is expected to be about 40 per cent higher than it is today, and the market as a whole worth some $25 billion.

Clearly, Asian markets, particularly China, Indonesia and Viet Nam, will become very important for equipment suppliers in developed market economies over the next few years. Some forecasts of planned generation additions for the region are given in table IV.80. China's need for new power capacity has already been mentioned, including its new economic zones in the south and in the Yangtze River valley. Indonesia, with its population of 187 million, has a strong unsatisfied demand for new power which could be further increased if the economy opened up to foreign investment. The mar-

Table IV.80. Planned annual additions to power generation in countries and areas of Asia and the Pacific

Country or area	Added capacity (megawatts per year)
China and Hong Kong	12 000-15 000
Republic of Korea	1 800
Taiwan Province	1 700
Indonesia	1 600
Thailand	1 200
Malaysia	1 000
Philippines	700
Viet Nam	400
Other	600
TOTAL	21 000-24 000
For comparison	
Switzerland	15 000
Sweden	30 000
Germany	100 000

Source: Asea Brown Boveri data presented at annual press conference, Zurich, 11 March 1993.

ket in Viet Nam could grow very fast in the next decade, and European equipment suppliers are maintaining frequent contacts. Thailand is currently ahead in the development cycle, but more infrastructural development in rural areas would spur demand for greater power capacity. Another market that could develop in Asia is Myanmar, which will start to exploit its gas fields, and thus perhaps create a market for combined-cycle power plants.

In the United States, Westinghouse forecasts more than a 2 per cent annual increase in peak electricity demand, which could mean orders of 120 gigawatts over the next 10 years [52]. Both Westinghouse and Siemens, which has recently stepped up its involvement in the United States, see good opportunities for work that will replace or modernize existing capacity, which has an older average life than the capacity in Western Europe.

There are, however, a number of uncertainties in assessing the outlook for the power-generating equipment industry, particularly in developing countries. The chief issue is determining whether funds can be found to pay for new power plants, no matter how much additional generating capacity may be needed. India, for example, has nearly 200 million people who will increase the demand of the country for more power-generating capacity. However, lack of investment funds and dwindling foreign aid have contributed to the country's inability to add new generating capacity. The market for independent power projects in Asia and elsewhere is opening up, but in many countries there is still no realistic alternative to government-sponsored projects financed with government-guaranteed debt. It is already recognized that, even for fast-growing economies, the cost of a new power station creates financing problems, and imaginative privately financed projects shared by international consortia of suppliers will be a key element in keeping power capacity in line with demand without straining the public finances of a developing country. A recent example of an agreement on a private power plant in Asia shows how large such projects are becoming. In Indonesia, the Government has approved an investment licence for Mission Energy of the United States to build a $2-billion power station at Paiton in East Java. The plant, which will consist of two coal-fired, 600-megawatt power units, will be Indonesia's first privately built, owned and operated station linked directly into the national grid. According to reported estimates by donor countries, Indonesia must invest $30 billion into the grid during the 1990s to satisfy domestic demand; one third of that figure should come from private investors.

The financing problem is particularly acute for nuclear plants, partly because of the generally politicized environment in which this sector operates, but also because of the difficulty of assessing and controlling risk in the markets of developing countries. Consequently, no examples of independent nuclear power projects in developing countries appear to exist, and private promoters in any case are unlikely to favour a technology that involves much longer lead-times than modern combined-cycle plant. One of the most complex issues involving nuclear power concerns the stations designed and operated in the former USSR and in Eastern Europe. While the availability of financing for Eastern European power projects is difficult, western equipment suppliers are particularly keen to encourage their Governments to finance the modification or shut-down of those nuclear plants. There are 15 so-called RBMK (graphite-moderated, Chernobyl-type) nuclear stations in operation in the former USSR and Eastern Europe, and 66 of various generations of VVER (pressurized-water-type) stations in use or under construction. The more modern of the latter can most easily be brought into line with western safety standards. Suppliers such as Asea Brown Boveri, Siemens and Westinghouse are vying for this work, but funding is necessary not only for that, but also, in the case of shut-downs, for replacing conventional generating capacity. Practical considerations suggest that several of the RBMK reactors will not be shut down because of the economic consequences. In Saint Petersburg, for example, four RBMKs supply about 70 per cent of the electricity for the city and its surrounding area.

From a technology standpoint, the onward march of combined-cycle gas turbine technology seems likely, particularly as worries over the availability of gas as a fuel source are declining. General Electric foresees nuclear power dropping from 10 per cent of orders between 1987 and 1991 to 6 per cent from 1996 to 2001; combined-cycle and gas turbine orders will collectively rise from 39 per cent between 1987 and 1991 to 43 per cent from 1992 to 1995, before declining to 38 per cent from 1996 to 2001 [52]. Two points are worth noting here. First, nuclear and conventional (that is coal-fired) steam generation still accounts for about half of the projected 100 gigawatt market in 2010. Secondly, the GEC Alsthom projection suggests that by 2010 the integrated-gasification-combined cycle clean-coal technology could account for 10 per cent of the total market [52]. Meanwhile, environmental factors, and in particular the problem of the greenhouse effect, could produce much stronger legislation on emissions. This would suggest that nuclear power has an important role to play, at least in the long term, by providing a clean alternative to emission-producing power generation. For the same reason, it also implies that the often neglected hydroelectric power generation as a fuel is also likely to have an important long-term future.

No changes in market structure are foreseen over the medium term. Barriers to entry are higher than ever because of technological developments requiring, for example, heavy spending on gas turbine development. If anything, remaining excess capacity could lead to restructuring the fringe around the four major company groupings (five, if GEC Alsthom is considered separately from General Electric, whose gas turbine technology it uses). If the market continues to develop as predicted, there ought to be enough work to sustain these groupings. However, a serious downturn could threaten that position. In particular, Japanese companies could become much more aggressive in non-Asian export markets as their home market matures.

Concerning manufacturing capacity in developing countries, the main obstacles to the development of a power-generating equipment industry in developing countries are the lack of financing for investment in this heavy industry and capital-intensive sector, lack of skilled labour, and the cost and time needed to acquire technologies and to implement them on an industrial scale. In terms of the interrelationship between North and South, the industrializing countries of the South should begin to develop equipment-producing capacity, mainly in the less sophisticated technologies and through cooperative agreements with companies of the North providing the engineering design for the installation. Inevitably, the market focus of the major equipment suppliers will be Asia. However, it has been noted that there are power-generating equipment industries, or parts thereof, in many other countries, and more could be joining them. Siemens is among the companies negotiating with Egypt over the establishment of some local power plant factories. Egypt wants to step up local participation, although it does not want to become a fully integrated producer. This type of association will be developed in the future, but major companies from developed countries will expand their application of advanced technologies and further concentrate on their core business.

K. Fertilizer equipment (ISIC 3822)*

1. Recent trends and current conditions

The fertilizer equipment industry provides a unique link between agricultural and industrial development, and often presents a nucleus for the broadly based development of a heavy chemical industry. Fertilizers are manufactured in plants varying in size from a simple operation run by a few people, representing a modest investment, to huge plants worth millions of dollars and requiring hundreds of trained employees. Almost all these fertilizer plants involve chemical manufacturing operations of varying technical complexity.

Because of rapid population growth and increased per capita incomes, the world is faced with the problem of expanding its food supply rapidly enough to keep pace with the growing food consumption. Since the supply of new land is limited, most of the expansion will have to come from increased yields on land already cultivated. This will imply a growing supply and use of technology, including the development and use of more efficient processes to produce fertilizers and to make them relatively less expensive. Technological development is thus essential in the fertilizer equipment industry.

The limited existing information on fertilizer equipment suggests that it is a highly competitive industry, where the battle for a share in the market is often fierce. As a result, production, trade, price and capacity expansion data are often difficult or impossible to obtain. Thus, assessments such as that given in the present survey must be partially based on estimates.

The world fertilizer equipment industry has been historically and structurally linked to both the agricultural and chemical engineering industries, which have gone through a major technological revolution since the end of the Second World War. In the 1980s, new processes were developed and new equipment was built and installed. As a result, the fertilizer technology industry is able to offer a wide range of processes with diverse associated equipment to produce a greater variety of fertilizer products. This makes it possible to better adapt fertilizers to varying soils at different locations. Although this technological revolution started and continues in developed countries, only a few developing countries have participated, albeit on a more modest scale than in developed countries.

Recently, regional patterns of demand for fertilizers have significantly affected sales of equipment in different parts of the world. Increasing concerns over the environment, which have led to strictly enforced legislation in the fertilizer industry, have had a definite adverse effect on the demand for conventional fertilizer equipment. Other important influences include: the increasing number of companies in Eastern Europe offering processes and technology as a result of recent political changes; greater demand for technology in developing countries; and the impact on technological developments in the North of policies adopted to reduce fertilizer overcapacity and environmental damage.

Market prices for fertilizer equipment have always responded most significantly to economic conditions prevailing in buyers' markets, although major price swings for fertilizer equipment have been associated with the cyclical nature of both the supply and demand markets. After a prolonged period of steady prices, international prices for fertilizer equipment have been increasing since 1987, due to the strong demand from importing countries.

Competitiveness in this industry has historically been assessed by the price gap that exists between equipment producers and process licensors. Production costs are affected by the price gap, as well as by exchange rate variations in the currency of the producing country. A competitive factor, which partially offsets the price disadvantage for some producers, is advanced technology. The development of high-technology machinery tends to strengthen the competitive position of the fertilizer equipment industry in developed countries compared to those in developing countries, since the latter tend to lack the human and capital resources needed to develop new technologies.

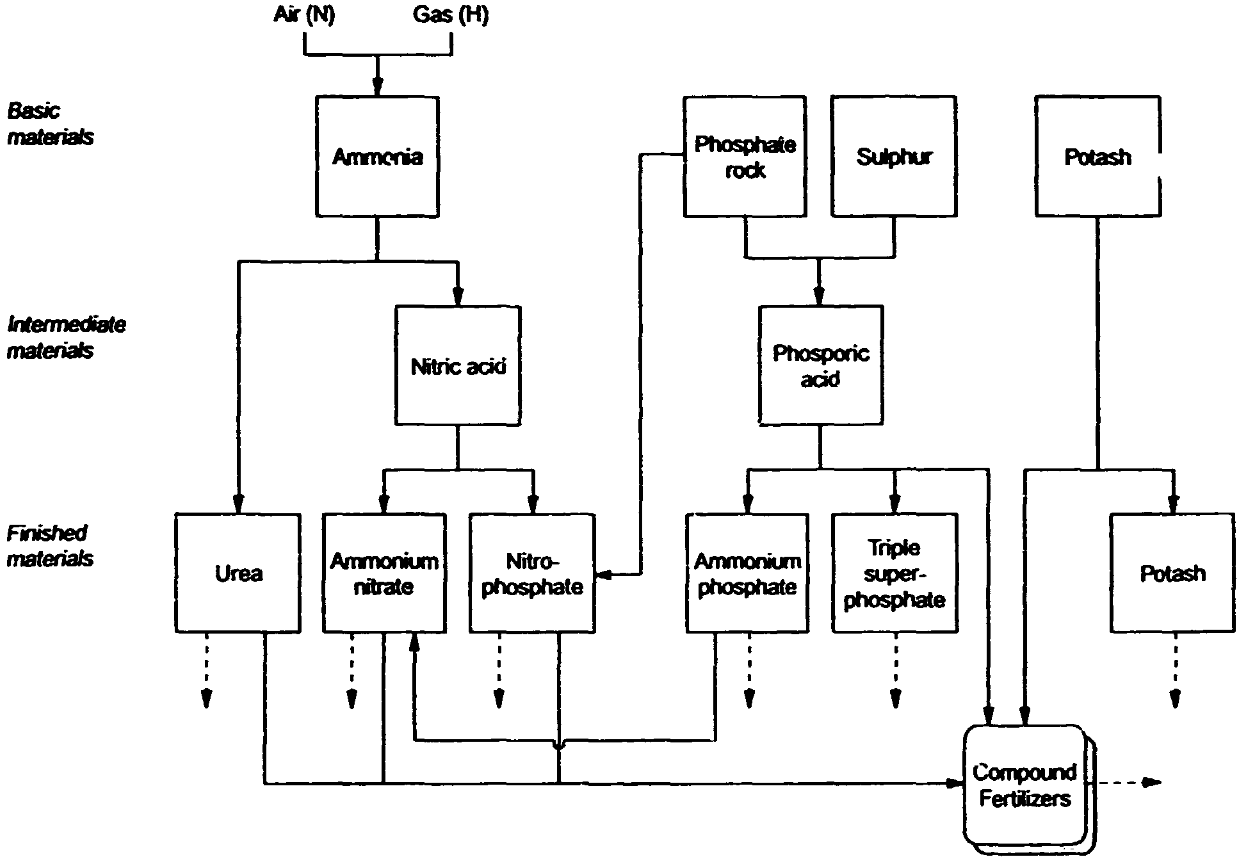
(a) Equipment classification and process definitions

In terms of structure, the fertilizer equipment industry, as defined here, comprises manufacturing equipment used to process or transform raw materials into inorganic or mineral fertilizers. Equipment for organic fertilizers, such as animal manure, sewage sludge and composted organic materials, are not included. Raw materials contain the three essential plant primary nutrients: nitrogen, generally expressed in the elemental form, N; phosphorus, generally referred to as phosphates and expressed as P_2O_5 or P; and potassium, generally called potash and expressed either in the oxide form, K_2O, or as the element, K. Fertilizer manufacturing equipment is used to process raw materials to manufacture: simple fertilizers containing only one of the three major nutritive elements; compound fertilizers containing two (binary) or three (tertiary) major nutritive elements; and mixed fertilizers, obtained by mixing simple fertilizers. Manufacturing the first two normally involves chemical as well as physical processes, while the third is a purely physical process once simple fertilizers are available. Figure IV.29 presents a production flow chart for the principal fertilizers traded worldwide.

A variety of processes have been developed to accomplish these transformations. There is a need to include process developers along with equipment suppliers in the definition of fertilizer equipment companies. Many of these subordinates involved in fertilizer technology only develop and license the processes; others may only be involved in designing, engineering, constructing and supplying plants and specific items of equipment; and

*UNIDO acknowledges the contribution of Brigitte Bocoum, Department of Mineral Resource Economics, West Virginia University.

Figure IV.29. Production flow chart for principal fertilizer materials



Source: Manual on Fertilizer Statistics, Economic and Social Development Paper No. 102 (Rome, Food and Agriculture Organization of the United Nations, 1991).

still others are involved in all aspects of equipment development and production. The major types of specialized equipment available today are listed in table IV.81.

(b) Recent trends in consumption and production

Generally speaking, trends in the consumption of fertilizer equipment are similar to those for the types of fertilizer produced by such equipment. Because the industry is directly linked to the demand for fertilizers, increases in fertilizer use have raised the demand for fertilizer equipment and enhanced the tendency to implement newly developed processes at times when the demand for finished fertilizers was on the rise. Recently, some large investments in fertilizer processing plants in developing countries have also caused an increase in demand for processing machinery [61]. This has stimulated the entire fertilizer equipment industry. Manufacturers in the North are experiencing greater growth in their export markets. A factor that may limit growth, though, is the capital-intensiveness of the industry, which leads to long pay-off periods for existing technologies and extra-high risks in introducing new ones.

Lack of data on equipment purchases by country makes it difficult to rank the largest consumers of equipment in the world, but estimates have been made on the basis of fertilizer production capacity. Table IV.82 lists some of the major fertilizer-equipment-consuming countries in 1990 according to their estimated current fertilizer capacity, although not necessarily all the largest ones, since information on all countries was not available. The three leading consumers in 1990 were the United States with about 55 million tonnes, Canada with 22.2 million tonnes and, surprisingly, India with 21.4 million tonnes. These estimates also show that seven other developing countries, namely Brazil, China, Indonesia, Mexico, Morocco, Pakistan and Tunisia, were among the top 20 consumers of fertilizer equipment,

Table IV.81. Fertilizer processing equipment, 1992

Type of equipment	
Ammonia converters	Mining machines
Ammonia storage	Mist eliminators
Pressure	Nitric acid absorbers
Refrigerated	Phosphate rock mills
Compressors, centrifugal	Phosphoric acid
For ammonia synthesis	Agitators
Compressors, reciprocating	Evaporators
For ammonia synthesis	Filters
For urea synthesis	Pipe reactors
Coolers	Prilling towers
Corrosion-resistant materials	Reforming furnaces tubes
Metallic	Sulphur burners
Non-metallic	Sulphur filters
Draglines	Sulphur grinding mills
Fertilizer handling plant	Sulphur melters
Bagging	Sulphur pumps
Blending	Superphosphate dens
Bulk handling	Urea synthesis reactors
Granulators	
Ammoniators	

Source: The British Sulphur Corporation, *World Directory of N.P.K.S. Process & Plant Suppliers* (London, 1992).

Table IV.82. Major world consumers of compound fertilizer equipment, 1990

Country	Consumption[a] (thousand tonnes)	Percentage share[b]
United States	55 013	17.5
Canada	22 167	7.0
India	21 439	6.8
Czechoslovakia	19 220	6.1
Germany	15 156	4.8
USSR	13 848	4.4
Brazil	12 940	4.1
France	12 250	3.9
Italy	8 765	2.8
Netherlands	8 380	2.7
Turkey	8 001	2.5
Spain	7 774	2.5
Indonesia	7 195	2.3
Japan	7 061	2.2
United Kingdom	6 163	1.9
Morocco	5 300	1.7
Mexico	5 198	1.6
Tunisia	3 913	1.2
China	3 108	1.0
Pakistan	2 337	0.7
Total	245 228	77.9
World	314 800	100.0

Source: The British Sulphur Corporation, *World Directory of Fertilizer Manufacturers* (London, 1990).

a/ Derived from total fertilizer capacity, including compound fertilizers, by company for each country.

b/ Percentage of world total.

with a combined share of about 20.9 per cent of the production capacity for all fertilizer equipment types. The countries listed in table IV.83 accounted for over 77 per cent of the global consumption of fertilizer equipment, indicating a high degree of concentration in this segment of the industry.

Conservative estimates of equipment consumption in 1990, based on the number of purchasing companies and not tonnes of fertilizer equivalents, are provided in table IV.83 also for the year 1990. The data indicate that demand for fertilizer equipment was most diversified in developing market economies, with India alone having 44 companies purchasing equipment in 1990s. Next came the United States with 36 companies. A total of 423 companies are known to purchase fertilizer equipment. Of these, 167 are in the developed market economies, 168 in developing market economies, 80 in the former centrally planned economies, and 7 in China.

Table IV.84 provides greater detail on individual country and regional market shares in the global demand for each fertilizer equipment category in 1991. While China was the leading consumer of nitrogen processing equipment, it was only thirteenth in consumption of potash processing equipment, and was not listed among the top 20 consumers of phosphate processing equipment. Canada and the United States were leading consumers of potash and phosphate equipment, respectively. The Russian Federation was the second largest consumer of all three types of fertilizer equipment. Five newly independent States of the former USSR were among the leading consumers of fertilizer equipment in the world. Their respective shares were as follows: Azerbaijan 0.2 per cent of all potash equipment demand; Belarus 15.7 per cent of potash equipment; Kazakhstan 2.2 per cent of phosphate processing equipment; Ukraine 4.4 per cent of the world's consumption of nitrogen equipment, 2 per cent of phosphate equipment, and 1.2 per cent of potash equipment; Uzbekistan 1.3 per cent of nitrogen equipment and 1.5 per cent of phosphate equipment. Although the country is a major process developer, Japan was among the top 20 consumers in only one category, nitrogen equipment. India ranked fourth in the nitrogen equipment category, and was only the nineteenth most important consumer of phosphate equipment. Morocco was the third largest consumer of phosphate equipment.

As an economic-geographic group, the former centrally planned economies of Eastern Europe and the USSR dominated the demand market for nitrogen equipment, while developed market economies were the leading consumers of phosphate and potash equipment in 1991. The market shares accounted for by developing market economies were 26.4 per cent, 28.1 per cent and 2.7 per cent for nitrogen, phosphate and potash equipment, respectively. The dominant shares by equipment category were accounted for by Asia with 18.5 per cent, Africa with 13.3 per cent and Asia with 2.3 per cent. North America was the leading consumer of fertilizer equipment among developed countries, with shares of 13.5 per cent, 33.3 per cent and 35.7 per cent for nitrogen, phosphate and potassium equipment, respectively. The consumption share of the former USSR was significant in all equipment categories, ranging from 19.1 per cent for nitrogen and phosphate equipment to 36 per cent for potash equipment. In terms of quantity, world consumption of nitrogen equipment was the largest for all three types, at over 115 million tonnes of capacity, followed at a distance by potash processing machinery at 36.5 million tonnes, and phosphate equipment at 35.6 million tonnes in 1991.

World consumption of nitrogen and phosphate equipment has grown over the recent period from 1987 to 1990. As shown in table IV.85, global consumption increased by 5.5 per cent and 2.4 per cent for these two categories, but increased by 5.6 per cent in the case of potash processing equipment. Differences in consumption among fertilizer types and region can been seen in figure IV.30. The most remarkable increases in consumption over recent years occurred in China, with 220 per cent and 140 per cent increases for phosphate and potash equipment, respectively. Construction of the Hubei phosphate project was initiated in China and its implementation has resulted in large purchases of processing equipment. China's phosphate fertilizer capacity is expected to increase by 2.5 million tonnes by the year 2000. Also, the country has recently purchased large quantities of potash processing equipment for its operations in the province of Qinghai, which are expected to produce around 800,000 tonnes of potassium chloride, a potash-based fertilizer.

Because of the lack of sales data, it is difficult to give precise figures for fertilizer equipment production worldwide. However, estimates may be derived from table IV.86, which groups all the countries producing fertilizer equipment. Although the table contains information only on the number of companies in operation at different locations throughout the world, the numbers are a good

Table IV.83. World consumption of fertilizer equipment, 1990

Economic grouping, region, country or area	Number of purchasing companies
Developed market economies	
Western Europe	
Germany	11
France	9
United Kingdom	9
Netherlands	8
Italy	7
Belgium	6
Spain	6
Greece	5
Ireland	4
Portugal	3
Austria	2
Denmark	2
Switzerland	2
Finland	1
Iceland	1
Norway	1
Sweden	1
North America	
United States	36
Canada	17
Oceania	
Australia	5
New Zealand	5
Other	
Japan	17
Israel	5
South Africa	4
Total, A	167
Developing market economies	
Asia	
India	44
Turkey	7
Indonesia	6
Republic of Korea	4
Pakistan	4
Philippines	4
Malaysia	3
Saudi Arabia	3
Taiwan Province	3
Bangladesh	2
Myanmar	2
Iran (Islamic Republic of)	2
Iraq	2
Jordan	2
Abu Dhabi	1
Afghanistan	1
Bahrain	1
Cyprus	1
Kuwait	1
Lebanon	1
Qatar	1
Syrian Arab Republic	1
Thailand	1
Viet Nam	1
Latin America	
Brazil	22
Argentina	3
Colombia	3
Cuba	3
Peru	3
Trinidad and Tobago	3
Chile	2
El Salvador	2
Mexico	2
Venezuela	2
Costa Rica	1
Dominican Republic	1
Ecuador	1
Uruguay	1
Africa	
Egypt	5
Zimbabwe	3
Morocco	2
Nigeria	2
Algeria	1
Côte d'Ivoire	1
Libyan Arab Jamahiriya	1
Mauritius	1
Mozambique	1
Senegal	1
United Republic of Tanzania	1
Tunisia	1
Uganda	1
Zambia	1
Total, B	169
Former centrally planned economies	
Eastern Europe	
Romania	11
Czechoslovakia	7
Poland	7
Yugoslavia	7
Bulgaria	4
Hungary	4
USSR	40
Total, C	80
China	7
Total, D	7
World, A, B, C, and D	423

Source: The British Sulphur Corporation, *World Directory of Fertilizer Manufacturers* (London, 1990).

Table IV.84. World consumption of fertilizer equipment by type, 1991[a]

Rank in 1991	Nitrogen[b]: Economic grouping, region or country	Nitrogen[b]: Consumption (thousand tonnes)	Nitrogen[b]: Percentage share of world total	Rank in 1991	Phosphate[c]: Economic grouping, region or country	Phosphate[c]: Consumption (thousand tonnes)	Phosphate[c]: Percentage share of world total	Rank in 1991	Potash[d]: Economic grouping, region or country	Potash[d]: Consumption (thousand tonnes)	Potash[d]: Percentage share of world total
					A. Top consuming countries						
1	China	19 609	17.0	1	United States	11 249	31.7	1	Canada	11 190	30.7
2	Russian Federation	13 690	11.9	2	Russian Federation	3 341	9.4	2	Russian Federation	6 880	18.9
3	United States	12 963	11.0	3	Morocco	2 772	7.8	3	Belarus	5 740	15.7
4	India	8 416	7.3	4	Tunisia	1 472	4.1	4	Germany	4 800	13.2
5	Ukraine	5 103	4.4	5	South Africa	876	2.5	5	United States	1 835	5.0
6	Romania	3 505	3.0	6	Brazil	825	2.3	6	France	1 500	4.1
7	Netherlands	3 053	2.7	7	Mexico	819	2.3	7	Israel	1 380	3.8
8	Canada	2 851	2.5	8	Kazakhstan	775	2.2	8	Jordan	840	2.3
9	Germany	2 830	2.5	9	Former Yugoslavia	740	2.1	9	Spain	750	2.1
10	Indonesia	2 777	2.4	10	Ukraine	710	2.0	10	United Kingdom	500	1.4
11	Mexico	2 419	2.1	11	Poland	639	1.8	11	Ukraine	450	1.2
12	Poland	2 208	1.9	12	Canada	567	1.6	12	Italy	250	0.7
13	France	1 812	1.6	13	Republic of Korea	555	1.6	13	China	170	0.5
14	Bulgaria	1 721	1.5	14	France	542	1.5	14	Brazil	150	0.4
15	Japan	1 636	1.4	15	Romania	542	1.5	15	Azerbaijan	60	0.2
16	Uzbekistan	1 549	1.3	16	Turkey	541	1.5	16			
17	Trinidad and Tobago	1 394	1.2	17	Uzbekistan	530	1.5	17			
18	Italy	1 340	1.2	18	Spain	495	1.4	18			
19	Egypt	1 249	1.1	19	India	493	1.4	19			
20	Pakistan	1 210	1.1	20	Belgium-Luxembourg	490	1.4	20			
					B. Developed market economies						
	North America	15 544	13.5		North America	11 856	33.3		North America	13 028	35.7
	Western Europe	13 516	11.7		Western Europe	2 727	7.7		Western Europe	7 800	21.4
	Oceania	610	0.5		Oceania	57	0.2		Oceania	-	-
	Other[e]	2 312	2.0		Other developed[f]	1 732	4.9		Other developed[g]	1 380	3.8
	Total	31 982	27.8		Total	16 372	46.0		Total	22 208	60.8

Table IV.84 *(continued)*

Rank in 1991	Economic grouping, region or country	Nitrogen[b] Consumption (thousand tonnes)	Nitrogen[b] Percentage share of world total	Rank in 1991	Economic grouping, region or country	Phosphate[c] Consumption (thousand tonnes)	Phosphate[c] Percentage share of world total	Rank in 1991	Economic grouping, region or country	Potash[d] Consumption (thousand tonnes)	Potash[d] Percentage share of world total
	C. Former centraliy planned economies										
	Former USSR	22 923	19.9		Former USSR	6 805	19.1		Former USSR	13 130	36.0
	Eastern Europe	10 119	8.8		Eastern Europe	2 131	6.0		Eastern Europe	-	-
	Total	33 042	28.7		Total	8 936	25.1		Total	13 130	36.0
	D. Developing market economies										
	Africa[f]	3 080	2.7		Africa[f]	4 733	13.3		Africa[f]	-	-
	Asia[g]	21 238	18.5		Asia[g]	3 530	9.9		Asia[g]	840	2.3
	Latin America	6 103	5.3		Latin America	1 719	4.8		Latin America	150	0.4
	Total	30 421	26.4		Total	9 982	28.1		Total	990	2.7
	E. Centrally planned Asia										
	China	19 609	17.0		China	291	0.8		China	170	0.5
	Total	19 609	17.0		China	291	0.8		China	170	0.5
World, A, B, C, D and E		115 054	100.0	World, A, B, C, D and E		35 581	100.0	World, A, B, C, and D		36 498	100.0

Source: World Bank/FAO/UNIDO Industry Working Group on Fertilizers, *World and Regional Supply and Demand Balances for Nitrogen, Phosphate, and Potash, 1990/91-1996/97*, World Bank Technical Paper No. 176 (Washington, D.C., World Bank, 1992).

a/ Approximated by using fertilizer capacity by country and region.
b/ Thousand tonnes of ammonia.
c/ Thousand tonnes of phosphoric acid.
d/ Thousand tonnes of potash.
e/ South Africa, Japan and Israel.
f/ Excluding South Africa.
g/ Excluding Japan and Israel.

Table IV.85. World consumption of fertilizer equipment by type and by region, 1987 and 1990[a]
(Million tonnes)

Economic grouping or region	Consumption 1987	Consumption 1990	Percentage change 1987-1990	Percentage share 1990
	A. Nitrogen			
Developed market economies				
North America	15.8	15.8	-	13.4
Western Europe	12.3	12.4	0.8	10.5
Oceania	0.6	0.6	-	0.5
Other[b]	2.3	2.4	4.3	2.0
Total	31.0	31.2	0.6	26.4
Developing market economies				
Africa	1.8	1.8	-	1.5
Latin America	5.0	6.1	22.0	5.2
Asia	21.1	23.2	10.0	19.6
Total	27.9	31.1	11.5	26.3
Former centrally planned economies	34.2	36.1	5.6	30.6
China	18.8	19.7	4.8	16.7
World	111.9	118.1	5.5	100.0
	B. Phosphate			
Developed market economies				
North America	12.1	12.1	-	31.2
Western Europe	3.6	3.5	-2.8	9.0
Oceania	0.1	0.1	-	0.3
Other[b]	2.4	2.4	-	6.2
Total	18.2	18.1	-0.5	46.7
Developing market economies				
Africa	5.4	5.4	-	13.9
Latin America	1.8	1.8	-	4.6
Asia	4.3	4.6	7.0	11.9
Total	11.5	11.8	2.6	30.4
Former centrally planned economies	8.1	8.7	7.4	22.4
China	0.1	0.2	100.0	0.5
World	37.9	38.8	2.4	100.0
	C. Potash			
Developed market economies				
North America	9.9	11.2	13.1	33.0
Western Europe	5.5	5.6	1.8	16.5
Oceania	-	-	-	-
Other[b]	1.3	1.4	7.7	4.1
Total	16.7	18.2	9.0	53.7
Developing market economies				
Africa	-	-	-	-
Latin America	0.1	0.1	-	0.3
Asia	0.8	0.9	12.5	2.7
Total	0.9	1.0	11.1	2.9

Table IV.85 *(continued)*

Economic grouping or region	Consumption 1987	Consumption 1990	Percentage change 1987-1990	Percentage share 1990
Former centrally planned economies	14.5	14.6	0.7	43.1
China	-	0.1	..	0.3
World	32.1	33.9	5.6	100.0

Sources: *Improving the Supply of Fertilizers to Developing Countries*, World Bank Technical Paper No. 97, Industry and Energy Series (Washington, D.C., World Bank, 1989); International Fertilizer Industry Association, *Summary of World Fertilizer Capacities* (Paris, 1991).

a/ Approximated using fertilizer capacity of each region.

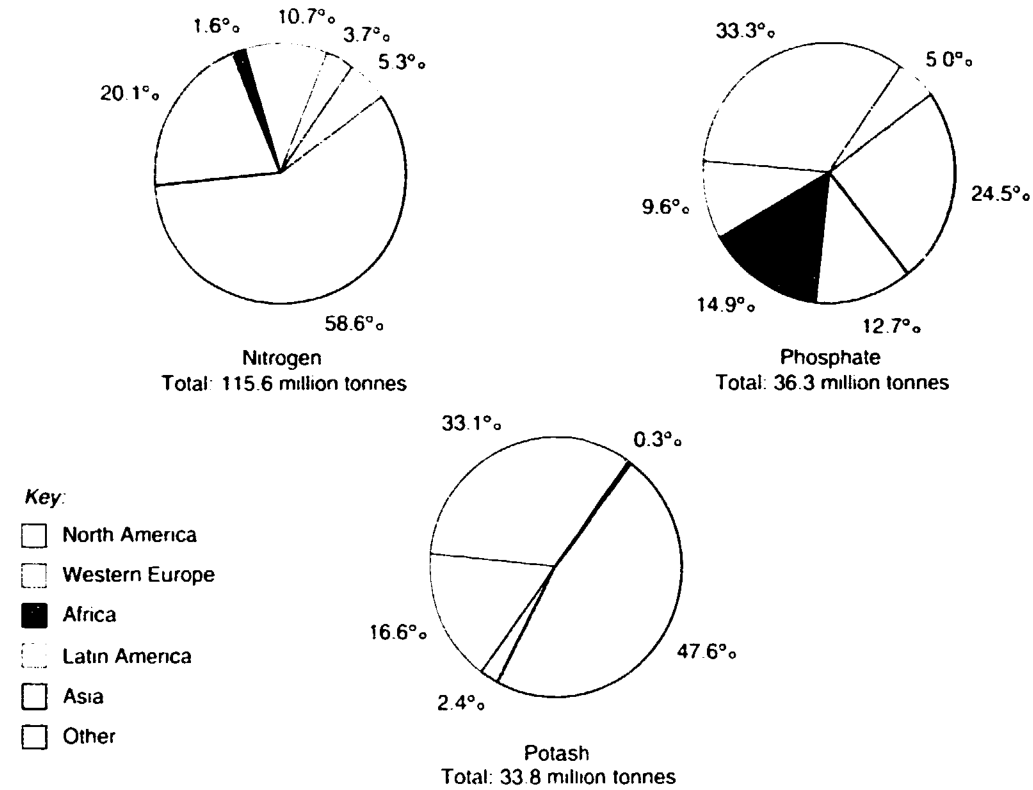
b/ Israel, South Africa and Japan.

Table IV.86. World producers of fertilizer equipment, 1992

Economic grouping, region, country or area	Number of companies in operation	Economic grouping, region, country or area	Number of companies in operation
Developed market economies		United Arab Emirates	2
Western Europe		Brunei Darussalam	1
United Kingdom	64	Iran (Islamic Republic of)	1
Germany	52	Iraq	1
France	34	Oman	1
Italy	25	Pakistan	1
Belgium	17	Philippines	1
Netherlands	16		
Spain	14	Latin America	
Sweden	11	Brazil	21
Switzerland	9	Mexico	7
Finland	7	Argentina	5
Austria	4	Venezuela	3
Greece	1	Colombia	2
Ireland	1	Chile	2
Norway	1	Bahamas	1
Portugal	1		
		Africa	
North America		Nigeria	2
United States	109	Tunisia	2
Canada	22	Algeria	1
		Egypt	1
Oceania		Libyan Arab Jamahiriya	1
Australia	14	United Republic of Tanzania	1
New Zealand	1		
		Total, B	118
Other			
Japan	43	*Former centrally planned economies*	
South Africa	7		
Israel	3	Eastern Europe	
		Poland	12
Total, A	460	Czechoslovakia	3
		Hungary	1
Developing market economies		Romania	1
Asia		Former USSR	
India	18	Russian Federation	5
Singapore	10	Ukraine	1
Republic of Korea	6		
Saudi Arabia	6	Total, C	23
Hong Kong	5		
Malaysia	5	China	7
Thailand	5		
Indonesia	2	Total, D	7
Taiwan Province	2		
Turkey	2	World, A, B, C and D	608

Source: The British Sulphur Corporation, *World Directory of N.P.K.S. Process and Plant Suppliers* (London, 1992).

Figure IV.30. World consumption of fertilizer equipment by type and by region



Sources: Improving the Supply of Fertilizers 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).

indication of the degree of competition and activity at specific sites.

There are about 608 companies manufacturing fertilizer equipment worldwide. The majority of these companies are subsidiaries of transnational corporations involved in related activities. Over three fourths are located in developed market economies, with Western Europe alone hosting 261 such companies. The United States has the largest number of fertilizer equipment companies with a total of 109; Japan has about 43 companies, while the United Kingdom and Germany have 64 and 52, respectively. Asia leads the developing market economies, with 69 companies, whereas Africa hosts only 8. Because of limited availability of data on production, a further comparative analysis of production trends was not attempted.

2. *Major companies in the global industry*

Several of the world's leading companies producing equipment for the fertilizer industry also manufacture equipment used in the chemical and mineral processing industries. For this reason, it is not possible to determine the value of the sales and profits generated by fertilizer equipment production alone. Use must rather be made of information on companies that license processes and technology, that design, engineer and build plants, and that supply major items of equipment specifically used by the fertilizer industry [62].

There is often a high degree of specialization between the basic three equipment categories and sometimes within each category. Oligopolistic producer organizations dominate the equipment business today. A major oligopolistic trait of the industry concerns the high barriers to entry which potential newcomers face. Entry into the industry is inhibited by several important factors: very large investment costs required for equipment plants; difficulties associated with acquiring the requisite technological know-how, since existing major equipment producers own the patents and licences; and the existence of large integrated chemical and petrochemical engineering companies that seems to operate more economically than separate operations, at least in the case of nitrogen equipment. Moreover, industry associations in developed market economies have a decisive influence on regulating the fertilizer industry as a whole. These associations exhibit behaviours which is sometimes attributed to cartels, exercising considerable influence on price setting and other conditions of the industry. Developing countries most often lack the means to develop a heavy industry such as the fertilizer equipment industry, and have not historically been in a position to influence major market forces, although the situation today is changing to some extent.

(a) Largest companies in the North

A list of the fertilizer equipment manufacturing companies located in the North with the major types of equipment they produce is given in table IV.87. There are 12 developed market economies that produce specialized fertilizer equipment. Poland is the only former centrally planned economy where fertilizer equipment plants are known to exist, although process developers are active elsewhere in those economies.

In the United States, Feeco International Incorporated, a Wisconsin-based firm offers a wide variety of equipment. The company, established in 1951 and under the same ownership today, has as its principal activity the design and supply of granular fertilizer equipment and processes. A. J. Sackett & Sons, founded in 1987, is one of the oldest companies involved in fertilizer equipment manufacturing in the United States. It holds many patents in the industry, and continues to design and build systems for bulk blends, liquid fertilizers, complex fertilizers and superphosphate manufacture, together with associated equipment. By working with an international network of dealers, distributors and agent organizations, Doyle and VERT-TEX (its export agent) are proving to be most effective in providing local areas with direct sales and local service.

Among process developers, Dravo Corporation is a highly integrated company with interests in construction, process plants and facilities, manufacturing construction equipment and consulting engineering. It is a typical example of a fertilizer equipment company which is also involved in engineering and construction of ferrous and non-ferrous mineral- and metal-processing facilities, and many other industrial installations. The company supplies specialized equipment for ammonia storage, fertilizer handling plants, granulators, equipment for phosphoric acid manufacture and catalysts for sulphuric acid manufacture.

Another major process developer in the United States is Foster Wheeler Corporation, a New-Jersey-based company which is a leading designer, engineer and constructor of plants not only for the fertilizer industry, but also for the petroleum, petrochemical, chemical, coal-conversion and other energy-related industries. It operates worldwide in conjunction with its subsidiary companies, offering complete project management services and operator training in addition to its design, engineering and construction activities.

The Renneburg Division of Heyl & Patterson Incorporated, established in 1874, is another well-known equipment designer in the United States that specializes in nitrogen equipment. Jacobs Engineering Group Incorporated, which acquired Dorr-Oliver in 1974 and Zellars-Williams Incorporated in 1981, has been in operation since the 1930s, and is an acknowledged leader in the design and construction of facilities in the fertilizer industry. The M. W. Kellogg Company, based in Houston, Texas, is a subsidiary of Dresser Industries Incorporated, and was founded in 1901. It is a major international design, engineering and construction firm which has been a considerable force in ammonia and nitrogen fertilizer technology for the past 35 years. In 1983, M. W. Kellogg designed a new ammonia process that revolutionized the industry by considerably reducing fuel and energy requirements. Struthers Scientific & International Corporation of Pennsylvania is a major equipment designer and fabricator serving the process industry with a specialized line of heat transfer and high-pressure products. It was established by Struthers Wells in 1960 with the aim of promoting specialized equipment through licensee fabricators strategically located around the world.

It is not uncommon for oil and gas companies to own branches that specialize in fertilizer technology development. This is more common in the nitrogen equipment industry since petroleum producers have the natural gas supplies needed in nitrogen production. Typical examples of such firms are Amoco, Exxon, Shell and Texaco.

The Tennessee Valley Authority (TVA), an energy-producing agency of the United States Government which is also responsible for fertilizer research and development, controls the National Fertilizer and Environmental Research Center at Muscle Shoals, Alabama, through which it can obtain United States patents and negotiate non-exclusive licences for use of the technology. The organization has developed several processes for fertilizer production, although its current emphasis is shifting more towards environmental impact studies.

A great number of fertilizer equipment manufacturing plants are also located in the United Kingdom. These companies, unlike the majority of those in the United States, tend to specialize in one or two types of equipment. For example, Begg, Cousland & Company, which has been in existence for more than 130 years, manufactures fibre filters used in platinum recovery from nitric acid plants, and mist eliminators used in sulphuric acid plants. H. J. Digwood, on the other hand, specializes in fertilizer-handling plant equipment, including equipment for bagging, dry bulk blending and bulk handling. Friatec and Hayward Tyler are well-known fabricators of sulphur pumps in the United Kingdom. Many other companies in that country concentrate on the development and engineering of fertilizer plants. Among these, the better known are Davy Process Technology, H & G Process Contracting, Hydro Agri International Licensing, John Brown Engineers & Constructors and Johnson Matthey PLC. The majority of these companies also operate overseas, and often own subsidiaries or are associated with other companies in Latin America, India and other European countries.

Some important process developers are located in Germany. Although these companies do not manufacture specialized equipment for the fertilizer industry, they are responsible for designing a great number of processes. Some of the major German process developers are Lurgi GmbH, Linde AG, Kali and Salz AG in the field of potash equipment; and John Brown Deutsche Engineering GmbH, formed by a merger between the Austrian Voest-Alpine Industrieanlagenbau GmbH of Linz and Deutsche Engineering der Voest-Alpine Industrieanlagen GmbH. The latter company is active not only in fertilizer technology, but also in polymer and synthetic fibre technology.

Italy is also actively involved in fertilizer technology. Although most of the companies established in that country have parent companies elsewhere in the North, a few of them, such as Enichem Agricoltura SpA and Snamprogetti, operate independently and are major suppliers of fertilizer equipment and technology. Nuovo Pignone of Florence specializes in compressors for both ammonia and urea synthesis. Snamprogetti SpA of Milan is perhaps the largest process developer and plant designer in Italy. Sixty per cent of that company is owned

Table IV.87. Manufacturers of fertilizer equipment in the North, 1992

Country and company	Type of equipment
United States	
Ferguson Industries, Inc.	Ammonia converters
Struthers Scientific & International Corp.	Ammonia converters, nitric acid absorbers, reforming furnaces, urea synthesis reactors
Feeco International, Inc.	Ammonia storage, pressure storage (refrigerated), fertilizer handling plant, ammoniators, phosphoric acid evaporators, sulphur burners, sulphur grinding mills, superphosphate dens
Alon Processing, Inc.	Corrosion-resistant materials (metallic)
Chemipulp/Jenssen	Coolers, sulphur burners and melters
Doyle Equipment Manufacturing Co.	Fertilizer handling plant
Cooper Energy Services	Centrifugal compressors
The A.J. Sackett & Sons Co.	Fertilizer handling plant, ammoniators, superphosphate dens
Koch Engineering Co., Inc.	Corrosion-resistant materials (non-metallic), mist eliminators
Chas. S. Lewis & Co., inc.	Corrosion-resistant materials (metallic), sulphur pumps
Andritz Sprout Bauer, Inc.	Fertilizer handling plant (bulk handling), granulators
Heyl & Patterson, Inc.	Ammoniators
Kennedy van Saun Corporation	Ammoniators, sulphur grinding mills
Jim Browder Company	Mist eliminators
CECO Filters, Inc.	Mist eliminators
Monsanto Enviro-Chem Systems, Inc.	Mist eliminators
Norton Chemical Process Products	Nitric acid absorbers
Tuthill Corporation, Tuthill Pump Division	Sulphur pumps
Swenson Process Equipment	Phosphoric acid evaporators
Vulcan Cincinnati, Inc.	Phosphoric acid evaporators
Bird Machine Company	Phosphoric acid filters
Eimco Process Equipment Co.	Phosphoric acid filters
Jacobs Engineering Group, Inc.	Pipe reactors
Vulcan Cincinnati, Inc.	Prilling towers, urea synthesis reactors
Fybroc/Met-Pro Corporation	Sulphur pumps
Dean Pump/Met-Pro Corporation	Sulphur pumps
Denmark	
Haldor Topsoe A/S	Ammonia converters
Noro A/S	Granulators
Poland	
Polimex-Cekop Ltd	Ammonia converters, ammonia storage, coolers, mist eliminators, nitric acid absorbers, prilling towers, urea synthesis reactors
Prosynchem Engineers and Contractors	Ammonia converters, coolers, mist eliminators, nitric acid absorbers, urea synthesis reactors
Netherlands	
Kinetics Technology International BV	Ammonia storage, reforming furnaces (tubes)
Hosokawa Micron Europe BV	Granulators, phosphate rock mills, sulphur grinding mills
Pannevis BV	Phosphoric acid filters
United Kingdom	
Inco Alloys International Ltd	Corrosion-resistant materials (metallic)
The Accrington Brick & Tile Company	Corrosion-resistant materials (non-metallic)
Corning Process Systems-Corning Ltd	Corrosion-resistant materials (non-metallic)
Newell Dunford Ltd	Fertilizer handling plant, ammoniators
H.J. Digwood Ltd	Fertilizer handling plant
GEC Mechanical Handling Ltd	Fertilizer bagging and bulk handling
Richard Simm & Sons	Fertilizer bagging and bulk handling
Polysius Ltd	Fertilizer bulk handling
Begg, Cousland & Co Ltd	Mist eliminators, phosphoric acid filters
Friatec Ltd	Mist eliminators, sulphur pumps
Knit Mesh Ltd	Mist eliminators
Bradley Pulverizer Co.	Phosphate rock mills, superphosphate dens
Wellman Process Engineering Ltd	Phosphoric acid evaporators
Delkor Ltd	Phosphoric acid filters
Pierson & Co.	Phosphoric acid filters
Hayward Tyler Fluid Dynamics Ltd	Sulphur pumps
Switzerland	
Sulzer Escher Wyss Ltd	Centrifugal and reciprocating compressors, coolers, phosphoric acid evaporators

Table IV.87 (continued)

Country and company	Type of equipment
Italy	
Nuovo Pigone	Centrifugal compressors for ammonia synthesis, reciprocating compressors for urea synthesis
Sweden	
Sandvik Steel	Corrosion-resistant materials (metallic)
Cellchem AB	Sulphur melters
Norway	
Hydro Packaging	Fertilizer bagging and bulk handling
Australia	
Minproc Engineers Pty Ltd	Mist eliminators
Chemical Construction & Equipment Ltd	Phosphoric acid filters, sulphur pumps
Belgium	
Atelier Louis Carton SA	Coolers
Monsanto Europe SA	Mist eliminators
Profile SA	Phosphoric acid filters
Canada	
Firing Industries Ltd	Coolers, fertilizer handling plant, granulators, sulphur grinding mills
Cominco Engineering Services Ltd	Coolers
Cemetics International Co. Ltd	Corrosion-resistant materials (metallic)
Prochem Mixing Equipment Ltd	Phosphoric acid agitators
Spain	
ESPINDESA	Pipe reactors
Intecsa Uhde Industrial SA	Pipe reactors, reforming furnaces (tubes)

Source: The British Sulphur Corporation, *World Directory of N.P.K.S. Process and Plant Suppliers* (London, 1992).

by Eni, and 20 per cent each by Snam and Agip. The activities of Snamprogetti are spread worldwide and involve the development, design and construction of industrial facilities and associated infrastructure, including pipelines and plants for offshore processing, refining, gas treatment, fertilizers, chemicals, energy systems, metallurgical processing and waste treatment. Both Tecnimont of Milan and Tecnologie Progetti Lavori of Rome are important fertilizer plant constructors in Italy.

The fertilizer equipment industry of France is well-known for the contribution of companies such as Heurtey Industries, Le Carbone-Lorraine and, especially, Krebs & Companie SA to fertilizer equipment design and plant construction. In Japan, major process developers are also active in the shipbuilding industry, for example, Mitsubishi Heavy Industries, Mitsui Engineering & Shipbuilding Company and Hitachi Zosen Corporation.

In many instances, engineering design for fertilizer plants is provided by process licensors such as M. W. Kellogg and Uhde GmbH for ammonia and Snamprogetti SpA and Toyo Engineering for urea. In other cases, the process licensor sells the technology and basic engineering through a predetermined limited number of engineering firms. Thus, the DSM urea process is generally marketed by Stamicarbon, which provides the basic engineering, but with engineering procurement and construction supervision services available from a limited number of other engineering companies. In some cases the process licence and basic engineering are sold directly to clients who assume responsibility for detailed engineering. As the latter are restricted to manufacturers having significant experience in the industry, many companies in the North are affiliated with others. For example, Compania Tecnica Internazionale Progetti SpA (CTIP) of Italy and Bufete Industrial of Mexico are both affiliated with M. W. Kellogg; and Monsanto Enviro-Chemical Systems Incorporated of St. Louis, Missouri, is affiliated with Monsanto Europe SA, a company based in Belgium. Other companies also have subsidiaries, for example, Norton Chemical Process Products of Akron, Ohio, which owns subsidiaries in both Japan and the United Kingdom.

Several transnational corporations deal both with process know-how and with the main engineering and construction activities in nitrogen production. These include M. W. Kellogg, Fluor, Brown & Root Braun and Foster Wheeler in the United States; Snamprogetti and Tecnimont in Italy; Stamicarbon in the Netherlands; Uhde GmbH in Germany; Heurtey Industries in France; and Toyo Engineering, Mitsubishi Heavy Industries, Mitsui Engineering & Shipbuilding Company and Sumitomo in Japan. Technologies for ammonia synthesis and furnace design are restricted to very few sources. In ammonia processing, the processing steps with naphtha as a feedstock are substantially the same as those utilizing natural gas, and the sources of technology are usually the same. A close relationship has also tended to develop between the application of particular technologies and the use of engineering and construction services from certain corporations.

(b) Largest companies in the South

Manufacturers of fertilizer equipment in the South are listed in table IV.88. Ensuring adequate fertilizer supplies has necessitated major investments in domestic fertilizer production capability in a number of countries. Private participation has been encouraged in the fertilizer sector, generally in the form of joint ventures. Abundant raw material resources, such as natural gas, phosphate rock and potash, provide considerable scope for fertilizer production in several developing countries, with opportunities for setting up production facilities, including equipment manufacturing [63].

While the consumption of fertilizer equipment in developing countries has risen significantly over the years, equipment production is still concentrated in developed countries. However, recent increases in fertilizer equipment capacity have taken place in Brazil, India and the Republic of Korea. These countries are the only producers of fertilizer equipment in the South, although process modification has taken place at other sites. Governments in these countries have been very active in the acquisition of foreign technology and know-how and the adaptation of new technologies. There are three companies which manufacture fertilizer equipment in Brazil today. About 15 others have obtained process licences from or are affiliated with larger entities of the North. These companies are steadily diversifying into a greater variety of equipment, and often manufacture a wide range of chemical and petrochemical equipment and products as well. India has a similar structure, with two companies manufacturing equipment and a great number of others involved in process design and improvements.

While there is considerable potential for the growth of fertilizer equipment production in developing countries, several constraints need to be more effectively tackled. Most importantly, there are very limited R and D facilities, except in Brazil and India, and the manufacturing facilities are heavily dependent on imports of spare parts and components, implying that there may be a need to reduce dependence on imports. Thus, while the technological capability to ensure adequate and efficient manufacture of fertilizer equipment in developing countries is still inadequate, considerable progress is being made in a few countries.

3. Capacity utilization and expansion plans

Although depressed world economic conditions are currently causing stagnation in investments in the fertilizer equipment market, expansion plans are still being carried out to implement new equipment design. Information on recent capacity expansions worldwide for equipment manufacturing plants is not available. Thus, data availability restricts the present analysis to recent purchases of equipment by plants that have plans to produce above 400,000 tonnes of fertilizer products per year as shown in table IV.89. It is important to note that a significant number of other fertilizer companies not reviewed in this survey have recently made purchases of equipment, and are projecting expansions of a smaller magnitude than those discussed.

In Israel, new fertilizer equipment is to be installed by Negev Phosphates/Rotem Fertilizers at the Bikat Beer Sheba processing plant by 1995. This equipment consists of facilities for phosphoric acid production [64]. Equipment purchased from the Jacobs Engineering Group to process potassium chloride is to be installed in 1993 in Jordan at its Dead Sea fertilizer plant. This represents the most significant recent purchase by any single company. There are plans in Saudi Arabia to utilize the Prayon process licensed by Lurgi GmbH and Coppee Lavalin NV/SA for its Al Jubail phosphoric acid plant. Thailand has plans to purchase potassium chloride technology from the Jacobs Engineering Group to increase its ferti-

Table IV.88. Manufacturers of fertilizer equipment in the South, 1992

Main category of equipment	Equipment subtype	Name of company	Country
Ammonia converters		Cobrasma S.A.	Brazil
Ammonia storage	Pressure storage	Nordon Industrias Metalurgicas S.A.	Brazil
	Refrigerated	Nordon Industrias Metalurgicas S.A.	Brazil
Granulators		Hindustan Dorr-Oliver Ltd	India
	Ammoniators	Jaragua S/A Industria Mecanica	Brazil
Phosphoric acid	Evaporators	Hindustan Dorr-Oliver Ltd	India
		Jaragua S/A Industria Mecanica	Brazil
	Filters	Hindustan Dorr-Oliver Ltd	India
Pipe reactors		Hindustan Door-Oliver Ltd	India
Reforming furnaces		Kinetics Technology India Ltd	India
Sulphur grinding mills		Jaragua S/A Industria Mecanica	Brazil

Source: The British Sulphur Corporation, *World Directory of N.P.K.S. Process and Plant Suppliers* (London, 1992).

Table IV.89. Recent purchases of fertilizer equipment[a/]

Country and contractor	Equipment licensor	Company	Location	Product	Capacity (thousand tonnes/year)	Expected completion
			A. Phosphate and Potassium			
Israel		Negev Phosphates/ Rotem Fertilizers	Bikat Beer Sheba	Phosphoric acid	500	1995
Jordan	Jacobs	Dead Sea Chemical	Dead Sea	Potassium chloride	1 800	1993
Morocco		Office chérifien des phosphates	Maroc Phosphore V	Phosphoric acid	600	..
Saudi Arabia						
Lurgi/Coppee Lavalin	Prayon	NCFC	Al Jubail	Phosphoric acid	540	..
Syrian Arab Republic						
Bouygues/Coppee Lavalin	Prayon	General Fertilizer Co.	Palmyra	Trisodium phosphate	500	..
Thailand						
Jacobs			Barmet Narong	Potassium chloride	1 000	..
Mitsui Engineering & Shipbuilding			Map Ta Phut	Nitrogen, phosphorus and potassium	1 000	..
United States		Mobil Mining & Minerals Co.	South Fort Meade	Phosphate rock	4 000	1995
			B. Nitrogen			
Austria						
John Brown Deutsche Engineering	John Brown Deutsche Engineering	Agrolinz	Linz	Ammonium nitrate	462	1993
Bahrain	Gulf Petrochemical Industries	..	..	Urea	495-560	1994
Bangladesh						
Chiyoda Corporation	Haldor Topsoe	Kamaphuli Co. Ltd	Chittagong	Ammonia	407	Suspended
Mitsubishi Heavy Industries	Snamprogetti/Hydro	Jamuna Fertilizer	Tarakandi	Urea	560	1992
Toyo Engineering	Toyo	Fertilizer Factory Ltd	Ghorasal	Urea	469	..
Bulgaria						
Urea Technologies	Urea Technologies	Chimico	Vratza	Urea	660	1995

Canada						
Uhde GmbH	Uhde GmbH	Saskferco Products	Belle Plaine	Ammonia	407	1992
China						
Technip	Snamprogetti	China National Technical Import Corporation	Fuling	Urea	578	1993
Technip	Snamprogetti	China National Technical Import Corporation	Jinxi	Urea	581	1993
India						
Snamprogetti	Snamprogetti	Nagarjuana Fertilizers & Chemicals Ltd	Kakinda	Urea	495	1992
Urea Technologies	Urea Technologies	Madras Fertilizers Ltd	Madras	Urea	485	1995
Indonesia						
Haldor Topsoe	Haldor Topsoe	P.T.Kalimantan Timur (Persero)	Bontang	Ammonia	595	1992
IKPT	M.W. Kellogg	Petrokima Gresik	East Java	Ammonia	446	1993
Toyo Engineering	Toyo Engineering	P.T.Pupuk Sriwidaja (Pusri-IB)	Palembang	Urea	579	1993
Toyo Engineering	Toyo Engineering	P.T.Pupuk Iskandar Muda	Aceh	Ammonia	386	1993
Toyo Engineering	Toyo Engineering	P.T.Petrokimia Gresik	Gresik	Urea	462	1993
Toyo Engineering	Toyo Engineering	P.T.Pupuk Sriwidaja	Palembang	Urea	569	1993
M.W.Kellogg/Rekayasa	M.W.Kellogg	PUSRI	Palembang	Ammonia	446	..
Iran (Islamic Republic of)						
M.W.Kellogg	Stamicarbon	Khorasan Petrochemical	Bojnurd	Urea	495	..
M.W.Kellogg	M.W.Kellogg	Iran/Kobe Steel	Qeshm Island	Urea	660	..
		Iran/Kobe Steel		Ammonia	594	..
Iraq						
M.W.Kellogg	M.W.Kellogg	Ministry of Industry	Baghdad	Ammonia	578	Suspended
Ireland						
Snamprogetti	Grande Paroisse	Irish Fertilizer Industries	Arklow	Nitric Acid	165	1993
Mexico						
M.W.Kellogg	M.W.Kellogg	PEMEX(Petroleos Mexicanos) PEMEX	Camargo	Ammonia	495	..
New Zealand						
Haldor Topsoe	Haldor Topsoe	Petrochemical Corp. of New Zealand Ltd.	Kapuni	Ammonia	495	..
Netherlands						
Simon Carves	Grande Paroisse	DSM	Geleen	Ammonia nitrate	550	..
Pakistan						
Haldor/Kellogg	Haldor/Kellogg	Dawood Hercules Chemical	Shekhupura	Urea	445	1993
Lurgi	Lurgi	Aj-Noor Fertilizer	Karachi	Ammonia	429	1995/96
Snamprogetti	Snamprogetti	Fauji Fertilizer Co.	Machhi Goth	Urea	695	1992
Snamprogetti	Snamprogetti	Fauji Fertilizer Co.	Machhi Goth	Ammonia	400	1992

Table IV.89 *(continued)*

Country and contractor	Equipment licensor	Company	Location	Product	Capacity (thousand tonnes/year)	Expected completion
Poland						
Tecnimont	Montedison	Zaklady Azotowe Pulawy	Pulawy	Urea	560	1993
Qatar	Qatar Fertilizer	Qatar Fertilizer	Umm Said	Ammonia	500	1995/96
Russian Federation						
Haldor Topsoe	Haldor Topsoe	PO Angarsk-nefreorgsintez	Angarsk	Ammonia	449	1992
Soviet	Soviet	TOAZ, Russia	Nizhnetambovskoye	Ammonia	45	1993
Soviet	Soviet	TOAZ, Russia	Nizhnetambovskoye	Urea	560	1993
Urea Casale SA	Snamprogetti	Togliattiazot	Togliatti	Urea	990	1992
Saudi Arabia						
Chiyoda Corporation	Stamicarbon/ Hydro Agri	Saudi Arabian Fertilizer Co.	Jubail	Urea	600	1994
Chiyoda Corporation	Haldor Topsoe	Saudi Arabian Fertilizer Co.	Jubail	Ammonia	500	1994
Trinidad and Tobago						
M.W.Kellogg	M.W.Kellogg	Fertrin	Point Lisas	Ammonia	495	1993
United States						
Ammonia Casale SA	Ammonia Casale	Unocal Corporation	Kenai, Alaska	Ammonia	541	1992
Urea Technologies	Urea Technologies	Not disclosed	Northwest	Urea	778	1996

Source: *Phosphorus and Potassium*, No. 183, January-February 1993; and *Nitrogen*, No. 196, March-April 1992.

a/ Above 400,000 tonnes per year fertilizer capacity.

lizer capacity by 1 million tonnes per year. However, the project is still in its preliminary phase. In Thailand, compound fertilizer technology by Mitsui Engineering & Shipbuilding Company has been purchased for the Map Ta Phut plant, which is also expected to add a million tonnes per year to the country's fertilizer capacity starting in 1995. Other phosphate equipment purchases are projected by Mobil Mining & Minerals Corporation for the company's South Fort Meade plant in Florida, which is expected to generate an additional 4 million tonnes per year of phosphate rock in the United States.

Recorded purchases of fertilizer equipment are most significant for the nitrogen category. Available information shows major purchases by companies in both developed and developing countries [65]. In the former centrally planned economies, the Russian Federation recently contracted urea technology developed by Snamprogetti SpA through Urea Casale SA of Switzerland for its Togliatti fertilizer complex. Another equally significant purchase was recorded in 1992 in New Zealand, where Petrochemical Corporation of New Zealand acquired Haldor Topsoe technology for its Kapuni plant. A decision to start up full-scale urea production in 1996 somewhere in the north-west region of the United States is anticipated by a non-disclosed company using technology developed by Urea Technologies. In the United States, Unocal Corporation has recently purchased ammonia technology from Ammonia Casale SA of Switzerland for its Kenai plant in Alaska. There are ongoing plans in Trinidad and Tobago to purchase technology developed by M. W. Kellogg for Point Lisas in 1993.

In Saudi Arabia, the Saudi Arabian Fertilizer Company is soon to use a new urea process developed by Stamicarbon BV/Hydro Agri and contracted by Chiyoda Corporation, a Japanese company specializing in licensing processes from Ammonia Casale SA and Stamicarbon BV. The expansions in both ammonia and urea capacities expected in 1993 at Nizhnetambovskoye, Russian Federation, have been made possible by the addition of equipment developed by the former USSR. The Angarsk plant, constructed by Haldor Topsoe, of the PO Angarsk-nefreorgsintez company of the Russian Federation will soon generate another 449 billion tonnes of ammonia per year. Equipment to be installed in Pakistan includes facilities for ammonia and urea production with technology obtained from Haldor Topsoe, M. W. Kellogg, Lurgi GmbH and Snamprogetti. In the Netherlands, ammonia nitrate technology was obtained from Simon-Carves, a process plant contractor operating worldwide with major branches in Australia, South Africa and the United Kingdom, for DSM Agro BV to modernize its Geleen plant.

Mexico has two new ammonia plants under construction. These plants are each expected to generate 495 billion tonnes per year at Lazaro Cardenas and Carnago, where PEMEX (Petroleos Mexicanos) have made recent purchases of M. W. Kellogg technology. Plans by the Ministry of Industry of Iraq to purchase M. W. Kellogg ammonia through Stamicarbon BV have been recently suspended. The Islamic Republic of Iran, on the other hand, has made concrete plans to increase its nitrogen capacity by the mid-1990s. The equipment is expected to be purchased from Stamicarbon BV and M. W. Kellogg. Several projects aimed at increasing nitrogen capacity by over 3.1 million tonnes per year by 1995 are taking place in Indonesia. A few plants are already in operation. Ammonia and urea technology was obtained from Ammonia Casale SA, Haldor Topsoe, Toyo Engineering and M. W. Kellogg.

In China, two projects, the Fuling and Jinxi projects of the China National Technical Import Corporation, each with an anticipated capacity exceeding 400,000 tonnes per year, are currently in progress. Equipment was purchased from Technip of France. India is also planning a significant expansion in its nitrogen capacity, using processes developed by Snamprogetti SpA and Uhde GmbH, at Nagarjuana Fertilizers & Chemicals and Madras Fertilizers, which are projecting urea capacity expansions exceeding 450,000 tonnes per year by the mid-1990s. Other countries with planned significant capacity expansions for urea and ammonia are Austria, Bahrain, Bangladesh, Bulgaria and Canada. Most of the technology to be utilized will again originate from the transnational corporations Stamicarbon, Haldor Topsoe, Toyo Engineering, Uhde GmbH and M. W. Kellogg.

4. *Technological trends*

In the early days of the fertilizer industry, processes were relatively simple, starting with raw materials that frequently had a higher concentration of nutrient elements than did the finished products. Over the years, progress in fertilizer production technology has led to processes of increasing refinement and complexity. The plant nutrient concentration of the products has increased beyond that of the raw materials, and the minimum economic size of plants has also increased.

(a) *Current equipment design*

Technological and engineering requirements vary substantially in their complexity and maturity between the different branches of the industry. Compound fertilizer plants are relatively less sophisticated and generally do not present major technological problems. The production of nitric acid, ammonium nitrate and triple superphosphate and the mining of phosphate rock and potash ores involve more complex technologies and processes, but these processes are well developed and available from a number of sources. The most complex technology, involving a high degree of sophistication in both basic designs and detailed engineering, relates to the production of ammonia and urea [66]. Also important are superphosphate and potash processing and granular fertilizer.

Ammonia processing technology. Ammonia synthesis is the basic step in all nitrogen fertilizer production. Ammonia is produced and then further processed to produce either urea or ammonium nitrate, the two most common nitrogen fertilizers. Nitrogen fertilizer production requires the fixation of atmospheric nitrogen, a process that uses large amounts of energy. Fixation requires the preparation of a "hydrogen-nitrogen" mixture for subsequent compression and ammonia synthesis, for which the steam reforming process based on natural gas (essentially methane) or on light hydrocarbons (naphtha) is most commonly used because of its lower investment and operating costs. Ammonia synthesis is carried out under high pressure obtained in either of two types of compressors depending on plant scale.

For smaller plants, compression and ammonia synthesis are performed in reciprocating compressors, while centrifugal compression is the more modern and economical technique for medium- to large-sized plants. For ammonia mini-plants, which is an emerging technology used mostly in developing countries, the more popular processes are ammonia synthesis from natural gas, by a process based on Imperial Chemical Industries—ammonia version 5 (ICI-AMV), or pressure swing absorption (PSA), or the Benfield low-heat process for carbon dioxide, or by coal-based ammonium synthesis or ammonium-synthesis gas plants based on air gasification. With naphtha becoming less and less important as a feedstock, use of conventional electrolysis is no longer of significance, and with the use of coal yet to be proven commercially, natural gas is likely to remain the basic source for almost all ammonia technology.

Urea technology. Urea is commonly manufactured from reacting carbon dioxide with ammonia to form ammonium carbamate which is further disintegrated to form urea. Several methods are used to decompose the carbamate formed as an intermediate product in the overall reaction. These consist of a series of decomposition and separation steps involving changes of pressure. One of the most popular of such methods today is the stripping process. New-generation urea processes combine elements of stripping with specially designed synthesis reactors. Whichever process type is selected, there is the option of forming the urea product into either prills or granules for ease of handling, storage, transport and application. Most of the world's supply of urea is in a prilled form, but granulation processes have become more popular recently.

Superphosphate processing. Superphosphates are produced by the acidulation of phosphate rock to produce monocalcium phosphate. The two major types are single superphosphate when acidulation is by sulphuric acid, and triple superphosphate when the acidulation is by phosphoric acid. In addition to these two there are various partial acidulation techniques, and the use of mixed acids to produce the so-called double superphosphate. The manufacture of single superphosphate is still practised both on a batch and on a continuous basis in a den. Triple superphosphate is manufactured in a continuous den or through a slurry granulation process. In slurry granulation processes the initial reaction takes place in stirred vessels from which the reaction slurry is fed direct to a rotary drum granulator, where granulation is performed. The moist granules are dried and screened, and then sent to storage.

Potash processing. There are three main techniques for beneficiating potash ores, namely thermal dissolution, flotation and electrostatic refining. Each takes advantage of differences in chemical or physical properties of the ore constituents. The choice between thermal dissolution, flotation or electrostatic beneficiation depends on factors such as the ore grade, local energy sources and the percentage of insoluble clays. In all processes the ore undergoes preliminary crushing and grinding to separate individual potassium chloride and halite crystals. The crystalline potassium chloride produced by all three major methods is, for the most part, finer-grained than is required. Vacuum crystallizers can be designed to produce a specific desired grain size. Dry, fine crystalline material may also be compacted between rollers and then broken up and screened, with the undersize fraction being returned to the compactor and the oversize part returned to the crusher. Granulation yields a rounded grain of uniform size, as fine damp crystals (from the flotation unit) agglomerate while undergoing a rolling movement.

Granular fertilizers. Granular fertilizers may be obtained using four different techniques: granulation of dry materials with no chemical reaction; granulation of dry-mixed materials with chemical reaction; slurry granulation; and melt granulation. The first process simply involves the mechanical mixing of dry materials with water or, more usually, steam to form granules with a more or less uniform particle size. In most operations a drum generator is used, although a pan granulator may be employed. Granulation with chemical reaction is often performed in an ammoniator-granulator in which solid raw materials are fed to a rotating drum with phosphoric acid, sulphuric acid or ammonia. During the melt granulation process, a smaller amount of water is introduced when compared with the slurry process.

(b) New process developments

A significant degree of concentration exists in the technology and process know-how and engineering sectors of the fertilizer equipment industry, particularly for nitrogen fertilizer production where there are a few companies operating on a transnational basis. These companies from developed companies in the North are sources of the most important technological advances in use currently and in the foreseeable future. While many fertilizer companies have made frequent and important contributions, most of the accumulated know-how and current effort comes from widely diversified companies in which fertilizer manufacture may be a small component of total activities. Outside this group of countries, the most significant contribution has been from work on catalysts and process improvements utilizing local resources by State organizations in India, Romania and the former USSR.

The successful application of developments in process technologies depend on the planning, manufacture and use of various pieces of equipment, machinery and instrumentation for process control, a process that requires high precision engineering and the capability for dealing with high pressures. Major developments have taken place mostly in Germany and the United States, with significant contributions from Italy, France and some other developed countries. However, they have also been utilized in Brazil, India and the Republic of Korea, where equipment fabrication facilities have been developed. Particular attention is drawn to the following types of equipment: synthetic gas compressors for ammonia plants; air compressors for ammonia and nitric acid plants; carbon dioxide compressors used in modern urea plants; centrifugal pumps for large-capacity urea plants; and other specialized items. The latter include special filters for large phosphoric acid plants and the centrifugally cast special alloy tubes for reformers in ammonia plants. In addition, Germany and the United States provide particularly important types of instrumentation technology for special components and design systems.

During the 1940s and 1950s, a number of urea manufacturing technologies were developed. Pioneering work was done by BASF AG and by Montecatini (later Montedison). About the same time there were several developments in the United States, for example, by Allied Chemical Corporation and by Chemico. Of those various efforts, the work of Montedison was particularly important. The oil crisis of the mid-1970s was responsible for significant improvements in the design of ammonium synthesis loops and the inclusion of developments in physical chemistry such as cryogenic and membrane hydrogen recovery, which led to a large reduction in energy consumption, of 6 to 7 per cent according to one source [66].

Other advances in catalytic steam reforming have led to a better use of high-pressure steam. More recently, new trends have emerged in nitrogen fertilizer technology, particularly in the manufacture of ammonia. The technologies that have had worldwide impact in recent years are those of Snamprogetti SpA, Stamicarbon, and Mitsui Toatsu Chemicals and Toyo Engineering. Snamprogetti has attracted increasing attention in recent years, and a number of large plants have been built using its process technology and engineering. There has also been considerable use of process technology and basic engineering from Montedison and Mitsui Toatsu Chemicals.

Important processes in the manufacture of nitric acid are owned by Uhde GmbH (Germany), La Grande Paroisse (France) and Wheatherly (United States). Uhde appears to be particularly active. India and the former USSR have adopted the features of these various processes to build successful large-capacity plants. The processes in current use for manufacturing wet phosphoric acid of around 30 per cent P_2O_5 concentration are from Société chimique Prayon-Rupel (Belgium), Rhône Poulenc Chimie (France), Dorr-Oliver (United States), Fisons (United Kingdom) and Nissan Chemical Industries (Japan). Nissan employs the hemihydrate process, giving greater overall efficiency and good-quality gypsum. Concentrated acid at around 50 per cent P_2O_5 is also produced by the hemihydrate route, with processes from Nissan Chemical Industries, Fisons and Occidental Chemical (United States). The process technology for monoammonium phosphate products has been developed by four fertilizer companies—Scottish Agricultural Industries Ltd. (United Kingdom), Fisons, Gardinier (France), and Norsk-Hydro (Norway). In particular, the Fisons Minifos system has been widely adopted during the past 15 years.

Nitrophosphates are produced by replacing sulphuric acid with nitric acid for the acidulation of phosphate rock. Pioneering work was done by Odda-Smelteverke (Norway) and Uhde. BASF AG provided some process improvements. Other modifications to the Odda process came from DSM and from Kampka (Germany). Another, using solvent extraction, has been adopted in the Czech Republic and Hungary. The trend towards a wide range of nitrogen-phosphate and nitrogen-phosphate-potassium mixed fertilizers has required high-analysis phosphate intermediates for granulation with ammonia nitrate or urea. Apart from phosphoric acid, the manufacture of monoammonium phosphate has become a major processing activity for this purpose.

Major technological improvements for the industry as a whole have centred on techniques to improve the concentration of finished-product plant nutrients to cut shipping and storage costs; on chemical mixing instead of dry mixing to increase the homogeneity of the mixed fertilizer; and on the increased manufacture of binary or tertiary mixtures which are preferred over single-nutrients types to improve the effectiveness of fertilizers. Major new processes under development are granular urea-nitric phosphates, ammonia polyphosphate suspensions, and nitrogen-sulphur suspensions.

Among other new fertilizer manufacturing processes, some attention has been given to processes replacing formaldehyde as a conditioning or 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) in the 1980s patented process improvements for the cone mixer for producing triple superphosphate, the drum granulator for producing granular ammonium phosphates, and the pipe reactor for producing ammonia-polyphosphate fluid fertilizer. 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 known processes (Stamicarbon, Snamprogetti, Toyo, Montecatini) are still popular. However, the new TVA falling-curtain process has received acclaim because it 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, and its unusual versatility in making a large variety of particle sizes. A new process also has been developed by TVA in collaboration with the Fertilizer Institute to find a suitable replacement for formaldehyde which is currently being used by a large segment of the urea industry. The toxic nature of this chemical has recently led to enactment of protective environmental legislation that prohibits its use. Because heat is essential in producing polyphosphate from orthophosphate, emphasis has been directed to more efficient use of the chemical heat reaction generated by ammoniation of the acids. Also, a process has been developed 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, thus eliminating the chance of losing nitrogen to the atmosphere.

Technological innovations are also important with respect to specialized fertilizer equipment. In the past few years, drum and pan granulation techniques have gained greater acceptance in the nitrogen industry. While the considerable design improvements made in pan granulators have allowed this equipment to be applied 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 single superphosphate and triple superphosphate. 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.

No significant improvements have been reported recently in potash processing. Further technological developments in the fertilizer industry include the use of nitric acid instead of sulphuric acid to digest phosphate rock, which eliminates the need for sulphur and offers environmental advantages.

It has been possible to decrease energy consumption in some of the most energy-intensive operations of fertilizer processing by introducing new technologies and rationalizing existing ones. Modern ammonia plants use lower-energy ammonia processes. Energy savings are achieved, for example, by shifting a greater proportion of the reforming duty to the secondary reformer, or by using new, low-pressure-drop converter designs which reduce compression costs.

The fertilizer equipment manufacturing industry is highly capital-intensive, and the production of fertilizers requires expensive investment in plant. The sulphur sector also requires highly complex technology. Investment in new equipment plant has been steady, and existing methods have been modified to generate better energy-saving processes or to reduce process emissions, a major concern of environmentalists. The fertilizer technology sector thus remains dynamic.

(c) *Developing country efforts*

In the developed market economies, R and D activities and the resulting process developments and patents are practically wholly controlled by corporations, most of them transnational corporations. Their technological pre-eminence is not only in process development, but also in the production of critical equipment, machinery and instrumentation systems. The only notable exception to this general rule is the R and D work of TVA in the United States over the past 35 years. Its work on process technologies has been substantial; however, it has not been a factor in the development of ammonia and urea processes and basic engineering, unlike the M. W. Kellogg Company. Moreover, TVA has not been involved in the more complicated and large-scale engineering requirements of plants.

There can be little doubt that much greater efforts will be necessary in developing countries to enhance design and engineering capabilities in process industries, particularly the fertilizer industry, and to promote greater absorption and development of process know-how through increased R and D activities. The continuing dependence on a few companies based in developed economies for process technology, basic designs and engineering, and supervision responsibilities at various stages of fertilizer manufacturing poses the important issue of how such dependence can be significantly reduced. Opportunities for further technical cooperation between developing-country institutions and enterprises in the design and engineering of fertilizer plants also need to be fully explored and developed as far as possible.

5. *Environmental considerations*

Compliance with increasingly strict environmental regulations while still producing fertilizers that are competitive on the world market has been a major concern of most producers in developed countries over the past decade. Growing environmental concerns have offered opportunities for innovation for equipment-supplying companies and fertilizer process developers. Thus, development and implementation of technologies with less impact on the environment is revolutionizing the processing equipment sector of the fertilizer industry. Most of the newer processes are aimed at reducing emissions going to the atmosphere and groundwater. The introduction of double absorption in the design of sulphuric acid plants, and of units to remove fluoride compounds and to dispose of phosphogypsum in the design of phosphoric acid plants, as well as the addition of specialized equipment to remove nitric oxide emissions during the nitric acid process are typical examples of additional investments required to deal with effluents.

There are also problems associated with the storage and handling of fertilizer materials which have necessitated improvements in equipment design. For example, ammonia is an extremely toxic product which can, when stored in large quantities as a liquid either under pressure or at low temperatures, present a major safety hazard. Great care must be taken in the design of large-scale ammonia storage facilities to protect the local community. Ammonium nitrate, a major fertilizer in Europe and the United States, is now produced, stored and transported under controlled conditions to avoid explosive decomposition.

6. *Short- and medium-term outlook*

The world fertilizer equipment industry is currently recovering from a malaise which began in the mid-1980s. The causes of the downturn were attributed mainly to secular shifts in world supply and demand and the creation of overcapacity in the fertilizer market. Special problems exist for developed countries today because of related environmental regulations that affect the costs of production. The participation of developing countries has increased somewhat, mostly in the nitrogen equipment industry.

Most fertilizer process designers and equipment manufacturers are caught in a trend towards specialization that started several years ago for technical and economic reasons. This specialization is based on different factors, such as the manufacturing method, the volume of equipment and the size of the order. While the fertilizer industry has suffered from relatively low financial returns during the past decade, investment in new plants has continued, and existing plants have been modernized to take advantage of energy-saving processes or to reduce emissions. Fertilizer technology is expected to remain a dynamic sector in the future.

There are signs that increasing trade in fertilizer technology will be a feature of the industry in future years. This is because of a persistent regional imbalance between supply and demand. Production of fertilizers is increasingly significant, for example, in developing countries with larger populations, but very little process design is taking place in those countries. Also, the development of production in the new producing countries will undoubtedly encounter more difficult problems than in countries with a long-established industrial infrastructure. The increasing number of fertilizer complexes in the South will serve, however, as an incentive to locate fertilizer plants closer to fertilizer sources.

In the subcontracting business, where relations with customers are paramount, a certain geographical proximity has always been a factor. Imports from Brazil, India, Republic of Korea and the former centrally planned economies are now beginning to appear on the scene, and exports from other developing countries may soon have an impact on the international market. The fertilizer equipment industry, however, has taken a number of measures in respect of quality, productivity, service and costs to meet these challenges.

Most investment is likely to be through technology transfer from the North, probably in joint-venture companies and projects. Transnational corporations from the United States, Western Europe and Japan are expected to continue to have a strong lead in R and D and also to hold patent rights to newly developed processes.

L. Industrial lift trucks (ISIC 384315-884319)*

1. Recent trends and current conditions

The past two years have been a difficult period for the world industrial lift-truck industry, with the recession in major developed countries reducing the demand for a product which over the past 50 years has been the most important piece of materials-handling equipment. Lift trucks are electric or engine-powered machines used for lifting and transporting materials and goods in warehouses, docks, building sites etc.; they come in a wide variety of shapes and sizes. The most common type, which accounts for over two thirds of global output, is the counterbalanced lift truck. Machines are often referred to as fork-lift trucks (fork-lifts), but the general term "lift truck" is preferred. Some of the machines, such as the large ones used to lift shipping containers, do not have forks as such.

The industry is technologically mature, suffers from manufacturing excess, especially in Western Europe, and is very cyclical. Entry barriers are relatively low, the manufacture of lift trucks is not difficult, and many components are shared with the automotive industry. Major producers in developed market economies generally manufacture high-quality products, and it is hard for any company to establish a clear technological lead. Even so, there are some key differentiators in the manufacture of the lift truck, notably improved product performance and design, with reduced manufacturing costs. Producers of older designs face higher costs; they cannot hold margins, and have to cut prices [67]. This has been evident in the volume of production, and even on the more specialist product lines.

All this provides a background for an industry which has already gone through an era of regionalization of production and of markets, and is now moving towards global markets. This trend has been encouraged, more than anything else, by the success over the past 15 years of Japanese producers. In Europe and the United States, there is a trend towards large single manufacturing centres, with output potential as high as 20,000 units per year.

Materials-handling is estimated at 0.5 per cent of the GNP of developed countries. Lift trucks and other specialized materials-handling equipment are a major part of this, with new lift trucks estimated at between $9.3 billion and $12.5 billion per year. Financial information from the industry is hard to obtain, but at present the size of the market is likely to be towards the lower end of that range.

The second half of the 1980s was a period of strong growth for the industry, following a very difficult five years from 1980 to 1985, particularly for European suppliers who lost substantial ground in their home markets to Japanese importers. Some recent changes occurring in world market sales for 1989 to 1992 are reported in table IV.90. Declining sales reflect the deepening extent of the recession, though the change is less difficult than in other engineering sectors. Unlike construction equipment, for example, lift trucks are sold to an enormous variety of industries, some of which are stable, while others come and go. Like construction equipment, European sales have been buoyed by strong demand in Germany following reunification, but this has now tapered off. In western markets the traditionally high volume of sales of counterbalanced trucks has fallen off appreciably from its all-time high level. The European market as a whole is still above the trough of any previous recession, and some trucks, such as very narrow-aisle trucks and crane systems used in the warehousing equipment sector, have held up well and continue to show yearly growth.

Regional variations in world sales are given in figure IV.31 for 1990. The North American market is benefiting from higher unit volumes due to stronger domestic market, while the European market for new equipment remains weak with lower volumes and margins. In Asia,

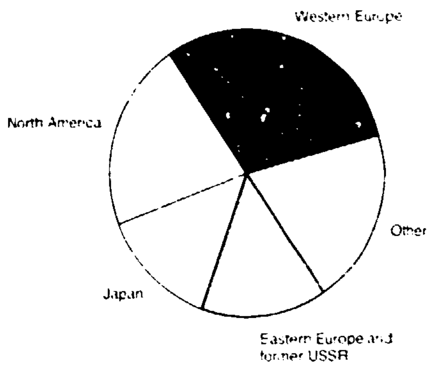
*UNIDO acknowledges the contribution of Andrew Baxter, *Financial Times*.

Table IV.90. World sales of industrial lift trucks by region, 1989-1992

Region	Fork-lift trucks less hand-operated units					Fork-lift trucks including hand-operated units					
	1989 (thousand units)	1990 (thousand units)	Percentage share 1989	Percentage share 1990	Percentage change 1989-1990	1990 (thousand units)	1991 (thousand units)	1992 (thousand units)	Percentage share 1991	Percentage share 1992	Percentage change 1991-1992
Western Europe	128	142	26.4	30.2	10.9	180	162	150	31.8	30.6	-7.4
North America	121	100	24.9	21.3	-17.4	120	120	140	23.5	28.6	16.7
Japan	65	65	13.4	13.8	-	100	110	94	21.6	19.2	-14.5
Eastern Europe and former USSR	75	70	15.5	14.9	-6.7	..	..	..	..	..	..
Other	96	93	19.8	19.8	-3.1	150	118	106	23.1	21.6	-10.2
TOTAL	485	470	100.0	100.0	-3.1	550	510	490	100.0	100.0	-3.9

Sources: Linde lift-truck producer, Aschaffenburg, Germany (December 1992); and Allan Rawnsley Services, *Fork-lift Trucks: World Production and Markets* (Cheshire, United Kingdom, December 1991).

Figure IV.31. World sales of industrial lift trucks by region, 1990



Source: Allan Rawnsley Services, *Fork-lift Trucks: World Production and Markets* (Cheshire, United Kingdom, December 1991).

the Japanese producer Nippon Yusoki reported a 66.0 per cent fall in profits for the first half of 1992, because of declining sales and intensified price competition in the Japanese market [68]. But economic growth has continued uninterrupted in South-East Asia, with increasing containerized traffic and sales of container-handling equipment.

(a) Production

In the European market, Germany is the dominant manufacturer, accounting for 38.6 per cent of the regional output, or 61,000 units in 1990. Japanese manufacturers, however, produce extensively not only in the United States and but also in Western Europe. Total output of Japanese-designed lift trucks produced in Japan, in transplant factories and by licensees has been estimated to have exceeded 160,000 units in 1990, or almost a third of global output [68]. Further changes in global production have occurred since then, most notably the collapse of Eastern European production, which was dominated by Balkancar of Bulgaria. The decline of the United States as a domestic production base has levelled after sourcing from the Republic of Korea failed to meet expectations, causing logistical problems and a substantial build-up of inventories. Manufacturing is now being realized by companies such as Clark Material Handling, while Hyster-Yale has emerged as a true low-cost producer after making major efforts in the 1980s to raise productivity.

(b) Major companies

Table IV.91 presents the 1991 world rankings of lift-truck manufacturers. The political upheaval in Eastern Europe and the former USSR has decimated these markets; and Balkancar, once the world's largest lift-truck producer, and which still offers old truck designs, has

Table IV.91. World's leading lift-truck companies, 1991

Rank	Company	Country	Sales (million dollars)	Percentage share
1	Linde	Germany	1 822	19.2
2	Toyota	Japan	1 119	11.8
3	Jungheinrich	Germany	789	8.3
4	Komatsu	Japan	777	8.2
5	NACCO (Hyster-Yale)	United States	714	7.5
6	Nordico (BT)	Sweden	561	5.9
7	Toyo Umbanki	Japan	496	5.2
8	Clark Equipment	United States	449	4.7
9	Crown Equipment	United States	348	3.7
10	Nissan	Japan	335	3.5
11	Lancer Boss	United Kingdom	322	3.4
12	Manitou	France	240	2.5
13	Svedala (Kalmar)	Sweden	222	2.3
14	Mitsubishi H.I	Japan	190	2.0
15	Iveco (Fiat and Pimpespo)	Netherlands	128	1.3
16	J.C. Bamford	United Kingdom	143	1.5
17	Caterpillar	United States	141	1.5
18	Atlet	Sweden	130	1.4
19	Balkancar	Bulgaria	123	1.3
20	Raymond	United States	117	1.2
21	Cesab	Italy	79	0.8
22	Lansing GmbH[a]	Germany	60	0.6
23	Valmet	Finland	47	0.5
24	Lugli	Italy	39	0.4
25	Sve Trucks	Sweden	38	0.4
26	Desta	Czechoslovakia	36	0.4
27	Orenstein & Koppel	Germany	21	0.2
28	Lafis	Germany	19	0.2
	TOTAL		9 506	100.0

Source: *Foerdermittel Journal* (Munich, Europa-Fachpresse-Verlag GmbH, December 1992).
Note: The ranking does not include changes in industry structure in 1992 (see text, section 4).
[a] Now part of Linde.

been unable to penetrate new markets. While the top 28 companies listed in the table dominate the industry and account for more than 80 per cent of all sales, there are more than 200 significant lift-truck manufacturers [69]. Figure IV.32 illustrates the percentage share of sales.

(c) Regional sales

In Europe, the four principal EEC countries, France, Germany, Italy and United Kingdom, account for 70 per cent of Western European sales. Japanese producers are concentrating on the high-volume sector, which consists of counterbalanced trucks weighing up to three tonnes and offering a technically sound product at competitive prices. This has encouraged some European manufacturers to search for specialized niches.

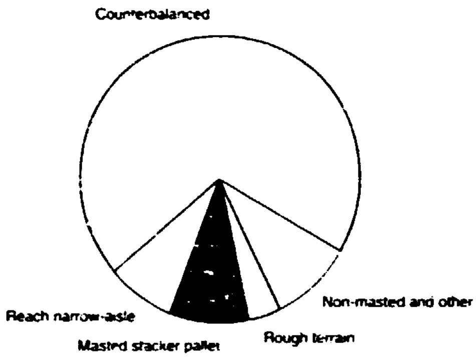
In North America, the United States market accounts for 90 per cent of the total. The technical features and performance of many of United States lift trucks have lagged behind Japanese- and Western-European-designed vehicles, although United States manufacturers are now closing the gap. The Japanese market is dominated by domestic producers. Declines in production and sales in Eastern Europe has already been mentioned, and this leaves just under 20 per cent of 1990 world sales for the rest of the world. In descending order of importance, this comprises markets in Asia excluding Japan, Australasia, Latin America and Africa.

Another approach for analysing world sales is by type of truck. As shown in table IV.92, the mix of trucks varies greatly according to geographical region. Narrow-aisle and reach trucks are popular in Western Europe, but less so in North America, where there are fewer constraints on space. In Japan, low-roofed warehouses of restricted size predominate, thus favouring small-capacity counterbalanced trucks. A reflection of how world sales vary by truck type is given in figure IV.32.

(d) International trade

With regard to trade flows in 1991, Japanese producers had 100 per cent of their home market in the counterbalanced truck sector, 50 per cent of the North American market, 28 per cent of the Western European market and 30 per cent of other country markets (these figures include sales by transplants) [67]. European manufacturers accounted for 62 per cent of the European market, 11 per cent of the North American and 8 per cent of other markets. United States manufacturers with production in the United States provided the North American market with 24 per cent of its lift trucks, the European market with 4 per cent, and markets in other countries with 2 per cent of their trucks.

Figure IV.32. Variation in sales by truck types, 1990



Source. Allan Rawnsley Services. *Fork-lift Trucks World Production and Markets* (Cheshire, United Kingdom, December 1991).

It is hardly surprising, therefore, that the major trade issues in this industry have centred on Japanese producers. Again they possess advantages because of the predominant trade barriers *vis-à-vis* other countries. While the import duty within the EEC for lift trucks is 4.9 per cent, EFTA countries do not pay duty. In addition, there is a voluntary restraint agreement under which Japanese manufacturers have agreed to limit exports to the EEC to 14,000 units a year. This helps to explain the trend towards Japanese transplants in those countries. Controversy remains, however, over the so-called grey imports of trucks from Japan which do not comply with the 1986 EEC lift-truck safety directive, and which are alleged to be priced unfairly low. In the United States, Hyster filed a dumping complaint against Japanese producers in 1986, and the International Trade Commission subsequently ruled in favour of the United States company. In 1988, the United States Government imposed import duties of up to 51.5 per cent on Japanese trucks. However, the Japanese responded by setting up assembly plants in the United States, and thus maintained their 50 per cent market share.

Table IV.92. World lift-truck sales by type and region, 1990
(Thousand units)

Region	Counter balanced	Reach narrow-aisle	Masted stacker pallet	Rough terrain	Non-masted and other	World total	Percentage share
Western Europe	90	15	15	7	15	142	30.2
North America	72	8	5	5	10	100	21.3
Japan	50	2	3	-	10	65	13.8
Eastern Europe	70	-	-	-	-	70	14.9
Other	44	13	20	6	10	93	19.8
TOTAL	326 (69.4)	38 (8.1)	43 (9.1)	18 (3.8)	45 (9.6)	470	100.0

Source: Allan Rawnsley Services, *Fork-lift Trucks: World Production and Markets* (Cheshire, United Kingdom, December 1991).

Note: Figures in parentheses are percentages of world trade.

(e) Employment

In Europe, employment was not very much affected by the growth of the industry from 1984 to 1990, since the mergers and acquisitions in the industry had a compensating effect. Since 1990, the decline in market sales in almost all countries has led to job losses. Broadly, the trend towards outsourcing of components also reduces employment in lift-truck manufacture.

(f) Profits

As for the financial performance of the industry, volumes are low, turnover is poor, and losses are being incurred. Prices in the United States and Europe are probably recovering from inflation, but the trend over the past 15 years has been a price deterioration relative to inflation [67]. However, even though prices are low, a handful of larger producers are maintaining a widening price differential against some other manufacturers, assisted by the maintenance of R and D spending.

2. *Markets and capacity in developing countries*

According to table IV.90, the rest of the world, which excludes Japan, North America, Western Europe and Eastern Europe, produced 93,000 lift trucks, or 19.8 per cent of world production in 1990. Japanese transplant factories in countries such as Australia account for a significant portion of this, while the industry in the Republic of Korea represents 65 per cent of the total for the rest of the world. After the Republic of Korea are countries and areas such as Brazil, China, India and Taiwan Province. According to producers in developed market economies, market requirements are satisfied essentially by domestic production in Brazil, China, Republic of Korea, South Africa, Taiwan Province and Turkey, but overall the rest of the world relies heavily on imports. The latter accounted for 19.8 per cent of world sales in 1990.

Relative to worldwide demand, markets in developing countries, except the industrializing countries of Asia, are not the top priority of producers in developed market economies, and this situation is not expected to change much in the next five years. Given the high degree of market saturation in Western Europe, economic growth in developing countries will make their markets much more important in the long run. For the moment, sophisticated warehousing techniques are not needed, and local demand is too small to establish production of lift trucks. Apart from the size of the market, the other limiting factors are the small opportunity for local supply of key components (making logistics very complex), restrictions relating to the imports of components, and the lack of reliable and frequent transport capabilities.

However, some opportunities for producers in developed market economies still exist. Linde, which derives less than 3 per cent of its sales from developing countries, has sold lift trucks to Algeria, Côte d'Ivoire, Ghana, Iran, Islamic Republic of, Malaysia, Morocco, Nigeria, Republic of Korea, Saudi Arabia, Singapore, Tunisia, United Arab Emirates and others [67]. Since in the poorest countries orders are in many cases financed by the World Bank, competition at the tendering stage is high. Typically, a country will need port terminal equipment, distribution and then materials-handling equipment as its economy grows. This provides outlets for container-handling front-lift counterbalanced trucks, very narrow-aisle products, and, progressively, the whole range of products.

Among the important producing countries in Asia, producers in the Republic of Korea build mainly versions of recent Japanese designs, which are good for many applications. As shown in table IV.91, none of the producers in the Republic of Korea are big enough to be included in the list of the world's top 28 producers, but it should be remembered that most of their exports to developed market economies have been lift trucks supplied to original equipment manufacturers. The biggest lift-truck producers in the Republic of Korea are Daewoo Heavy Industries and Samsung Shipbuilding and Heavy Industries. Other producers are Doowon, Halla, Hyundai, Goldstar, Doosan (a licensee of Lancer Boss) and Tong Myung. Samsung and Daewoo have long exported lift trucks on an original-equipment-manufacturer basis, notably Samsung's arrangement to supply Clark Equipment with around 8,000 lift trucks a year. Overall, Samsung produces more than 10,000 lift trucks a year, mostly for export to the United States.

But it was Halla that became the first lift-truck company in the Republic of Korea to export its product using its own brand name. The company is initially targeting export markets in South-East Asia, but later plans to expand to Western Asia, Europe and Latin America. Daewoo is joining the trend to export under its own name. While it had previously supplied lift trucks worth more than $100 million over several years to Caterpillar, that arrangement is now being phased out. To counteract this, Daewoo is planning to promote direct exports of in-house models through stronger dealership networks in European, South-East Asian and other promising markets. Other producers focus on the domestic lift-truck market, which has been sluggish in recent months after some years of strong growth. The domestic market rose from 7,900 units in 1990 to about 10,000 in 1991, and an estimated 15,000 in 1992.

Samsung's deal with Clark Material Handling is now coming to an end with Terex, the new owner of Clark, taking production back to the United States. However, the most important foreign alliance for producers in the Republic of Korea are with Japanese companies, as they have provided the bulk of the technical expertise. In 1991, Halla Engineering and Heavy Industries formed a tie with Komatsu of Japan to produce engine-driven fork-lifts of 2 to 15 tonnes, while Goldstar Industrial Systems has concluded a series of deals with Toyo Umbanki, which started in 1989 with battery-driven fork-lifts, counterbalanced trucks, reach trucks and engine-driven trucks. It is understood that Doowon Heavy Industries has recorded a technical agreement with Toyota involving the production of both engine-driven and electric motor-driven lift trucks. Another company of the Republic of Korea, Doosan, manufactures lift trucks of 2- to 3.5-tonne capacity under licence from Lancer Boss of the United Kingdom.

Other developing countries and areas in Asia with lift-truck industries include Taiwan Province, whose producers are Yang Iron Works, Prince Motors and Chin Yuan Iron Works. However, none of these companies make lift trucks exclusively. Lift-truck companies in Malaysia are also beginning to sell their products in Europe. The trucks are low-priced and often based on old Japanese models. The materials-handling industry in China is also beginning to emerge as a volume producer of lift trucks. The industry is currently seeking joint ventures and licensing deals that would enable them to build from European designs in China.

Elsewhere, Brazil has the best-developed lift-truck sector, with at least 12 manufacturers of self-propelled (electric- or engine-driven) lift trucks. The largest company, Compañia Hyster based at São Paulo, is foreign-owned, and Toyota also has a manufacturing plant at Soracaba. Other companies are locally owned, and their exports are mostly in small quantities.

Apart from the Japanese technical agreements with companies in the Republic of Korea, Nippon Yusoki has also set up a joint venture in Singapore with United Motor Works to market and provide maintenance for lift trucks in the six ASEAN countries. As for the sourcing of parts by big foreign producers in developing countries, again the Japanese have come to the fore. In 1991, Komatsu Forklift began sourcing cast parts for lift trucks from Bangkok Komatsu Industry, a joint venture between the Japanese company and its local sales agent. The plan was for 150 tonnes per month of parts to be shipped to Japan. Also in 1991, Toyo Umbanki set up a joint venture in Anhui province of China to begin producing cast parts for its Japanese-built lift trucks. It is understood that from 1993 the joint venture will also start supplying parts to a Chinese lift-truck maker. As with markets in developing countries themselves, it is possible that such sourcing contracts will increase in the future, if only because they will be needed to comply with local content requirements. Given the previous excess capacity in the western lift truck industry in developed market economies, and in supplying industries such as foundries, the incentive to source in developing countries has been low.

3. *Capacity utilization and expansion plans*

(a) Domestic capacity

Worldwide, the lift-truck industry suffers from a substantial surplus in manufacturing capacity, which means that the market remains intensely competitive. In 1989, when the world lift-truck market was at its peak, excess capacity was well in excess of 10 per cent. In 1992, it appeared that the industry could produce as much as 50 per cent more than its current output. Take-overs, mergers and joint ventures have not done a great deal to solve the problem, as they have been offset by new capacity, as in the United States, where Japanese companies invested in greenfield sites. Excess capacity is less marked in non-counterbalanced lift trucks than in counterbalanced, which is the dominant product type.

With current market conditions adding to the problems of structural overcapacity in the industry, perhaps it is hardly surprising that producers do not at present have ambitious expansion plans. Although much of the manufacturing capacity is old and needs refurbishment, the focus of current and projected investment is on new products, which often leads to investment in manufacturing. Western European producers have also been modernizing their production facilities to increase efficiency and productivity. In Germany, Linde invested heavily through the 1980s to modernize its facilities. At Aschaffenburg, where Linde produces mainly diesel and liquid petroleum gas-powered lift trucks, it spent $27 million in 1989 on a new vehicle assembly hall, welding facilities for fork carriers, and a sand-blasting plant for larger components. At the related Still company at Hamburg, which concentrates on electric trucks, automation of hydraulic cylinder production was completed in 1990.

In the United Kingdom, Linde has spent some $75 million on reshaping the industrial truck business of Lansing-Bagnall, which it acquired in 1989. It introduced production technology similar to that used at Aschaffenburg, but has sensibly limited capacity to 15,000 units a year. Jungheinrich of Germany has also invested heavily in new plant and manufacturing facilities, and recently invested $68.5 million in production and fabrication systems at its Hamburg plant and in a new specialized production unit at Luneberg.

The biggest planned investment in the lift-truck industry at present involves the United Kingdom producer, Lancer Boss, which will begin manufacturing at its home base in Leighton Buzzard, thus consolidating its seven separate sites. More efficient methods of manufacture will be an important element in the Lancer Boss plan to remain competitive in volume markets for lift-trucks.

(b) Direct investment overseas

The most important trend in direct overseas investment over the past decade has been the expansion by major Japanese lift-truck producers. Besides their investment in developing countries, the two main thrusts of their overseas development have been in Europe and the United States. Japanese suppliers, led by Toyota, rely mainly on supplying standard fork-lifts rather than specialist equipment, and in the mid-1980s suffered from the imposition of United States anti-dumping duties. Komatsu, Nissan, Toyo Umbanki and Toyota established production facilities in the United States in 1987 and expanded in 1988. The presence of Nissan in the United States was achieved following the joint acquisition with Marubeni (a Japanese trading house) of Illinois-based Barret Industrial.

In Europe, Japanese producers have hitherto relied on production transplants where European producers make lift trucks on their behalf. But some of these arrangements are now being allowed to lapse. In preparation for the single European market, Japanese lift-truck makers began to transfer manufacturing plants. In Spain, Nissan Motor Iberica has become the first Japanese lift-truck producer to make electric trucks in Europe, and also produces engine-driven trucks. Mitsubishi Heavy Industries, whose lift truck activities have merged with those of Caterpillar, began assembling lift trucks at Almere in the Netherlands in 1991, leading to the subsequent cancellation of a production alliance with Sadam of Italy. Toyo Umbanki is also producing lift trucks in Belgium, while Nippon Yusoki has taken a more cautious approach. It set up a spare parts and after-sales service facility in Belgium in 1992, but still imports its electric lift-trucks from Japan. Some production deals are still being implemented. Lancer Boss makes engine lift trucks in the United Kingdom for Komatsu, in an arrangement that is now in its second five-year period, and has been expanded to include design work. A further production agreement involving electric lift trucks is pending.

Given the current recession, it is understandable that no major new investments are planned. Japanese companies had to make production cutbacks in the United

States and in Europe as well in 1991. Nissan announced production cuts of up to 10 per cent in late 1991 and has restructured its United States lift-truck production and sales operations. In 1993, Nissan Industrial Equipment and Barret finally merged to produce North American Nissan Forklift, which will have 400 employees and the capacity to produce 9,000 fork-lifts a year. At the beginning of 1992 Komatsu also began scaling back operations at its United States production subsidiary.

Apart from investments made by Japanese companies, the biggest direct overseas investment in recent years was by Hyster, the United States producer. It recently began an $18.2 million expansion at its Craigavon factory in Northern Ireland, which it first established in 1981. In line with the trend among major lift-truck producers, Craigavon was originally designed to be the world source for Hyster's XL products, developed in the late 1970s to meet the challenge from Japan and Asia as a whole. The expansion project was backed by the Northern Ireland Development Board, and it is hoped that employment will rise from 380 in 1991 to 720 in 1994. High productivity and a competitive cost structure were important factors in this expansion plan.

(c) *Component sourcing*

Component sourcing policies are changing in line with business developments. One of the justifications for recent mergers and acquisitions has been to achieve a more common sourcing of parts across different product ranges within the enlarged groups. The limiting factor is that lift trucks are sold in a wide variety of configurations, which to some extent reduces the ability to achieve common component sourcing.

However, probably the biggest productivity gain to have emerged from the component side in the past 20 years is the increased use of automotive components. Typical out-sourced components would have a very low labour content, and the benefits from out-sourcing would come from specialized automated manufacturing in high volumes. Linde has started to purchase parts and components from low-cost Eastern European countries [67]. Volume is still low, but will expand. If a given part can be sourced from outside at lower costs and the quality fulfils its requirements, it will stop production and outsource instead. But this is not a valid policy for parts that have a design unique to Linde, and exchange rates can also have a bearing on purchasing policies. The Mitsubishi and Caterpillar joint venture has also considered opportunities to source both components and complete trucks outside the company, but in general it is looking for long-term relationships.

As has happened in other industries, the component supply policy of Japanese companies has changed as it has moved to overseas manufacturing. Accordingly, the local content ratio of machinery and other products made overseas has been increasing [68]. However, Japanese lift-truck producers such as Nissan and Mitsubishi have reached local content ratios for manufacturing in the United States and Europe as high as 60 per cent.

4. *Industry restructuring*

There have been several important take-overs in the lift-truck industry recently; after a series of mergers which took place in the mid- to late-1980s, a second wave is well under way in an industry which is plagued by excess capacity, increasing price competition from Japanese and Asian producers, and an excessive number of producers, especially in Europe.

In 1992, Terex, a diversified industrial and construction equipment group, paid $95 million for Clark Material Handling, which had been put up for sale by its United States owner, Clark Equipment. Elsewhere, Caterpillar of the United States and Mitsubishi Heavy Industries of Japan are merging their lift-truck businesses into a global joint venture of which 80 per cent will be owned by MHI. In 1992, Linde of Germany, the world's biggest lift-truck manufacturer in sales terms, purchased a 51 per cent stake in Iveco's Fiat OM Carrelli Elevatori. In addition, Lancer Boss, the biggest independently owned United Kingdom producer, is buying the central distributor Manualp of France, while Crown Equipment, a large United States producer, is taking a minority stake in Hamech of the United Kingdom.

In the earlier wave of mergers, producers made acquisitions in order to expand their presence ahead of the single European product ranges. In that, as well as the present wave, medium-sized companies are realizing that they need to merge with companies of similar or larger size in order to survive as the industry becomes increasingly international; and large companies with a strong home base or effective regional coverage are looking to become global. In Europe, some privately held producers have retained that status too long, and are looking at mergers.

Linde of Germany, NACCO of the United States, Nordico and Svedala Industri of Sweden and Lancer Boss of the United Kingdom have been the main active participants in the industry mergers. Linde was the industry leader in 1989 as a result of a string of acquisitions in the 1980s, which included Fenwick in France, Wagner and Still in Germany, and Lansing-Bagnall in the United Kingdom. It has also been helped by a strong growth in turnover, and has moved quickly to exploit opportunities in the eastern part of Germany, where it has purchased Leipzig-based VTA to create a strong dealer network.

As shown in table IV.91, NACCO (North American Coal Corporation Industries) is in fifth place, behind Toyota of Japan, which is expanding in the United States and in Europe via greenfield development rather than take-overs. NACCO's major business sector, Hyster-Yale Materials Handling, comprises Yale, bought in 1985, and Hyster, acquired in 1989.

Swedish companies have also been active, with the diversified manufacturing company KF Industri, now renamed Nordico, placed sixth in the 1991 rankings after the take-over of BT of Sweden. In addition, Kalmar Industries acquired Coventry-Climax of the United Kingdom and Germany's Larf and Irion warehouse systems companies in the 1980s. Kalmar's owner, Procordia, sold its lift-truck operation to Componenta International of Sweden, which was purchased by Svedala, the Swedish transnational corporation, in 1991.

Lancer Boss, the privately held United Kingdom company, purchased Munich-based Steinbock in 1983 and Barcelona-based SAM Fenwick in 1987, and had a majority stake in Hyco of Milan, the reach-truck producer, in 1992.

In the United States, Terex has purchased Clark, a leader in terms of its product and its unrivalled United

States dealer network, for a surprisingly low $95 million. The subsequent and important Caterpillar and MHI merger was less surprising. The two companies have had long-standing, successful cooperation in hydraulic excavators, and Caterpillar, the world leader in construction equipment, did not want to loose further market shares. The new company, Mitsubishi Caterpillar Forklift, will have strong regional autonomy while reaping economies of scale that would not have been possible earlier. Combining the two companies will make the ninth or tenth biggest company in the industry.

5. *Technological trends*

Technologically, industrial lift trucks are a mature product sector, with no substantial leaps in technical development expected. Apart from environmentally related issues such as emissions, noise, vibration and battery development, the R and D carried out by lift-truck companies is heavily oriented towards increased advances in product performance, on the one hand, and comfort in the cab, on the other hand. Apart from these areas, perhaps the most interesting issue involves the changing role of lift trucks in automated warehouses, and as a link in increasingly sophisticated logistics chains.

With proprietary technology at a relatively low level in the industry, and the various types of lift trucks well defined and unlikely to change much, producers are trying to gain on each other with new product features devoted to increasing productivity in operation. One approach is to offer machines that can achieve slightly more than a previous model. For example, growing pressure on warehouse space is often met by raising the height of pallet racking to accommodate an extra level of stock. This opens up a market opportunity for reach trucks that can reach higher. The current maximum overall lift height in the industry is 10.7 metres, as illustrated by recent new products from Jungheinrich and Linde. Such developments are important, because in warehousing there are usually alternative methods for every problem; a greater lift height on a reach truck narrows the performance gap between this type of truck and high-rack stacker trucks. Occasionally, patented technology will help the new product programme of a company. The latest reach trucks of Jungheinrich, for example, have a patented hydraulic cushioning system which results in faster handling cycles. Working like shock absorbers in a car, the cushioning reduces mast sway when the truck is retrieving loads at the upper lift heights. This improves performance speed and operator safety.

A second important area is essentially ergonomic, and has been introduced to improve the performance of the driver, and thus the overall productivity of the machine. A recently introduced reach truck from Lancer Boss has soft-touch controls for finger-tip operation, hydrostatic power steering to enhance ease in driving and reduce fatigue, and a fully adjustable upholstered suspension seat and panoramic visibility to improve safety and minimize the chance of damage to the load or racking.

Lift-truck producers offer such features to persuade customers to trade in their old models in favour of the increased productivity from more modern ones. Another fairly common feature on modern lift trucks is electronic controls. Micro-electronics are being used increasingly to improve productivity and reduce energy consumption and maintenance costs. Warehouse computing is continuing to grow in popularity as operators acknowledge the benefits of using on-board terminals, scanners and readers to get the most out of their lift trucks. The bar code scanners, radio data terminals and host warehouse computers combine into a sophisticated warehouse control system, plotting the route of the truck and allowing operators to communicate directly with a warehouse control system without using paper and without leaving the truck.

These developments are encouraging lift-truck producers to view their products as part of an integrated warehouse system, and to align their marketing accordingly. Linde, for example, has developed a computer-based software package called Stratos to design and test material-handling systems using computer-aided design techniques. The service aims at encouraging truck users to get the most cost-effective results from a warehousing system.

Indeed, the major technology issue for lift-truck producers in the future is the impact of automated warehousing systems on their business. A future trend towards a higher degree of automation ought to favour other material-handling systems, such as stacker cranes of automatic guided vehicles. There is certainly increased use of high-density warehousing where normal counterbalanced lift trucks are dimensionally unsuitable. However, lift truck producers do not see any danger that their products will be significantly displaced during the next 10 years. They have developed special types such as very narrow-aisle lift trucks to address such markets, and are constantly updating and improving their products. The markets for self-guided vehicles and warehouse management systems are growing, but from small bases; so far it has proven difficult to combine their technological and commercial benefits. Probably the biggest current deterrent to growth for these types of product is their marginal profit opportunity. Technology developments may also affect the mix of different types of lift truck in different applications. Containerization, for example, has reduced the number of lift trucks used in ports, but this decline could be offset, for example, by sales of container-stuffing trucks.

Furthermore, lift trucks are expanding their areas of application by specialization of truck attachments, often supplied externally. An example is the Forklift Mate series of 15 attachments launched by the Japanese company Sanyo Kiki for such tasks as grabbing, turning, digging, clamping and scooping. However, possible customer resistance to even more advanced enhancements may act as a deterrent.

As for changes in the manufacturing technology used to produce lift trucks, introducing a new model offers the capability to modify, and in some cases dramatically change, the manufacturing process. Thus, the introduction of robot welding or large single-cast counterweights can be accommodated on an incremental basis. There is also considerable scope for improved application of manufacturing technology, particularly modern flexible manufacturing systems, which can produce small batches efficiently.

6. *Environmental considerations*

The production of lift trucks raises the same environmental concerns as in most other sectors of mechanical engineering. The industry does not work with dangerous materials or chemicals, so the pollution caused by the industry is relatively minor. However, environmental and safety factors are playing an increasingly important part in product design and specification. The issues here are exhaust emissions, noise and vibration levels, safety of the operator and, most recently, disposal of used parts such as batteries.

These issues are becoming more important partly because of regulatory changes. In recent years, there has been considerable emphasis on reducing the noise levels of lift trucks, and producers in developed countries have worked to cut noise to minimum levels. Exhaust emission regulations are becoming tougher in markets such as that of the European Community, although emissions have not created anywhere near the same level of concern as for road vehicles. Rules restricting the use of internal-combustion-engine trucks in enclosed spaces are becoming more stringent.

Now, and in the next few years, the most significant of these environmental issues for the lift-truck industry is the battle between the engine and the electric truck. Table IV.93 shows that roughly the same proportion of the two engine types, electronic motors or internal combustion, are built into counterbalanced trucks. Engines can be fuelled by liquid petroleum gas, diesel oil or petrol. Narrow-aisle trucks used in modern warehouses are all electric-powered, whereas rough-terrain lift trucks are all engine-powered. In the European market for counterbalanced lift-trucks, this proportion changes slightly; it is 60 per cent for internal combustion and 40 per cent for electric-powered trucks.

Although there has been some shift from diesel power to propane gas power, the more logical shift to electric-powered trucks has not taken place as most manufacturers predicted in the 1970s. In Japan, the ratio of electric lift-truck production to total production is growing. Production of electric lift-trucks in the first eight months of 1991 accounted for more than 30 per cent of the total, compared with 26.9 per cent for the whole of 1990.

Some producers believe the time will come when no form of internal-combustion-engine truck will be allowed to operate other then outside, because of noise levels and fume emissions. Germany, in particular, has the toughest regulations for internal-combustion-engine vehicles operating indoors. In outside use, however, the internal-combustion-engine truck currently remains supreme because of its ability to travel long distances. Technology is now coming to the aid of both the electric and internal-combustion-engine lift-truck producers, although it should be said that most of the major companies in the industry still employ both types. In electric trucks, the key development is that of longer-life batteries. For example, the Japanese company Toyoda Automatic Loom Works has launched a project aimed at developing a high-output sealed nickel-hydrogen battery for driving lift trucks. These batteries would power a lift truck over 2.3 times the distance (on a single charge) compared with conventional lead batteries, and would achieve speeds about 1.6 times faster. But the best long-term prospect is generally viewed as being the nickel-metal-hydride battery, being developed by Ovonics in the United States.

Another approach is simply to use large-capacity conventional batteries and mount them on trucks designed to match the work throughput and the resilience of an internal-combustion-engine truck. Linde has recently launched a range of electric lift-trucks built to work in environments such as rough yards. There is, however, a further environmental problem, with electric trucks likely to become more important as European Community regulations on industrial wastes are tightened up. Old batteries are one of the key environmentally sensitive waste products from lift trucks in their working lives; others include hydraulic and brake fluids, tyres, packag-

Table IV.93. World lift-truck sales by truck type and motive power, 1990
(Thousand units)

Truck type	Global sales			Percentage share of total world sales		
	Internal combustion engine	Electric	Total	Internal combustion engine	Electric	Total
Counterbalanced, of which	159	167	326	34.6	36.3	70.9
Up to 2 tonnes	68	129	197	14.8	28.0	42.8
2 - 5 tonnes	56	30	86	12.2	6.5	18.7
5 - 10 tonnes	26	8	34	5.7	1.7	7.4
Over 10 tonnes	9	-	9	2.0	-	2.0
Reach narrow-aisle	-	38	38	-	8.3	8.3
Masted stacker pallet	-	43	43	-	9.3	9.3
Rough terrain	8	-	8	1.7	-	1.7
Non-masted and other	13	32	45	2.8	7.0	9.8
Total	180	280	460	39.1	60.9	100.0

Source: Allan Rawnsley Services, *Fork-lift Trucks: World Production and Markets* (Cheshire, United Kingdom, December 1991).

ing materials and plastics. All of these present problems for environmentally safe disposal, an issue that manufacturers can no longer ignore. The industry, until recently not very aware of how recyclable a lift truck is, has been surprised to find that it is much better in this respect than a car.

A new and growing battery technology involves fuel cells; these represent a form of battery which is continuously fed with a hydrogen-rich fuel such as methanol. The main advantage of a fuel cell is that it does not need the frequent recharging necessary for batteries. Fuji Electric is developing small fuel cells for vehicles such as lift trucks, and researchers at Siemens are working on similar ideas. The main current drawbacks are carbon monoxide poisoning and higher unit costs, but these should be lessened over the next decade.

Among attempts to clean up the internal combustion engine, hydrostatic or electric transmissions can be used, allowing the motor to run at lower speeds, thus reducing the emissions. German and Japanese companies are investing in lean-burn internal combustion engines equipped with catalytic converters. In Germany, government inspectors are already monitoring the proportion of carbon particles in the atmosphere of enclosed spaces where diesel exhaust fumes are present. Adhering to the present limit of 0.2 milligrams of carbon per cubic metre, the German engine company Deutz has recently introduced the use of soot traps on the exhaust.

Jungheinrich, the major German lift-truck producer, has in the past two years taken a two-pronged approach to cleaning up internal combustion engines. On the one hand, it has launched a range of liquid-petroleum-gas-powered counterbalanced lift-trucks, fitted with a two-stage catalytic converter. Whereas previously liquid-petroleum-gas trucks could only be used in well-ventilated environments on an intermittent basis, substantially longer work cycles can now be undertaken. On the other hand, the company has launched a range of clean diesel lift trucks incorporating all the latest advances in internal-combustion-engine and noise reduction technology. Developments such as this could continue to forestall a major increase in the use of electric lift trucks.

In the manufacturing process for lift trucks, the most polluting process is probably the paint shop, but it would be wrong to overestimate the problem when compared with the challenge that automotive producers face. At Linde, the waste air from the painting centre is passed through an incinerator to remove the volatile organic compounds. The control of emission levels is guaranteed by sensors. Lancer Boss in the United Kingdom has also recently installed a new paint shop aimed both at improving the product finish and the quality of the working environment; the paint booth air is changed four times a minute.

7. *Short- and medium-term outlook*

The immediate prospects for the lift-truck industry are, inevitably, dependent on the pace at which markets in developed market economies recover from recession. As discussed earlier, the North American market is already showing some signs of recovery, but the situation in Europe is still unclear. Given the importance of the German market, which accounts for about 30 per cent of the Western European market, the actions of the Bundesbank in relation to interest rates could be particularly significant. Customers reduce spending on lift trucks in times of recession, but the industry generally lags behind rather than leads any recovery. This is because customers wait for evidence of increased activity before, perhaps, investing in a new warehouse or updating their current facilities. Although the latest model of lift truck might offer significant productivity improvements over a customer's current model, it still represents an expense that may not be undertaken until economic conditions are more favourable.

The outlook in the markets of developed market economies, therefore, is one of slow recovery for the lift-truck industry. The projections in table IV.94 suggest that only in 1995 will the market reach the level it attained in 1988. This forecast, however, was prepared early in the current recession, before its effects spread to Japan. There also is considerable doubt that the Eastern European market will recover at all over the next few years. Industrial equipment, after all, is emerging as a fairly low priority in Eastern Europe and the former USSR. The critical condition of the food distribution network in the former USSR ought to stimulate demands for lift trucks, but it is difficult to see how such purchases will be financed. In contrast, the strong growth in the NICs of Asia seems likely to continue, barring any major collapse in the world economy.

As for the structure of the lift-truck industry, there is general unanimity in the industry over current trends.

Table IV.94. Forecast of world demand for lift trucks, 1990-1995
(Thousand tonnes)

Region	Actual 1990	Forecast 1993	1994	1995	Percentage change 1990-1995
Western Europe	142	145	150	155	9.2
North America	100	110	120	125	25.0
Japan	65	65	65	65	-
Eastern Europe	70	50	60	65	-7.1
Other	93	75	80	90	-3.2
TOTAL	470	445	475	500	6.4
Index (1990=100)	100	95	101	106	

Source: Allan Rawnsley Services, *Fork-lift Trucks: World Production and Markets* (Cheshire, United Kingdom, December 1991).

Lancer Boss says that a very small number of major manufacturers will supply the majority of the world market [67]. Major companies are growing fast, and the difference in size between the largest three or four and the rest is increasing. The smaller companies may well manufacture for the larger ones or will be bought by them, and the number of failures is increasing each year. In Europe, particularly, observers expect increased concentration in manufacturing companies through the 1990s, although the current recession has yet to produce any major collapses in the industry. An alternative strategy for smaller companies that wish to remain independent will be to concentrate on a niche or specialist product.

Finally, with regard to the outlook for the lift-truck industry in developing countries, it seems that the advantages of the South as far as labour and other resource costs are concerned are certainly not sufficient to allow them to reach a significant position in the world industrial truck market in the next decade. For this type of product, labour costs are not high, and are easily offset by other cost problems such as logistics, transport and other inefficiencies. The expansion of a lift-truck industry must follow domestic industrialization; a manufacturer with no home market can never play a significant role internationally. This implies that growth in this industry over the next few years, apart from the NICs of Asia, will take place in Brazil, China, Egypt, India, Iran, Islamic Republic of, Mexico, Nigeria and Turkey.

As regard the chances for newcomers from developing countries entering the international market for lift trucks, there are a number of obstacles to be surmounted. They may need to design trucks to serve different purposes for industries in the North. In the latter countries, trucks are designed to safety standards different from those applied in the South. In addition, developed countries have ready access to advanced components (such as engines, pumps and electrical and electronic controllers) as well as advanced design technology to optimize design for manufacture. Apart from safety regulations, other legal barriers can include import duties and product liability requirements. In addition, a potential new supplier has to break the existing relationship by offering distinct comparative advantages. One approach, as taken by Malaysian exporters to the United Kingdom, is to offer a relatively basic but good-value lift truck. Even so, this will still require support from spare parts and service staff, and a network of dealers if it is to be successful. For this reason, joint ventures with producers in developed market economies involving licensed production of recent, if not current, designs would be a better way for a developing country both to serve its own needs, and to export products which it could not sell in an already established marketing network.

M. Numerically controlled machine tools (ISIC 3823)*

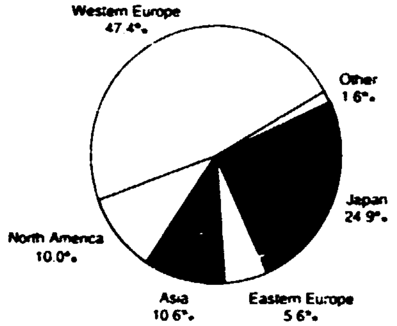
1. Recent trends and current conditions

World production of machine tools peaked in 1990 at $45.5 billion after seven continuous years of growth; it then declined by 10 per cent in 1991 and by more than 19 per cent in 1992. This brought the total value of production down to $32.5 billion. The collapse of markets in Eastern Europe and the former USSR combined with the current recession caused sales to decline in almost every region of the world. While some major producing countries in Asia also witnessed a decline, others did not. The share of production and consumption of major regions can be viewed in figures IV.33 and IV.34. Western Europe continues as the major region for both production and consumption, with Japan almost as important. Western Europe and Japan produce 72 per cent of the world's machine tools, but they consume only 56 per cent. Other regions are all net importers, consuming more than they produce [70].

(a) Production

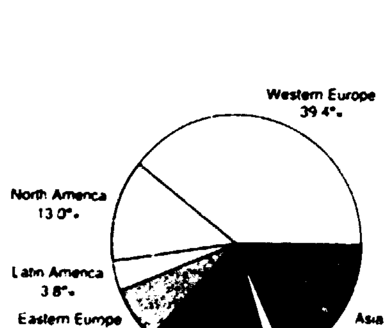
Machine-tool production for a wide range of countries and areas over the period 1987 to 1992 appears in table IV.95. Regional totals in the table include estimates for other countries in the region based on the trade data

Figure IV.33. World machine-tool production, 1992



Source: American Machinist, vol. 137, No. 3 (March 1993), pp. 34-35, and vol. 133, No. 2 (February 1989), p. 61, with adjustments based on trade data of OECD countries for regional and world totals for countries not reported.

Figure IV.34. World machine-tool consumption, 1992



Source: American Machinist, vol. 137, No. 3 (March 1993), pp. 34-35, and vol. 133, No. 2 (February 1989), p. 61, with adjustments based on trade data of OECD countries for regional and world totals for countries not reported.

*UNIDO acknowledges the contribution of Anderson Ashburn, *American Machinist*.

Table IV.95. World machine-tool production, 1987, 1991 and 1992

Economic grouping, region, country or area	Production 1987	Production 1991	Production 1992	World share 1987	World share 1991	World share 1992	Percentage change 1987-1991	Percentage change 1991-1992
	(million dollars)							
A. Developed economies								
Western Europe	14 021.8	18 993.8	16 510.3	43.1	44.0	47.4	35.5	-13.1
Austria	155.0	272.5	246.2	0.5	0.6	0.7	75.8	-9.7
Belgium	179.3	272.7	193.7	0.6	0.6	0.6	52.1	-29.0
Croatia	..	..	75.0	..	..	0.2	..	..
Denmark	76.8	75.4	67.2	0.2	0.2	0.2	-1.8	-10.9
Finland	35.3	52.4	49.4	0.1	0.1	0.1	48.4	-5.7
France	766.1	1 021.4	926.2	2.4	2.4	2.7	33.3	-9.3
Germany	6 402.6	8 841.9	7 852.0	19.7	20.5	22.5	38.1	-11.2
Italy	2 235.2	3 470.1	3 056.4	6.9	8.0	8.8	55.2	-11.9
Netherlands	47.3	112.3	99.9	0.1	0.3	0.3	137.4	-11.0
Portugal	18.7	31.6	29.1	0.1	0.1	0.1	69.0	-7.9
Spain	575.0	750.6	630.5	1.8	1.7	1.8	30.5	-16.0
Sweden	257.7	352.4	329.5	0.8	0.8	0.9	36.7	-6.5
Switzerland	1 652.4	2 011.9	1 695.0	5.1	4.7	4.9	21.8	-15.8
United Kingdom	1 058.4	1 293.6	1 049.3	3.3	3.0	3.0	22.2	-18.9
Yugoslavia[a]	515.0	367.0	150.9	1.6	0.8	0.4	-28.7	..
Eastern Europe and former USSR	6 240.0	4 776.0	1 956.3	19.2	11.1	5.6	-23.5	-59.0
Czechoslovakia	405.0	130.8	91.4	1.2	0.3	0.3	-67.7	-30.1
German Democratic Republic	1 312.0	..	..	..	..	..	..	..
Hungary	210.0	40.6	9.0	0.6	0.1	-	-80.7	-77.8
Poland	322.7	92.6	50.9	1.0	0.2	0.1	-71.3	-45.0
Former USSR	3 976.3	..	..	12.2	..	..	..	..
Russian Federation	..	3 200.0	1 050.0	..	7.4	3.0	..	-67.2
Ukraine	..	1 280.0	740.0	..	3.0	2.1	..	-42.2
North America	2 829.1	3 588.2	3 477.7	8.7	8.3	10.0	26.8	-3.1
Canada	244.1	322.2	290.7	0.7	0.7	0.8	32.0	-9.8
United States	2 585.0	3 266.0	3 187.0	7.9	7.6	9.1	26.3	-2.4
Japan	6 419.4	11 638.7	8 671.3	19.7	27.0	24.9	81.3	-25.5
Other	161.3	176.6	170.5	0.5	0.4	0.5	9.5	-3.5
Australia	45.0	14.0	17.0	0.1	-	-	-68.9	21.4
South Africa	12.3	27.6	28.5	-	0.1	0.1	124.4	3.3
B. Developing economies								
Asia	2 246.5	3 600.6	3 681.7	6.9	8.3	10.6	60.3	2.3
China	821.7	1 445.5	1 738.6	2.5	3.3	5.0	75.9	20.3
Hong Kong	1.4	28.3	34.1	-	0.1	0.1	1 921.4	20.5
India	277.7	221.6	197.6	0.9	0.5	0.6	-20.2	-10.8
Republic of Korea	530.9	798.4	600.0	1.6	1.8	1.7	50.4	-24.8
Singapore	35.0	89.6	100.7	0.1	0.2	0.3	156.0	12.4
Taiwan Province	577.8	992.2	983.7	1.8	2.3	2.8	71.7	-0.9
Latin America	631.7	404.4	369.6	1.9	0.9	1.1	-36.0	-8.6
Argentina	34.8	30.4	36.8	0.1	0.1	0.1	-12.6	21.1
Brazil	575.5	350.0	305.8	1.8	0.8	0.9	-39.2	-12.6
Mexico	21.4	24.0	27.0	0.1	0.1	0.1	12.1	12.5
Total	32 549.8	43 178.3	34 837.4	100.0	100.0	100.0	32.7	-19.3

Source: *American Machinist*, vol. 137, No. 3 (March 1993), pp. 34-35, and vol. 133, No. 2 (February 1989), p. 61, with adjustments based on trade data of OECD countries for regional and world totals for countries not reported.

[a] Data for 1987 and 1991 relate to the territory of Yugoslavia as it existed in 1987 and 1991; data for 1992 are those of the Federal Republic of Yugoslavia as constituted in 1992.

reported by OECD countries. Japan, the largest producing country, had the largest production decline between 1991 and 1992, some $3 billion. That was 30 per cent in yen terms, but the stronger yen reduced it to 25.5 per cent in dollar terms. Even so, Japan produced about one fourth of the world's machine tools in 1992. Germany, the second most important producer, had a decline in production of $1 billion, 17 per cent when measured in deutsche mark, but only 11.2 per cent in dollar terms. This decline left Germany with 22.5 per cent of world production. The United States holds third place, with a decline of about 2.4 per cent, while Italy dropped to fourth place with a decline of 11.9 per cent. The principal exception to the general decline was China, where production increased by $293 million, a 24 per cent increase when measured in the internal currency used by China. That becomes 20.2 per cent when converted at the official rate for the yuan renminbi. This made China the fifth largest producing country. Two independent States of the former USSR had a combined level of production that would have slightly exceeded that of China, but separately the Russian Federation was seventh and Ukraine was eleventh. Each had drastic declines in production, as did all countries of Eastern Europe.

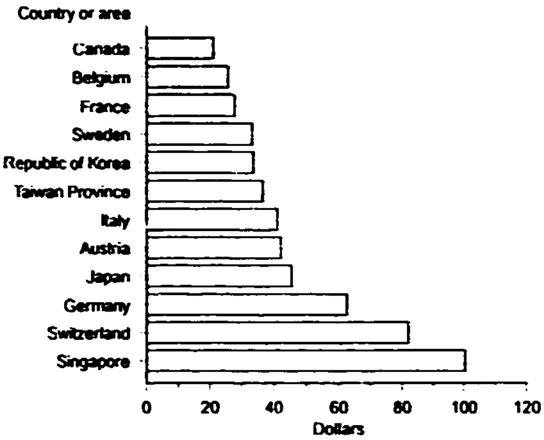
France, Spain, Sweden, Switzerland and United Kingdom were the other European countries among the 15 largest producers. In Asia, Taiwan Province was ninth and the Republic of Korea thirteenth. A Latin American country, Brazil, is the last that falls into this group.

(b) Consumption

Consumption is measured as the value of production reduced by the value of exports and increased by the value of imports. The level of production is a measure of the state of the machine tool industry in a country, while the level of consumption is a measure of the rate of development of the durable goods and metalworking industries that use machine tools as a critical part of their manufacturing operations. Consumption declined even more in Japan than did production, falling by 36 per cent when measured in yen, or 31.8 per cent in dollars, as the industry sought to increase exports. Table IV.96 shows consumption for the principal producing countries and areas in each region, and includes estimates for consumption by other countries in the regional totals. Such estimates can be made on the basis of detailed export data provided by many producing countries. The top five producing countries were also the top five consuming countries, and in the same order. Germany, Italy, Japan and United States all saw production declines, but consumption fell even faster, causing them to increase their export efforts. China was an exception, with consumption not only increasing, but at a faster rate than did production, a 27.1 per cent increase compared with 20.3 per cent for production.

Another measure of consumption is provided in table IV.97, which divides total consumption by population to give the consumption per capita in each country and area. On this basis the range is from $100.49 per capita for Singapore to $0.29 per capita in India. Developed countries such as Austria, Germany, Italy, Japan and Switzerland possess high consumption ratios, while the United Kingdom and the United States have lower ones. The relative size of per capita consumption in the 12 major countries and areas is given in figure IV.35.

Figure IV.35. Countries and areas with highest per capita consumption of machine tools, 1992



Source: American Machinist, vol. 137, No. 3 (March 1993).

Among developing countries and areas, with the exception of Singapore, Taiwan Province and Republic of Korea are the leaders. Despite impressive investment, China has extremely low per capita consumption, and, as the ratio in table IV.97 suggests, the country needs greater industrialization to achieve a higher standard of living.

(c) International trade

There is extensive international trade in machine tools, not only to consuming countries which do not produce but also between the major producing countries. Table IV.98 reports the imports, exports and trade balance for the major producing countries. In the table, regional and world totals are only for the countries listed; thus exports exceed imports by nearly $2.8 billion of shipments to other countries. Again, the totals do not include the estimated production of unlisted countries (about $225 million).

Germany dominates exports with nearly 27.8 per cent of the total, followed by Japan with 21 per cent. These two countries, with nearly half the total, are followed by Switzerland, Italy, and the United States. Germany is also a major importer, with nearly 13.7 per cent of the total, followed by the United States with 12.3 per cent, France with 8.6 per cent, China with 5.7 per cent, Italy with 5.1 per cent and the United Kingdom with 5 per cent. Considering the level of its consumption, Japan is a small importer. Though its import share has increased from 2.1 to 4.1 per cent in the past five years, it still practises some forms of import restriction.

A broader picture of machine-tool trade is provided in table IV.99, which summarizes trade in metalworking machinery between 17 OECD countries and some 79 other countries and areas. Metalworking machinery is a broader category than machine tools, and includes tools, dies, jigs, fixtures, accessories and measuring machinery. The table shows the development of Israel and Ireland and the emergence of Turkey and Thailand as producing countries. Although the import levels of developing countries are still small, the table does show the impressive growth of imports in most of those countries from 1986 to 1991.

Table IV.96. World machine-tool consumption, 1987, 1991 and 1992

Economic grouping, region, country or area	Consumption 1987	1991 (million dollars)	1992	World share 1987	1991	1992	Percentage change 1987-1991	1991-1992
				A. Developed economies				
Western Europe	11 203.2	15 912.3	13 525.9	34.9	37.2	39.4	42.0	-15.0
Austria	159.0	338.6	333.5	0.5	0.8	1.0	113.0	-1.5
Belgium	206.1	347.0	256.9	0.6	0.8	0.7	68.4	-26.0
Croatia	..	..	56.0	..	..	0.2	..	..
Denmark	133.8	113.6	101.2	0.4	0.3	0.3	-15.1	-10.9
Finland	120.9	95.7	62.8	0.4	0.2	0.2	-20.8	-34.4
France	1 219.9	1 924.5	1 583.7	3.8	4.5	4.6	57.8	-17.7
Germany	4 001.4	6 046.6	5 033.7	12.5	14.1	14.7	51.1	-16.8
Italy	1 753.0	2 718.0	2 384.7	5.5	6.3	6.9	55.0	-12.3
Netherlands	229.0	266.3	299.0	0.7	0.6	0.9	16.3	12.3
Portugal	42.3	137.4	125.9	0.1	0.3	0.4	224.8	-8.4
Spain	606.9	803.4	751.7	1.9	1.9	2.2	32.4	-6.4
Sweden	377.3	362.3	290.0	1.2	0.8	0.8	-4.0	-20.0
Switzerland	576.7	704.3	565.7	1.8	1.6	1.6	22.1	-19.7
United Kingdom	1 087.1	1 364.6	1 141.2	3.4	3.2	3.3	25.5	-16.4
Yugoslavia[a]	356.6	220.0	124.9	1.1	0.5	0.4	-38.3	..
Eastern Europe and former USSR	7 214.2	5 212.6	2 381.8	22.5	12.2	6.9	-27.7	-54.3
Czechoslovakia	160.0	173.5	72.8	0.5	0.4	0.2	8.4	-58.0
German Democratic Republic	308.5	..	..	1.0	..	..	..	..
Hungary	164.0	25.8	6.1	0.5	0.1	-	-84.3	-76.4
Poland	428.5	263.3	127.9	1.3	0.6	0.4	-38.6	-51.4
Former USSR	5 303.2	..	..	15.5	..	..	..	..
Russian Federation	..	2 900.0	1 080.0	..	6.8	3.1	..	-62.8
Ukraine	..	1 320.0	780.0	..	3.1	2.2	..	-40.9
North America	4 675.6	4 903.7	4 454.2	14.6	11.5	13.0	4.9	-9.2
Canada	708.4	563.6	576.7	2.2	1.3	1.7	-20.4	2.3
United States	3 967.2	4 340.1	3 877.5	12.3	10.1	11.3	9.4	-10.7
Japan	3 649.1	8 327.3	5 678.2	11.4	19.4	16.5	128.2	-31.8
Other	411.0	714.8	312.4	1.3	1.7	0.9	73.9	-56.3
Australia	177.3	82.0	101.0	0.6	0.2	0.3	-53.8	23.2
South Africa	73.7	454.8	48.4	0.2	1.1	0.1	517.1	-89.4
				B. Developing economies				
Asia	3 345.7	5 920.2	6 264.5	10.4	13.8	18.2	76.9	5.8
China	1 033.5	1 819.8	2 313.6	3.2	4.3	6.7	76.1	27.1
Hong Kong	70.4	33.8	41.3	0.2	0.1	0.1	-52.0	22.2
India	389.6	311.8	260.2	1.2	0.7	0.8	-20.0	-16.5
Republic of Korea	979.5	1 643.9	1 492.5	3.0	3.8	4.3	67.8	-9.2
Singapore	95.0	266.6	281.4	0.3	0.6	0.8	180.6	5.6
Taiwan Province	412.7	646.3	759.8	1.3	1.5	2.2	56.6	17.6
Western Asia	350.0	450.0	400.0	1.1	1.1	1.2	28.6	-11.1
Latin America	1 276.0	1 377.4	1 320.4	4.0	3.2	3.8	7.9	-4.1
Argentina	57.1	113.1	106.6	0.2	0.3	0.3	98.1	-5.7
Brazil	601.5	320.3	200.8	1.9	0.7	0.6	-46.7	-37.3
Mexico	267.4	324.0	513.0	0.8	0.8	1.5	21.2	58.3
Total	32 124.8	42 818.3	34 337.4	100.0	100.0	100.0	33.3	-19.8

Source: American Machinist, vol. 137, No. 3 (March 1993), pp. 34-35, and vol. 133, No. 2 (February 1989), p. 61, with adjustments based on trade data of OECD countries for regional and world totals for countries not reported.

[a] Data for 1987 and 1991 relate to the territory of Yugoslavia as it existed in 1987 and 1991; data for 1992 are those of the Federal Republic of Yugoslavia as constituted in 1992.

Table IV.97. Per capita consumption of machine tools for selected countries and areas, 1992

Country or area	Consumption (million dollars)	Population (thousands)	Per capita (dollars)
Singapore	281.4	2 800	100.49
Switzerland	565.7	6 900	81.99
Germany	5 033.7	80 600	62.45
Japan	5 678.2	124 400	45.64
Austria	333.5	7 900	42.21
Italy	2 384.7	58 000	41.11
Taiwan Province	759.8	20 800	36.53
Republic of Korea	1 492.5	44 300	33.69
Sweden	290.0	8 700	33.33
France	1 583.7	56 900	27.83
Belgium	256.9	10 000	25.69
Canada	576.7	27 400	21.05
United Kingdom	1 141.2	57 800	19.74
Netherlands	299.0	15 200	19.67
Spain	751.7	38 600	19.47
Denmark	101.2	5 200	19.46
United States	3 877.4	255 600	15.17
Ukraine	780.0	52 100	14.97
Finland	62.8	5 000	12.56
Yugoslavia	124.9	10 000	12.49
Croatia	56.0	4 600	12.17
Portugal	125.9	10 500	11.99
Hong Kong	41.3	5 700	7.25
Mexico	513.0	87 700	5.85
Australia	101.0	17 800	5.67
Czechoslovakia	72.8	15 700	4.64
Russian Federation	1 080.0	274 572	3.93
Poland	127.9	38 400	3.33
Argentina	106.6	33 100	3.22
China	2 313.6	1 165 800	1.98
Brazil	200.8	150 800	1.33
South Africa	48.4	41 700	1.16
Hungary	6.1	10 300	0.59
India	260.2	882 600	0.29
Total	31 428.6	3 627 472	8.66[a/]

Source: American Machinist, vol. 137, No. 3 (March 1993).
[a/] Average.

(d) *Major companies in the global industry*

Most machine-tool producers are relatively small, often privately owned companies. A few large firms have had success with machine-tool subdivisions, notably Thyssen in Germany, and Mitsubishi Heavy Industries, Toyota and Komatsu in Japan. However, there are very few cases where large diversified companies have been successful when they acquired machine-tool operations. The 25 companies listed in table IV.100 each had machine tool sales of more than $300 million in 1991. Of these 16 are Japanese, six are German, and three are based in the United States, Most of these companies are international in manufacturing as well as in distribution. One half of the Japanese companies have plants in the United States, and some have plants in Europe. All the United States companies have plants in Europe, and one half of the German companies have plants in the United States.

There were large State-owned companies in Eastern Europe, but comparable data are lacking. Now that their operations are being rationalized and privatized, they are shrinking to much smaller sizes. Of the three top companies listed in table IV.100, each had sales of more than $1 billion in 1991. Of the three, Yamazaki Mazak, listed third, was actually the largest producer of machine tools. Amada produces some machines, but is primarily a marketing company selling machine tools produced by others. Many of these are made by Amada Wasino and Amadasonoike, partially owned by Amada. Fanuc is the major world producer of numerical control systems, although it also produces machine tools, robots and plastics machinery. More than half the sales of Ingersoll Milling are by three companies that it owns in Germany. Giddings & Lewis acquired Cross & Trecker late in 1991; if they had been combined for the entire year, sales would have been about $600-million [71].

2. *Manufacturing capacity of developing countries and areas*

(a) *China*

Chinese manufacturing capacity began expanding in the early 1980s, reaching a peak of $1.1 billion in 1989. Production fell back by almost a third in 1990, as economic reforms faltered. It has since resumed, and output increased in 1991 and again in 1992, when it reached $1.7 billion. However, production figures are reported in yuan renminbi, an internal currency, which cannot be accurately converted into dollars. Export and import data are reported in dollars. Exports, which peaked in 1990, have declined each year since, but imports after several flat years are said to have increased by 43 per cent in the past two years. It is difficult to match these gains with the trade data reported by other countries. The data in table IV.99 indicate a substantial drop in imports from 1986 to 1991. However, the very real rise in re-exports from Hong Kong, for example, which is also not reflected in that table, suggests that a large share of China's imports are coming indirectly through third countries [72].

(b) *Taiwan Province*

With a machine-tool production capacity now close to $1 billion a year, Taiwan Province had its first drop in production in many years in 1992. Exports to both the United States and Europe were down, and though focusing on the market in China, this did not fully make up the difference. Although trade is prohibited with China, it takes place openly through other third countries. Several companies are producing computer numerically controlled (CNC) lathes and machining centres on a commodity basis using Japanese controls. There has been very little demand for the more advanced types of equipment in Taiwan Province, though this seemed to change in 1991 with a 27 per cent increase in imports despite the decline in domestic production. The industry in Taiwan Province is made up of a large number of small companies. The largest firm registered sales in 1990 of $60 million [73].

(c) *Republic of Korea*

Capacity peaked in 1991 when production reached almost $800 million. In 1992, production fell by 25 per cent as the recession dampened the domestic market, and exports did not make up the difference. Although the capacity is less than that in Taiwan Province the state of manufacturing is viewed as more advanced. Industry in the Republic of Korea has been a heavy investor in imported machine tools, and the volume increased in 1992, despite the recession, to account for more than 60 per cent of consumption. There are fewer and larger companies in the Republic of Korea than in most countries of the Pacific rim. The largest is Saeilo, formerly known as Tong-Il, which had sales of about $450 million in 1990. Another large company is Kia Machine Tool, with sales of $405 million in 1990, which builds presses and special machines for the automotive industry, much of which goes into their own vehicle parts plants [74], [75].

(d) Brazil

Brazil has protected its machine-tool industry by import restrictions. Under protection, capacity expanded rapidly and reached a peak of $575 million in 1987. Contributing to the expansion were a number of plants built by German and Italian firms. Imports were generally around $40 million, but exports were even less. The

Table IV.98. Machine tool imports, exports, and trade balance for selected producing countries and areas, 1987 and 1992
(Million dollars)

Economic grouping, region, country or area	1987 Imports (million dollars)	1987 Exports	1987 Balance	1992 Imports (million dollars)	1992 Exports	1992 Balance	Percentage share: Imports 1987	Imports 1992	Exports 1987	Exports 1992	Percentage change 1987-1992: Imports	Exports
A. Developed economies												
Western Europe	5 275.1	8 379.9	3 104.8	7 010.1	10 349.3	3 339.2	42.6	51.0	56.4	61.2	32.9	23.5
Austria	173.7	169.7	-4.0	408.5	321.2	-87.3	1.4	3.0	1.1	1.9	135.2	89.3
Belgium	321.1	294.3	-26.8	434.2	371.0	-63.2	2.6	3.2	2.0	2.2	35.2	26.1
Croatia	..	..	..	6.0	25.0	19.0	-	-	..	0.1	..	..
Denmark	115.5	58.5	-57.0	122.8	88.8	-34.0	0.9	0.9	0.4	0.5	6.3	51.8
Finland	114.9	29.3	-85.6	51.4	38.0	-13.4	0.9	0.4	0.2	0.2	-55.3	29.7
France	738.1	284.3	-453.8	1 176.6	519.0	-657.6	6.0	8.6	1.9	3.1	59.4	82.6
Germany	1 253.5	3 654.7	2 401.2	1 881.0	4 699.3	2 818.3	10.1	13.7	24.6	27.8	50.1	28.6
Italy	566.3	1 048.5	482.2	702.6	1 374.3	671.7	4.6	5.1	7.1	8.1	24.1	31.1
Netherlands	361.2	179.5	-181.7	369.8	170.7	-199.1	2.9	2.7	1.2	1.0	2.4	-4.9
Portugal	33.0	9.4	-23.6	113.5	16.7	-96.8	0.3	0.8	0.1	0.1	243.9	77.7
Spain	250.7	218.8	-31.9	449.7	328.4	-121.3	2.0	3.3	1.5	1.9	79.4	50.1
Sweden	312.3	192.7	-119.6	266.6	306.1	39.5	2.5	1.9	1.3	1.8	-14.6	58.8
Switzerland	360.1	1 435.8	1 075.7	324.5	1 453.8	1 129.3	2.9	2.4	9.7	8.6	-9.9	1.3
United Kingdom	529.7	501.0	-28.7	681.9	590.0	-91.9	4.3	5.0	3.4	3.5	28.7	17.8
Yugoslavia[a/]	145.0	303.4	158.4	21.0	47.0	26.0	1.2	0.2	2.0	0.3	..	..
Eastern Europe and former USSR	2251.5	2113.3	-138.2	250.3	124.7	-125.6	18.2	1.8	14.2	0.7	-88.9	-94.1
Czechoslovakia	85.0	330.0	245.0	43.0	61.5	18.5	0.7	0.3	2.2	0.4	-49.4	-81.4
German Democratic Republic	198.9	1 202.4	1 003.5	..	..	..	1.6	..	8.1	..	..	..
Hungary	124.5	170.5	46.0	4.3	7.2	2.9	1.0	-	1.1	-	-96.5	-95.8
Poland	203.9	98.1	-105.8	105.0	28.0	-77.0	1.6	0.8	0.7	0.2	-48.5	-71.5
Former USSR	1 639.2	312.3	-1326.9	..	..	..	13.2	..	2.1	..	..	..
Russian Federation	..	..	..	50.0	20.0	-30.0	-	0.4	-	0.1	..	..
Ukraine	..	..	..	48.0	8.0	-40.0	-	0.3	..	-	..	..
North America	2 496.9	650.4	-1 846.5	2 186.6	1 210.1	-976.5	20.2	15.9	4.4	7.2	-12.4	86.1
Canada	528.0	63.7	-464.3	491.6	205.6	-286.0	4.3	3.6	0.4	1.2	-6.9	222.8
United States	1 968.9	586.7	-1382.2	1 695.0	1 004.5	-690.5	15.9	12.3	3.9	5.9	-13.9	71.2
Japan	264.8	3 035.1	2 770.3	560.7	3 553.8	2 993.1	2.1	4.1	20.4	21.0	111.7	17.1
Other	201.1	7.4	-193.7	124.1	20.2	-103.9	1.6	0.9	-	0.1	-38.3	173.0
Australia	137.2	4.9	-132.3	90.0	6.0	-84.0	1.1	0.7	-	-	-34.4	22.4
South Africa	63.9	2.5	-61.4	34.1	14.2	-19.9	0.5	0.2	-	0.1	-46.6	468.0
B. Developing economies												
Latin America	336.0	41.7	-294.3	660.3	209.5	-450.8	2.7	4.8	0.3	1.2	96.5	402.4
Argentina	38.3	16.0	-22.3	75.0	5.2	-69.8	0.3	0.5	0.1	..	95.8	-67.5
Brazil	49.0	23.0	-26.0	85.3	190.3	105.0	0.4	0.6	0.2	1.1	74.1	727.4
Mexico	148.7	2.7	-146.0	500.0	14.0	-486.0	1.2	3.6	..	0.1	236.2	418.5
Asia	1 561.5	636.1	-925.4	2 939.9	1 446.0	-1 493.9	12.6	21.4	4.3	8.5	88.3	127.3
China	494.0	93.0	-401.0	780.0	205.0	-575.0	4.0	5.7	0.6	1.2	57.9	120.4
Hong Kong	75.0	6.0	-69.0	314.4	307.2	-7.2	0.6	2.3	..	1.8	319.2	5 020.0
India	146.6	34.7	-111.9	75.3	12.7	-62.6	1.2	0.5	0.2	0.1	-48.6	-63.4
Republic of Korea	486.1	37.5	-448.6	994.0	101.5	-892.5	3.9	7.2	0.3	0.6	104.5	170.7
Singapore	145.0	85.0	-60.0	353.9	173.3	-180.6	1.2	2.6	0.6	1.0	144.1	103.9
Taiwan Province	214.8	379.9	165.1	422.3	646.3	224.0	1.7	3.1	2.6	3.8	96.6	70.1
Total	12 386.9	14 863.9	2 477.0	13 732.0	16 913.6	3 181.6	100.0	100.0	100.0	100.0	10.9	13.8

Source: *American Machinist*, vol. 33, No. 2 (February 1989), p. 61, and vol. 137, No.3 (March 1993), p. 34.

a/ Data for 1987 and 1991 relate to the territory of Yugoslavia as it existed in 1987 and 1991; data for 1992 are those of the Federal Republic of Yugoslavia as constituted in 1992.

Table IV.99. Total trade in metalworking machinery of selected countries and areas with 17 OECD countries, 1986 and 1991
(Million dollars)

Economic grouping, region, country or area	1986 Imports (million dollars)	1986 Exports (million dollars)	1991 Imports (million dollars)	1991 Exports (million dollars)	Percentage share Imports 1986	Percentage share Imports 1991	Percentage share Exports 1986	Percentage share Exports 1991	Percentage change Imports 1986-1991	Percentage change Exports 1986-1991
A. Developed economies										
Western Europe										
Austria[a]	358.9	583.3	187.8	490.7	2.1	1.7	2.2	2.6	-47.7	-15.9
Belgium and Luxembourg	505.7	1 059.4	256.8	466.3	3.0	2.3	4.0	2.5	-49.2	-56.6
Denmark	178.2	204.2	74.4	141.6	1.1	0.7	0.8	0.8	-58.2	-30.7
Finland[a]	127.2	136.2	35.6	85.2	0.8	0.3	0.5	0.5	-72.0	-37.4
France[a]	954.3	2 034.7	384.4	863.0	5.7	3.5	7.7	4.6	-59.7	-57.6
Germany[a]	1 607.2	3 266.6	2 847.6	4 865.0	9.6	26.0	12.4	26.1	77.2	48.9
Greece	39.8	84.9	1.5	7.9	0.2	-	0.3	-	-96.2	-90.7
Iceland	3.7	4.0	0.2	0.2	-	-	-	-	-94.6	-95.0
Ireland[a]	55.0	105.9	25.8	42.2	0.3	0.2	0.4	0.2	-53.1	-60.2
Italy[a]	521.7	1 182.6	937.9	1 805.9	3.1	8.6	4.5	9.7	79.8	52.7
Netherlands[a]	406.4	642.9	212.0	398.4	2.4	1.9	2.4	2.1	-47.8	-38.0
Norway[a]	117.6	103.3	14.3	27.2	0.7	0.1	0.4	0.1	-87.8	-73.7
Portugal	49.9	168.1	10.1	21.5	0.3	0.1	0.6	0.1	-79.8	-87.2
Spain[a]	185.6	715.1	169.7	346.7	1.1	1.6	2.7	1.9	-8.6	-51.5
Sweden[a]	364.5	435.5	261.5	390.2	2.2	2.4	1.6	2.1	-28.3	-10.4
Switzerland[a]	500.3	713.0	1 244.4	1 956.5	3.0	11.4	2.7	10.5	148.7	174.4
United Kingdom[a]	790.4	1 293.7	489.0	949.5	4.7	4.5	4.9	5.1	-38.1	-26.6
Yugoslavia	193.5	124.5	24.4	97.7	1.2	0.2	0.5	0.5	-87.4	-21.5
Eastern Europe and former USSR										
Bulgaria	185.9	79.9	7.1	16.9	1.1	0.1	0.3	0.1	-96.2	-78.8
Czechoslovakia	131.6	190.5	54.1	137.3	0.8	0.5	0.7	0.7	-58.9	-27.9
German Democratic Republic	66.1	..	47.7	..	0.4	0.4	..	..	-28.8	..
Hungary	57.7	148.4	17.8	58.4	0.3	0.2	0.6	0.3	-69.2	-60.6
Poland	99.9	182.3	25.2	52.8	0.6	0.2	0.7	0.3	-74.8	-71.0
Romania	19.3	30.9	6.5	18.4	0.1	0.1	0.1	0.1	-66.3	-40.5
Former USSR	775.9	1 306.8	36.5	56.5	4.6	0.3	4.9	0.3	-95.3	-95.7
North America										
Canada	712.7	692.9	235.3	277.7	4.2	2.6	2.2	1.5	-67.0	-59.9
United States[a]	2 878.0	2 861.9	501.8	1 104.1	17.1	4.6	10.8	5.9	-82.6	-61.4
Japan[a]	387.1	465.4	2 419.5	3 030.9	2.3	22.1	1.8	16.3	525.0	551.2
Other										
Australia	272.4	217.5	7.9	21.6	1.6	0.1	0.8	0.1	-97.1	-90.1
Israel	88.0	106.5	25.1	35.3	0.5	0.2	0.4	0.2	-71.5	-66.9
New Zealand[a]	46.0	16.7	2.5	4.1	0.3	-	0.1	-	-94.6	-75.4
South Africa	82.3	159.3	5.5	8.2	0.5	0.1	0.6	-	-93.3	-94.9
B. Developing economies										
Africa										
Algeria	112.8	121.1	0.2	0.4	0.7	-	0.5	-	-99.8	-99.7
Cameroon	4.2	3.2	0.1	-	-	-	-	-	-97.6	-100.0
Egypt	66.2	82.9	1.2	0.4	0.4	-	0.3	-	-98.2	-99.5
Gabon	3.3	2.2	-	-	-	-	-	-	-100.0	-100.0
Ghana	4.2	15.5	-	0.4	-	-	0.1	-	-100.0	-97.4
Liberia	1.0	-	-	-	-	-	-	0.2	-100.0	..
Libyan Arab Jamahiriya	44.9	43.3	-	0.1	0.3	-	0.2	-	-100.0	-99.8
Côte d'Ivoire	4.1	2.9	0.2	0.1	-	-	-	-	-95.1	96.6
Morocco	18.6	28.0	0.1	0.1	0.1	-	0.1	-	-99.5	-99.6
Nigeria	58.5	18.5	-	0.7	0.3	-	0.1	-	-100.0	-96.2
Tunisia	22.8	27.9	0.1	0.8	0.1	-	0.1	-	-99.6	-97.1
Zaire	5.6	6.4	-	-	-	-	-	-	-100.0	-100.0
Asia										
Developing market economies										
Brunei Darussalam	0.6	1.4	-	-	-	-	-	-	100.0	-100.0
Hong Kong	87.5	148.8	6.1	9.6	0.5	0.6	0.1	0.1	-93.0	-93.5
India	252.0	285.6	7.2	11.8	1.5	1.1	0.1	0.1	-97.1	-95.9
Indonesia	72.2	259.8	0.2	0.1	0.4	-	1.0	-	-99.7	-100.0
Malaysia	33.6	269.1	0.4	2.7	0.2	-	1.0	-	-98.8	-99.0
New Guinea	1.3	0.9	-	-	-	-	-	-	-100.0	-100.0
Pakistan	37.0	44.6	-	-	0.2	-	0.2	-	-100.0	-100.0

Economic grouping, region, country or area	1986 Imports (million dollars)	1986 Exports (million dollars)	1991 Imports (million dollars)	1991 Exports (million dollars)	Percentage share Imports 1986	Percentage share Imports 1991	Percentage share Exports 1986	Percentage share Exports 1991	Percentage change 1986-1991 Imports	Percentage change 1986-1991 Exports
Asia (continued)										
Developing market economies										
Phillipines	31.1	65.5	0.2	3.3	0.2	-	0.2	-	-99.4	-95.0
Republic of Korea	684 4	1 580.8	33.6	104.4	4.1	0.3	6.0	0.6	-95.1	-93.4
Singapore	108.5	329.0	26.5	57.5	0.6	0.2	1.2	0.3	-75.6	-82.5
Taiwan Province	248.6	530.8	230.1	407.3	1.5	2.1	2.0	2.2	-7.4	-23.3
Thailand	43.3	461.0	0.5	29.6	0.3	-	1.7	0.2	-98.8	-93.6
Centrally planned economies										
China	1002.0	632.1	17.6	115.7	6.0	0.2	2.4	0.6	-98.2	-81.7
Western Asia										
Abu Dhabi	5.2	1.4	-	-	-	-	-	-	-100.0	-100.0
Iran (Islamic Republic of)	127.1	457.0	0.6	0.3	0.8	-	1.7	-	-99.5	-99.9
Iraq	25.8	-	0.5	-	0.2	-	-	-	-98.1	..
Kuwait	9.3	12.9	-	0.1	0.1	-	-	-	-100.0	-99.2
Oman	7.6	5.3	-	0.1	-	-	-	-	-100.0	-98.1
Qatar	2.1	1.9	-	-	-	-	-	-	-100.0	-100.0
Saudi Arabia	56.3	89.9	0.7	0.6	0.3	-	0.3	-	-98.8	-99.3
Syrian Arab Republic	6.5	6.7	-	0.7	-	-	-	-	-100.0	-89.6
Turkey[a]	121.6	278.2	1.5	20.7	0.7	-	1.1	0.1	-98.8	-92.6
United Arab Emirates	7.9	29.9	0.3	0.6	-	-	0.1	-	-96.2	-98.0
Latin America										
Argentina	40.3	101.9	1.2	2.4	0.2	-	0.4	-	-97.0	-97.6
Bahamas	0.4	1.1	-	-	-	-	-	-	-100.0	-100.0
Brazil	137.1	266.9	29.8	71.8	0.8	1.3	0.1	0.4	-78.3	-73.1
Chile	18.4	55.8	-	-	0.1	-	0.2	-	-100.0	-99.6
Columbia	21.3	27.4	-	0.1	0.1	-	0.1	-	100.0	-99.6
Ecuador	11.5	12.8	-	-	0.1	-	-	-	-100.0	-100.0
Guatemala	2.2	6.3	-	-	-	-	-	-	-100.0	100.0
Mexico	372.6	570.7	5.0	8.3	2.2		2.2	-	-98.7	-98.5
Netherlands Antilles	0.6	2.6	-	0.2	-	-	-	-	-100.0	-92.3
Peru	8.6	13.6	-	-	0.1	-	0.1	-	-100.0	-100.0
Trinidad and Tobago	5.3	6.4	-	-	-	-	-	-	-100.0	-100.0
Venezuela	101.2	177.5	-	0.1	0.6	-	0.7	-	-100.0	-99.9
Total	16 800.0	26 404.4	10 933.8	18 628.9	100.0	100.0	100.0	100.0	-34.9	-29.4

Source: *OECD Foreign Trade by Commodities* (Paris, OECD, 1992).

[a] Countries whose import and export data are combined in the tabulation.

new economic policies which began in 1990 both restricted the market and opened it to imports. As a result, consumption and production have fallen each year, and the industry is operating at about 50 per cent of capacity. Although consumption in 1992 was only a third ($200 million) of its 1987 peak and imports more than doubled to $85 million, the production level was as high as it was because exports ($190 million) are more than seven times their level of 1986 [76].

(e) India

India has aggressively promoted the development of its machine-tool industry, and one government company and some 325 private companies have a capacity that is about $300 million a year. However, this level of production has not been reached since 1988, as both domestic demand and exports declined. The Russian Federation accounted for 70 per cent of total exports as recently as 1991, but since then has slowed its purchases. As a result, total exports in 1992 were less than 7 per cent of production. Emphasis has been put on the development of CNC machine tools and this has been accomplished primarily through licensing of foreign technology. By 1992, 32 companies had a total of 46 such agreements on CNC technology. As a result, the percentage of machine-tool production represented by CNC machines grew steadily from 20 per cent in 1987 to 37 per cent in 1991 [77].

(f) Singapore

Production consists primarily of the assembly of machines from imported and domestic parts. A fraction of the imports are re-exported to developing countries in Asia. A fully computer-integrated plant has been established by Yamazaki Mazak to produce machine-tool components for export to Japan. The developing role of Singapore as a manufacturing and technical centre for South-East Asia is spurring the development of local supporting companies, providing such services as tool and mould production, metal stamping, fine blanking, die casting and precision machining. However, the recession in the United States and Europe caused a reduction in both exports and imports in 1992.

Table IV.100. World's 25 largest machine-tool companies, 1991

Rank	Company and country	Turnover[a] 1990 (million dollars)	Turnover[a] 1991 (million dollars)	Percentage change 1990-1991	Profit[b] 1990 (million dollars)	Profit[b] 1991 (million dollars)	Percentage change 1990-1991	Number of employees
1	Amada Co., Ltd. (Japan)	1 207.2	1 330.6	10.2	113.7	112.7	-0.9	1 696
2	Fanuc Ltd. (Japan)	1 100.7	1 027.0	-6.7	242.3	246.1	1.6	2 181
3	Yamazaki Mazak Corp. (Japan)	1 150.4	1 011.3	-12.1	..	..	..	3 800
4	Okuma Machinery Works (Japan)	739.0	847.9	14.7	32.9	43.1	31.0	1 954
5	Thyssen Maschinenbau GmbH (Germany)	..	684.6	..	..	..	..	6 400
6	Mori Seiki Co., Ltd. (Japan)	661.3	684.0	3.4	81.2	107.1	31.9	1 874
7	Toyoda Machine Works (Japan)	464.1	565.8	21.3	19.5	6.0	-69.2	4 876
8	Komatsu Ltd. (Japan)	470.7	531.7	13.0	195.1	209.3	7.3	15 033
9	Pittler Consolidated Group (Germany)	411.6	527.0	28.0	14.8	-16.5	-211.5	5 766
10	Toshiba Machine Co., Ltd. (Japan)	374.2	475.8	27.2	35.6	52.2	46.6	3 395
11	Ingersoll Milling Machine Co. (United States)	400.0	460.0	15.0	..	..	..	4 250
12	Trumpf Group (Germany)	399.7	454.6	13.7	20.7	14.0	-32.4	2 914
13	Fuji Machine Mfg. Co. Ltd. (Japan)	435.7	451.2	3.6	48.4	47.3	-2.3	1 027
14	Schuler Group (Germany)	464.2	439.7	-5.3	..	..	..	4 015
15	Hitachi Seiki Co., Ltd. (Japan)	364.8	420.5	15.3	22.8	14.2	-37.7	1 280
16	Citizen Watch Co., Ltd. (Japan)	298.4	392.8	31.6	80.9	109.6	35.5	3 273
17	Maho, AG (Germany)	442.1	384.1	-13.1	8.7	-17.3	-298.9	3 459
18	Cincinnati Milacron, Inc. (United States)	433.7	383.7	-11.5	-24.3	-100.2	..	6 903
19	Gildemeister Group (Germany)	443.2	380.5	-14.1	10.2	-17.4	-270.6	3 510
20	Makino Milling Machine Co., Ltd. (Japan)	336.6	379.5	12.7	31.9	29.1	-8.8	1 134
21	Amada Wasino Co., Ltd. (Japan)	321.8	364.3	13.2	15.1	18.3	21.2	545
22	Nippei Toyama Corp. (Japan)	266.8	361.4	35.5	9.2	13.9	51.1	1 133
23	Amadasonoike Co., Ltd. (Japan)	364.7	325.2	-10.8	23.9	21.4	-10.5	710
24	Giddings & Lewis, Inc. (United States)	232.2	304.9	31.3	19.7	22.0	11.7	4 520
25	Mitsubishi Heavy Industries Ltd. (Japan)	248.6	302.7	21.8	485.2	736.9	51.9	45 433

Source: "Blue Bulletin", *American Machinist*, 28 August 1992.

a/ Turnover figures represent the portion of total figures accounted for by machine tools (including numerical controls).

b/ Net profit figures represent the after-tax profit for the total turnover of the company.

(g) Hong Kong

Production in 1990 (latest figures) increased by 38 per cent over 1989, though the number of firms involved decreased from 93 in 1989 to 80 in 1990. Production capacity is obviously very limited in Hong Kong, and is not likely to expand. In general, all manufacturers are shifting their operations across the border into Guangdong province of China, where labour costs are much lower and rapid economic development is creating opportunities for both industrial and consumer products. It is evident that the Hong-Kong-based firms are serving both as a conduit for machine tools into China and for exports of machines from China.

3. Capacity utilization and expansion plans

(a) Japan

Production of metal-cutting machines peaked in 1990 at $9.7 billion, and that of metal-forming machines in 1991 at $2.2 billion. This probably was close to capacity at the time, and represented more than 27 per cent of the world production of machine tools. Because Japanese firms upgrade their plants almost continuously, capacity has increased since then. However, the collapse of domestic demand and the decline in exports has reduced output by about one third. It has been the rapid expansion of the manufacturing base of Japan combined with restrictions on imports that has caused almost uninterrupted growth of machine-tool capacity. Expansion efforts have slowed, but efforts to improve efficiency will entail some investment in new equipment. Increasing resistance to Japanese imports in Europe and North America will limit their ability to increase exports, which will make it more difficult to increase capacity utilization [76].

(b) Germany

The boom that followed the unification of Germany came to a halt in 1991. Capital costs of reconstructing the eastern part of the country turned out to be much higher than anticipated. The high interest rates imposed to prevent inflation restricted the flow of capital, and the almost complete loss of markets in the former USSR and the other Eastern European countries combined to create a severe recession. Machine-tool production declined by more than 11.2 per cent. The difference between the two areas is indicated by the fact that the decline was 14 per cent in the western part of Germany and 35 per cent in the eastern part. Production in the western part of Germany peaked at $8.7 billion in 1990, and was around $1 billion in the eastern part. In 1992, the combined output decreased to $7.8 billion, and production was down by about one third from its 1990 peak. A further decline of about 13 per cent in 1993 is expected [78].

(c) United States

Although consumption of machine tools decreased by almost 10.7 per cent because of the recession, imports decreased by 13.9 per cent, and exports increased by

71.2 per cent in 1992 [79]. As a result, production declined by less than 2.4 per cent and the share of world production increased from 7.6 to 9.1 per cent. This was partly due to improved relative prices, mainly because of the lower value of the dollar. The comparatively good performance of the United States is an indication that the downsizing, restructuring and modernizing of the industry that has been going on for several years is beginning to show results. By the end of 1992, as the country was showing signs of coming out of the recession, the Department of Commerce predicted that machine-tool shipments would increase by 8 per cent in 1993 [80]. While excess plant and equipment capacity still exist after the downsizing, skilled employees that are needed to expand production have left and may not be easily replaceable. The numerous apprentice programmes that existed in the industry at one time have all been abandoned in the turmoil that saw industry volume sink to less than one half of its former levels.

(d) Italy

Machine-tool production capacity can be surmised from the production peak of $3.9 billion reached in 1990. This ended a steady 15-year increase that made Italy the second largest producer and the third largest exporter in Europe. The level of orders, however, began to decline in 1990, and moved steadily downwards through 1992. Industry capacity is still about $4 billion, and it is operating at around 75 per cent of capacity. This decline in output is expected to continue in 1993. Imports, which come mainly from Germany and Switzerland, have declined even more than domestic production. Exports also declined more than domestic consumption, most sharply to Europe, although this was partially offset by the development of new markets. Although metal-forming machines have performed better in domestic markets, exports were much more than those of metal-cutting machines.

(e) Switzerland

Switzerland has a highly-developed industry with the world's most intense consumption of machine tools (though currently the consumption per capita is exceeded by Singapore's rapid development). The machine-tool industry has traditionally specialized in producing the most precise machines available. One result has been that more than 80 per cent of the output is exported, and imports of more standard types make up the majority of local consumption. Production peaked in 1990 at $3.1 billion, but has declined since by more than 40 per cent [81]. Some restructuring has taken place which has reduced capacity in the past two years, but it is probably still close to sales of $3 billion, and the industry is operating far below this level.

(f) Russian Federation and Ukraine

The territories of these two countries were major machine-tool producing areas of the former USSR. In 1990, total production accounted for 199,196 units. In 1991 and 1992, separate data were necessary. Production in the Russian Federation in 1991 was 90,198 units, and in 1992 was estimated at 41,400 units [82]. Production in Ukraine in 1991 was 46,642 units (35,829 metal-cutting and 10,813 metal-forming units), and for the first nine months of 1992 was 38,402 units (30,517 metal-cutting and 7,885 metal-forming units). Exports were 867 units in 1991 and imports were 556 units. In 1992, exports declined further (205 units at the rate through September), while imports increased (776 units at the nine-month rate) [83].

(g) Spain

Capacity in Spain can also be estimated from the level of production reached in 1990, around $1 billion. Because of falling demand both in the home market and for exports, production has fallen by more than 35 per cent since then. In 1992, the decline in exports, primarily to Germany and France, was held at 16 per cent, although the decline in consumption was 6.4 per cent. The fact that imports increased by 3.3 per cent in the face of this decline was the result of the completion of orders placed earlier by the transnational automotive industry.

(h) Yugoslavia

Yugoslavia produced in 1990 machine tools worth $630 million, 73 per cent of which were exported mostly to the former USSR and Eastern Europe. The collapse of that market and the developing political crisis in Yugoslavia reduced production in 1991 to $375 million. In 1992 and 1993 the territory was engulfed in war. For the newly constituted Federal Republic of Yugoslavia, which includes the machine-tool producing areas in Serbia, production stood at $150 million, much of which was evidently added to producer inventories rather than consumed. Exports were a mere $47 million, all of which took place in the early part of the year before the United Nations resolution. The other machine-tool producing area was Croatia, which registered production of $75 million in 1992, one third of which was exported, mostly to the Russian Federation and Germany.

(i) Poland

Capacity in 1990, measured realistically, was about $125 million. Poland produced 15,539 metal-cutting machines in 1991, of which 182 were numerically controlled. That was a reduction of more than 40 per cent from 1990. In 1992, production in the first 11 months was 7,479, down 45 per cent over the same period in 1991, and only 72 were numerically controlled. There were exports of 7,179 machines in 1990, but only 3,990 in 1991 (2,300 to developed market economies). There were imports of 9,287 machines in 1990 (5,481 from developed market economies) and 2,777 in 1991 (1,990 from developed market economies). Due to the liberalization of foreign trade, both government- and privately-owned factories are able to export and import machine tools in addition to the foreign trade conducted by Metalexport, a government agency. Although privatization of the industry has been discussed for several years there has been no action taken so far. The present plan is to divide the industry into three groups, the best five in the first group, a second group comprising 18 factories believed able to survive, and a third group consisting of the rest which are to be liquidated [84].

(j) South Africa

With limited machine-tool production capacity in South Africa, more than 90 per cent of its demand has been filled by imports mainly from China, the former

Czechoslovakia, Japan, Taiwan Province and Europe. The armaments industry, once the major customer, has virtually disappeared. Demand from the railway and motor vehicle industries have declined steadily. The devaluation of the rand and the imposition of import duties have caused real prices to increase by 400 per cent in the 1980s. This has made prohibitive the purchase of machine tools by small businesses, thus impeding the development of small-scale industry.

(k) Hungary

Early estimates for Hungary suggest that capacity reached over $100 million in 1992, but less than the $210 million reported in 1987. About 90 per cent of the production of the country was based on exports to the USSR and other Eastern European countries. This market collapsed at the same time as internal economic problems brought capital investment within the country almost to a halt. The two major machine-tool builders were privatized and established joint ventures with German companies: Szerszámgépipari Müvek with Maho and Csepel with F+K. But economic instability has so far put the German partners in danger of bankruptcy. While capacity still exists, production in Hungary, which had already dropped by one half, appears to have fallen by another 77.8 per cent in 1992, despite the fact that the Hungarian machine-tool industry was once considered to be one of the more advanced in Eastern Europe [85].

4. *Restructuring and deployment*

Massive restructuring is currently taking place in Germany. State-owned manufacturing companies of the former German Democratic Republic are being restructured by Treuhandstalt, the German trust, which took over the companies. Its action includes downsizing, restructuring and ultimately shutting down where necessary and selling where possible. In downsizing, companies are reduced to their core businesses, with dormitories, day-care centres and other peripheral activities stripped away. New management is brought in to handle purchasing and cost control, functions that did not exist under the former regime. Other steps include converting power from the pollution-laden soft coal mined locally to gas or oil, and providing capitalization to make business viable. As an example, Heckert, a machining manufacturer in Chemnitz which had 4,500 employees when the trust took over, now has only 500. While the capital being provided by the German trust does not exist to the same extent in the other Eastern European countries, similar efforts at reconstruction are being made throughout the region, notably in the Czech Republic, Poland and Hungary.

In Western Europe the combination of the single European market and the recession is forcing many companies to restructure to survive. Some companies in Germany are combining functions only short of complete merger to reduce costs.

5. *Environmental considerations*

Ozone-depleting compounds must be phased out by the end of 1995 in the United States, and similar action is anticipated in other countries. The most widespread issue is the likely impact on sales of refrigerating and air-conditioning equipment. More critical in metalworking plants is the need to replace chlorinated solvents used in vapour degreasing. Many new types of parts that have been developed are receiving considerable attention. One type of system uses water with regulated chemical injections and heated drying in a system with closed-loop water treatment. Others use ultrasonic cleaning combined with liquid detergent.

6. *Numerical control technology*

Numerical control has not only modified the nature of most types of machine tools, combined with computers used for design, scheduling and inventory control, it is changing the basic nature of the manufacturing process itself. Numerical control operates a machine tool with a program that provides digital information covering the motions and speed of the machine and such functions as changing of tools and workpieces. It involves not only the control itself, but also the servomotors on the machine that carry out the commands from the control. It may include sensors to keep the control informed on the position and condition of machine elements, as well as the programs (or software) that instruct the control. For auxiliary functions, it requires tool and work-changing mechanisms equipped to respond to control impulses. It is possible for such machines to be so equipped and programmed that they are able to operate for long periods unattended.

Virtually all numerical controls today contain a computer in the form of one or more microprocessors, though a few contain more elaborate minicomputers. Initially, such controls were called computer numerical controls, but today the term numerically controlled (NC) is understood to mean computer control.

The controls market is dominated by Japan. Table IV.101 compares NC machine-tool production in 12 countries and areas for which information is available. These countries and areas accounted for about 80 per cent of world production of all types in 1991, and probably an even larger share of production of NC types. Among them, Japan had a 45 per cent share of production of NC machine tools. Almost all Japanese machines use Japanese controls. A major share of the controls used in the Republic of Korea, Taiwan Province and United States are also Japanese, and the share is growing in Europe. Fanuc is the major control builder in Japan, and in the world. Fanuc supplies machine-tool builders with a complete package that includes the control, servomotors and software. It operates alone in Asia; elsewhere, in a joint venture with General Electric, once the principal control builder. GE Fanuc supplies Fanuc control systems and related equipment developed by General Electric.

Almost half (by value) of the machine tools produced in 1991 were NC, as the NC portion increased from 39 per cent in 1987 to 48 per cent in 1991. The fastest-growing countries and areas were Taiwan Province, India, Japan and Spain, in that order, all of which more than doubled the value of NC machine output. Japan and Spain each had more than 60 per cent of production in NC machine tools; France and Germany had 54 per cent (production figures for Germany cover only the western

Table IV.101. Numerically controlled and total machine-tool production by selected country or area, 1987 and 1991
(Value in million dollars)

Country or area	1987 production					1991 production					
	NC machine tools: Units	NC machine tools: Value	Total machine-tool value	Percentage share of NC machine tools	Percentage share by country	NC machine tools: Units	NC machine tools: Value	Total machine-tool value	Percentage share of NC machine tools	Percentage share by country	Percentage change 1987-1991
Japan	35 460	3 364.7	6 419.4	52.4	37.1	55 032	7 240.3	11 638.7	62.2	45.0	115.2
Germany	18 965	3 299.7	6 402.6	51.5	36.4	19 145	4 422.3	8 122.5	54.4	27.5	34.0
United States	6 409	931.0	2 585.0	36.0	10.3	8 212	1 118.2	3 312.1	33.8	7.0	20.1
Switzerland	..	..	1 652.4	..	..	4 090 b/	702.5a/	1 730.2a/	40.6	4.4	..
France	..	..	766.1	..	..	..	500.6	912.9	54.8	3.1	..
Spain	..	214.9	575.0	37.4	2.4	..	452.7	750.6	60.3	2.8	110.7
Italy	..	645.5	2 235.2	28.9	7.1	..	439.3	3 470.1	12.7	2.7	-31.9
United Kingdom	1 862 b/	291.2b/	1 058.4b/	27.5	3.2	1 816 b/	430.7b/	1 146.2b/	37.6	2.7	47.9
Republic of Korea	2 039	160.3	530.9	30.2	1.8	3 675	291.2	798.4	36.5	1.8	81.7
India	193	35.9	277.7	12.9	0.4	679	82.9	221.6	37.4	0.5	130.9
Austria	..	..	155.0	..	..	2 179 b/	126.0b/	272.5b/	46.2	0.8	..
Taiwan Province	2 714	114.5	577.8	19.8	1.3	5 944	275.9	962.6	28.7	1.7	141.0
TOTAL	67 642	9 057.7	23 235.5	39.0	100.0	100 772	16 082.6	33 339.0	8.2	100.0	77.6

Sources: International exchange of statistics compiled by the European Committee for the Cooperation of the Machine Tool Industries; Economic Handbook of the Machine Tool Industry (McLean, Virginia, Asssociation for Manufacturing Technology, 1993).

a/ Switzerland does not report NC production. These are export figures. Total production was $2,092.3.

b/ Major NC machine-tool types only.

part of the country). The only decline was in Italy, where the value of NC machines produced fell by 32 per cent, and NC machines accounted for less than 13 per cent of production.

As shown in table IV.102, Japan is also the principal user of NC machines, and installs more than one third of the NC machines installed in these countries and areas. Germany followed closely, accounting for about a fourth of the NC machines installed (including for 1991 an estimate of consumption for the eastern part of the country). Spain had the third highest rate of installation, with 53 per cent of consumption being of NC machines. The biggest increases in consumption were recorded in Taiwan Province and the Republic of Korea, though the rate remains well behind that in the leading countries. However, Italy has not adopted NC technology; it purchased nearly 40 per cent fewer machines between 1987 to 1991. It should be noted that Italy has a 36 per cent share of production from metal-forming machines, which was much higher than Japan at 21 per cent, though not much higher than Germany at 35 per cent.

The application of NC machines varies widely between machine types, as shown in table IV.103. On the basic of the production of a dozen countries and areas that report production by type, 59 per cent of metal-cutting machines are NC, but only 18 per cent of metal-forming machines are. Among individual types, 100 per cent of machining centres, 76 per cent of lathes, and 72 per cent of milling machines produced were NC.

Control systems are becoming smaller in size. The use of edge technology permits more components to be mounted on a single board. Software has become more

Table IV.102. Numerically controlled and total machine-tool consumption by selected country and area, 1987 and 1991
(Value in million dollars)

Country or area	1987 consumption					1991 consumption					
	NC machine tools: Units	NC machine tools: Value	Total machine-tool value	Percentage share of NC machine tools	Percentage share by country	NC machine tools: Units	NC machine tools: Value	Total machine-tool value	Percentage share of NC machine tools	Percentage share by country	Percentage change 1987-1991
Japan	22 661	2 030.2	3 649.1	55.6	25.7	38 934	4 916.3	8 327.3	59.0	35.5	142.2
Germany	6 206	1 342.7	4 001.4	33.6	17.0	22 434	3 399.1	5 326.9	63.8	24.6	153.2
United States	15 474	1 842.3	3 967.2	46.4	23.4	15 316	1 913.8	4 452.1	43.0	13.8	3.9
France	..	896.0	1 219.9	73.4	11.4	..	790.0	1 815.9	43.5	5.7	-11.8
Republic of Korea	2 341	216.0	979.5	22.1	2.7	5 305	584.4	1 643.9	35.5	4.2	170.6
United Kingdom	..	390.0	1 087.1	35.9	4.9	1 784	520.1a/	1 364.6	38.1	3.8	33.4
Spain	..	301.3	606.9	49.6	3.8	..	430.4	803.4	53.6	3.1	42.8
Italy	..	662.3	1 753.0	37.8	8.4	..	407.7	2 718.0	15.0	2.9	-38.4
Switzerland	..	120.0	576.7b/	20.8	1.5	2 368	253.2b/	422.7	36.0	1.8	111.0
Taiwan Province	.	87.7	412.7	21.3	1.1	2 880	242.0c/	627.0	37.4	1.7	175.9
TOTAL	46 682	7 888.5	18 253.5	43.2	100.0	89 021	13 457.0	28 519.0	47.2	97.3	70.6

Source: International exchange of statistics compiled by the European Committee for the Cooperation of the Machine Tool Industries; Economic Handbook of the Machine Tool Industry (McLean, Virginia, Asssociation for Manufacturing Technology, 1993).

a/ Major machine-tool types only.

b/ Switzerland does not report NC production. This is the figure for imports only.

c/ Taiwan Province does not report imports. This is production minus exports only.

Table IV.103. Numerically controlled machine-tool producti
(Milli

Country or area	Metal-cutting	NC metal-cutting	Percentage of NC metal-cutting	Machining centres	NC machining centres	Percentage of NC machining centres	Lathes	NC lathes	Percentage of NC lathes	Drilling and boring machinery	NC drilling and bori machine
Japan											
Production	9 394.9	6 810.3	72.0	2 290.0	2 290.0	100.0	1 941.4	1 749.0	90.0	477.7	324.1
Consumption	6 771.1	4 590.7	68.0	1 584.5	1 584.5	100.0	1 220.0	1 057.1	87.0	292.4	172.6
Germany											
Production	5 685.7	3 858.1	68.0	739.3	739.3	100.0	1 191.9	877.8	74.0	345.0	123.5
Consumption	4 185.9	2 967.3	71.0	207.4	207.4	100.0	911.5	1 022.3	112.0	264.8	129.1
United States											
Production	2 291.8	969.4	42.0	379.7	379.7	100.0	341.0	267.0	78.0	133.3	64.7
Consumption	3 367.5	1 743.5	52.0	633.4	633.4	100.0	650.9	513.4	79.0	190.6	109.2
Switzerland											
Production	1 328.4	601.7	45.0	56.8	56.8	100.0	188.1	107.7	57.0	122.9	91.6
Consumption	329.9	226.2	69.0	79.5	79.5	100.0	98.7	84.9	86.0	27.9	13.7
France											
Production	658.6	387.3	59.0	58.9	58.9	100.0	92.7	83.0	90.0	..	..
Consumption	1 345.9	649.2	48.0	183.0	183.0	100.0	227.9	188.3	83.0	..	..
Spain											
Production	506.6	354.2	70.0	47.3	47.3	100.0	83.4	56.0	67.0	32.1	9.4
Consumption	425.7	297.4	70.0	43.4	43.4	100.0	82.1	67.9	83.0	31.9	14.7
Italy											
Production	2 352.9	439.3	19.0	291.7	291.7	100.0	353.2	214.0	61.0	115.0	..
Consumption	2 050.7	456.6	22.0	287.5	287.5	100.0	320.2	228.2	71.0	64.2	..
United Kingdom											
Production	753.1	387.0	51.0	131.8	131.8	100.0	232.2	97.8	42.0	..	..
Consumption	789.5	435.0	55.0	88.9	88.9	100.0	246.1	139.5	57.0	..	..
Taiwan Province											
Production	681.3	273.5	40.0	126.0	126.0	100.0	224.6	123.3	55.0	84.4	2.00
Consumption	384.3	129.8	57.0	82.5	82.5	100.0	114.5	96.2	84.0	19.6	8.0
Republic of Korea											
Production	659.3	291.1	44.0	93.7	93.7	100.0	269.8	158.4	59.0	40.6	2.7
Consumption	1 247.4	514.0	41.0	134.4	134.0	100.0	305.4	169.2	55.0	130.3	50.1
India											
Production	200.1	81.3	41.0	26.6	26.6	100.0	62.7	31.8	51.0	24.3	8.2
Consumption	..	..	..	..	..	..	..	..	..	..	..
Denmark											
Production	34.0	5.6	16.0	-	-	-	0.5	-	-	12.5	1.2
Consumption	77.9	49.2	63.0	17.0	17.0	100.0	22.9	17.2	75.5	14.3	8.0
TOTAL											
Production	24 536.7	14 458.8	59.0	4 241.8	4 241.8	100.0	4 981.6	3 765.8	76.0	1 276.7	627.4
Consumption	20 975.8	12 148.8	58.0	3 341.5	3 341.5	100.0	4 201.0	3 584.2	85.0	1 036.0	505.4

Source: International exchange of statistics compiled by the European Committee for the Cooperation of the Machine Tool Industries; Economic Handbook of the Machine Tool Ind

...consumption by type for selected countries and areas, 1991
...rs)

...ntage of drilling boring ...hinery	Milling	NC milling	Percentage of NC milling	Grinding machines	NC grinding machines	Percentage of NC grinding machines	Metal-forming machines	NC metal-forming machines	NC metal-forming machines	Total machines	Total NC machines	Percentage of NC machines
9.0	457.2	284.3	62.0	1 205.6	477.3	40.0	2 237.3	430.1	19.0	11 632.3	7 240.4	62.0
9.0	357.1	225.3	63.0	934.8	337.2	36.0	1 519.2	325.7	21.0	8 290.3	4 811.9	59.0
0.0	686.8	560.5	82.0	753.8	476.3	63.0	2 436.7	564.2	23.0	8 122.5	4 422.3	54.0
9.0	504.6	397.0	79.0	578.8	257.8	45.0	1 514.7	431.8	29.0	5 326.9	3 399.1	64.0
9.0	214.2	181.2	85.0	476.4	175.0	37.0	1 030.3	148.9	14.0	3 312.1	1 118.2	34.0
7.0	251.4	201.7	80.0	607.2	234.9	39.0	1 084.6	170.3	16.0	4 452.1	1 913.8	43.0
5.0	75.8	59.7	79.0	338.1	199.6	59.0	401.6	100.6	25.0	1 730.2	702.5	41.0
9.0	34.6	14.2	58.0	53.7	25.1	47.0	92.7	27.0	29.0	422.7	253.2	60.0
..	..	..	..	32.8	6.2	19.0	254.3	113.3	45.0	912.9	500.6	55.0
..	..	..	..	169.6	89.6	53.0	4700.0	140.8	30.0	1 815.9	790.0	44.0
9.0	171.9	132.4	77.0	44.9	29.7	66.0	214.0	98.6	40.0	750.6	452.7	60.0
6.0	61.6	59.1	96.0	59.2	20.8	35.0	377.6	137.0	36.0	803.4	434.4	54.0
..	243.6	225.3	92.0	308.0	..	..	1 117.2	..	..	3 470.1	439.3	13.0
..	249.8	232.0	93.0	201.3	..	..	667.6	..	..	2 718.3	456.6	17.0
..	68.7	41.6	61.0	126.7	76.4	60.0	393.8	43.7	11.0	1 146.8	430.7	38.0
..	153.6	120.9	79.0	153.6	120.9	79.0	437.1	85.1	19.0	1 226.6	520.1	42.0
2.0	83.2	16.0	19.0	49.3	6.2	13.0	281.2	2.3	1.0	962.6	275.9	29.0
1.0	25.2	10.7	42.0	40.0	18.3	46.0	242.8	22.2	9.0	627.0	242.0	39.0
7.0	94.6	19.1	20.0	33.3	2.4	7.0	139.1	..	..	798.4	..	..
3.0	135.8	44.7	33.0	188.7	69.3	37.0	396.6	..	..	1 643.9	..	..
4.0	23.9	2.6	11.0	21.4	3.9	18.0	17.9	1.6	9.0	218.0	82.9	38.0
..	..	..	..	..	..	..	..	..	..	..	..	..
0.0	0.1	-	-	17.6	4.4	25.0	75.3	26.7	35.0	75.3	26.7	35.0
6.0	2.6	-	-	7.7	2.5	32.0	113.5	56.7	50.0	113.5	56.7	50.0
9.0	2 120.0	1 522.7	72.0	3 407.9	1 457.4	43.0	8 628.7	1 530.0	18.0	33 131.8	15 692.2	47.0
9.0	1 766.3	1 305.6	74.02	2 995.6	1 176.4	39.0	6 916.4	1 296.6	20.0	27 440.6	12 877.8	47.0

...ean, Virginia, Association for Manufacturing Technology, 1993).

user-friendly, making it easier for operators to program a machine. The 32-bit processor has become standard in NC control systems, and in some cases, more than one is included. In high-speed machining, lags in response time of servomechanisms can be appropriately adjusted. By combining two 32-bit processors in a single control, a reduced-instruction-set-computing processor can look ahead at future blocks in the program, calculate what this lag will involve, and make adjustments to the rate of acceleration or deceleration.

Communications is a key function in integrating NC systems into the factory. Most NC systems now have some communications capability, most often for receiving distributed programs and for generating status reports. The requirement of compatible interfaces between the control and the network is the principal problem in developing a factory system. However, the Open System Interconnect protocols from the International Standards Organization shows promise of standardizing network software.

(a) Turning machines

The most common NC machines are lathes, including horizontal spindle machines with flat, slant and vertical beds and vertical machines. Most of these machines now have been originally designed as NC machines, and tend to look less and less like the traditional lathe. The traditional way of machining a round part was to turn one end of it in a lathe, move it to a second lathe to turn the other end, and then move it to a milling machine for milling and drilling operations that required rotating tools. Now many NC turning machines can complete such parts by using a single machine. Making a controlled axis of the spindle permits stopping the work in controlled positions, and then indexing it to various stationary positions. Providing powered positions in the tool turret makes it possible to use rotating tools on this workpiece.

Automatic loading of work has advanced from accessory devices that were bolted to the machine or free-standing robots, to those such as integral robot or gantry devices that can supply workpieces from a variety of sources (tables, rack or bins). Twin-spindle machines for chucked parts, usually with automatic transfer of the work from one spindle to the other, complete the cycle and permit complete machining of a part in one continuous operation. On front-loading machines, the part is turned end for end as it is moved from the first spindle to the second. In the conventional lathe design, the second spindle is at the tailstock end of the lathe, and transfer is usually accomplished by advancing this second spindle to grasp the machined end from the first spindle. In some machines both spindles have longitudinal movement under numerical control.

A variety of different configurations have been developed to combine these functions. On some machines both spindles are equally powered and have equal tooling characteristics. In such cases, the spindles can be programmed to operate separately on different workpieces or work together on the two ends of a single workpiece. In other designs, the second spindle is a subspindle, the size and power of which is less than that of the main spindle. The simplest machines may be a simple three-axis machine with a single tool turret and a small subspindle. At the other end of the range are complex machines with six or more axes, three or more tool turrets, and a second spindle comparable in size and power to the first.

The choice of machine depends on whether most of the work is concentrated among a few or is fairly equally divided. In either case the goal is to shorten production time and costs by eliminating the use of extra machines, the moving of parts between machines and waiting time between operations. This would ultimately lead to a twin spindle-machine with automatic handling which is able to operate for long periods without an operator.

(b) Machining centres

Machining centres are at the heart of the revolution in manufacturing that numerical control has created. Despite their complexity and comparatively high price, the value of machines produced each year is about the same as for NC turning machines. In the countries and areas included in table IV.103, the value of machining centres produced is 13 per cent higher, but the value of NC lathes consumed is 7 per cent higher. Production of NC turning machines, especially the simpler types, is much more widespread than that of machining centres, so that there is more export of machining centres from these countries and areas.

The machining centre was created to take advantage of numerical control. Originally, a horizontal-spindle machine with an automatic tool changer and work mounted on a turntable, could machine four sides of a prismatic workpiece in a single series of operations. Later, tilting turntables added the top to the sequence. Vertical-spindle machines proved much less costly because they did not require as heavy a frame as is needed for an accurate horizontal spindle. And vertical-spindle machines could perform all the operations on the top of the work-piece as well as milling the four sides, though it still could not drill holes or make undercuts on the sides.

But then universal machines were developed in which the spindle could be shifted from a horizontal position to a vertical. Designs vary, but generally the universal spindle cannot perform as heavy and as accurate work as a horizontal one. Methods to increase the efficiency of machining centres include the addition of pallet-changing devices that could change workpieces, adoption of methods to worn tools automatically, and to mount a number of smaller workpieces on the sides of a "tombstone" fixture. Such parts could be use in combination with different parts that could be programmed.

At some point as the refinements added to the machining centre increase, such as on-machine gaging of work, broken tool detection and replacement, the machine begins to be thought of as a "cell", a complete unit for manufacturing a certain class of parts. Cells may contain more than one machine, the second machine often being an NC turning machine, but if two or more machining centres are combined in a cell with computerized scheduling and programing of them both, it becomes a flexible manufacturing system. Early experience with such systems was often disappointing, but as all the components have become more reliable, their use is increasing.

(c) Grinding machines

Grinding machines have been slower in converting to NC even though the first NC applications were made to plain cylindrical grinders more than 20 years ago. But by

1991, by value about 43 per cent of the grinders produced in the 12 countries and areas listed in table IV.103 used NC machines. Leading developers have been in Europe, mainly in Germany, Switzerland and the United Kingdom. Special-purpose grinders for cutting tools and other precision work have been developed, but numerical control is also finding a home in more conventional grinders. The controls developed for grinders tend to be more complex than those for most metal-cutting operations, requiring extensive feedback from the machine on the progress of not only the size of the work but the size and condition of the wheel and the temperature being maintained.

Grinding is particularly susceptible to problems such as vibration or distortion; the latter is caused by temperature changes in either the machine or the work. An early approach to greater precision was to use granite for the base of the machine. In recent years a special form of concrete has been more common. Concrete was first used by an Italian manufacturer in a horizontal boring machine more than 20 years ago, and later was developed into a composite of crushed stone held together by a plastic binder. They are becoming more common and are particularly useful for grinders. These epoxy-concrete or polyester-concrete structures are superior to either cast iron or fabricated steel both in damping vibration and in thermal stability. On a composite base, attaching points for the rest of the machine and any accessories must be carefully planned, and steel mounting pads must be cast into the original structure. Sometimes a thin metal casting or steel plate case is filled with the composite in order to provide a surface that can be drilled and tapped. One NC grinder introduced in 1992 has gone beyond the base and uses a polyester-composite construction for all major components, including the base, saddle and wheel head.

(d) Punching and shearing machines

The principal application of numerical control in metal-forming is in punching and shearing machines. NC punching machines, for working sheet and plate, are virtually a new class of machine, as is the machining centre in metal-cutting. They have a tool-changing mechanism that changes both the punch above the work and the die below. These tools are carried in turrets, and in some machines operate from the turret which rotates under the machine ram to change tools. In another design, the punch and its mating die are transferred from the turrets to a position under the ram. The table does not move, but the sheet is held by grippers that move it on the table (equipped with ball rollers on the surface) to the position needed for the stroke. These machines reposition the sheet between strokes with precision, often in about a second, and when a tool change is required it takes only seconds longer than the repositioning. Punches are relatively small, and large openings are produced by overlapping punches.

Contours that cannot be produced with punches can be cut with a machine designed in essentially the same way as the one that cuts with either a plasma or laser. Some machines are capable of both punching and contour cutting. The development of this class of machine, which accounts for about two thirds of NC metal-forming machines, has made a major change in metal-forming. It is now possible to design many products from sheet or plate that were formerly designed as castings or to be machined from solid stock.

(e) Programming

One of the reasons for the rapid growth of NC has been the success in making the programs more user-friendly. For many operations, the control can be programmed by the operator. More complex machines have controls specifically designed for the machine types that are simple to program in comparison with those of the early years of numerical control. In fact the capabilities of many machines are determined as much by the systems built into the control as by the machine. Thus two lathes equipped with the same model control will have virtually identical capability. For this reason, some machine-tool builders either produce their own controls or have a control customized for them with the particular system characteristics desired.

While programming has simplified, the desire to accomplish more has introduced complications, and with increasing use being made of computer-aided design, the desire to be able to transfer these designs into manufacturing programs automatically has grown. The ultimate is called computer-aided process planning. In theory such a system could take a computer-aided design to determine which of the available machine tools should be used to manufacture it, plan the sequence of operations and then prepare the program.

Such a system must be customized for a particular plant. For a medium-sized manufacturer this may take between two and four man-years for engineering implementation. The program must have access to all the manufacturing process knowledge databases that relate to the equipment and materials involved. Because of the time and cost involved in installing a system of computer aided process planning, the process is more talked about than used. There have been a few such systems put into place, and a much larger number of cases in which simpler applications have been automated to create parts of the planning process that can be integrated into the overall plan, as it is developed in the traditional way by the engineers.

7. Short- and medium-term outlook

The short-term outlook is discouraging because of the severe recession in Europe and Japan. There may be some improvements in late 1993 and 1994, but it is not assured. The United States market should continue to improve in the short term, although a strengthened dollar may affect exports. Continued growth is expected in China, Singapore and the Malay Peninsula.

In the medium-term there could be some recovery from the low sales reached in 1992. However, there is still a substantial excess capacity for machine tools in the world, and consolidation and restructuring are likely to continue.

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Statistical annex

World Industry Development Indicators

Technical notes

1. Sources for the following country tables are:

(a) The UNIDO consolidated 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 (1991-1993) 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/IDP/Global Issues and Policy Perspectives Branch.

2. All values are in millions of United States 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, Brazil, Chile, Dominican Republic, Egypt, El Salvador, Ghana, Guatemala, Honduras, Nicaragua, Nigeria, Paraguay, Peru, 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 country 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 104 countries for which more complete data is available. This is a subset of the sample of 120 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 1990 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 1985, 1990 and 1994 is calculated relative to 1980. 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 1980 to 1994; 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, Detailed Tables (Volume II)* (OECD, Department of Economics and Statistics);

(e) *World Outlook* and *Quarterly Economic Review* (The Economist Intelligence Unit);

(f) *World Bank World Tables*;

(g) *Centrally Planned Economies, Economic Overview* (The Conference Board, Inc.);

(h) *Economic Forecast* (North-Holland);

(i) *Comecon Data 1991* (Vienna Institute for Comparative Economic Studies);

(j) Asian Development Bank;

(k) African Development Bank;

or else estimated on the basis of statistical analysis and other ad hoc information, including various periodicals and newspapers.

Forecast growth rates for 1993 and 1994 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 1991 to 1994 for each country were based on regression equations which contain GDP, aggregate MVA, lagged own-sector MVA and production indices as independent variables. Regressions are performed using deflated sectoral MVA values. Results are then reconverted into current dollar figures. 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 1990 to 1994 were projected only for a sample of 120 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 or MVA; and *(b)* the sector-specific time behaviour expressed in terms of a lag-structure of the value added of the sector.

8. Two figures are reported for manufacturing value added. One is based on the national income accounts definition and the other on the industrial census definition. The main differences are: *(a)* included in the national income accounts figure but not included in the industrial census figure is activity of establishments with less than some specified number of employees, typically 5 or 10, but the number is not fixed across countries; *(b)* 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 added − wages and salaries)/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. Whenever available the number of persons engaged was used for the calculation less the number of employees.

11. For the calculation of the structural indices and the value of θ in the diagram of industrial structural change, value-added figures in 1980 deflated prices were used.

The measure for structural change, θ, is defined by:

$$\cos \theta = \frac{\sum_i s_i(t) \cdot s_i(t-1)}{\sqrt{(\sum_i s_i(t)^2) \cdot (\sum_i s_i(t-1)^2)}}$$

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:

$$h = 100 \cdot (1 + \frac{\sum_i s_i \cdot \ln s_i}{h_{max}})$$

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

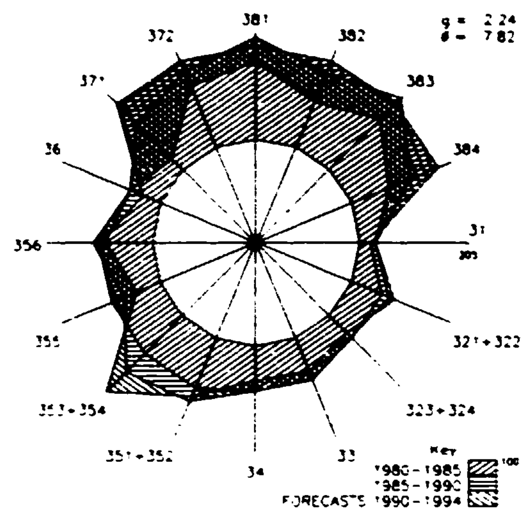
/na	value originating from national accounts statistics
/c	in 1980 constant prices
/e	estimated by UNIDO/PPD/IPP/GLO
/f	forecast by UNIDO/PPD/IPP/GLO
. . .	no value available
—	value is less than half a unit
n.a.	not available

Questions concerning the preparation of data can be directed to UGG@UNIDO1 or UGG@AWIUND21 through electronic mail (network BITNET respective EARN).

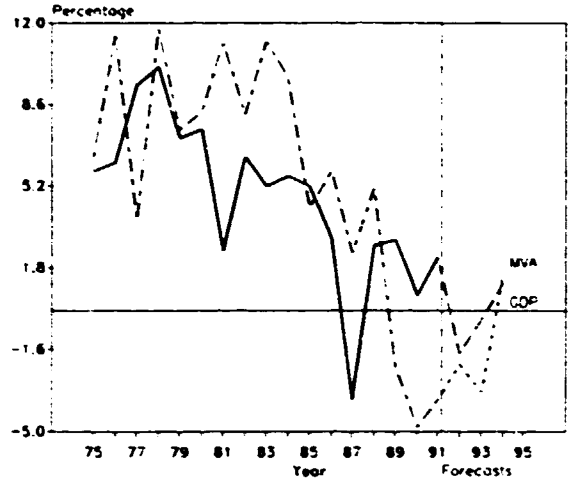
Regional classification of countries and territories:

Country or territory	UNITAD region		Page
AFGHANISTAN	Indian Subcontinent	(IN)	A-114
ALBANIA	Eastern Europe incl. former USSR	(EE)	A-114
ALGERIA	North Africa	(AN)	A- 9
ARGENTINA	Latin America	(LA)	A- 10
AUSTRALIA	Other developed countries	(OD)	A- 11
AUSTRIA	Western Europe (Industrialized)	(EN)	A- 12
BAHAMAS	Latin America and the Caribbean	(LA)	A-114
BAHRAIN	Western Asia (Near East)	(WA)	A-114
BANGLADESH	Indian Subcontinent	(IN)	A- 13
BARBADOS	Latin America	(LA)	A- 14
BELGIUM	Western Europe (Industrialized)	(EN)	A- 15
BELIZE	Latin America and the Caribbean	(LA)	A-114
BENIN	Tropical Africa (Sub-Sahara)	(TA)	A-114
BERMUDA	North America	(NA)	A-115
BHUTAN	Indian Subcontinent	(IN)	A-115
BOLIVIA	Latin America	(LA)	A- 16
BOTSWANA	Tropical Africa (Sub-Sahara)	(TA)	A- 17
BRAZIL	Latin America	(LA)	A- 18
BRUNEI DARUSSALAM	Asia East and South-East. Oceania	(AS)	A-115
BULGARIA	Eastern Europe incl. former USSR	(EE)	A- 19
BURKINA FASO	Tropical Africa (Sub-Sahara)	(TA)	A- 20
BURUNDI	Tropical Africa (Sub-Sahara)	(TA)	A- 21
CAMEROON	Tropical Africa (Sub-Sahara)	(TA)	A- 22
CANADA	North America	(NA)	A- 23
CAPE VERDE	Tropical Africa (Sub-Sahara)	(TA)	A-115
CENTRAL AFRICAN REPUBLIC	Tropical Africa (Sub-Sahara)	(TA)	A- 24
CHAD	Tropical Africa (Sub-Sahara)	(TA)	A-115
CHILE	Latin America	(LA)	A- 25
CHINA	Centrally planned Asia	(CA)	A- 26
COLOMBIA	Latin America	(LA)	A- 27
CONGO	Tropical Africa (Sub-Sahara)	(TA)	A- 28
COSTA RICA	Latin America	(LA)	A- 29
COTE D'IVOIRE	Tropical Africa (Sub-Sahara)	(TA)	A- 30
CUBA	Latin America	(LA)	A- 31
CYPRUS	Western Asia	(WA)	A- 32
CZECHOSLOVAKIA, FORMER	Eastern Europe incl. former USSR	(EE)	A- 33
DENMARK	Western Europe (Industrialized)	(EN)	A- 34
DJIBOUTI	Tropical Africa (Sub-Sahara)	(TA)	A-115
DOMINICAN REPUBLIC	Latin America	(LA)	A- 35
ECUADOR	Latin America	(LA)	A- 36
EGYPT	North Africa	(AN)	A- 37
EL SALVADOR	Latin America	(LA)	A- 38
EQUATORIAL GUINEA	Tropical Africa (Sub-Sahara)	(TA)	A-116
ETHIOPIA AND ERITREA	Tropical Africa (Sub-Sahara)	(TA)	A- 39
FIJI	South-East Asia	(AS)	A- 40
FINLAND	Western Europe (Industrialized)	(EN)	A- 41
FRANCE	Western Europe (Industrialized)	(EN)	A- 42
FRENCH GUIANA	Latin America and the Caribbean	(LA)	A-116
FRENCH POLYNESIA	Asia East and South-East. Oceania	(AS)	A-116
GABON	Tropical Africa (Sub-Sahara)	(TA)	A- 43
GAMBIA	Tropical Africa (Sub-Sahara)	(TA)	A- 44
GERMANY, EASTERN PART	Western Europe (Industrialized)	(EN)	A- 45
GERMANY, WESTERN PART	Western Europe (Industrialized)	(EN)	A- 46
GHANA	Tropical Africa (Sub-Sahara)	(TA)	A- 47
GREECE	Western Europe (South)	(ES)	A- 48
GUADELOUPE	Latin America and the Caribbean	(LA)	A-116
GUATEMALA	Latin America	(LA)	A- 49
GUINEA	Tropical Africa (Sub-Sahara)	(TA)	A-116
GUINEA-BISSAU	Tropical Africa (Sub-Sahara)	(TA)	A-116
GUYANA	Latin America and the Caribbean	(LA)	A-117
HAITI	Latin America and the Caribbean	(LA)	A-117
HONDURAS	Latin America	(LA)	A- 50
HONG KONG	South-East Asia	(AI)	A- 51
HUNGARY	Eastern Europe incl. former USSR	(EE)	A- 52
ICELAND	Western Europe (Industrialized)	(EN)	A- 53
INDIA	Indian Subcontinent	(IN)	A- 54
INDONESIA	South-East Asia	(AS)	A- 55
IRAN (ISLAMIC REPUBLIC OF)	Western Asia	(WA)	A- 56
IRAQ	Western Asia	(WA)	A- 57
IRELAND	Western Europe (Industrialized)	(EN)	A- 58
ISRAEL	Western Europe (South)	(ES)	A- 59
ITALY	Western Europe (Industrialized)	(EN)	A- 60
JAMAICA	Latin America	(LA)	A- 61
JAPAN	Japan	(JP)	A- 62

Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

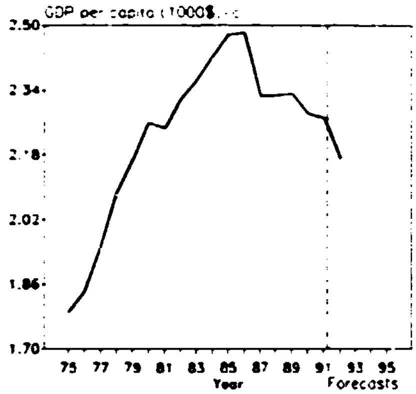


Source: National Accounts Statistics from UN/UNSO
Estimated by UNIDO/PPD/IPP/GLO

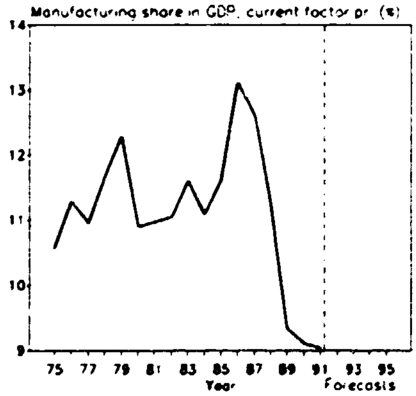
	1980	1985	1990
GDP: (n.a.c., millions of 1980-dollars)	42342	53959	56964
Per capita (1980-dollars) (n.a.c.)	2259	2477	2282
Manufacturing share (%) (n.a., current factor prices)	10.9	11.5	9.1
MANUFACTURING:			
Value added (n.a.c., millions of 1980-dollars)	3286	5029	5326
Industrial production index	100	154	157
Value added (millions of dollars)	3644	6157	5739 /e
Gross output (millions of dollars)	9122	13978 /e	13238 e
Employment (thousands)	312	413 /e	470 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	56 e	57 e
Wages and salaries including supplements (%)	22	25 e	26 e
Gross operating surplus (%)	18	19 e	17 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	29246	33067 /e	27263 e
Value added / worker	11682	14740 /e	12019 e
Average wage (including supplements)	6523	8303 e	7377 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.38	3.75	1.81 e
as a percentage of average θ in 1970-1975	74	72	35 e
MVA growth rate / θ	2.52	2.00	0.16
Degree of specialization	14.6	13.7	13.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	655	852	815 /e
313 Beverages	135	176	172 e
314 Tobacco products	176	229	216 e
321 Textiles	291	450	421 /e
322 Wearing apparel	234	362	370 e
323 Leather and fur products	52	80	73 e
324 Footwear	90	140	127 /e
331 Wood and wood products	120	205	189 /e
332 Furniture and fixtures	57	97	89 /e
341 Paper and paper products	143	242	223 /e
342 Printing and publishing	16	27	25 e
351 Industrial chemicals	14	25	22 /e
352 Other chemical products	93	167	170 e
353 Petroleum refineries	83	150	162 e
354 Miscellaneous petroleum and coal products	4	7	7 /e
355 Rubber products	17	30	25 /e
356 Plastic products	34	61	58 /e
361 Pottery, china and earthenware	10	14	14 /e
362 Glass and glass products	36	51	52 /e
369 Other non-metal mineral products	355	497	510 /e
371 Iron and steel	323	727	574 /e
372 Non-ferrous metals	19	42	37 /e
381 Metal products	265	598	576 /e
382 Non-electrical machinery	46	105	89 /e
383 Electrical machinery	123	278	265 /e
384 Transport equipment	181	407	317 /e
385 Professional and scientific equipment	30	67	69 /e
390 Other manufacturing industries	42	72	72 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

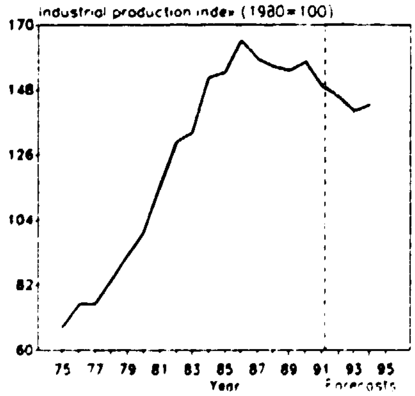
GDP per capita (1000$, n.a.c.)



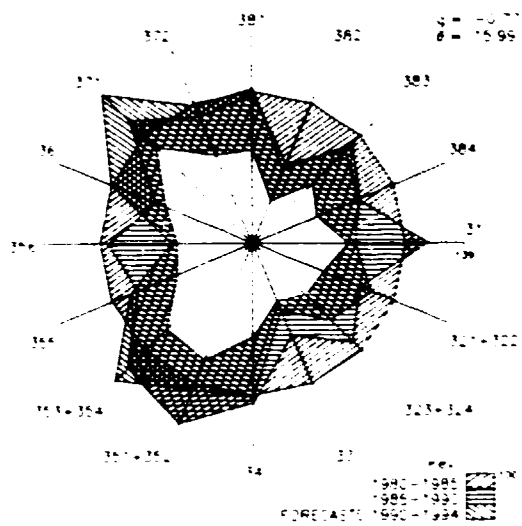
Manufacturing share in GDP, current factor pr. (%)



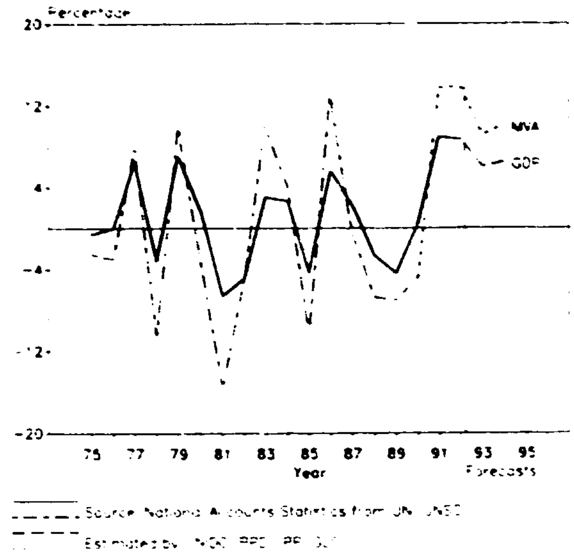
Industrial production index (1980=100)



Industrial structural change
Index of value added 1980=100



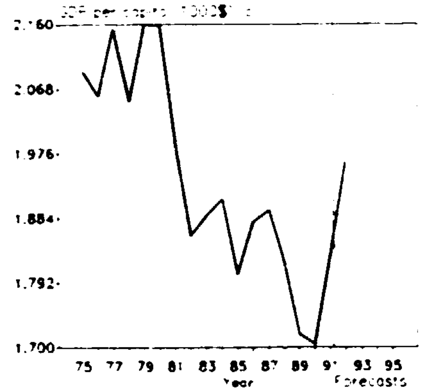
Annual growth rates of GDP and MVA
(Constant 1980 prices)



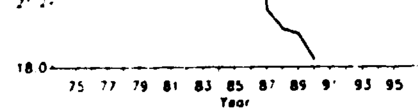
	1980		1985		1990	
GDP: real, millions of 1980-dollars	60917		54706		55101	
Per capita (1980-dollars, real)	2157		1804		1704	
Manufacturing share (%) (real, current factor prices)	25.0		27.3		18.3	e
MANUFACTURING:						
Value added (real, millions of 1980-dollars)	15224		12506		11586	
Industrial production index	100		86		90	
Value added (millions of dollars)	24511		23891		31156	
Gross output (millions of dollars)	55935	e	48084	e	79001	e
Employment (thousands)	1346	e	1127	e	942	e
-PROFITABILITY: in percent of gross output						
Intermediate input (%)	56	e	40	e	61	e
Wages and salaries including supplements (%)	10	e	11	e	5	e
Gross operating surplus (%)	33	e	49	e	31	e
-PRODUCTIVITY: dollars						
Gross output / worker	41552	e	42655	e	83873	e
Value added / worker	18208	e	25630	e	33080	e
Average wage (including supplements)	4301	e	4596	e	5767	e
-STRUCTURAL INDICES:						
Structural change θ (5-year average in degrees)	5.07		4.84		3.91	
as a percentage of average θ in 1970-1975	148		141		114	
MVA growth rate (θ)	-0.67		0.00		-2.05	
Degree of specialization	13.0		15.9		16.3	
-VALUE ADDED: millions of dollars						
311/2 Food products	3544		4912		4695	
313 Beverages	703		942		932	
314 Tobacco products	498		719		480	
321 Textiles	1703		1832		2209	
322 Wearing apparel	919		558		492	
323 Leather and fur products	284		350		336	
324 Footwear	245		240		190	
331 Wood and wood products	353		233		255	
332 Furniture and fixtures	225		185		246	
341 Paper and paper products	554		763		682	
342 Printing and publishing	679		800		695	
351 Industrial chemicals	914		1367		1844	
352 Other chemical products	1206		1916		1791	
353 Petroleum refineries	3647		5120		5169	
354 Miscellaneous petroleum and coal products	86		121		122	
355 Rubber products	331		327		353	
356 Plastic products	424		485		436	
361 Pottery, china and earthenware	189		130		156	
362 Glass and glass products	199		153		249	
369 Other non-metal mineral products	659		587		932	
371 Iron and steel	900		1239		1651	
372 Non-ferrous metals	235		257		305	
381 Metal products	1272		1499		1611	
382 Non-electrical machinery	1358		930		835	
383 Electrical machinery	902		936		1025	
384 Transport equipment	2289		2054		2140	
385 Professional and scientific equipment	86		95		112	
390 Other manufacturing industries	96		92		97	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

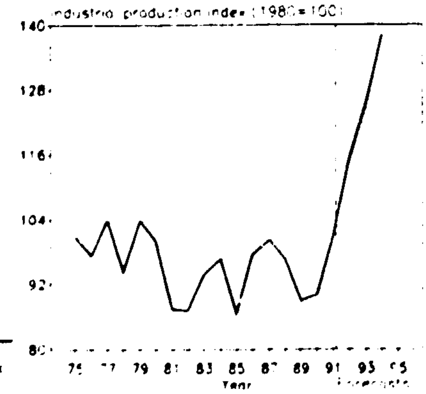
GDP per capita (1000$)



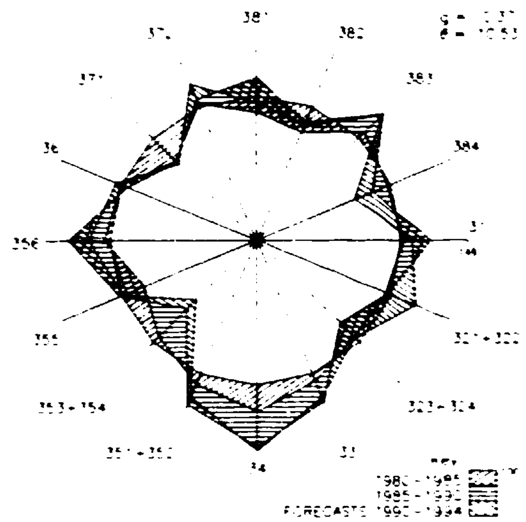
Manufacturing share in GDP (current prices) (%)



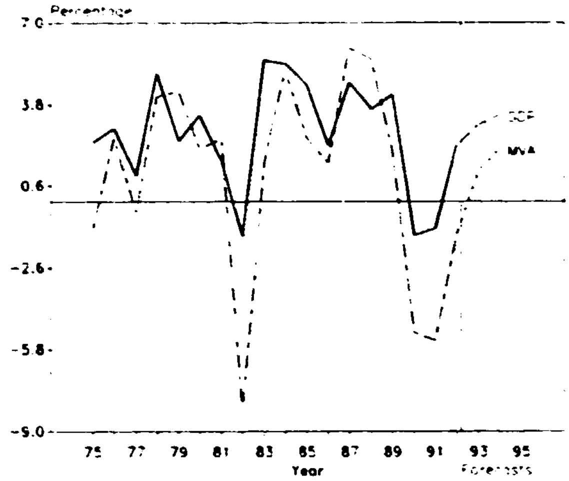
Industrial production index (1980=100)



Industrial structural change (index of value added: 1980=100)



Annual growth rates of GDP and MVA (Constant 1980 prices)



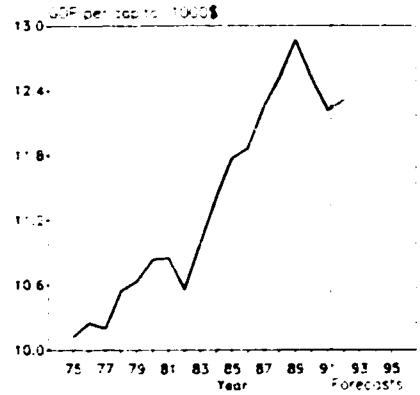
Source: National Accounts Statistics from UN (UNSO)

Estimated by UNIDO/PPD/IPP (GLO)

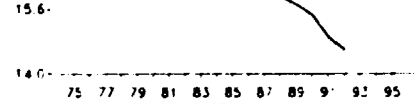
	1980	1985	1990
GDP: (total) millions of 1980-dollars	15924	185531	211350
Per capita (1980-dollars) (total)	10336	11773	12516
Manufacturing share (%) (total) (current factor prices)	19.0	17.4	15.4
MANUFACTURING:			
Value added (total) millions of 1980 dollars	30315	31682	34798
Industrial production index	100	104	111
Value added (millions of dollars)	29173	26900	47351 e
Gross output (millions of dollars)	75474	69328	127086
Employment (thousands)	1139	1012	1145 e
-PROFITABILITY: in percent of gross output			
Intermediate input	61	61	63 e
Wages and salaries including supplements	20	19	17 e
Gross operating surplus	18	20	21 e
-PRODUCTIVITY: dollars			
Gross output / worker	66402	67396	119912 e
Value added / worker	25230	26346	44348 e
Average wage (including supplements)	13356	12999	20370 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.75	4.48	2.20 e
as a percentage of average θ in 1970-1975	94	151	75 e
MVA growth rate (%)	1.34	-0.02	[illegible].89
Degree of specialization	[illegible]	[illegible]	11.6
-VALUE ADDED: millions of dollars			
311.2 Food products	3393	3764	7043 e
313 Beverages	785	847	1575 e
314 Tobacco products	248	179	233 e
321 Textiles	1250	955	1114
322 Wearing apparel	821	722	1006 e
323 Leather and fur products	93	75	137 e
324 Footwear	223	205	247 e
331 Wood and wood products	1252	1023	1776 e
332 Furniture and fixtures	505	507	1023 e
341 Paper and paper products	744	703	1458 e
342 Printing and publishing	1818	2131	4[illegible] e
351 Industrial chemicals	969	982	1799 e
352 Other chemical products	1136	1131	2155 e
353 Petroleum refineries	323	285	325 e
354 Miscellaneous petroleum and coal products	30	25	23 e
355 Rubber products	341	264	515 e
356 Plastic products	831	808	1599 e
361 Pottery, china and earthenware	46	41	69 e
362 Glass and glass products	246	254	403 e
369 Other non-metal mineral products	1183	1085	1635 e
371 Iron and steel	1320	1391	2134 e
372 Non-ferrous metals	1473	1409	2319 e
381 Metal products	2467	2041	4144
382 Non-electrical machinery	2091	1575	2749 e
383 Electrical machinery	1351	1329	2477 e
384 Transport equipment	2830	2579	3636
385 Professional and scientific equipment	290	279	517 e
390 Other manufacturing industries	263	246	415 e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

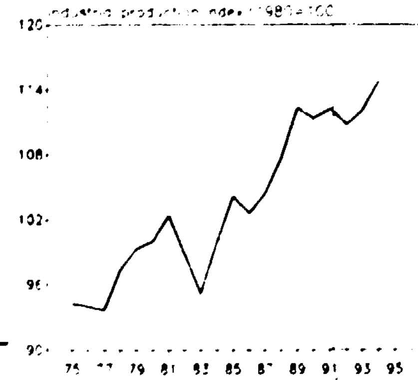
GDP per capita (1000$)

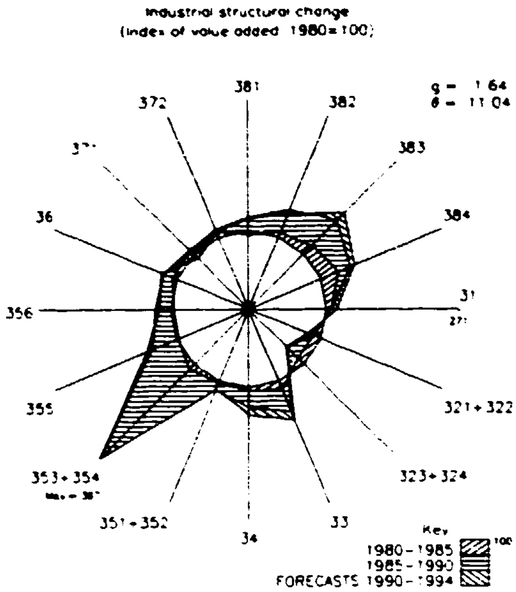


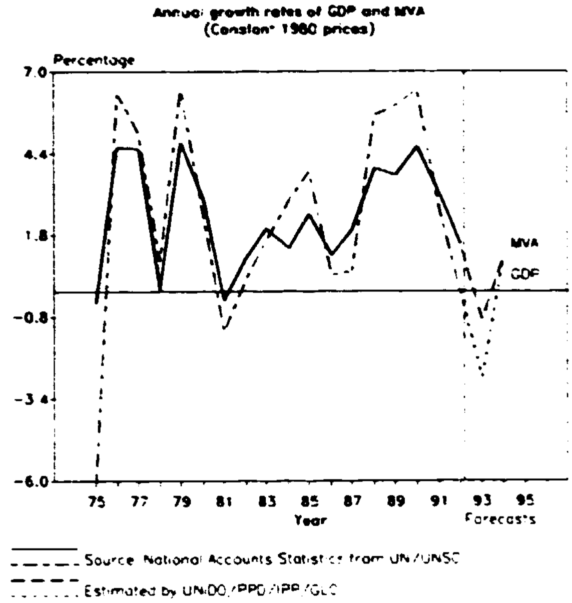
Manufacturing share in GDP, current factor prices (%)



Industrial production index (1980=100)

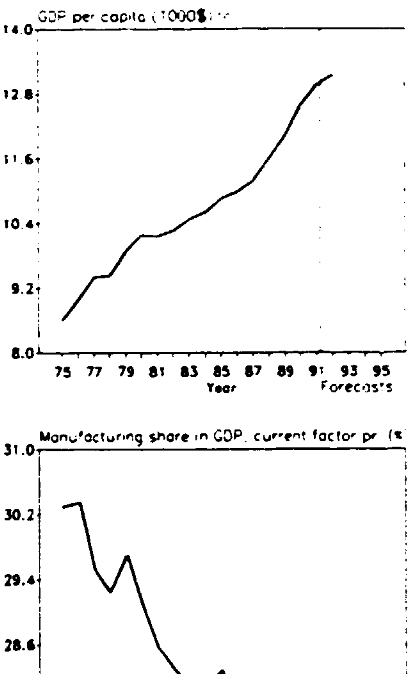


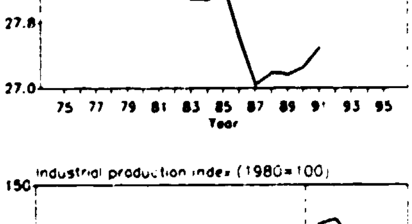


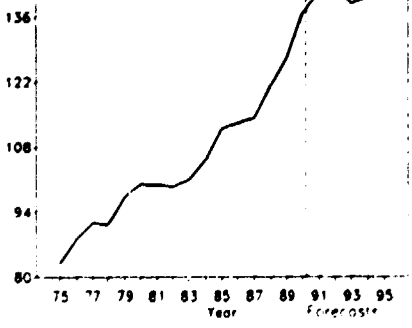


	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	76882	82071	95394
Per capita (1980-dollars) (na.c)	10183	10859	12578
Manufacturing share (%) (na) (current factor prices)	29.1	23.3	27.2
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	21384	23001	27704
Industrial production index	100	112	137
Value added (millions of dollars)	17987	15108	36828
Gross output (millions of dollars)	54666	45959	105[illegible]
Employment (thousands)	824	783	[illegible]
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67	67	65
Wages and salaries including supplements (%)	24	23	23 e
Gross operating surplus (%)	9	10	12 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	66339	58531	135118
Value added / worker	25579	22905	56942
Average wage (including supplements	15686	13342	30941 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.18	4.99	4.34
as a percentage of average θ in 1970-1975	76	91	79
MVA growth rate / θ	0.49	0.23	0.72
Degree of specialization	10.1	10.2	10.6
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1752	1472	3086 /e
313 Beverages	474	380	797 /e
314 Tobacco products	807	725	1491
321 Textiles	904	557	1456
322 Wearing apparel	512	353	619
323 Leather and fur products	63	45	100
324 Footwear	223	157	231
331 Wood and wood products	192	298	698 /e
332 Furniture and fixtures	365	733	2030 /e
341 Paper and paper products	645	509	1282 /e
342 Printing and publishing	726	626	1609 /e
351 Industrial chemicals	663	584	1307 /e
352 Other chemical products	534	398	919 /e
353 Petroleum refineries	80	72	607
354 Miscellaneous petroleum and coal products	35	27	64 /e
355 Rubber products	258	200	576 /e
356 Plastic products	281	215	559 /e
361 Pottery, china and earthenware	63	42	114 /e
362 Glass and glass products	244	237	616
369 Other non-metal mineral products	894	724	1646
371 Iron and steel	1225	1055	2194
372 Non-ferrous metals	280	241	518
381 Metal products	1542	1170	3035
382 Non-electrical machinery	1765	1502	4052
383 Electrical machinery	1615	1472	4343
384 Transport equipment	943	941	2224
385 Professional and scientific equipment	161	144	327 /e
390 Other manufacturing industries	143	130	377 /e

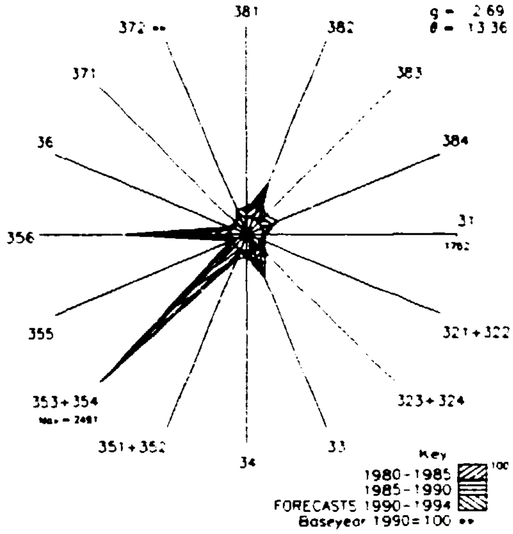
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex.



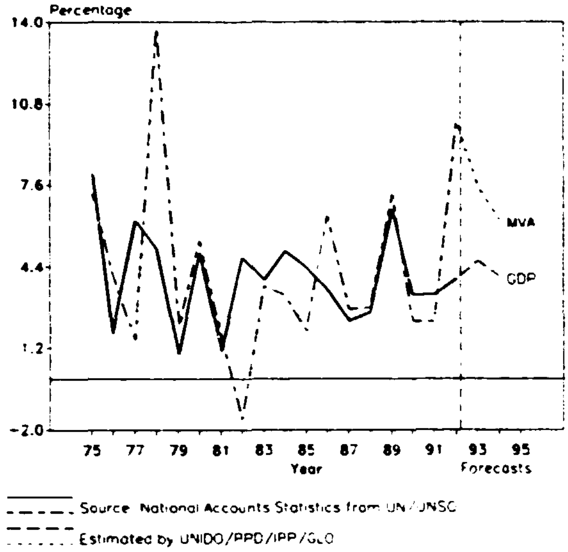




Industrial structural change
(Index of value added 1980=100)



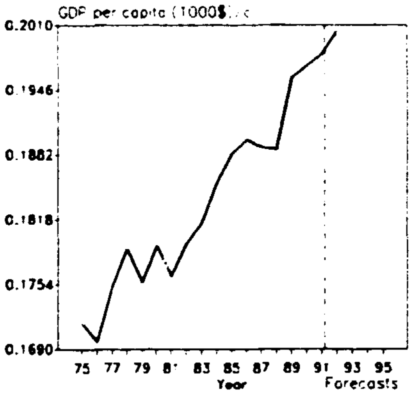
Annual growth rates of GDP and MVA
(Constant 1980 prices)



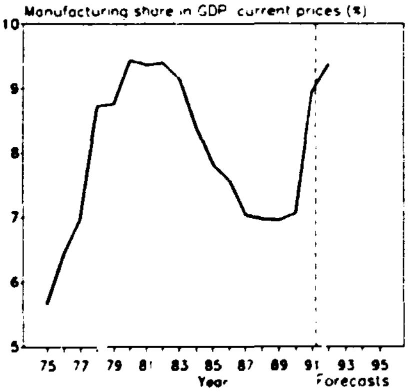
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	15806	19043	22765
Per capita (1980-dollars) /na.c	179	188	197
Manufacturing share (%) /na (current factor prices)	9 4	7 8	7 1
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1479	1612	1985
Industrial production index	100	98	113
Value added (millions of dollars)	834	863	1107 /e
Gross output (millions of dollars)	2253	2498	3025 /e
Employment (thousands)	412	469	522 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	63	65	64 /e
Wages and salaries including supplements (%)	12 /e	10 /e	18 /e
Gross operating surplus (%)	25 /e	24 /e	19 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	5466	5192	5416 /e
Value added / worker	2023	1794	1972 /e
Average wage (including supplements)	639 /e	557 /e	1036 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.86	8.02	5 15 /e
as a percentage of average θ in 1970-1975	79	92	59 /e
MVA growth rate / θ	3.14	0 21	0 23
Degree of specialization	36 0	25.3	27 5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	78	98	94 /e
313 Beverages	7	6	7 /e
314 Tobacco products	111	109	114 /e
321 Textiles	336	230	366 /e
322 Wearing apparel	-	8	17 /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	2 /e
341 Paper and paper products	23	19	29 /e
342 Printing and publishing	6	8	10 /e
351 Industrial chemicals	33	70	84 /e
352 Other chemical products	97	85	118 /e
353 Petroleum refineries	2	75	66 /e
354 Miscellaneous petroleum and coal products	1	2	6 /e
355 Rubber products	4	1	3 /e
356 Plastic products	-	2	4 /e
361 Pottery, china and earthenware	2	4	5 /e
362 Glass and glass products	4	4	5 /e
369 Other non-metal mineral products	14	7	12 /e
371 Iron and steel	39	35	29 /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	9	13	15 /e
382 Non-electrical machinery	4	17 /e	13 /e
383 Electrical machinery	19	18	30 /e
384 Transport equipment	11	10	23 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	8	7	8 /e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

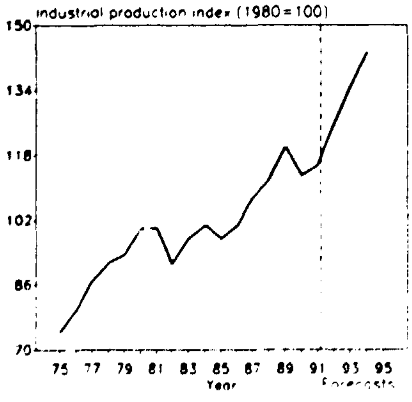
GDP per capita (1000$)/c

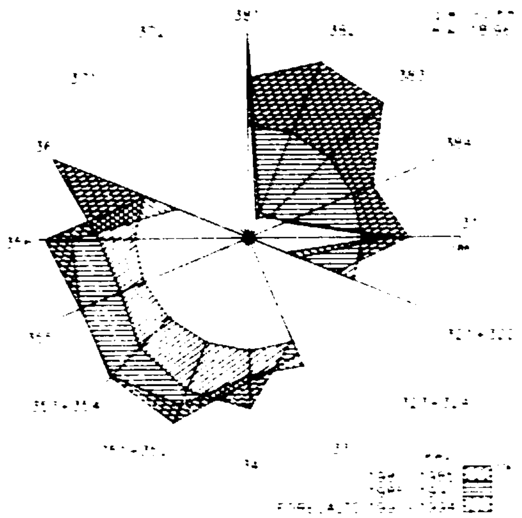


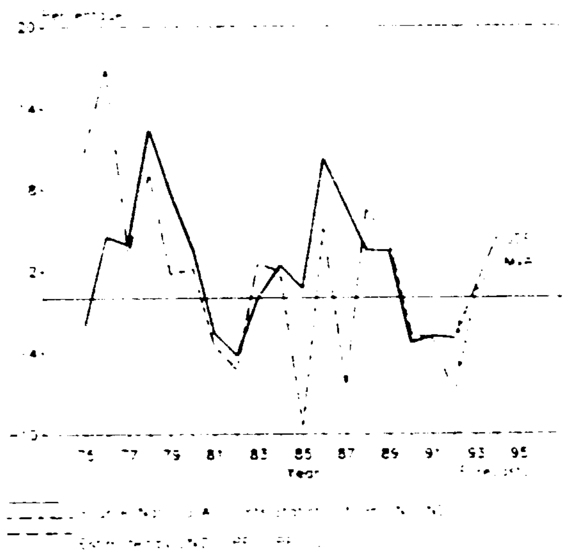
Manufacturing share in GDP current prices (%)



Industrial production index (1980=100)

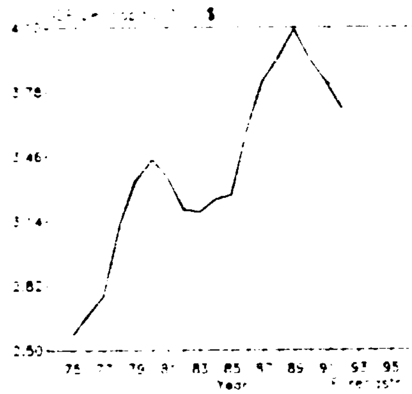


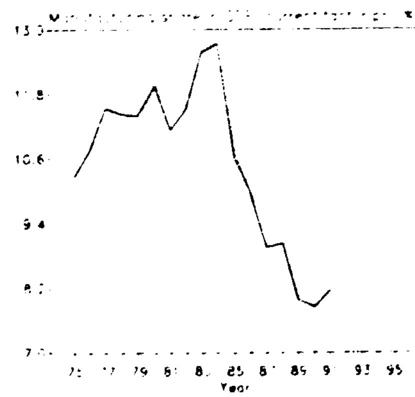




	1980	1985	1990
GDP: real, millions of 1980-dollars	[illegible]	[illegible]	[illegible]
Per capita (1980-dollars, real)	2442	3268	[illegible]
Manufacturing share (%, real, current factor prices)	[illegible]	[illegible]	[illegible]
MANUFACTURING:			
Value added (real, millions of 1980-dollars)	[illegible]	[illegible]	[illegible]
Industrial production index	[illegible]	[illegible]	95
Value added (millions of dollars)	[illegible]	[illegible]	[illegible]
Gross output (millions of dollars)	241	383	398
Employment (thousands)	[illegible]	[illegible]	[illegible]
-PROFITABILITY (in percent of gross output)			
Intermediate input	[illegible]	[illegible]	[illegible]
Wages and salaries including supplements	14	15	15
Gross operating surplus	[illegible]	[illegible]	[illegible]
-PRODUCTIVITY (dollars)			
Gross output / worker	[illegible]	[illegible]	[illegible]
Value added / worker	6654	[illegible]	[illegible]
Average wage (including supplements)	[illegible]	[illegible]	3449
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	[illegible]	[illegible]	[illegible]
as a percentage of average θ in 1970-1975	[illegible]	[illegible]	[illegible]
MVA growth rate (%)	[illegible]	[illegible]	[illegible]
Degree of specialization	[illegible]	[illegible]	[illegible]
-VALUE ADDED: (millions of dollars)			
311/2 Food products	[illegible]	25	[illegible]
313 Beverages	[illegible]	[illegible]	[illegible]
314 Tobacco products	[illegible]	[illegible]	[illegible]
321 Textiles	[illegible]		
322 Wearing apparel	[illegible]	[illegible]	[illegible]
323 Leather and fur products	[illegible]		
324 Footwear	[illegible]		
331 Wood and wood products	[illegible]		
332 Furniture and fixtures		[illegible]	[illegible]
341 Paper and paper products		[illegible]	[illegible]
342 Printing and publishing	4	[illegible]	[illegible]
351 Industrial chemicals	[illegible]	[illegible]	
352 Other chemical products		[illegible]	[illegible]
353 Petroleum refineries	[illegible]	[illegible]	[illegible]
354 Miscellaneous petroleum and coal products		[illegible]	
355 Rubber products	[illegible]	[illegible]	[illegible]
356 Plastic products	[illegible]	[illegible]	[illegible]
361 Pottery, china and earthenware			
362 Glass and glass products			[illegible]
369 Other non-metal mineral products	[illegible]		[illegible]
371 Iron and steel			
372 Non-ferrous metals		[illegible]	[illegible]
381 Metal products	[illegible]	[illegible]	[illegible]
382 Non-electrical machinery	[illegible]	[illegible]	[illegible]
383 Electrical machinery	[illegible]	[illegible]	[illegible]
384 Transport equipment	[illegible]	[illegible]	[illegible]
385 Professional and scientific equipment			
390 Other manufacturing industries	[illegible]	[illegible]	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.





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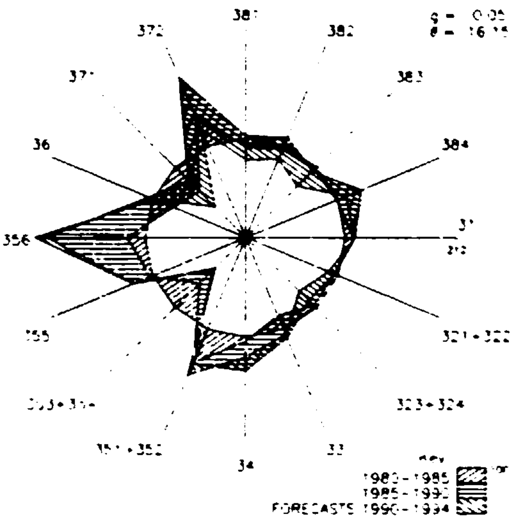
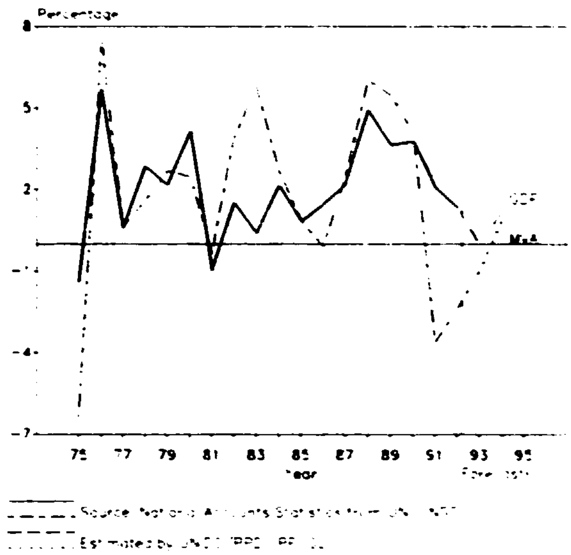
Industrial structural change
(Index of value added 1980=100)

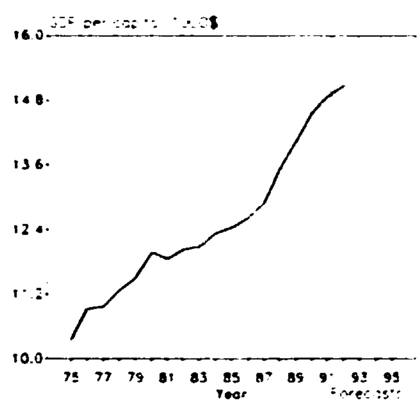


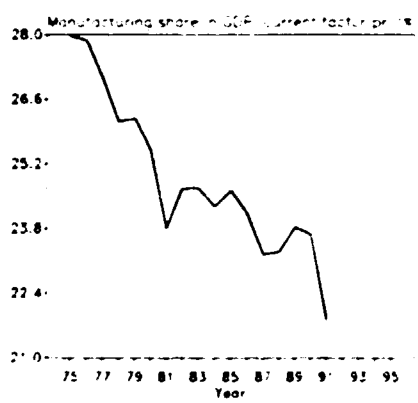
Annual growth rates of GDP and MVA
(Constant 1980 prices)

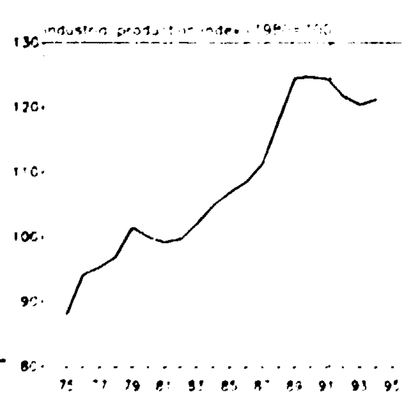


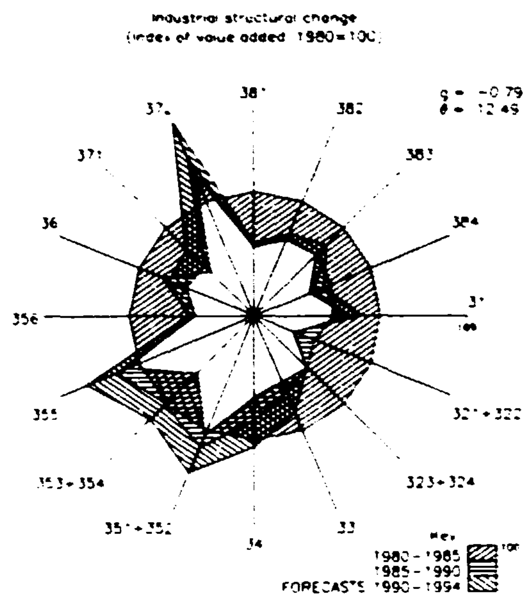
	1980	1985	1990
GDP: (n.a.c.) (millions of 1980-dollars)	118016	1226[illegible]	143454
Per capita (1980-dollars) (n.a.c.)	11979	12436	14573
Manufacturing share (%) (n.a.) (current factor prices)	25.5	24.5	23.[illegible]
MANUFACTURING:			
Value added (n.a.c.) (millions of 1980-dollars)	25772	29229	34519
Industrial production index	100	107	125
Value added (millions of dollars)	28130	18232	42392
Gross output (millions of dollars)	84723 e	59419	145712
Employment (thousands)	872	755	735
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67 e	69	[illegible]
Wages and salaries including supplements (%)	17 e	13 e	[illegible] e
Gross operating surplus (%)	17 e	17 e	[illegible] e
-PRODUCTIVITY: (dollars)			
Gross output / worker	97158 e	78700	199635
Value added / worker	30345	24149	57584
Average wage (including supplements)	16066 e	10618 e	22774 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.23	3.69	3.49
as a percentage of average θ in 1970-1975	63	72	63
MVA growth rate (θ)	0.20	0.0[illegible]	[illegible]
Degree of specialization	12.5	14.0	12.[illegible]
-VALUE ADDED: (millions of dollars)			
311/2 Food products	3991	2863	6015
313 Beverages	549	359	7[illegible]
314 Tobacco products	199	123	257
321 Textiles	1445	937	1786
322 Wearing apparel	671	392	960
323 Leather and fur products	136	93	183
324 Footwear	67	35	51
331 Wood and wood products	226	131	455
332 Furniture and fixtures	1123	614	1514
341 Paper and paper products	612	441	1095
342 Printing and publishing	926	602	1677
351 Industrial chemicals	2401	2253	4483
352 Other chemical products	665	467	1186
353 Petroleum refineries	517	212	305
354 Miscellaneous petroleum and coal products	72	36	59
355 Rubber products	193	130	314
356 Plastic products	819	633	2191
361 Pottery, china and earthenware	107	61	151
362 Glass and glass products	516	289	[illegible]
369 Other non-metal mineral products	654	307	881
371 Iron and steel	2294	985	2510
372 Non-ferrous metals	487	417	1140
381 Metal products	2071	1228	2835
382 Non-electrical machinery	2490	1556	3673
383 Electrical machinery	2303	1451	2313
384 Transport equipment	1892	1217	3195
385 Professional and scientific equipment	170	106	2[illegible]
390 Other manufacturing industries	517	294	[illegible]

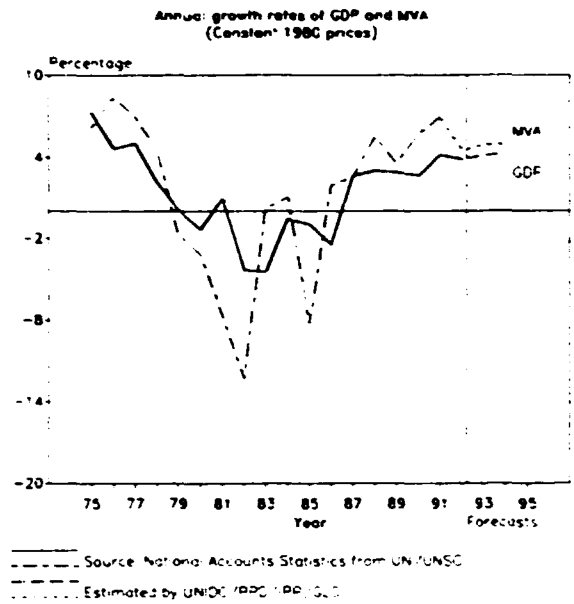
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

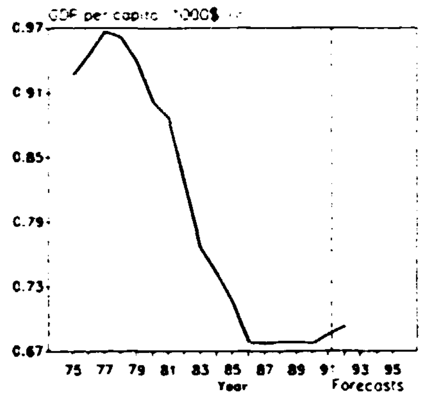






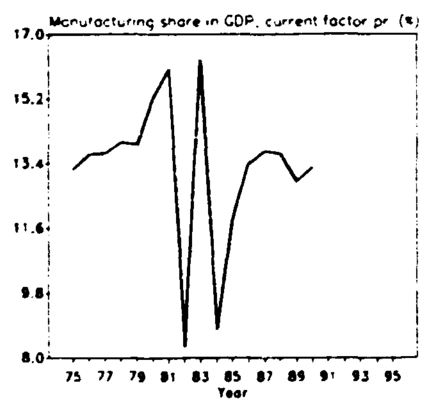


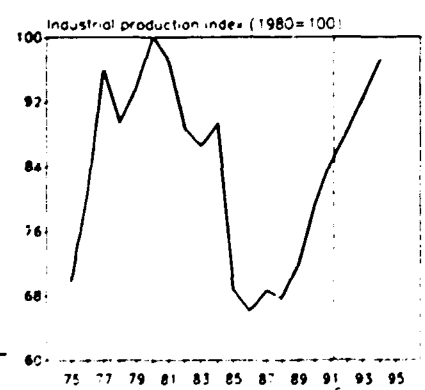




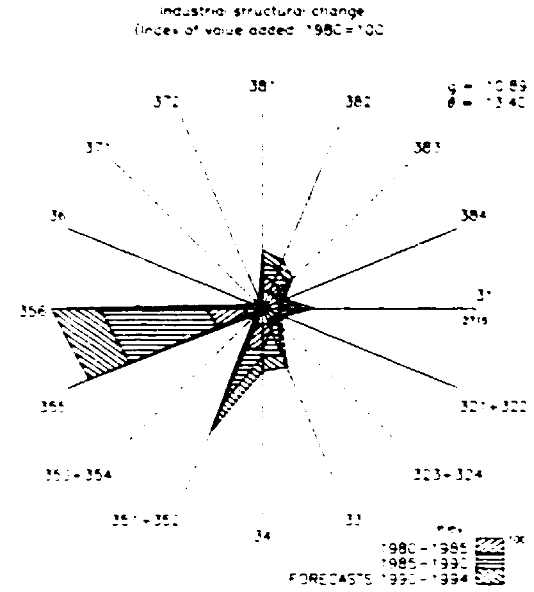
	1980	1985	1990
GDP: (mil. millions of 1980-dollars)	5018	4556	4952
Per capita (1980-dollars) (mil.)	901	715	677
Manufacturing share (%) (ma) current factor prices	15.2	11.8	13.3 /e
MANUFACTURING:			
Value added (ma.c) (millions of 1980-dollars)	734	551	564
Industrial production index	100	59	79
Value added (millions of dollars)	834	818	686 /e
Gross output (millions of dollars)	2465	1956 /e	1953 /e
Employment (thousands)	102	137 /e	160 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	56	58 /e	55 /e
Wages and salaries including supplements (%)	10	11 /e	12 /e
Gross operating surplus (%)	24	31 /e	33 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	24222	14325 /e	12178 /e
Value added / worker	8200	28350	31454 /e
Average wage (including supplements)	2438	1555 /e	1506 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	9.31	6.75 /e	5.03 /e
as a percentage of average θ in 1970-1975	114	78 /e	58 /e
MVA growth rate / θ	0.57	-0.93	0.58
Degree of specialization	25.4	28.0	31.7
-VALUE ADDED: (millions of dollars)			
311/2 Food products	243	261	273 /e
313 Beverages	62	37 /e	57 /e
314 Tobacco products	21	4	4 /e
321 Textiles	37	35	12 /e
322 Wearing apparel	47	30	28 /e
323 Leather and fur products	5	4	4 /e
324 Footwear	24	20	19 /e
331 Wood and wood products	24	21	22 /e
332 Furniture and fixtures	21	18	19 /e
341 Paper and paper products	1	1	2 /e
342 Printing and publishing	15	15	17 /e
351 Industrial chemicals	3	7	7 /e
352 Other chemical products	31	45	46 /e
353 Petroleum refineries	159	152	222 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	2	3	4 /e
356 Plastic products	12	9	8 /e
361 Pottery, china and earthenware	4	3	3 /e
362 Glass and glass products	11	9	10 /e
369 Other non-metal mineral products	25	35	20 /e
371 Iron and steel	12	9	9 /e
372 Non-ferrous metals	37	68	71 /e
381 Metal products	14	11	10 /e
382 Non-electrical machinery	6	6	5 /e
383 Electrical machinery	3	3	3 /e
384 Transport equipment	5	5	3 /e
385 Professional and scientific equipment	1	1	1 /e
390 Other manufacturing industries	3	5	5 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

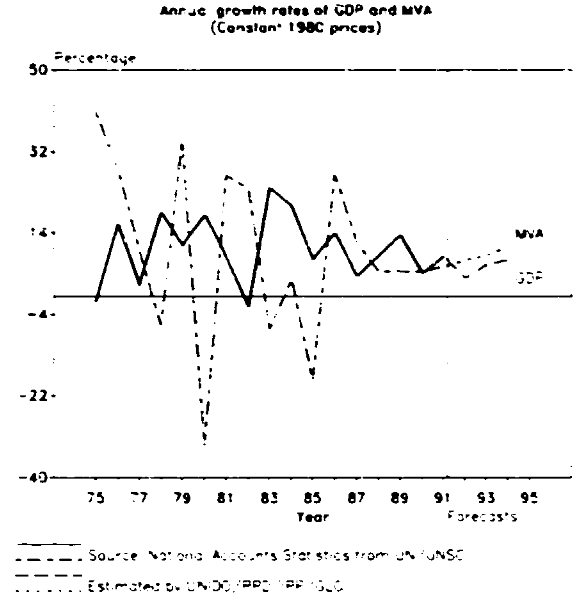




Industrial structural change
(Index of value added: 1980 = 100)

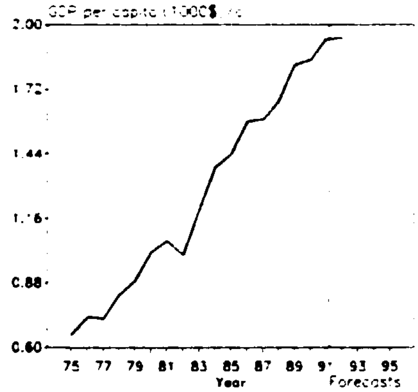


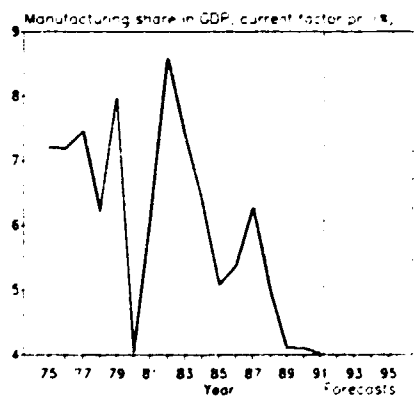
Annual growth rates of GDP and MVA
(Constant 1980 prices)

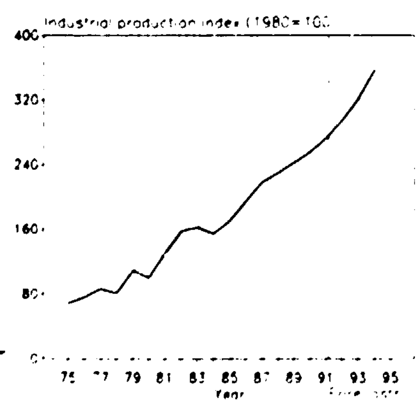


	1980	1985	1990
GDP: (n.a.c.) millions of 1980-dollars	913	1559	2411
Per capita (1980-dollars) (n.a.c.)	1012	1438	1646
Manufacturing share (%) (n.a.) current factor prices	4.0	5.1	4.1
MANUFACTURING:			
Value added (n.a.c.) millions of 1980-dollars	38	45	77
Industrial production index	100	171	256
Value added (millions of dollars)	41	46	148 e
Gross output (millions of dollars)	149	169	550 e
Employment (thousands)	5	10	24
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	73	73	73 e
Wages and salaries including supplements (%)	14 e	11 e	9 e
Gross operating surplus (%)	14 e	16 e	17 e
-PRODUCTIVITY: dollars			
Gross output / worker	27107	16581	22542 e
Value added / worker	7446	4518	6092 e
Average wage (including supplements)	3666 e	1880 e	2133 e
-STRUCTURAL INDICES.			
Structural change θ (5-year average in degrees)	3.90 e	8.73 e	5.83 e
as a percentage of average θ in 1970-1975	402 e	900 e	704 e
MVA growth rate / θ	1.32	1.40	2.15
Degree of specialization	33.7	27.5	27.2
-VALUE ADDED: millions of dollars			
311/2 Food products	13	14	46 e
313 Beverages	4	10	36 e
314 Tobacco products	-	-	- e
321 Textiles	4 e	2 e	5 e
322 Wearing apparel	2 e	1 e	4 e
323 Leather and fur products	- e	- e	- e
324 Footwear	1 e	- e	2 e
331 Wood and wood products	- e	- e	2 e
332 Furniture and fixtures	- e	- e	2 e
341 Paper and paper products	- e	1 e	2 e
342 Printing and publishing	- e	1 e	2 e
351 Industrial chemicals	- e	1 e	4 e
352 Other chemical products	- e	1 e	4 e
353 Petroleum refineries	-	-	- e
354 Miscellaneous petroleum and coal products	-	-	- e
355 Rubber products	- e	1 e	3 e
356 Plastic products	- e	- e	2 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	3 e	8 e
382 Non-electrical machinery	1 e	1 e	3 e
383 Electrical machinery	- e	1 e	2 e
384 Transport equipment	1 e	- e	1 e
385 Professional and scientific equipment	-	-	e
390 Other manufacturing industries	12	8	21 e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex







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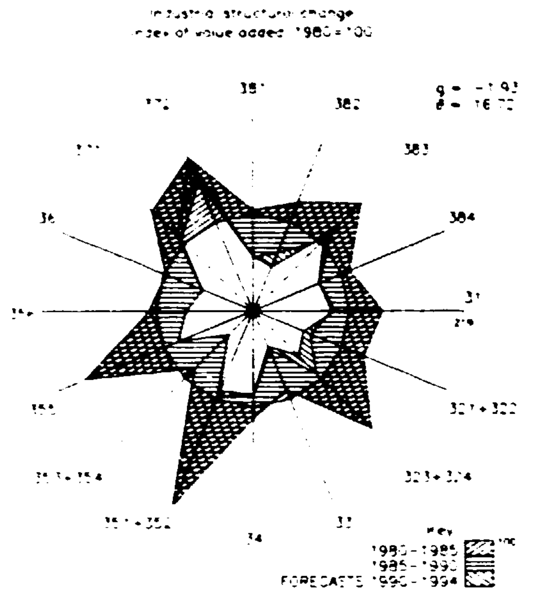
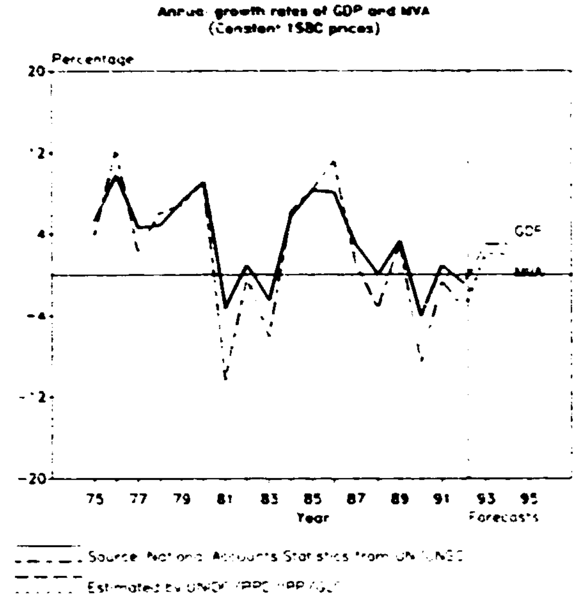
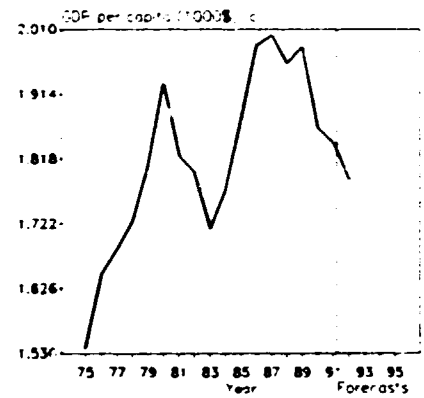
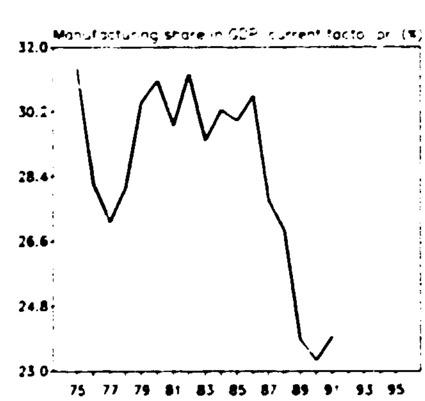


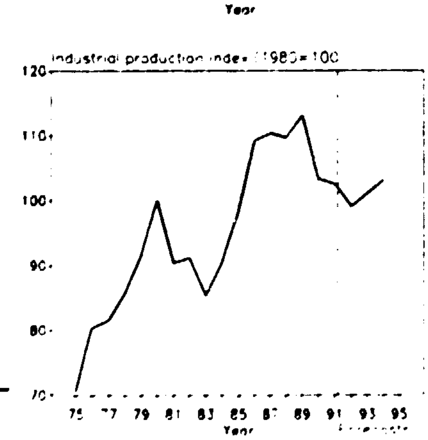


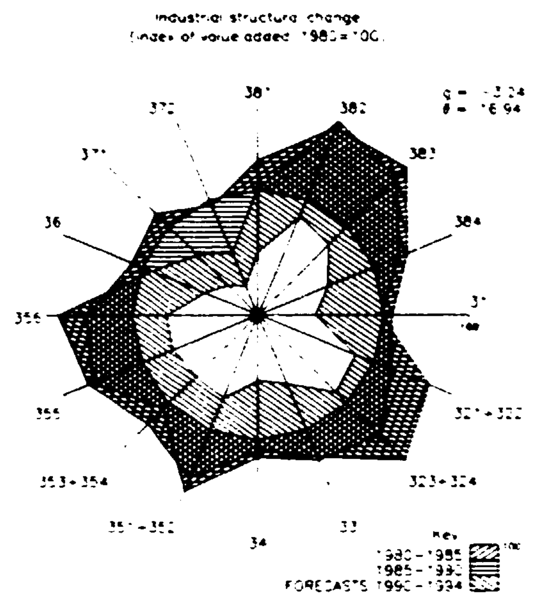
	1980		1985		1990	
GDP: (real, millions of 1980-dollars)	233962		254528		280406	
Per capita (1980-dollars) (real)	1929		1578		1563	
Manufacturing share (%) (real, current factor prices)	31.1		30.0		23.3	
MANUFACTURING:						
Value added (real, millions of 1980-dollars)	70679		68069		69529	
Industrial production index	100		98		103	
Value added (millions of dollars)	71690		77082		73294	
Gross output (millions of dollars)	176175		174241		291993	e
Employment (thousands)	4449		5501		5213	
-PROFITABILITY: (in percent of gross output)						
Intermediate input (%)	59		56		75	e
Wages and salaries including supplements (%)	7		9	e	8	e
Gross operating surplus (%)	34		35	e	17	e
-PRODUCTIVITY: (dollars)						
Gross output / worker	39599		31574		56015	e
Value added / worker	16114		14012		14061	
Average wage (including supplements)	2773		2753	/e	4334	e
-STRUCTURAL INDICES:						
Structural change θ (5-year average in degrees)	2.49	e	3.30	/e	5.65	e
(as a percentage of average θ in 1970-1975)	76	e	19	e	173	e
MVA growth rate (%)	2.56		1.32		-1.74	
Degree of specialization	9.0		9.7		9.2	
-VALUE ADDED: (millions of dollars)						
311/2 Food products	7996		9259		8687	
313 Beverages	1375		357		1388	
314 Tobacco products	495		587		726	
321 Textiles	4860		4586		3862	
322 Wearing apparel	2307		2639		2425	e
323 Leather and fur products	309		464		371	
324 Footwear	985		1353		1243	e
331 Wood and wood products	1903		1220		951	
332 Furniture and fixtures	1087		349		843	
341 Paper and paper products	2238		2260		2556	
342 Printing and publishing	1901		1436		2305	
351 Industrial chemicals	3428		5933	/e	3930	e
352 Other chemical products	3544		6465	/e	4560	/e
353 Petroleum refineries	3075		1956	/e	1343	e
354 Miscellaneous petroleum and coal products	1216		990	/e	714	/e
355 Rubber products	941		1420		1059	
356 Plastic products	1994		1742		1847	
361 Pottery, china and earthenware	190		844		761	e
362 Glass and glass products	558		525		447	e
369 Other non-metal mineral products	3447		1941		1930	e
371 Iron and steel	4128		4927		5811	e
372 Non-ferrous metals	1115		1554		2172	e
381 Metal products	3599		3063		2714	e
382 Non-electrical machinery	7111		7092		5282	e
383 Electrical machinery	4536		5831		6341	
384 Transport equipment	5625		4954		5652	
385 Professional and scientific equipment	453		532	e	637	e
390 Other manufacturing industries	1216		1532	/e	1738	e

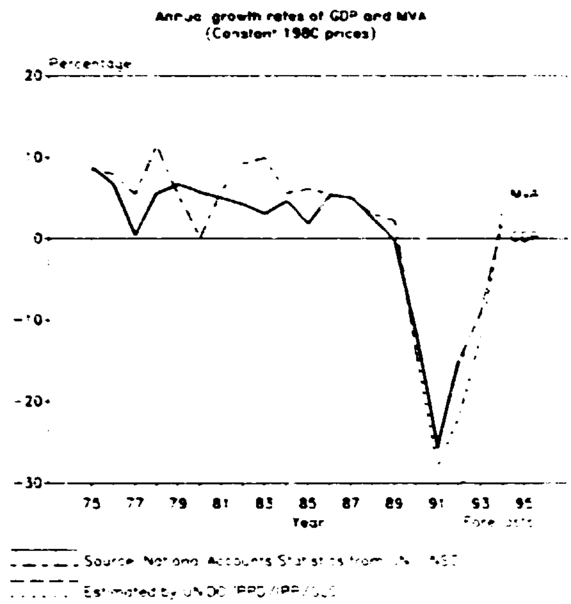
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex











	1980	1985	1990
GDP: nat.c. millions of 1980-dollars	19993	23392	23907
Per capita (1980-dollars) nat.c.	2256	2677	2652
Manufacturing share (%) na (current factor prices)	38.5	46.5	40.1
MANUFACTURING:			
Value added nat.c. millions of 1980-dollars	8447	12050	12059
Industrial production index	100	125	123
Value added (millions of 1980-dollars)	11771	14745	14535 e
Gross output (millions of dollars)	24310 e	39270 e	18225 e
Employment (thousands)	1250	1316	1374
-PROFITABILITY: in percent of gross output			
Intermediate input (%)			
Wages and salaries including supplements (%)	6 e	5 e	3 e
Gross operating surplus (%)			
-PRODUCTIVITY: dollars			
Gross output / worker	30586 e	48256	21446
Value added / worker c	9675	11738	11012 e
Average wage (including supplements)	1737 e	2577 e	1666 e
-STRUCTURAL INDICES:			
Structural change θ 5-year average in degrees	2.31	2.94 e	3.98 e
as a percentage of average θ in 1970-1975	30	91 e	123 e
MVA growth rate / θ	2.35	1.57	0.03
Degree of specialization	11.5	12.0	12.7
-VALUE ADDED: millions of 1980-dollars			
311/2 Food products	1870	1945	1342 e
313 Beverages	308	357	339
314 Tobacco products	426	472	349
321 Textiles	904	1003	1175
322 Wearing apparel	517	626	915
323 Leather and fur products	84	110	112
324 Footwear	156	218	284
331 Wood and wood products	248	258	240
332 Furniture and fixtures	233	347	352
341 Paper and paper products	119	141	112
342 Printing and publishing	83	91	108
351 Industrial chemicals	404	573	500
352 Other chemical products	291	486	483
353 Petroleum refineries			
354 Miscellaneous petroleum and coal products	126	134	156
355 Rubber products	227	323	332
356 Plastic products	110	150 e	175 e
361 Pottery, china and earthenware	45	40	58
362 Glass and glass products	121	140	133
369 Other non-metal mineral products	459	507	390
371 Iron and steel	447	513	304
372 Non-ferrous metals	139	180	102
381 Metal products	484	500	489
382 Non-electrical machinery	1491 e	2427 e	2511 e
383 Electrical machinery	743	1241	1152
384 Transport equipment	567	726	687
385 Professional and scientific equipment	172 e	233 e	299 e
390 Other manufacturing industries	937	853	937

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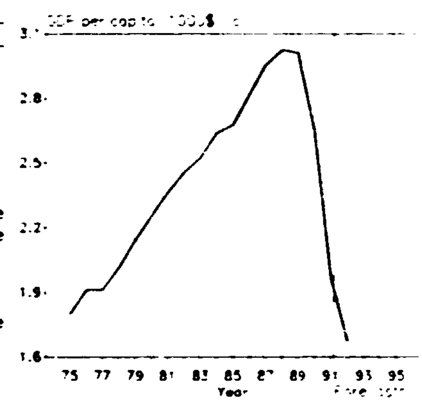

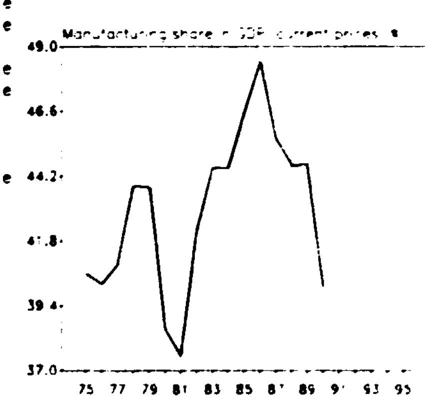

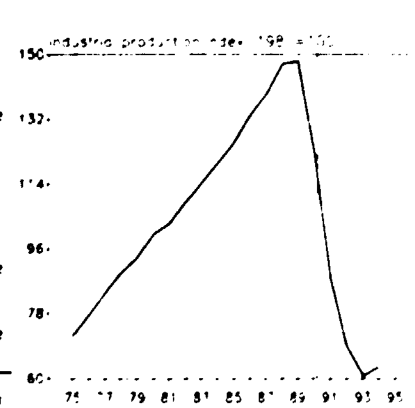

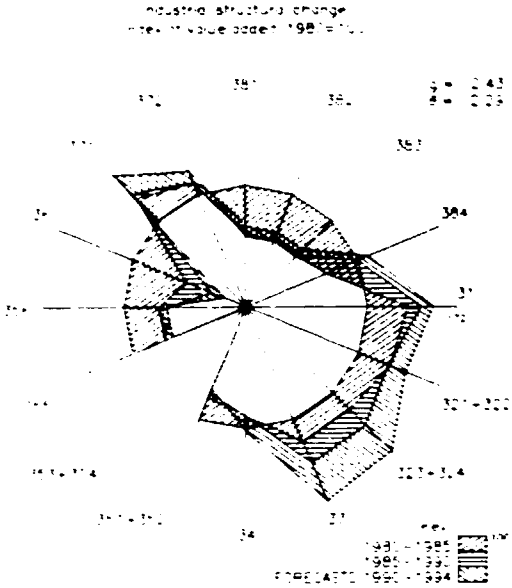

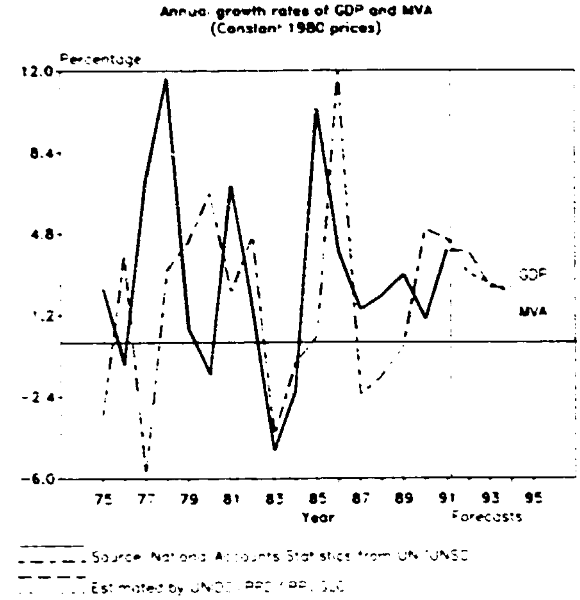

	1980	1985	1990
GDP (real, millions of 1980-dollars)	1257	1435	1607
Per capita (1980-dollars, real)	185	182	179
Manufacturing share (%) (real, current factor prices)	11.4	11.2	11.5
MANUFACTURING:			
Value added (real, millions of 1980-dollars)	141	144	163
Industrial production index	100	110	129
Value added (millions of dollars)	144	121 e	206 e
Gross output (millions of dollars)	391	318 e	596 e
Employment (thousands)	8	9 e	9 e
-PROFITABILITY (in percent of gross output)			
Intermediate input (%)	63	62 e	65 e
Wages and salaries including supplements (%)	8	7 e	8 e
Gross operating surplus (%)	28	31 e	27 e
-PRODUCTIVITY (dollars)			
Gross output / worker	47326	36452 e	64078 e
Value added / worker	17465	13890 e	22195 e
Average wage (including supplements)	4021	2712 e	5088 e
-STRUCTURAL INDICES			
Structural change θ (5-year average in degrees)	2.80	2.97 e	0.66 e
θ as a percentage of average θ in 1970-1975	240	255 e	57 e
MVA growth rate (%)	0.49	1.39	1.77
Degree of specialization	36.7	43.1	43.9
-VALUE ADDED (millions of dollars)			
311/2 Food products	55	55 e	98 e
313 Beverages	29	21 e	36 e
314 Tobacco products	1	1 e	2 e
321 Textiles	20	18 e	28 e
322 Wearing apparel	2	2 e	3 e
323 Leather and fur products	2	1 e	3 e
324 Footwear	3	3 e	5 e
331 Wood and wood products	-	- e	- e
332 Furniture and fixtures	2	1 e	3 e
341 Paper and paper products	-	- e	- e
342 Printing and publishing	1	1 e	1 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	1 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	1 e
372 Non-ferrous metals	1 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	3 e
385 Professional and scientific equipment	-	- e	- e
39 Other manufacturing industries	12	9 e	15 e

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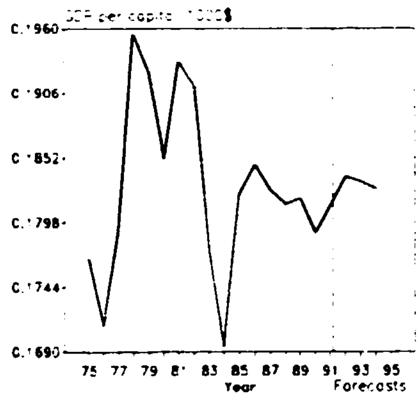

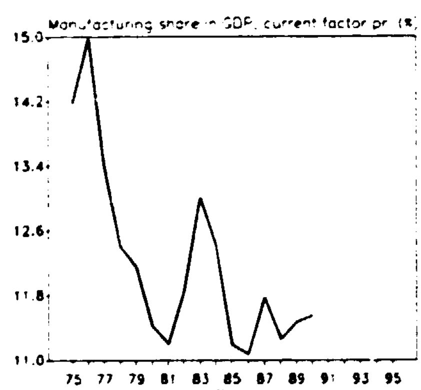

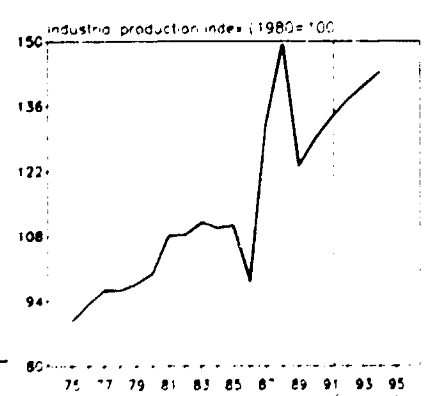

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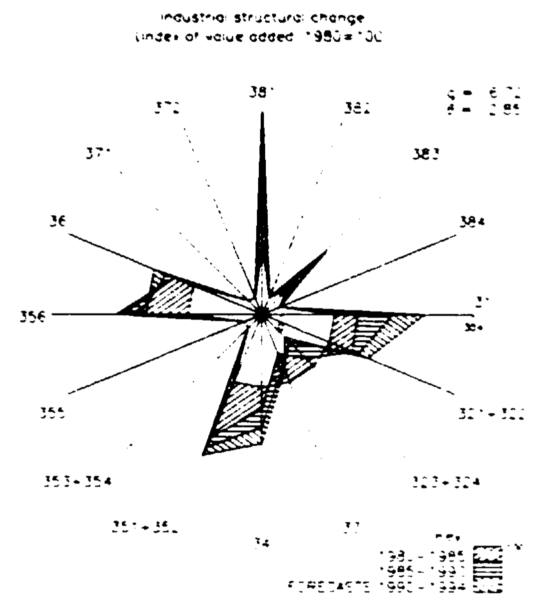
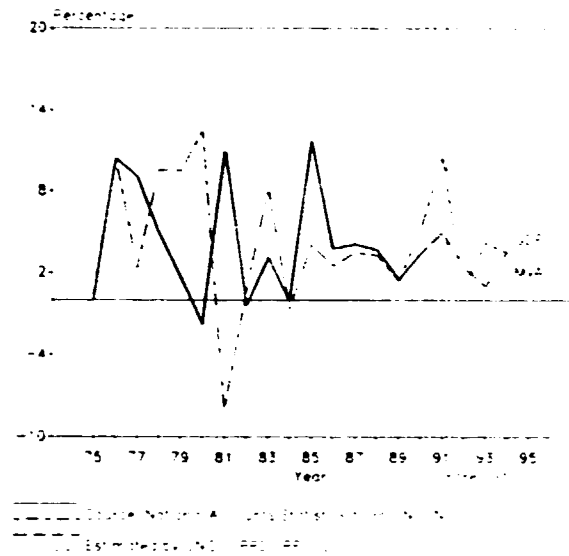
Industrial structural change (index of value added 1980=100)



Annual growth rates of GDP and MVA (Constant 1980 prices)



	1980	1985	1990
GDP: real, millions of 1980-dollars	951	1036	142[illegible]
Per capita (1980-dollars) real	230	226	26[illegible]
Manufacturing share (%) real, current factor prices	9.0	13.6	14.[illegible]
MANUFACTURING:			
Value added: real, millions of 1980-dollars	[illegible]	80	94
Industrial production index	100	144 e	178 e
Value added: millions of dollars	56	84 e	109 e
Gross output: millions of dollars	95	137 e	175 e
Employment (thousands)	3	4 e	5 e
-PROFITABILITY: in percent of gross output			
Intermediate input	41	39 e	38 e
Wages and salaries including supplements	9 e	10 e	9 e
Gross operating surplus	51 e	51 e	54 e
-PRODUCTIVITY: dollars			
Gross output / worker	27640	27581 e	33394 e
Value added / worker	16370	17238 e	19680 e
Average wage (including supplements)	2357 e	3378 e	3008 e
-STRUCTURAL INDICES:			
Structural change θ: 5-year average in degrees	5.30 e	3.7 e	1.53 e
as a percentage of average θ in 1970-1975	114 e	80 e	13 e
MVA growth rate θ	[illegible]	5.96	10.67
Degree of specialization	38.5	38.4	43.7
-VALUE ADDED: millions of dollars			
311/2 Food products	27 e	40 e	55 e
313 Beverages	3 e	19 e	25 e
314 Tobacco products	4 e	5 e	7 e
321 Textiles	2	3 e	3 e
322 Wearing apparel	3	4 e	4 e
323 Leather and fur products	.	. 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	.	e	. e
351 Industrial chemicals	.	3 e	3 e
352 Other chemical products		e	. 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	.	2 e	2 e
371 Iron and steel	.	- e	- e
372 Non-ferrous metals	-	- e	- e
381 Metal products	2	4 e	5 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

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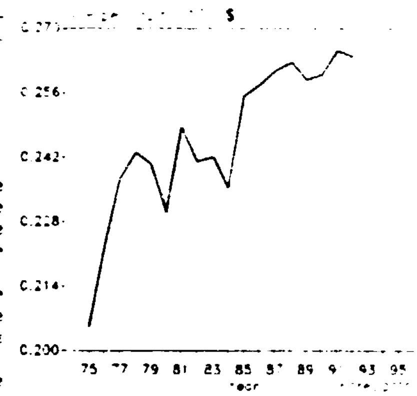

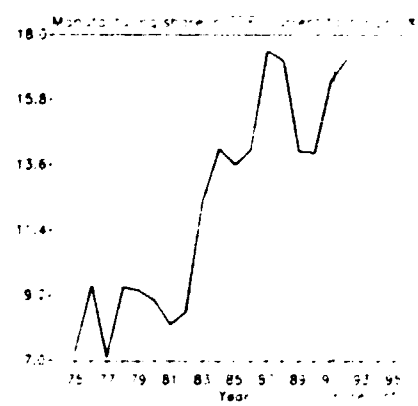

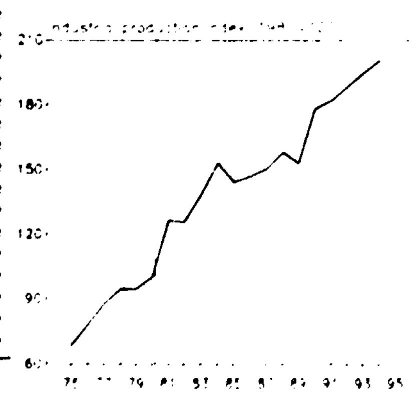

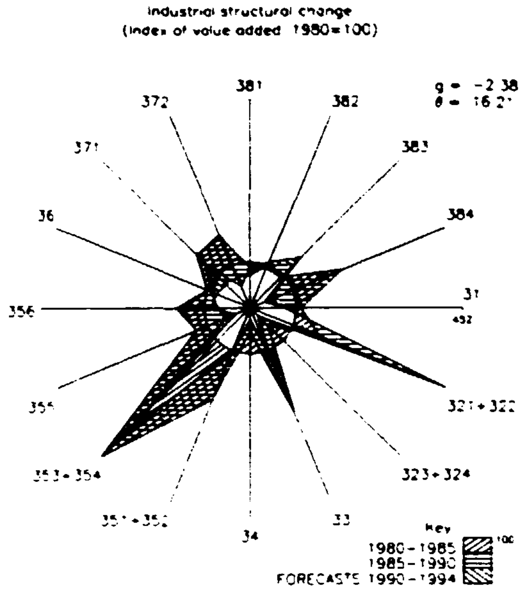

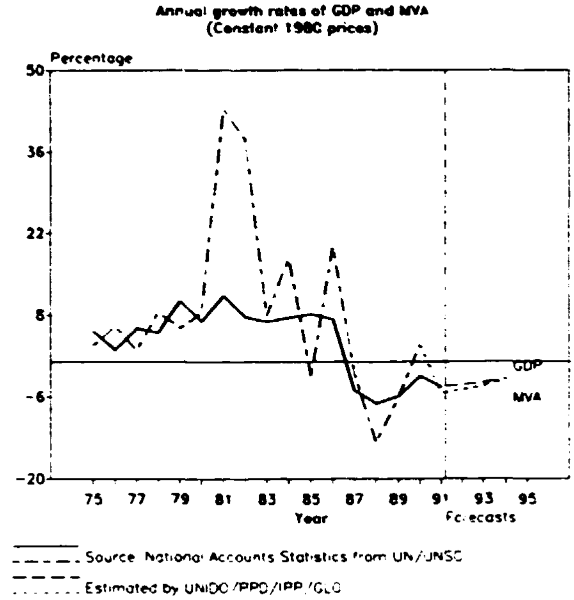

	1980	1985	1990
GDP: (na.c. millions of 1980-dollars)	6674	9911	8597
Per capita (1980-dollars) (na.c	771	986	727
Manufacturing share (%) (na current factor prices)	9.2	11.4	11.[illegible]
MANUFACTURING:			
Value added (na.c. millions of 1980-dollars)	587	1433	1399
Industrial production index	100	153	156
Value added (millions of dollars)	707 /e	705 /e	826
Gross output (millions of dollars)	1708 /e	1650 /e	2607
Employment (thousands)	51 /e	68 /e	50
-PROFITABILITY: in percent of gross output			
Intermediate input (%)	59 /e	57 /e	68
Wages and salaries including supplements (%)	14 /e	13 /e	14 /e
Gross operating surplus (%)	27 /e	30 /e	18 /e
-PRODUCTIVITY: dollars			
Gross output / worker	33434 /e	24107 /e	51631
Value added / worker	13838 /e	10410 /e	16357
Average wage (including supplements)	4794 /e	3075 /e	7281 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	8.88 /e	5.11 /e	9.82 /e
as a percentage of average θ in 1970-1975	109 /e	63 /e	121 /e
MVA growth rate / θ	1.37	1.06	-1.00
Degree of specialization	23.6	21.4	21.7
-VALUE ADDED: millions of dollars			
311/2 Food products	187 /e	128 /e	185
313 Beverages	183 /e	179 /e	294
314 Tobacco products	24 /e	20 /e	23
321 Textiles	36 /e	44 /e	-87
322 Wearing apparel	10 /e	14 /e	-27
323 Leather and fur products	7 /e	3 /e	3
324 Footwear	10 /e	4 /e	5
331 Wood and wood products	30 /e	57 /e	61
332 Furniture and fixtures	13 /e	24 /e	26
341 Paper and paper products	17 /e	7 /e	11
342 Printing and publishing	20 /e	8 /e	6
351 Industrial chemicals	10 /e	18 /e	17
352 Other chemical products	12 /e	19 /e	21
353 Petroleum refineries	15 /e	54 /e	114 /e
354 Miscellaneous petroleum and coal products	- /e	- /e	- /e
355 Rubber products	2 /e	2 /e	1 /e
356 Plastic products	16 /e	20 /e	25 /e
361 Pottery, china and earthenware	6 /e	4 /e	8
362 Glass and glass products	4 /e	3 /e	6
369 Other non-metal mineral products	12 /e	9 /e	16
371 Iron and steel	24 /e	30 /e	30
372 Non-ferrous metals	19 /e	25 /e	23
381 Metal products	13 /e	9 /e	17
382 Non-electrical machinery	18 /e	13 /e	32
383 Electrical machinery	4 /e	3 /e	9
384 Transport equipment	3 /e	5 /e	3
385 Professional and scientific equipment	- /e	- /e	-
390 Other manufacturing industries	11 /e	4 /e	5

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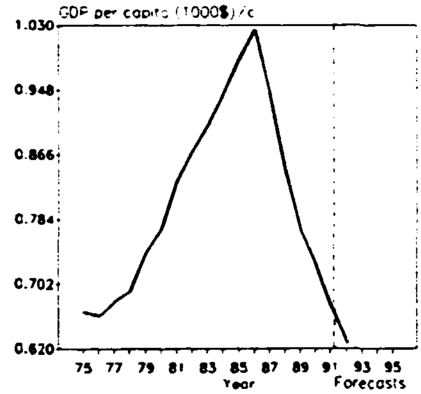
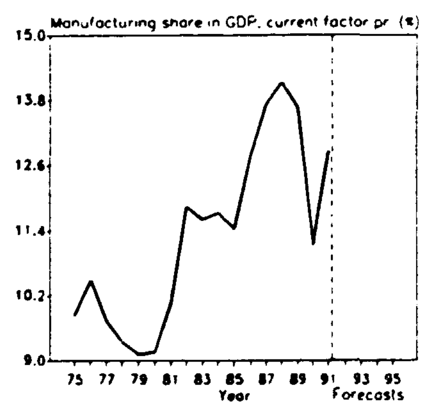
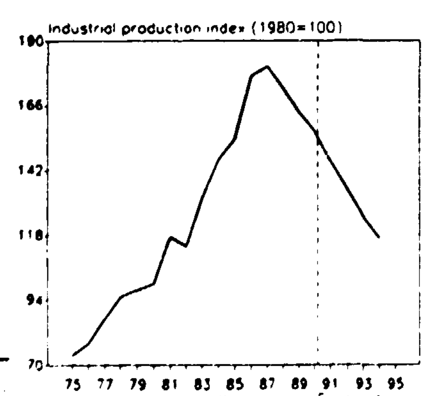
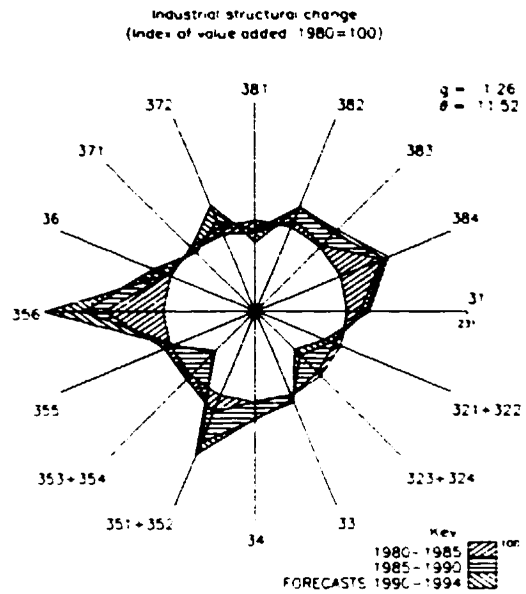
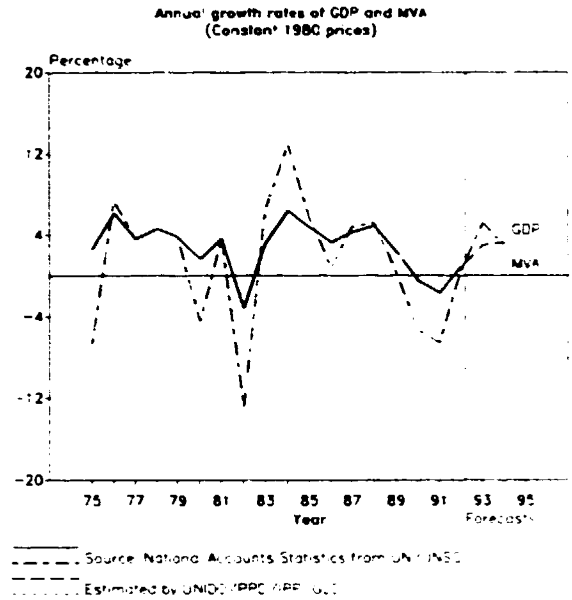




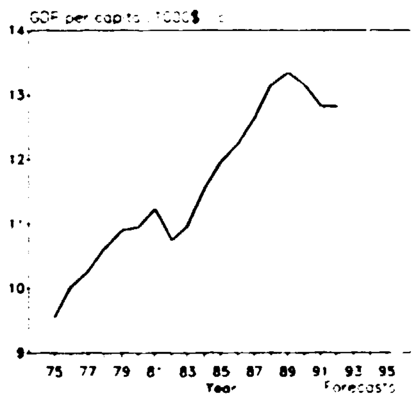


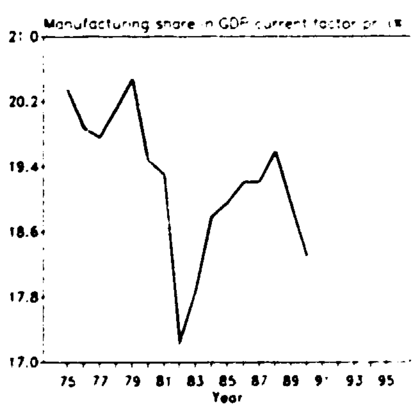


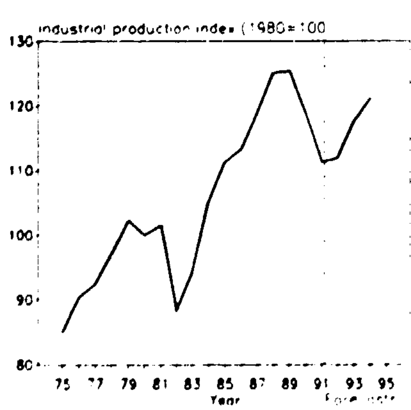


	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	263242	303726	349214
Per capita (1980-dollars) /na.c	10949	11968	13158
Manufacturing share (%) /na (current factor prices)	19.5	19.0	18.3 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	47086	53990	56928
Industrial production index	100	111	119
Value added (millions of dollars)	59803	74203	115821
Gross output (millions of dollars)	167211	211017	305886
Employment (thousands)	1853	1765	1828
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	65	62
Wages and salaries including supplements (%)	17	16	17 /e
Gross operating surplus (%)	19	19	21 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	89995	119212	167206
Value added / worker	32187	41950	63338
Average wage (including supplements)	15296	19168	28410 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.41	4.86	3.66
as a percentage of average θ in 1970-1975	76	108	81
MVA growth rate / θ	1.06	0.41	0.47
Degree of specialization	10.3	11.0	11.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	6142	8001	12352
313 Beverages	1660	2189	3211
314 Tobacco products	479	508	928
321 Textiles	2130	2152	2978
322 Wearing apparel	1694	1933	2679
323 Leather and fur products	154	154	172
324 Footwear	299	344	343
331 Wood and wood products	2968	3236	5014 /e
332 Furniture and fixtures	1044	1332	1888 /e
341 Paper and paper products	5714	5410	10124
342 Printing and publishing	3054	4517	7088
351 Industrial chemicals	2164	2570	5865
352 Other chemical products	2421	3755	5929
353 Petroleum refineries	1531	1867	1471
354 Miscellaneous petroleum and coal products	111	132	307
355 Rubber products	873	1069	1388 /e
356 Plastic products	873	1654	2717 /e
361 Pottery, china and earthenware	43	29	75 /e
362 Glass and glass products	385	578	706
369 Other non-metal mineral products	1497	1713	3048
371 Iron and steel	2652	2906	4006
372 Non-ferrous metals	2190	2284	3902
381 Metal products	4414	4363	6551
382 Non-electrical machinery	3952	4912	8060
383 Electrical machinery	3849	4531	7648
384 Transport equipment	5911	10088	14818
385 Professional and scientific equipment	667	659	891 /e
390 Other manufacturing industries	932	1223	1664

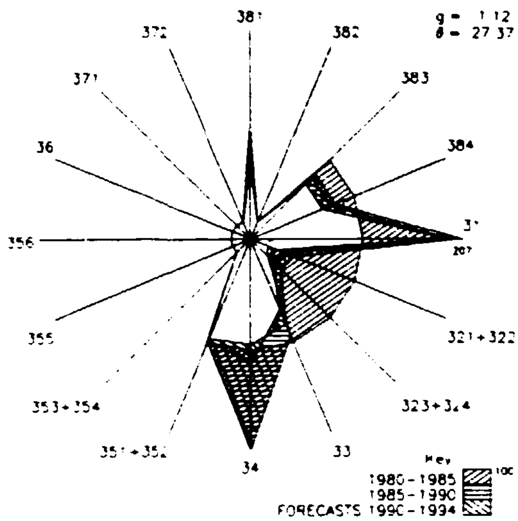
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



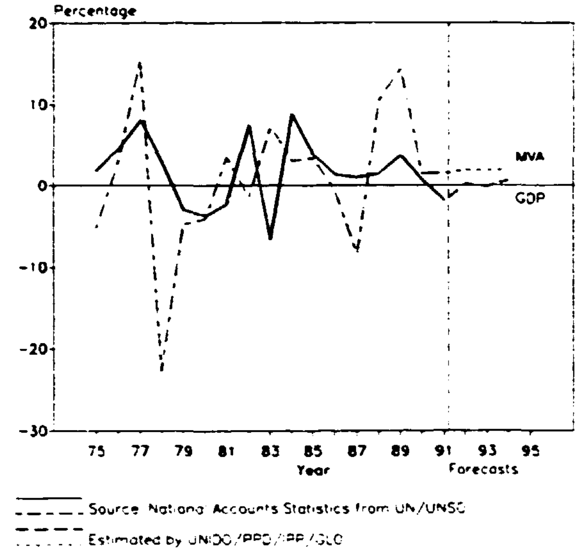




Industrial structural change
(index of value added 1980=100)



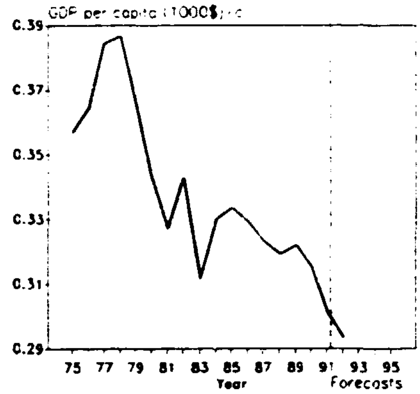
Annual growth rates of GDP and MVA
(Constant 1980 prices)



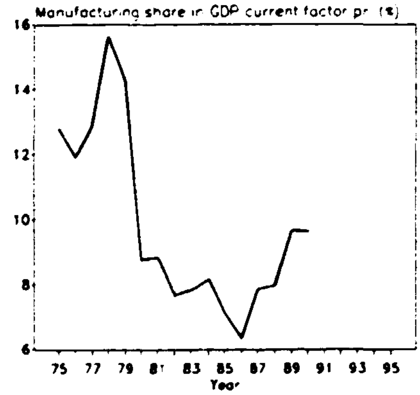
	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	797	883	958
Per capita (1980-dollars) (na.c)	343	334	315
Manufacturing share (%) (na) (current factor prices)	8.8	7.1	9.6 /e
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	71	83	97
Industrial production index	100	112	131
Value added (millions of dollars)	35 /e	33	48 /e
Gross output (millions of dollars)	98 /e	108	151 /e
Employment (thousands)	6 /e	8	4 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64 /e	70	68 /e
Wages and salaries (including supplements) (%)	16 /e	18 /e	17 /e
Gross operating surplus (%)	19 /e	12 /e	15 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	16359 /e	13101	32976 /e
Value added / worker	5932 /e	4157	10774 /e
Average wage (including supplements)	2691 /e	2415 /e	6022 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	9.49 /e	16.26 /e	17.21 /e
as a percentage of average θ in 1970-1975	166 /e	284 /e	301 /e
MVA growth rate / θ	-0.72	0.35	0.16
Degree of specialization	21.6	25.4	25.5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	5	8	13 /e
313 Beverages	3	4	6 /e
314 Tobacco products	4	6	10 /e
321 Textiles	5 /e	- /e	1 /e
322 Wearing apparel	1 /e	- /e	- /e
323 Leather and fur products	- /e	- /e	- /e
324 Footwear	-	-	- /e
331 Wood and wood products	11 /e	8	9 /e
332 Furniture and fixtures	-	1	1 /e
341 Paper and paper products	-	-	- /e
342 Printing and publishing	1	2	2 /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	2 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	-	1	1 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

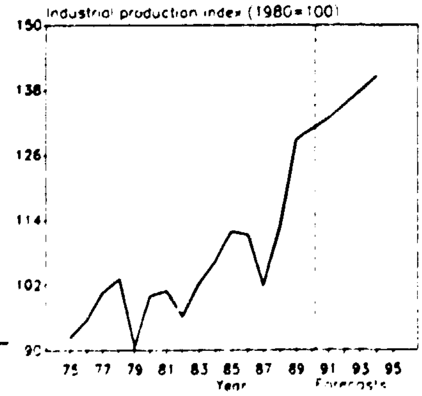
GDP per capita (1000$) (na.c)

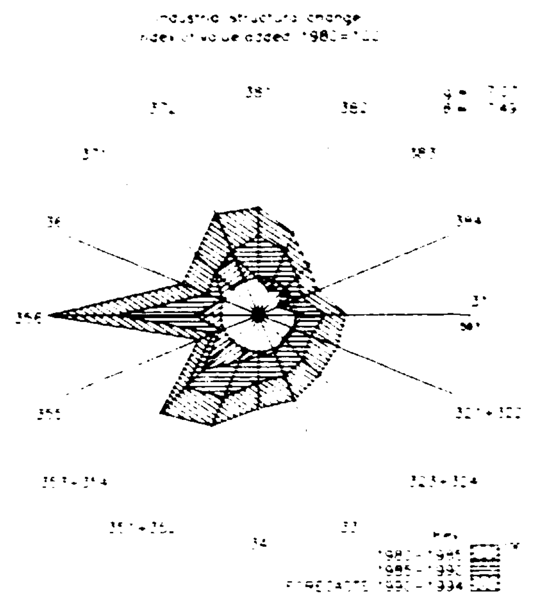


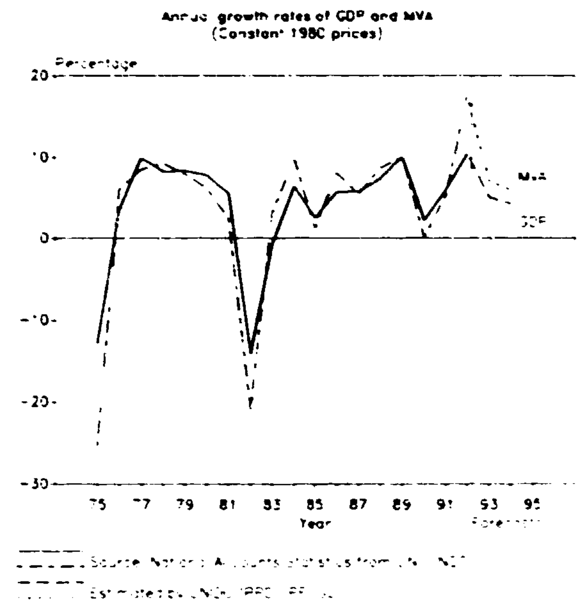
Manufacturing share in GDP current factor pr. (%)



Industrial production index (1980=100)

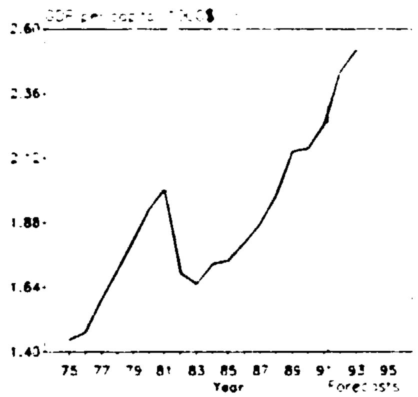


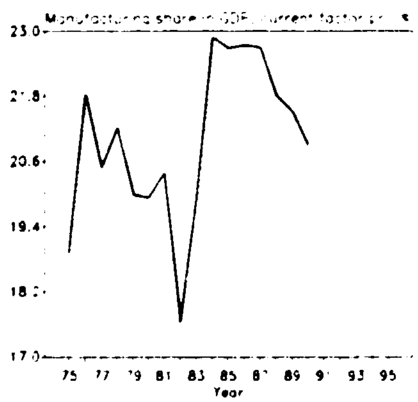


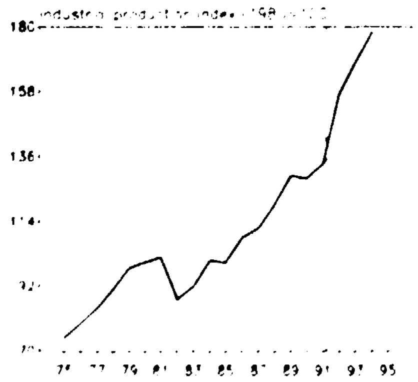


	1980		1985	1990	
GDP: (nat.) millions of 1980-dollars	27489		27275	38400	
Per capita (1980-dollars) (nat.)	1928		1739	2155	
Manufacturing share (%) (nat.) (current factor prices)	19.9		22.1	20.9	e
MANUFACTURING:					
Value added (nat.) millions of 1980-dollars	4830		4482	5107	
Industrial production index	100		100	125	
Value added (millions of dollars)	4991		4713	8757	
Gross output (millions of dollars)	10790		10477	21215	
Employment (thousands)	206		185	298	
-PROFITABILITY: (in percent of gross output)					
Intermediate input (%)	54		65	59	
Wages and salaries including supplements (%)	9	e	6	7	
Gross operating surplus (%)	38	e	39	34	
-PRODUCTIVITY: (dollars)					
Gross output / worker	51994		56369	70919	
Value added / worker	24050		25369	29274	
Average wage (including supplements)	4444	e	3498	4361	
-STRUCTURAL INDICES:					
Structural change θ (5-year average in degrees)	11.13		7.41	4.04	e
as a percentage of average θ in 1970-1975	63		42	23	e
MVA growth rate (%)	-0.31		0.73	2.19	
Degree of specialization	15.0		20.4	17.0	
-VALUE ADDED: (millions of dollars)					
311/2 Food products	827		805	1543	
313 Beverages	289		177	374	
314 Tobacco products	214		205	303	
321 Textiles	234		162	333	
322 Wearing apparel	111		83	163	
323 Leather and fur products	22		13	37	
324 Footwear	77		51	121	
331 Wood and wood products	153		143	270	
332 Furniture and fixtures	37		14	53	
341 Paper and paper products	231		278	561	
342 Printing and publishing	182		104	224	
351 Industrial chemicals	55		94	247	
352 Other chemical products	324		239	517	
353 Petroleum refineries	184		277	480	
354 Miscellaneous petroleum and coal products	27		47	69	
355 Rubber products	60		49	72	
356 Plastic products	50		63	178	
361 Pottery, china and earthenware	14		3	9	
362 Glass and glass products	38		27	51	
369 Other non-metal mineral products	145		115	218	
371 Iron and steel	158		225	284	
372 Non-ferrous metals	365		1175	1715	
381 Metal products	181		130	365	
382 Non-electrical machinery	95		59	168	
383 Electrical machinery	90		61	125	
384 Transport equipment	127		60	153	
385 Professional and scientific equipment	5		4	9	
390 Other manufacturing industries	13		7	14	

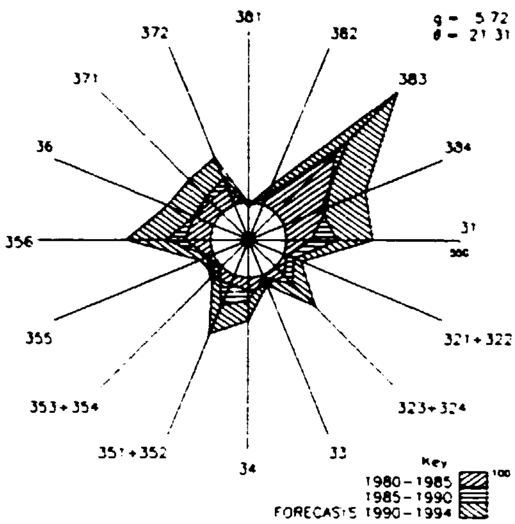
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



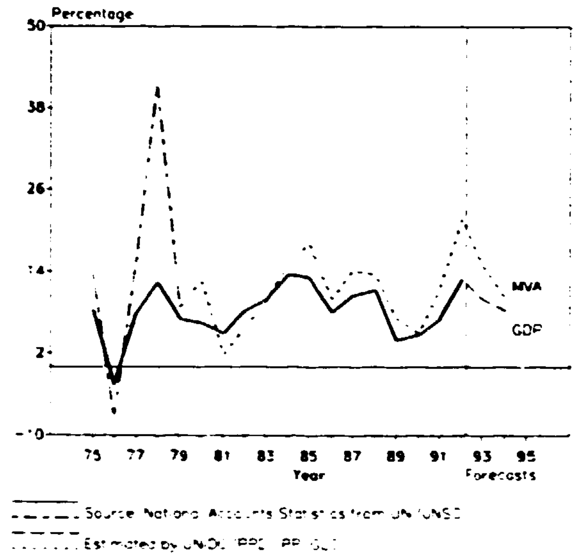




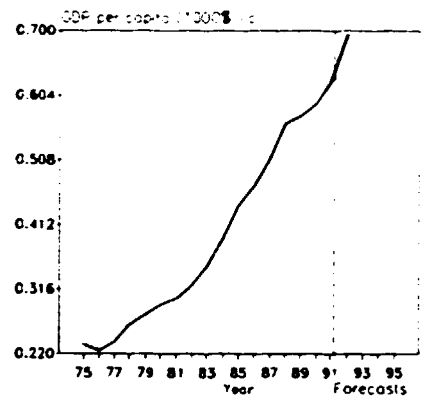
Industrial structural change
(Index of value added 1980=100)

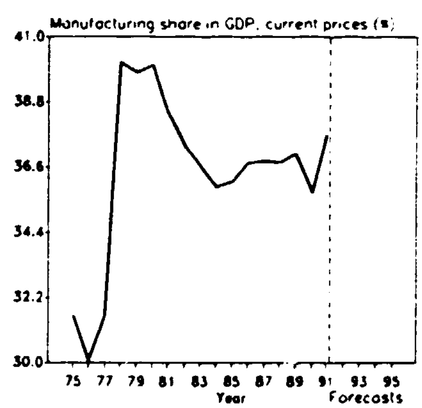


Annual growth rates of GDP and MVA
(Constant 1980 prices)



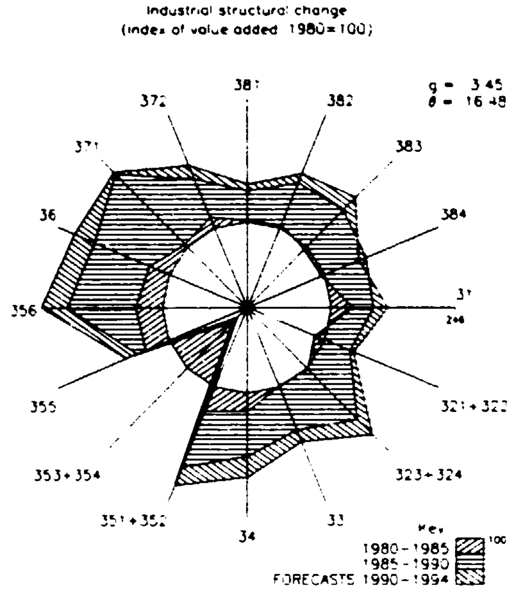
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	286716	459012	562193
Per capita (1980-dollars) /na.c	293	441	592
Manufacturing share (%) /na (current factor prices)	40.1	36.1	35.7
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	107146 /e	171761	275032
Industrial production index	...		
Value added (millions of dollars)	88577 /e	78380	90259
Gross output (millions of dollars)	232460 /e	246331	349604
Employment (thousands)	24390	29743	33950
-PROFITABILITY: (in percent of gross output			
Intermediate input (%)	62 /e	68	74
Wages and salaries including supplements (%)	6 /e	5	5 /e
Gross operating surplus (%)	32 /e	27	21 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	9531 /e	8282	10298
Value added / worker	3632 /e	2635	2659
Average wage (including supplements)	548	384	500 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.37 /e	5.91 /e	3.30
as a percentage of average θ in 1970-1975	122 /e	305 /e	170
MVA growth rate / θ	1.42	1.23	0.78
Degree of specialization	14.0	10.8	10.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	3764 /e	3433	4489
313 Beverages	1587 /e	1696	2414
314 Tobacco products	3545	3999	6220
321 Textiles	13409	8587	10299
322 Wearing apparel	1866a	1716a	2109a
323 Leather and fur products	911	747	944
324 Footwear	a	a	a
331 Wood and wood products	751 /e	591	502
332 Furniture and fixtures	653 /e	514	455
341 Paper and paper products	1929 /e	1532	1949
342 Printing and publishing	1042	960	1036
351 Industrial chemicals	7125	5584	8459
352 Other chemical products	2924	2292	3372
353 Petroleum refineries	4223	3676	2714
354 Miscellaneous petroleum and coal products	154 /e	183	208
355 Rubber products	2175	1593	1603
356 Plastic products	[illegible]	1317	1736
361 Pottery, china and earthenware	459	431	504
362 Glass and glass products	838	822	705
369 Other non-metal mineral products	4425	4340	4524
371 Iron and steel	6538 /e	5810	6571
372 Non-ferrous metals	1868 /e	1730	2050
381 Metal products	4861	2582	2946
382 Non-electrical machinery	13418	10941	10116
383 Electrical machinery	3216	6458	7445
384 Transport equipment	3013	4134	3918
385 Professional and scientific equipment	810	1021	843
390 Other manufacturing industries	1838 /e	1691	2125

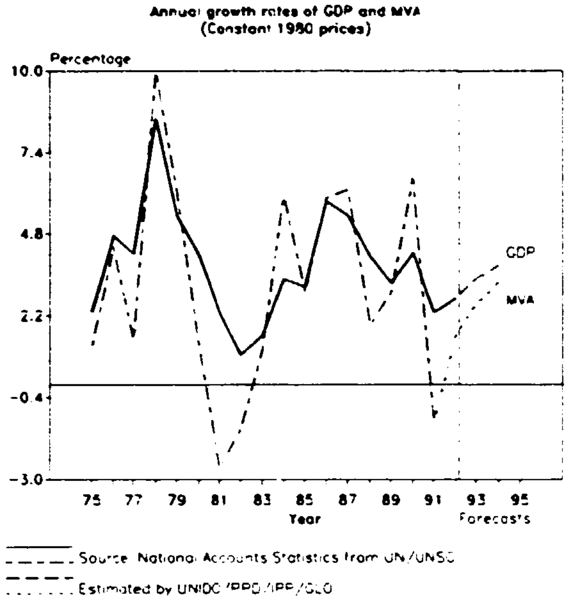




For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

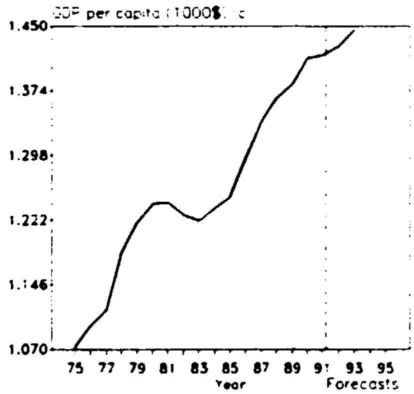
COLOMBIA

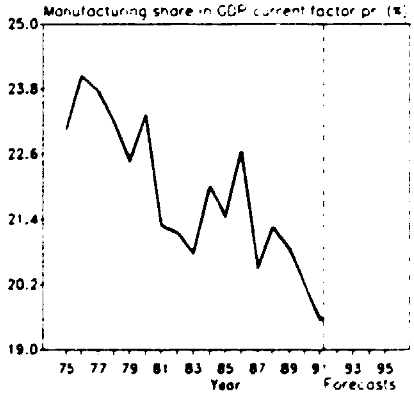


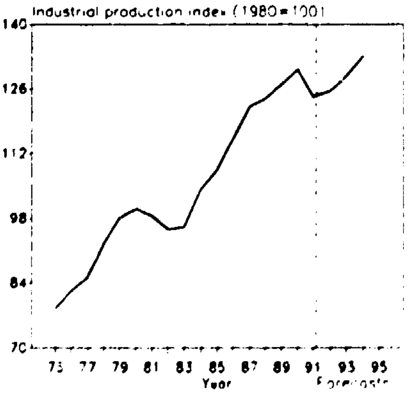


	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	33400	37325	46589
Per capita (1980-dollars) /na.c	1241	1249	1412
Manufacturing share (%) /na (current factor prices)	23.3	21.4	20.2
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	7772	8230	10354
Industrial production index	100	108	130
Value added (millions of dollars)	7131	6711	8250 /e
Gross output (millions of dollars)	16453	16814	21249 /e
Employment (thousands)	508	440	486 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	57	60	61 /e
Wages and salaries including supplements (%)	8	7	6 /e
Gross operating surplus (%)	35	33	33 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	31860	37516	42936 /e
Value added / worker	13809	15013	16671 /e
Average wage (including supplements)	2583	2708	2467 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	8.39	6.18	6.49 /e
as a percentage of average θ in 1970-1975	129	95	100 /e
MVA growth rate / θ	0.86	0.15	[illegible]
Degree of specialization	14.6	14.7	12.9
-VALUE ADDED: (millions of dollars)			
311/2 Food products	951	1166	1324 /e
313 Beverages	1021	1032	1002 /e
314 Tobacco products	160	224	175 /e
321 Textiles	803	619	838 /e
322 Wearing apparel	241	205	247 /e
323 Leather and fur products	59	47	61 /e
324 Footwear	50	54	98 /e
331 Wood and wood products	50	46	62 /e
332 Furniture and fixtures	34	29	40 /e
341 Paper and paper products	227	274	313 /e
342 Printing and publishing	185	180	250 /e
351 Industrial chemicals	303	405	552 /e
352 Other chemical products	419	457	592 /e
353 Petroleum refineries	773	90	107 /e
354 Miscellaneous petroleum and coal products	17	28	46 /e
355 Rubber products	117	138	131 /e
356 Plastic products	141	169	238 /e
361 Pottery, china and earthenware	44	46	61 /e
362 Glass and glass products	76	92	106 /e
369 Other non-metal mineral products	232	264	378 /e
371 Iron and steel	217	205	377 /e
372 Non-ferrous metals	34	36	44 /e
381 Metal products	260	242	278 /e
382 Non-electrical machinery	120	114	148 /e
383 Electrical machinery	244	211	309 /e
384 Transport equipment	256	221	306 /e
385 Professional and scientific equ[illegible]	26	38	77 /e
390 Other manufacturing industries	72	78	[illegible] /e

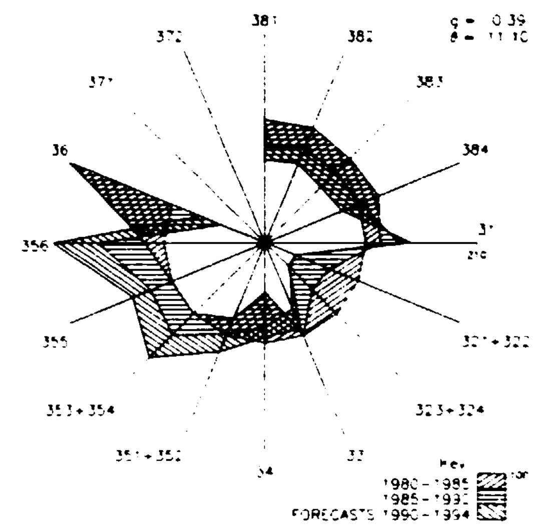
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



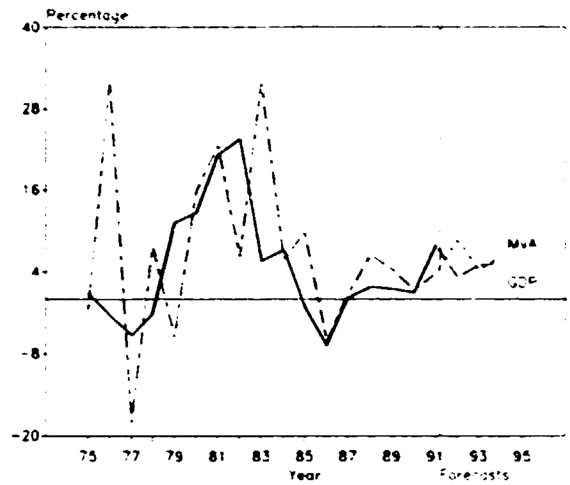




Industrial structural change
(index of value added 1980=100)



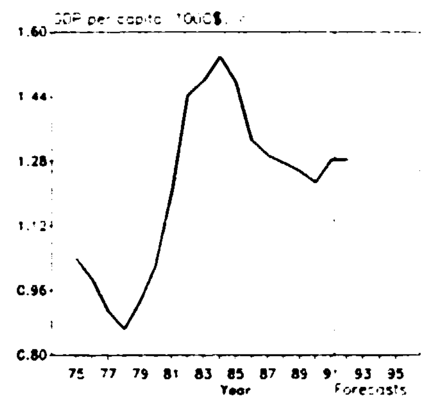
Annual growth rates of GDP and MVA
(Constant 1980 prices)



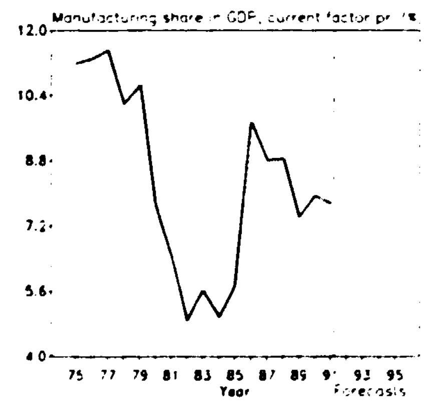
	1980		1985		1990	
GDP: (n.a.c., millions of 1980-dollars)	1706		2360		2784	
Per capita (1980-dollars) (n.a.c.)	1022		1474		1227	
Manufacturing share (%) (n.a., current factor prices)	7.7		5.7		7.9	
MANUFACTURING:						
Value added (n.a.c., millions of 1980-dollars)	128		256		272	
Industrial production index	100		183		155	
Value added (millions of dollars)	69	e	57		104	e
Gross output (millions of dollars)	193	e	154		276	e
Employment (thousands)	5	e	9		8	e
-PROFITABILITY: (in percent of gross output)						
Intermediate input (%)	64	e	63		62	e
Wages and salaries including supplements (%)	15	e	17	e	15	e
Gross operating surplus (%)	20	e	20	e	22	e
-PRODUCTIVITY: (dollars)						
Gross output / worker	16482	e	17590		34628	e
Value added / worker	5895	e	6525		13059	e
Average wage (including supplements)	5463	e	3032	e	5320	e
-STRUCTURAL INDICES:						
Structural change θ (5-year average in degrees)	6.72	e	11.49	e	6.45	e
as a percentage of average θ in 1970-1975	63	e	108	e	61	e
MVA growth rate θ	-0.60		0.17		0.05	
Degree of specialization	15.3		17.3		23.2	
-VALUE ADDED: (millions of dollars)						
311/2 Food products	11	e	10		23	e
313 Beverages	12	e	11		24	e
314 Tobacco products	3	e	3		9	e
321 Textiles	4	e	2	e	2	e
322 Wearing apparel	1	e	1	e	1	e
323 Leather and fur products	-	e	-	e	-	e
324 Footwear	3	e	2		2	e
331 Wood and wood products	7	e	5	e	7	e
332 Furniture and fixtures	4	e	3	e	4	e
341 Paper and paper products	1	e	-		1	e
342 Printing and publishing	1	e	-		1	e
351 Industrial chemicals	5	e	4	e	8	e
352 Other chemical products	3	e	2	e	4	e
353 Petroleum refineries	1	e	1	e	2	e
354 Miscellaneous petroleum and coal products	-	e	-	e	-	e
355 Rubber products	1	e	1	e	1	e
356 Plastic products		e	-	e	1	e
361 Pottery, china and earthenware	1	e	2	e	1	e
362 Glass and glass products	-	e	-	e	-	e
369 Other non-metal mineral products	-	e	-	e	-	e
371 Iron and steel	-	e	-		-	e
372 Non-ferrous metals	-	e	-		-	e
381 Metal products	4	e	4	e	5	e
382 Non-electrical machinery	1	e	1	e	2	e
383 Electrical machinery	2	e	2	e	2	e
384 Transport equipment	3	e	2		3	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

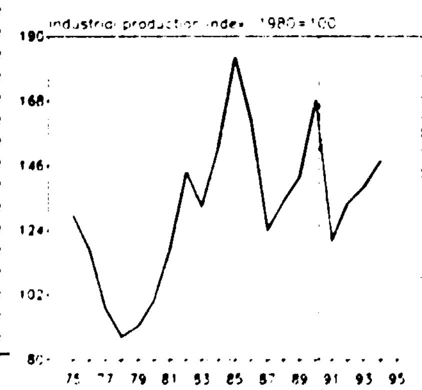
GDP per capita (1000$)

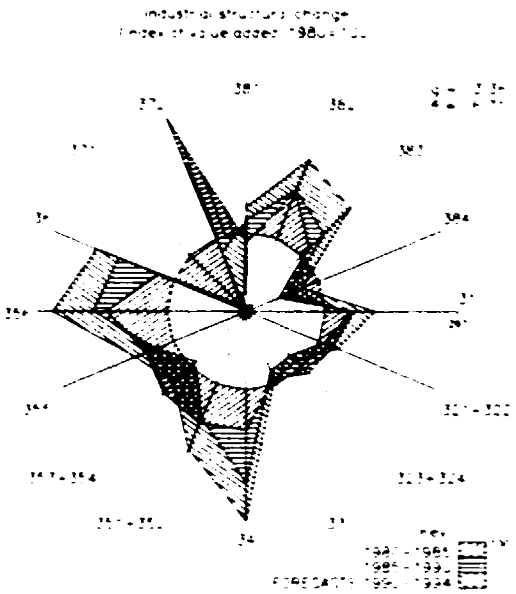


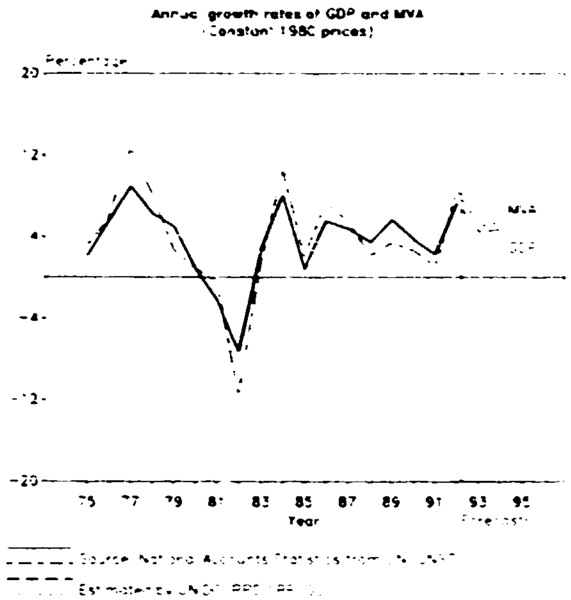
Manufacturing share in GDP, current factor pr. (%)



Industrial production index (1980=100)

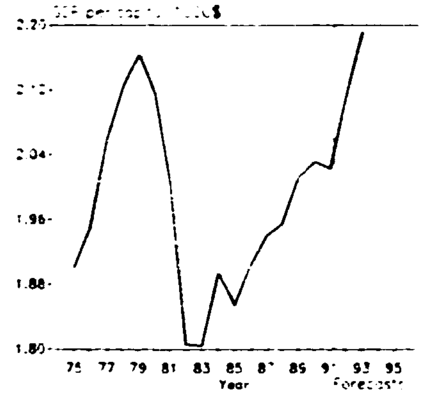


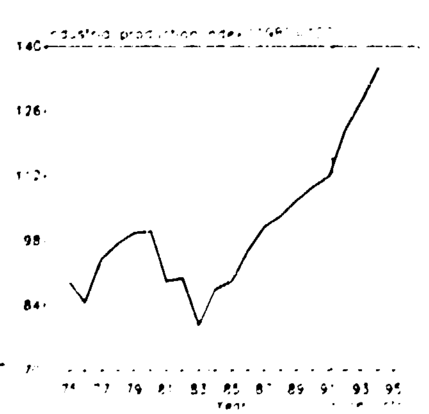




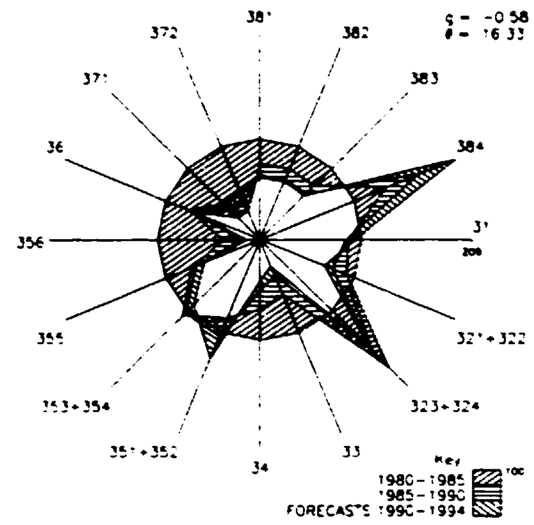
	1980		1985		1990	
GDP: in millions of 1980-dollars	4832		4900		6136	
Per capita (1980-dollars)	2114		1864		2031	
Manufacturing share (%) current factor prices	19.4		21.9		19.9	
MANUFACTURING:						
Value added in millions of 1980-dollars	899		908		1014	
Industrial production index	100		99		112	
Value added (millions of dollars)	788		762		926	
Gross output (millions of dollars)	2743		2468		3183	
Employment (thousands)	64	e	104		134	
-PROFITABILITY: in percent of gross output						
Intermediate input (%)	71		69		71	
Wages and salaries including supplements (%)	12		11		11	
Gross operating surplus (%)	17		20		18	
-PRODUCTIVITY: dollars						
Gross output / worker	35932	e	23757		23827	
Value added / worker	10532	e	7338		6923	
Average wage (including supplements)	4915	e	2569		2711	
-STRUCTURAL INDICES:						
Structural change θ (5-year average in degrees)	2.35		7.04		3.35	
as a percentage of average θ in 1970-1975	81		201		96	
MVA growth rate (θ)	1.02		0.77		0.07	
Degree of specialization	20.4		21.4		21.8	
-VALUE ADDED: millions of dollars						
311/2 Food products	241		247		286	
313 Beverages	96		94		122	
314 Tobacco products	24		28		30	
321 Textiles	33		23		31	
322 Wearing apparel	31		34		31	
323 Leather and fur products	7		5		5	
324 Footwear	10		9		7	
331 Wood and wood products	30		25		21	
332 Furniture and fixtures	26		14		21	
341 Paper and paper products	20		22		43	
342 Printing and publishing	18		21		32	
351 Industrial chemicals	19		26		30	
352 Other chemical products	40		42		49	
353 Petroleum refineries	40		45		33	
354 Miscellaneous petroleum and coal products	-		-	e	-	e
355 Rubber products	14		15		16	
356 Plastic products	19		26		34	
361 Pottery, china and earthenware	1		2		3	
362 Glass and glass products	3		7		10	
369 Other non-metal mineral products	25		19		34	
371 Iron and steel	4		-		-	e
372 Non-ferrous metals	1	e	-		1	
381 Metal products	15		12		19	
382 Non-electrical machinery	8		10		13	
383 Electrical machinery	25		21		32	
384 Transport equipment	31		10		16	
385 Professional and scientific equipment			1	e	2	e
390 Other manufacturing industries	2		3		4	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

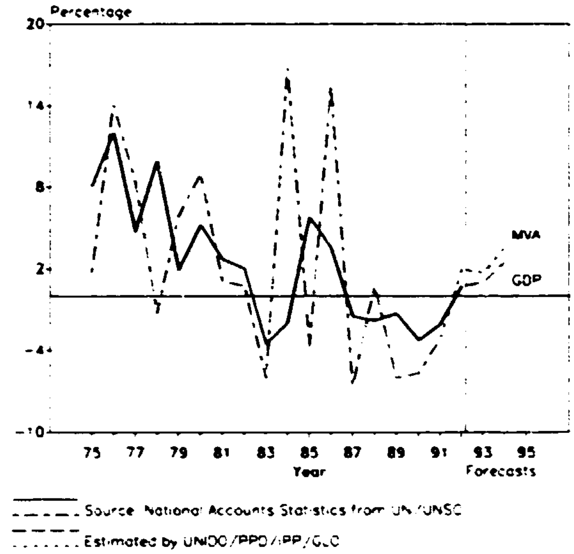




Industrial structural change
(Index of value added 1980=100)

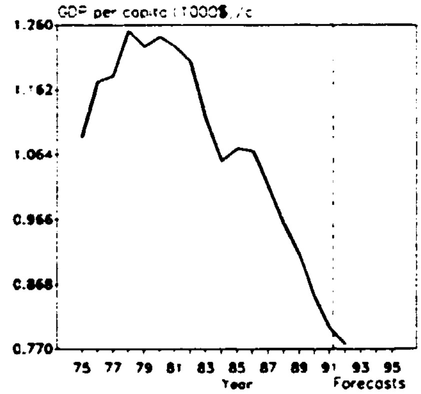


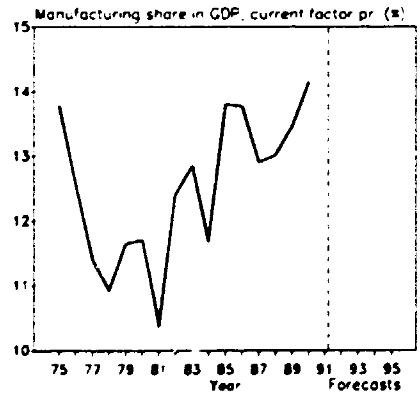
Annual growth rates of GDP and MVA
(Constant 1980 prices)

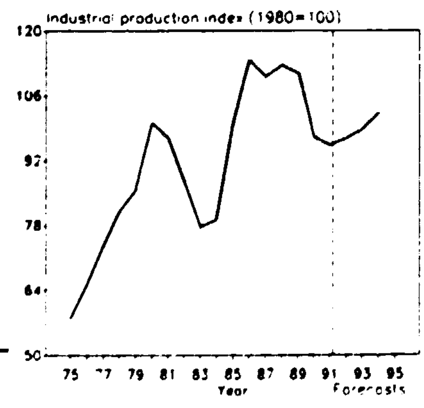


	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	10176	10660	10184
Per capita (1980-dollars) /na.c	1242	1073	849
Manufacturing share (%) /na (current factor prices)	11.7	13.8	14.1 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1141	1226	1178
Industrial production index	100	100	97
Value added (millions of dollars)	1273	719 /e	1409 /e
Gross output (millions of dollars)	4006	2869 /e	5423 /e
Employment (thousands)	67	55 /e	51 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	58	75 /e	74 /e
Wages and salaries including supplements (%)	10 /e	9 /e	7 /e
Gross operating surplus (%)	22 /e	16 /e	19 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	59631	51722 /e	104503 /e
Value added / worker	18950	12964 /e	27184 /e
Average wage (including supplements)	574. e	4026 /e	7859 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.82 /e	4.11 /e	2.76 /e
as a percentage of average θ in 1970-1975	82 /e	43 /e	29 /e
MVA growth rate / θ	0.77	-0.32	-0.18
Degree of specialization	23.5	26.1	27.7
-VALUE ADDED: (millions of dollars)			
311/2 Food products	303 /e	171 /e	339 /e
313 Beverages	75	35 /e	68 /e
314 Tobacco products	66 /e	32 /e	59 /e
321 Textiles	169 /e	97 /e	162 /e
322 Wearing apparel	8 /e	5 /e	8 /e
323 Leather and fur products	5 /e	6 /e	12 /e
324 Footwear	5 /e	6 /e	7 /e
331 Wood and wood products	67 /e	24 /e	32 /e
332 Furniture and fixtures	21 /e	8 /e	11 /e
341 Paper and paper products	14 /e	7 /e	10 /e
342 Printing and publishing	22 /e	9 /e	13 /e
351 Industrial chemicals	22 /e	10 /e	18 /e
352 Other chemical products	53 /e	29 /e	80 /e
353 Petroleum refineries	181 /e	119 /e	233 /e
354 Miscellaneous petroleum and coal products	- /e	- /e	- /e
355 Rubber products	4	2 /e	4 /e
356 Plastic products	1 /e	- /e	- /e
361 Pottery, china and earthenware	2 /e	1 /e	2 /e
362 Glass and glass products	- /e	- /e	- /e
369 Other non-metal mineral products	27 /e	12 /e	26 /e
371 Iron and steel	5 /e	1 /e	3 /e
372 Non-ferrous metals	3 /e	1 /e	2 /e
381 Metal products	70	33 /e	56 /e
382 Non-electrical machinery	3	1 /e	2 /e
383 Electrical machinery	20	9 /e	16 /e
384 Transport equipment	106	88 /e	223 /e
385 Professional and scientific equipment	-	- /e	- /e
390 Other manufacturing industries	20	14 /e	23 /e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex







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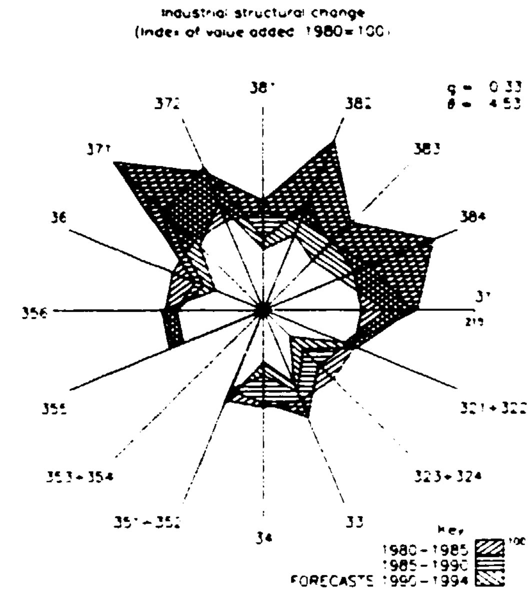
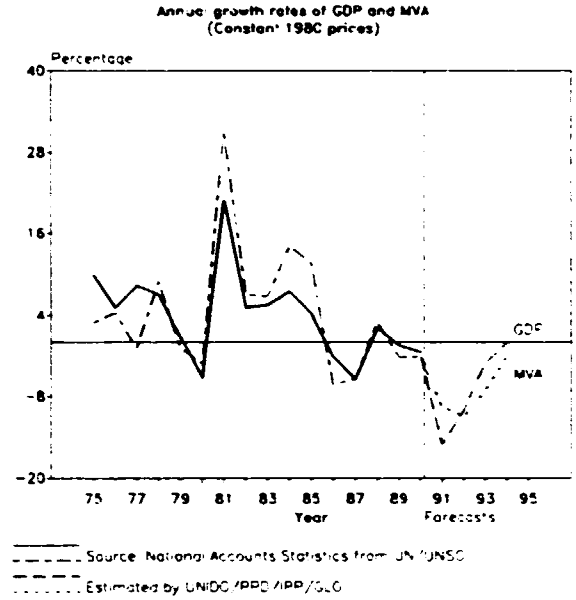
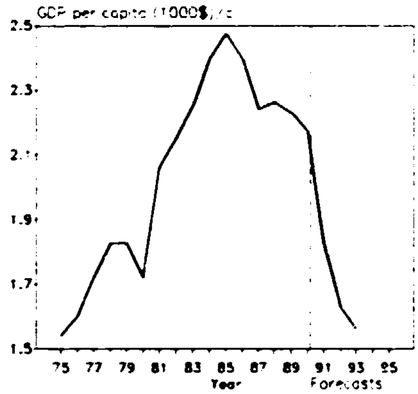
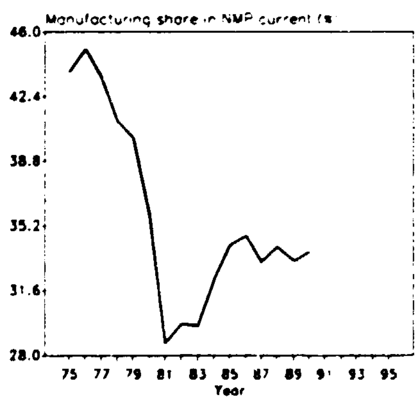


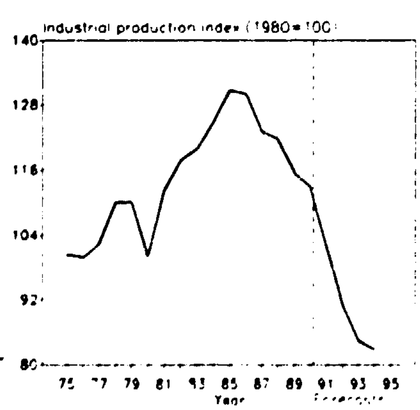


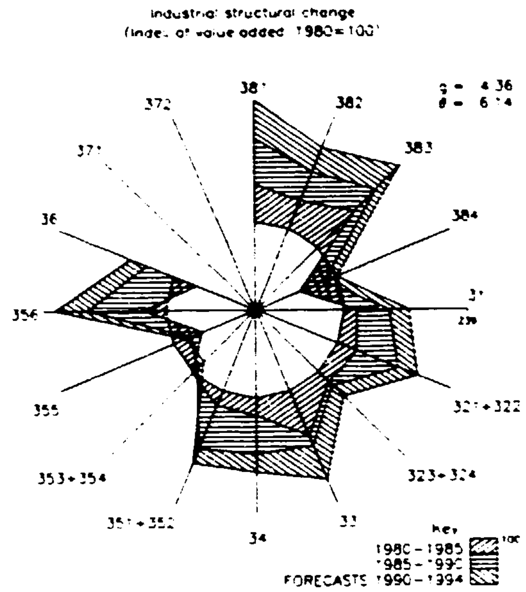
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	16653	24937	23051
Per capita (1980-dollars) /na.c	1721	2474	2172
Manufacturing share (%) /na (current factor prices)	35 8	34 1	33 8 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	5735	10905	9523
Industrial production index	100	131	113
Value added (millions of dollars)	4882	5120	5990 /e
Gross output (millions of dollars)	9725	12032	15644 /e
Employment (thousands)	501	654	709 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	50	57	62 /e
Wages and salaries including supplements (%)	13 /e	14 /e	14 /e
Gross operating surplus (%)	37 /e	29 /e	24 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	18444	17225	20658 /e
Value added / worker	6135	4757	8011 /e
Average wage (including supplements)	2606 /e	2514 /e	3199 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2 67 /e	3 51	3 45 /e
as a percentage of average θ in 1970-1975	171 /e	225	221 /e
MVA growth rate / θ	-0 11	1 95	-0 54
Degree of specialization	25 8	31 3	34 7
-VALUE ADDED: (millions of dollars)			
311/2 Food products	555	957	1033 /e
313 Beverages	246	273	358 /e
314 Tobacco products	1805	2004	2629 /e
321 Textiles	50	40	109 /e
322 Wearing apparel	146	98	88 /e
323 Leather and fur products	53	32	29 /e
324 Footwear	79	48	45 /e
331 Wood and wood products	58	53	52 /e
332 Furniture and fixtures	48	43	42 /e
341 Paper and paper products	46	44	13 /e
342 Printing and publishing	96	59	81 /e
351 Industrial chemicals	79 /e	54 /e	68 /e
352 Other chemical products	331 /e	225 /e	286 /e
353 Petroleum refineries			
354 Miscellaneous petroleum and coal products			
355 Rubber products	96 /e	65 /e	83 /e
355 Plastic products	83 /e	57 /e	72 /e
361 Pottery, china and earthenware	8	6	8 /e
362 Glass and glass products	17	13	19 /e
369 Other non-metal mineral products	188	104	112 /e
371 Iron and steel	27	44	37 /e
372 Non-ferrous metals	41	48	64 /e
381 Metal products	108	92	78 /e
382 Non-electrical machinery	153 /e	219 /e	176 /e
383 Electrical machinery	60	58	57 /e
384 Transport equipment	197 /e	281 /e	225 /e
385 Professional and scientific equipment	11 /e	16 /e	13 /e
390 Other manufacturing industries	201	188	213 /e

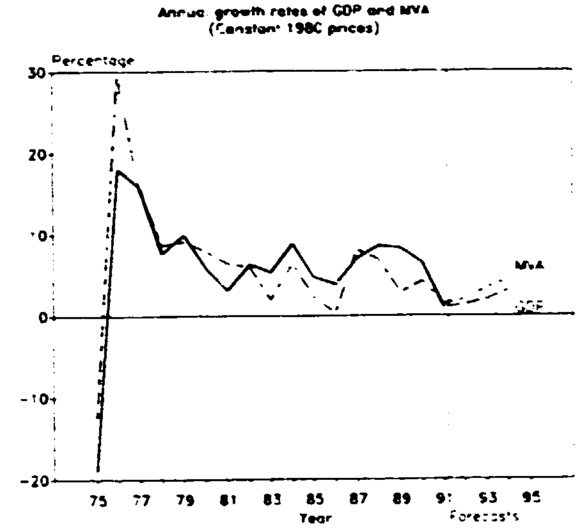
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex







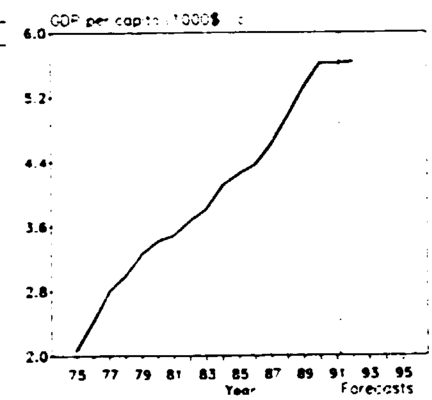


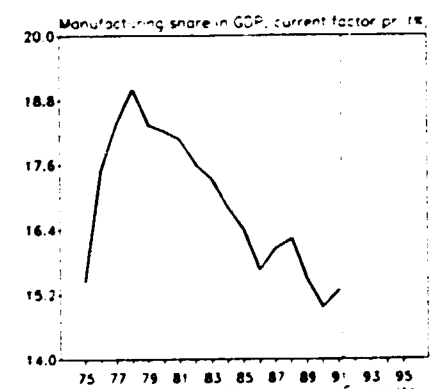


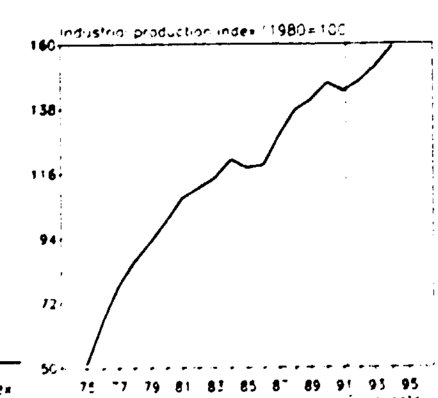
Source: National Accounts Statistics from UN/UNSO
Estimated by UNIDO/PPD/IPP/GLO

	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	2154	2831	3935
Per capita (1980-dollars) /na.c	3419	4251	5614
Manufacturing share (%) /na (current factor prices)	18.2	16.4	15.0
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	378	473	586
Industrial production index	100	118	147
Value added (millions of dollars)	406	378	792
Gross output (millions of dollars)	1134	1122	2196
Employment (thousands)	34	39	43
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	66	64
Wages and salaries including supplements (%)	15 /e	18	19
Gross operating surplus (%)	21 /e	16	17
-PRODUCTIVITY: (dollars)			
Gross output / worker	29417	25804	46057
Value added / worker	10525	8697	16606
Average wage (including supplements)	5063 /e	5143	9738
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.28	4.59	3.81
as a percentage of average θ in 1970-1975	101	64	53
MVA growth rate / θ	3.03	0.70	1.61
Degree of specialization	11.3	11.7	13.3
-VALUE ADDED: millions of dollars			
311/2 Food products	42	49	101
313 Beverages	37	29	73
314 Tobacco products	36	26	41
321 Textiles	16	14	32
322 Wearing apparel	53	54	118
323 Leather and fur products	5	6	11
324 Footwear	21	19	30
331 Wood and wood products	19	23	39
332 Furniture and fixtures	17	22	35
341 Paper and paper products	11	8	17
342 Printing and publishing	15	18	37
351 Industrial chemicals	3	2	3
352 Other chemical products	12	12	28
353 Petroleum refineries	6	5	7
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	3	2	3
356 Plastic products	11	11	25
361 Pottery, china and earthenware	-	1	2
362 Glass and glass products	-	-	1
369 Other non-metal mineral products	44	24	69
371 Iron and steel	-	-	-
372 Non-ferrous metals	.	-	-
381 Metal products	23	26	55
382 Non-electrical machinery	11	12	24
383 Electrical machinery	5	6	12
384 Transport equipment	8	4	9
385 Professional and scientific equipment	-	-	-
390 Other manufacturing industries	7	7	13

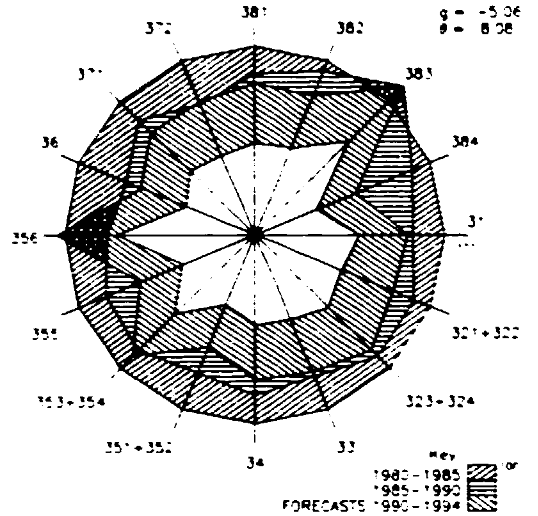
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



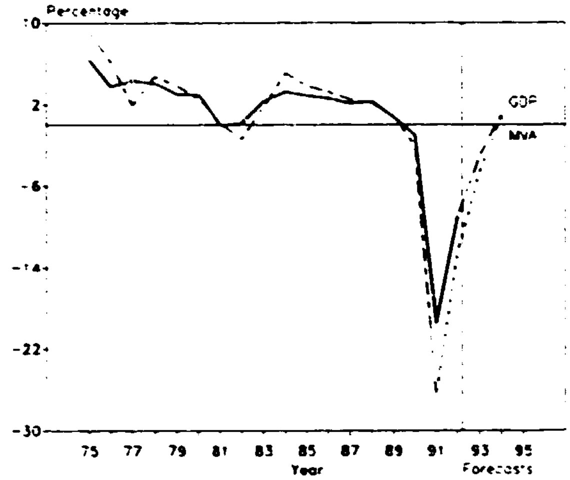




Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

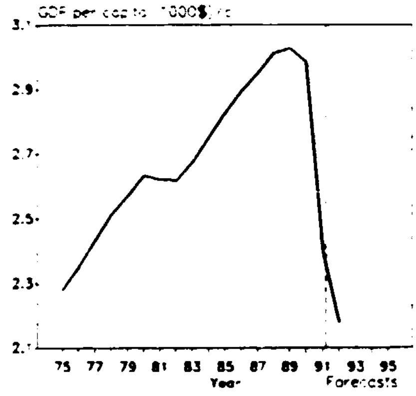


Source: National Accounts Statistics from UN/UNSO
Estimated by UNIDO/IPPD/IPP/GLO

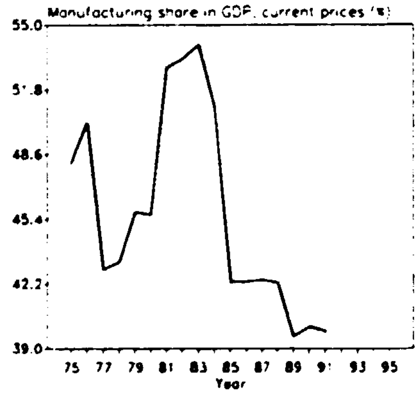
	1980	1985	1990
GDP: (na.c. millions of 1980-dollars)	40327	43826	46773
Per capita (1980-dollars) (na.c)	2634	2827	2986
Manufacturing share (%) (na) (current factor prices)	45.6	42.3	40.1
MANUFACTURING:			
Value added (na.c. millions of 1980-dollars)	22261	24404	26006
Industrial production index	100	121	130
Value added (millions of dollars)	17194	13083	12471
Gross output (millions of dollars)	41415	45108	44915
Employment (thousands)	2518	2588	2448
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	58	71	72
Wages and salaries including supplements (%)	15	13	13
Gross operating surplus (%)	27	16	15
-PRODUCTIVITY: (dollars)			
Gross output / worker	16448	17430	18348
Value added / worker	6828	5055	5094
Average wage (including supplements)	2438	2264	2396
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.32	2.96	4.37
as a percentage of average θ in 1970-1975	91	81	119
MVA growth rate / θ	2.35	-0.71	-0.52
Degree of specialization	15.9	17.0	14.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1257	911	916
313 Beverages	285	209	258
314 Tobacco products	33	23	24
321 Textiles	1100	848	790
322 Wearing apparel	271	236	223
323 Leather and fur products	94	69	66
324 Footwear	299	244	256
331 Wood and wood products	387	259	289
332 Furniture and fixtures	210	162	154
341 Paper and paper products	391	287	255
342 Printing and publishing	136	103	127
351 Industrial chemicals	1262	862	698
352 Other chemical products	178	130	177
353 Petroleum refineries	497	390	316
354 Miscellaneous petroleum and coal products	120	74	209
355 Rubber products	214	158	131
356 Plastic products	50	34	49
361 Pottery, china and earthenware	45	39	46
362 Glass and glass products	422	263	298
369 Other non-metal mineral products	773	488	411
371 Iron and steel	1753	1312	1271
372 Non-ferrous metals	327	214	236
381 Metal products	792	590	632
382 Non-electrical machinery	3452	2827	2597
383 Electrical machinery	853	828	894
384 Transport equipment	1677	1315	903
385 Professional and scientific equipment	94	67	84
390 Other manufacturing industries	223	140	192

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

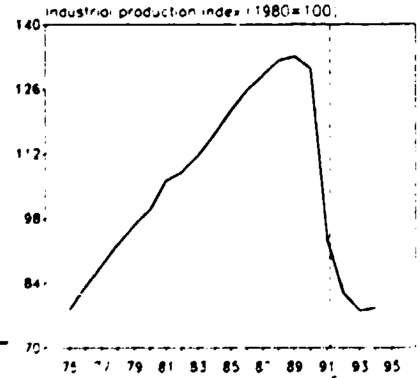
GDP per capita (1000$)(c)

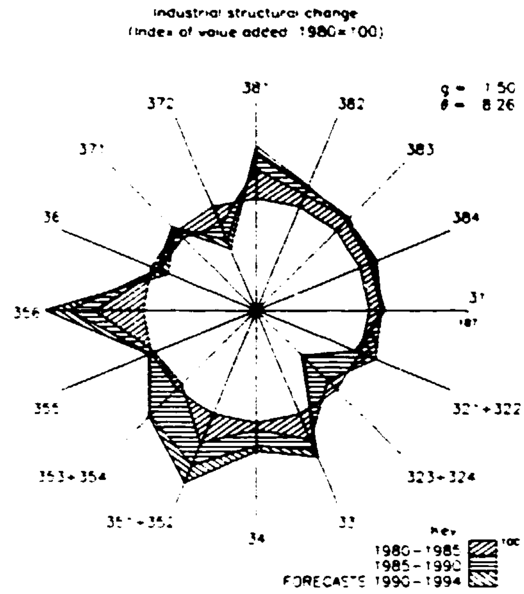


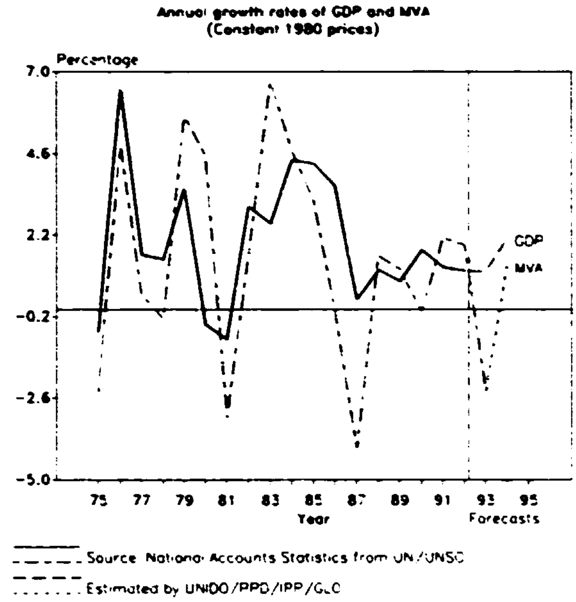
Manufacturing share in GDP, current prices (%)



Industrial production index (1980=100)

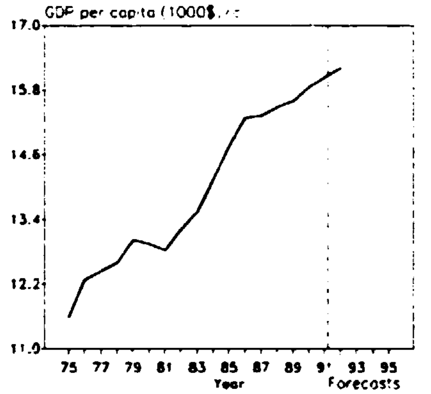


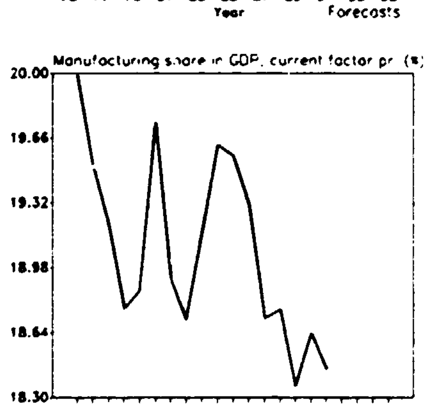


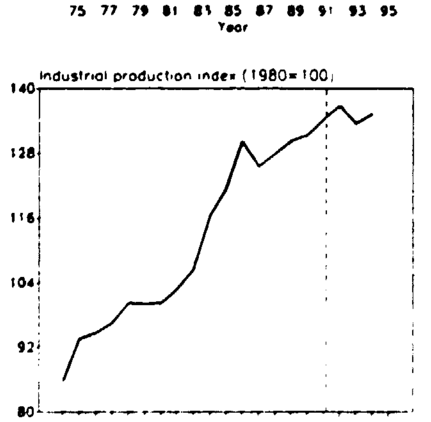


	1980	1985	1990
GDP: (na.c millions of 1980-dollars)	66321	75577	81529
Per capita (1980-dollars) (na.c	12943	14752	15853
Manufacturing share (%) (na (current factor prices)	19 7	19 6	18 6
MANUFACTURING:			
Value added (na.c (millions of 1980-dollars)	11411	12938	12746
Industrial production index	100	121	131
Value added (millions of dollars)	12774	11184	24593
Gross output (millions of dollars)	31526	27652	56712
Employment (thousands)	381	405	391
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	60	57
Wages and salaries including supplements (%)	24	22	23 /e
Gross operating surplus (%)	17	18	21 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	82313	68092	144739
Value added / worker	33351	27541	62773
Average wage (including supplements)	19697	15021	33096 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.95	2 95	2 00
as a percentage of average θ in 1970-1975	101	101	69
MVA growth rate / θ	0 92	0.91	0 51
Degree of specialization	14 4	14 9	15 0
-VALUE ADDED: (millions of dollars)			
311/2 Food products	2344	2022	4276
313 Beverages	490	386	756
314 Tobacco products	109	96	205
321 Textiles	423	375	706
322 Wearing apparel	231	199	293
323 Leather and fur products	30	20	15
324 Footwear	62	43	74
331 Wood and wood products	285	219	549
332 Furniture and fixtures	330	371	781
341 Paper and paper products	315	275	659
342 Printing and publishing	941	752	1773
351 Industrial chemicals	551	498	1142
352 Other chemical products	586	618	1586
353 Petroleum refineries	65	55	127
354 Miscellaneous petroleum and coal products	99	63	223
355 Rubber products	79	59	129
356 Plastic products	267	297	714
361 Pottery, china and earthenware	87	41	74
362 Glass and glass products	98	60	118
369 Other non-metal mineral products	627	478	1040
371 Iron and steel	175	124	295
372 Non-ferrous metals	71	45	76
381 Metal products	912	882	2030
382 Non-electrical machinery	1718	1475	3242
383 Electrical machinery	712	631	1337
384 Transport equipment	663	589	1162
385 Professional and scientific equipment	284	304	643
390 Other manufacturing industries	219	211	559

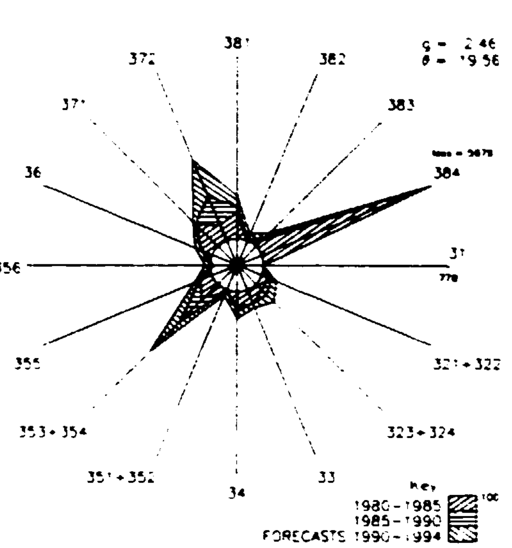
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



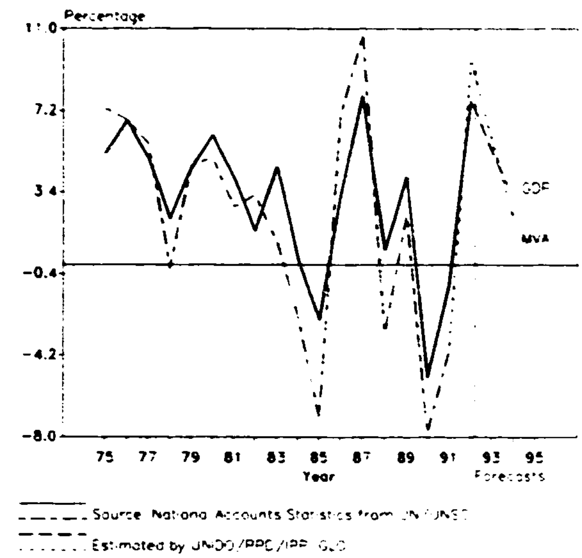




Industrial structural change
(index of value added 1980=100)

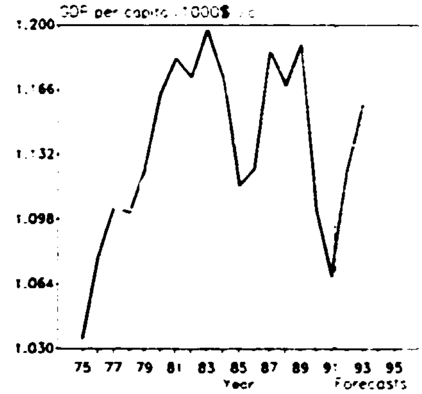


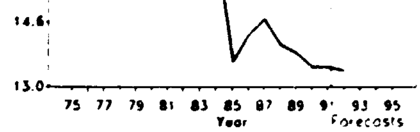
Annual growth rates of GDP and MVA
(Constant 1980 prices)

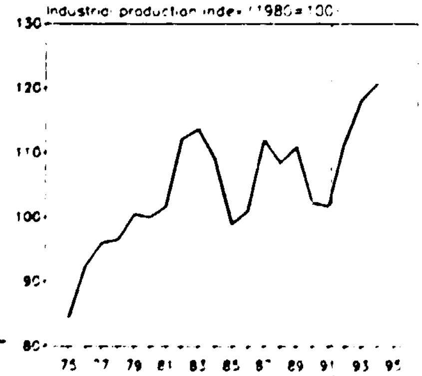


	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	6631	7159	7913
Per capita (1980-dollars) /na.c	1164	1116	1102
Manufacturing share (%) /na (current factor prices)	15 3	13 6	13 5
MANUFACTURING.			
Value added /na.c (millions of 1980-dollars)	1015	986	1067
Industrial production index	100	99	102
Value added (millions of dollars)	1013	783 /e	1293 /e
Gross output (millions of dollars)	2376	1822 /e	3034 /e
Employment (thousands)	146	131	139 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	57	57 /e	57 /e
Wages and salaries including supplements (%)	11	7 /e	6 /e
Gross operating surplus (%)	31	36 /e	37 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	16284	13877 /e	21898 /e
Value added / worker	6940	5966 /e	9373 /e
Average wage (including supplements)	1867	398	1248 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2 23	3 13 /e	2 30 /e
as a percentage of average θ in 1970-1975	67	94 /e	59 /e
MVA growth rate / θ	-0 63	0 93	0 59
Degree of specialization	39 0	30.5	28 9
-VALUE ADDED: (millions of dollars)			
311/2 Food products	510	293 /e	414 /e
313 Beverages	103	110 /e	179 /e
314 Tobacco products	50	42 /e	67 /e
321 Textiles	29	26 /e	45 /e
322 Wearing apparel	13	9 /e	16 /e
323 Leather and fur products	11	8 /e	14 /e
324 Footwear	13	13 /e	25 /e
331 Wood and wood products	2	3 /e	2 /e
332 Furniture and fixtures	11	11 /e	19 /e
341 Paper and paper products	19	21 /e	37 /e
342 Printing and publishing	14	13 /e	22 /e
351 Industrial chemicals	18	16 /e	21 /e
352 Other chemical products	41	27 /e	44 /e
353 Petroleum refineries	66	81 /e	209 /e
354 Miscellaneous petroleum and coal products	1	- /e	1 /e
355 Rubber products	6	6 /e	10 /e
356 Plastic products	21	12 /e	21 /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	29 /e	46 /e
371 Iron and steel	10	15 /e	24 /e
372 Non-ferrous metals	1	1 /e	3 /e
381 Metal products	21	28 /e	48 /e
382 Non-electrical machinery	5	3 /e	6 /e
383 Electrical machinery	7	6 /e	11 /e
384 Transport equipment	- /e	- /e	1 /e
385 Professional and scientific equipment	1	1 /e	2 /e
390 Other manufacturing industries	2	1 /e	3 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex







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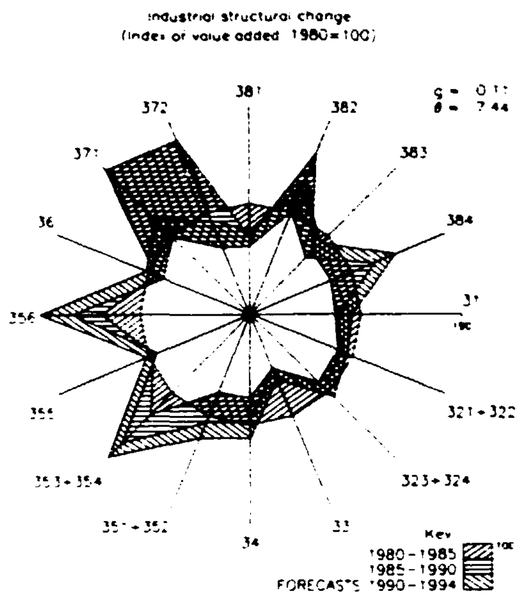
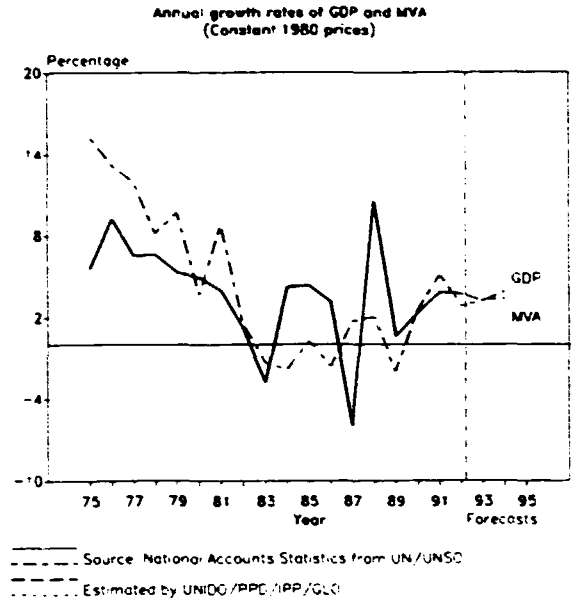
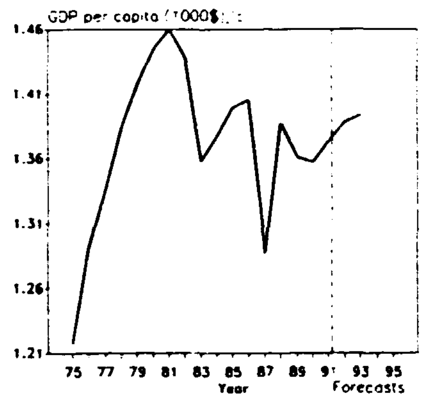
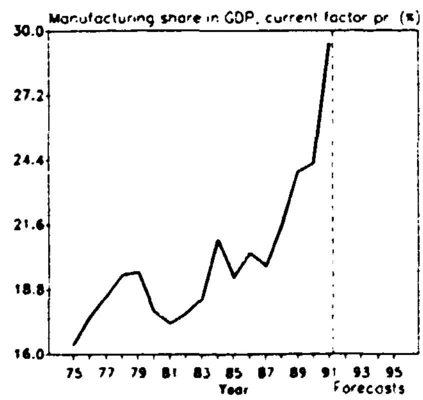


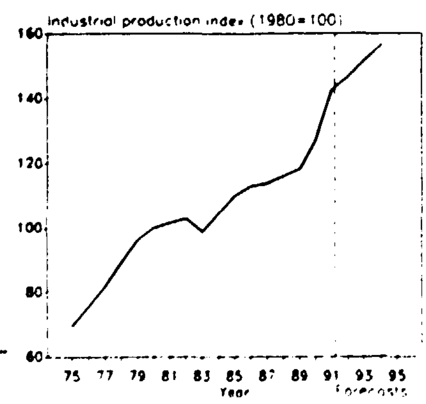


	1980	1985	1990
GDP: (na.c. millions of 1980-dollars)	11733	13040	14383
Per capita (1980-dollars) (na.c	1444	1399	1357
Manufacturing share (%) (na) (current factor prices	17.8	19.3	24.2
MANUFACTURING:			
Value added (na.c. millions of 1980-dollars)	2072	2219	2278
Industrial production index	100	110	127
Value added (millions of dollars)	1289	1322	860
Gross output (millions of dollars)	3571	4379	3934
Employment (thousands)	112	97	112
-PROFITABILITY: (in percent of gross output			
Intermediate input (%)	64	70	78
Wages and salaries including supplements (%)	16 /e	13	9 /e
Gross operating surplus (%)	20 /e	18	13 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	31623	45072	35083
Value added / worker	11414	13606	7666
Average wage (including supplements)	5092 /e	5677	3106 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.08	8.85	6.44
as a percentage of average θ in 1970-1975	221	162	118
MVA growth rate / θ	0.91	-0.23	0.25
Degree of specialization	17.2	16.7	19.7
-VALUE ADDED: (millions of dollars)			
311/2 Food products	294	328	228
313 Beverages	96	65	33
314 Tobacco products	46	17	1
321 Textiles	134	146	95
322 Wearing apparel	20	15	10
323 Leather and fur products	7	6	4
324 Footwear	6	7	6
331 Wood and wood products	35	18	16
332 Furniture and fixtures	28	23	9
341 Paper and paper products	42	41	34
342 Printing and publishing	40	35	27
351 Industrial chemicals	25	32	17
352 Other chemical products	90	76	75
353 Petroleum refineries	29	38	37
354 Miscellaneous petroleum and coal products	4	14	4
355 Rubber products	25	29	17
356 Plastic products	34	57	42
361 Pottery, china and earthenware	7	15	7
362 Glass and glass products	9	15	8
369 Other non-metal mineral products	100	101	60
371 Iron and steel	25	56	19
372 Non-ferrous metals	5	10	2
381 Metal products	93	78	44
382 Non-electrical machinery	4	7	3
383 Electrical machinery	59	58	32
384 Transport equipment	23	23	22
385 Professional and scientific equipment	2	9	3
390 Other manufacturing industries	7	5	3

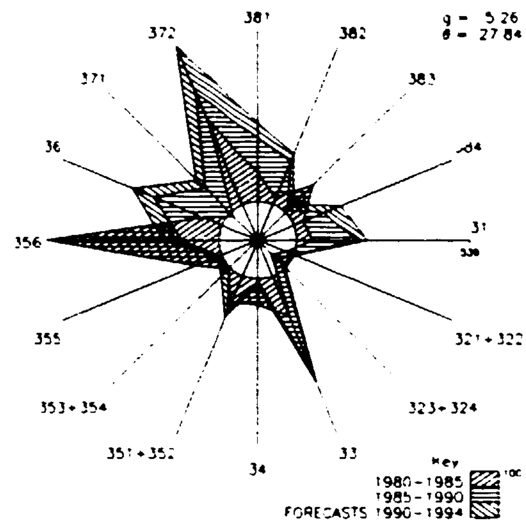
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



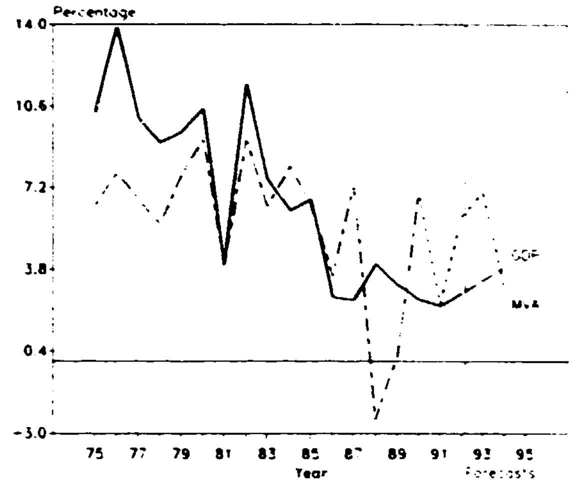




Industrial structural change
(Index of value added 1980=100)



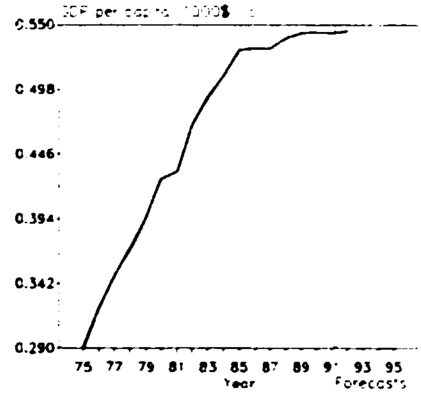
Annual growth rates of GDP and MVA
(Constant 1980 prices)



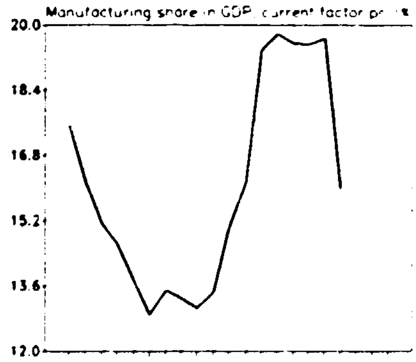
	1980	1985	1990
GDP: (na.c (millions of 1980-dollars)	17433	24646	23538
Per capita (1980-dollars) (na.c	426	530	544
Manufacturing share (%) (na (current factor prices)	12 9	15 0	19 5
MANUFACTURING:			
Value added (na.c (millions of 1980-dollars)	2173	3021	3508
Industrial production index	100	162	156
Value added (millions of dollars)	1769	2938	5036 e
Gross output (millions of dollars)	6986	10141	15976 e
Employment (thousands)	868	917	1019 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	75	71	68 e
Wages and salaries including supplements (%)	17 /e	18 /e	13 e
Gross operating surplus (%)	8 /e	11 /e	18 /e
-PRODUCTIVITY: dollars			
Gross output / worker	7984	10977	15532 e
Value added / worker	2023	3180	4897 e
Average wage (including supplements)	1360 /e	2008 /e	2061 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6 87	15 44	14 93 e
as a percentage of average θ in 1970-1975	98	221	214 e
MVA growth rate θ	0 50	0 32	0 56
Degree of specialization	22 6	15 0	18 4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	[illegible]	421	1102 e
313 Beverages	14	71	97 e
314 Tobacco products	21	131	181 e
321 Textiles	506	509	763 e
322 Wearing apparel	6	15	28 e
323 Leather and fur products	3	7	12 e
324 Footwear	22	9	22 e
331 Wood and wood products	9	24	29 e
332 Furniture and fixtures	7	19	54 e
341 Paper and paper products	42	76	59 e
342 Printing and publishing	39	101	75 e
351 Industrial chemicals	69	145	162 e
352 Other chemical products	87	205	311 e
353 Petroleum refineries	40	59	106 e
354 Miscellaneous petroleum and coal products	61	78	54 e
355 Rubber products	12	28	21 e
356 Plastic products	33	-21	103 e
361 Pottery, china and earthenware	6	12	43 e
362 Glass and glass products	17	22	37 e
369 Other non-metal mineral products	78	167	383 e
371 Iron and steel	88	98	264 e
372 Non-ferrous metals	64	279	414 e
381 Metal products	42	95	174 e
382 Non-electrical machinery	54	83	185 e
383 Electrical machinery	69	181	117 e
384 Transport equipment	65	106	187 /e
385 Professional and scientific equipment	4	13	39 e
390 Other manufacturing industries	1	6	5 e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

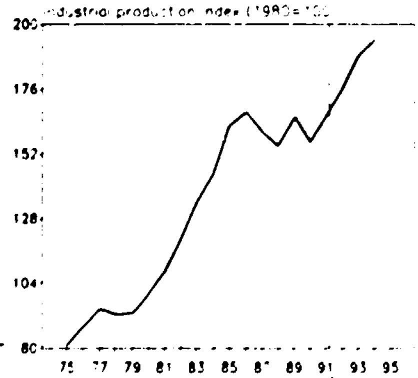
GDP per capita (1000$)



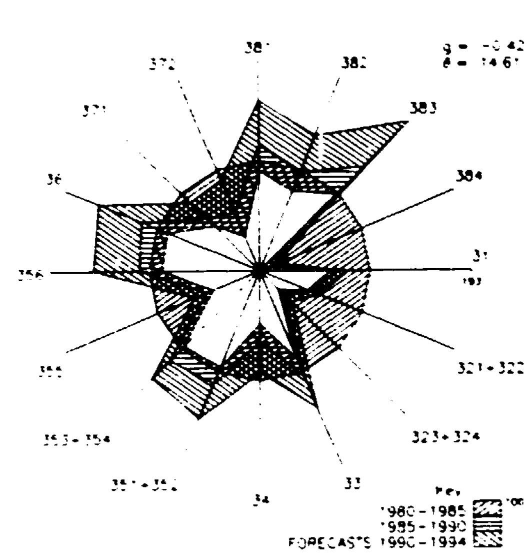
Manufacturing share in GDP (current factor prices)



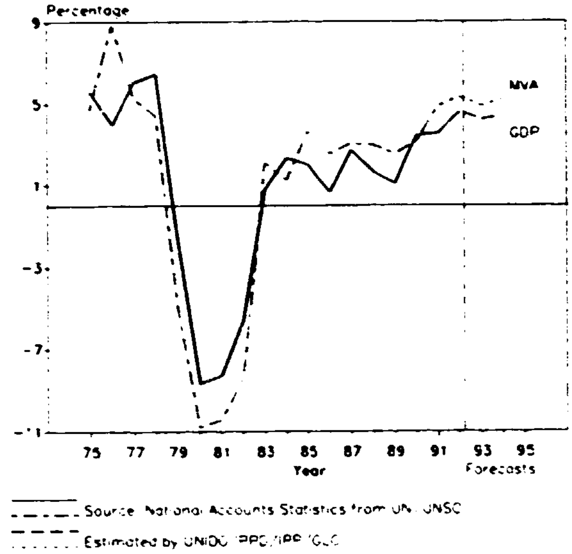
Industrial production index (1980=100)



Industrial structural change (index of value added: 1980 = 100)



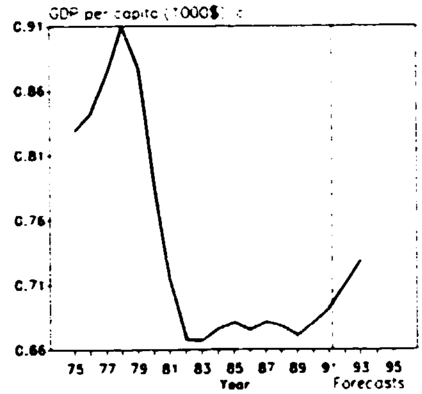
Annual growth rates of GDP and MVA (Constant 1980 prices)



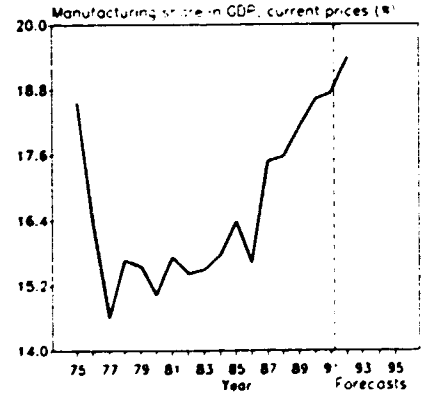
	1980	1985	1990
GDP: (m.a.c. millions of 1980-dollars)	3567	3247	3562
Per capita (1980-dollars, m.a.c.)	788	581	581
Manufacturing share (%) (m.a. current factor prices)	15.0	16.4	18.6
MANUFACTURING:			
Value added (m.a.c. millions of 1980-dollars)	536	471	541
Industrial production index	100	83	95
Value added (millions of dollars)	448	393	503 e
Gross output (millions of dollars)	1130	360	1274 e
Employment (thousands)	39	25	26 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	54	53 e
Wages and salaries (including supplements) (%)	15 e	12 /e	12 /e
Gross operating surplus (%)	24 /e	34 /e	35 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	28857	34129	47118 e
Value added / worker	11426	15595	22472 e
Average wage (including supplements)	4383 e	3990 /e	6024 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	11.59	9.32	2.30 e
as a percentage of average θ in 1970-1975	202	163	49 e
MVA growth rate (g)	-0.32	-0.77	1.14
Degree of specialization	19.1	18.0	18.5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	78	55	63 e
313 Beverages	63	59	105 e
314 Tobacco products	25	29	42 e
321 Textiles	62	40	55 e
322 Wearing apparel	16	10	15 e
323 Leather and fur products	5	5	7 e
324 Footwear	13	1	3 e
331 Wood and wood products	1	-	- e
332 Furniture and fixtures	3	4	6 e
341 Paper and paper products	40	24	39 e
342 Printing and publishing	8	8	16 e
351 Industrial chemicals	4	7	11 /e
352 Other chemical products	46	57	87 e
353 Petroleum refineries	14	20	30 e
354 Miscellaneous petroleum and coal products	2	-	2 e
355 Rubber products	4	3	4 e
356 Plastic products	13	15	25 e
361 Pottery, china and earthenware	-	-	- e
362 Glass and glass products	-	-	- e
369 Other non-metal mineral products	11	13	22 e
371 Iron and steel	9	7	11 /e
372 Non-ferrous metals	1	1	1 e
381 Metal products	10	12	20 /e
382 Non-electrical machinery	6	7	11 e
383 Electrical machinery	9	12	21 e
384 Transport equipment	1	-	- e
385 Professional and scientific equipment	-	1	1 /e
390 Other manufacturing industries	4	2	4 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

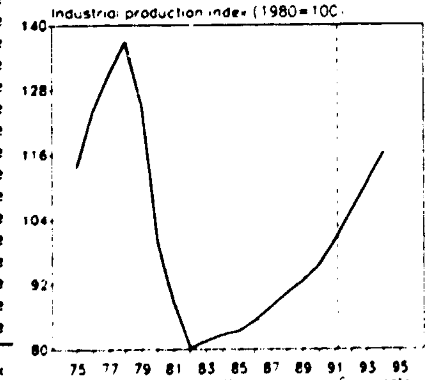
GDP per capita (1000$)

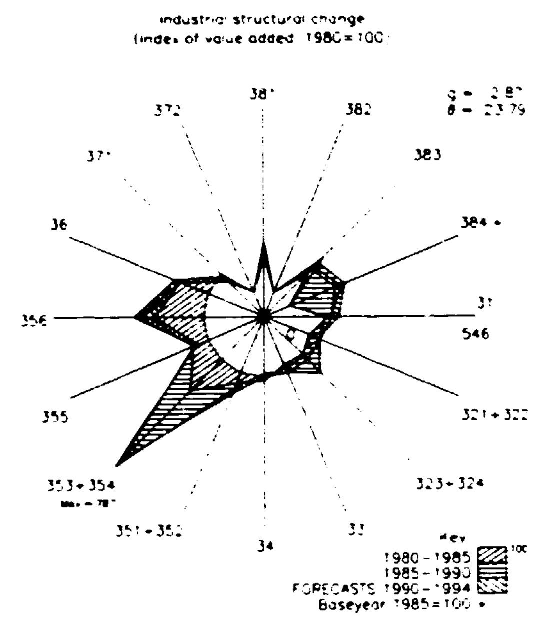


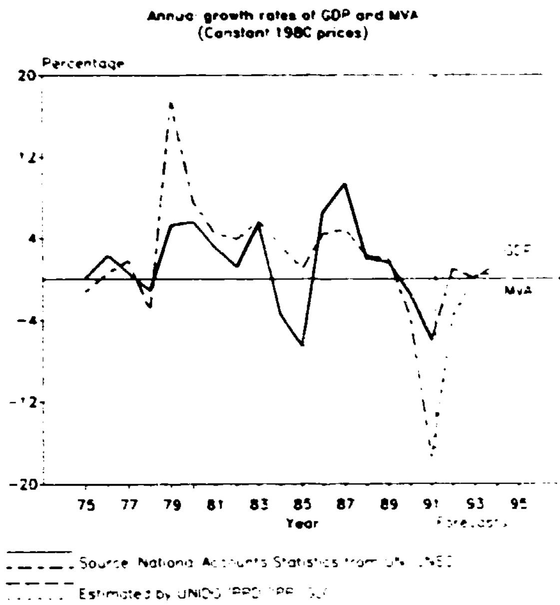
Manufacturing share in GDP, current prices (%)



Industrial production index (1980=100)

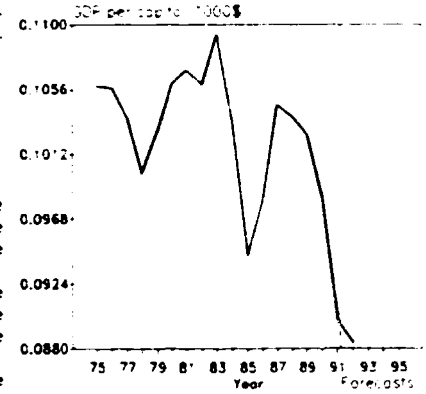


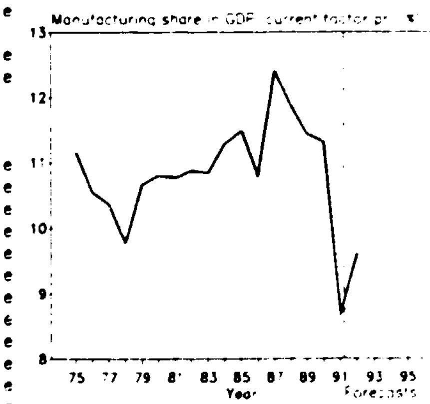


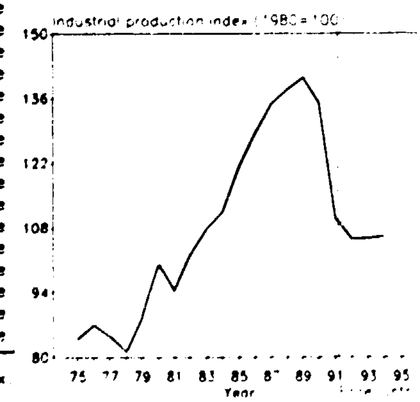


	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars	4106	4064	4826
Per capita (1980-dollars) (na.c	106	94	98
Manufacturing share (%) (na (current factor prices)	10 8	11 5	11 3
MANUFACTURING:			
Value added (na.c (millions of 1980-dollars)	400	479	526
Industrial production index	100	121	135
Value added (millions of dollars	453	577 /e	861 e
Gross output (millions of dollars)	1016	1375	1787 e
Employment (thousands)	77	88 /e	105 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	55	58 /e	52 e
Wages and salaries (including supplements (%)	8	9	9 e
Gross operating surplus (%)	37	33 /e	39 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	13215	15558	16984 e
Value added / worker	6003	6528 /e	8191 e
Average wage (including supplements)	1079	1332 /e	1549 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	9 90	5 78 /e	4 20 e
as a percentage of average θ in 1970-1975	162	95 /e	69 e
MVA growth rate / θ	0 59	0 24	1 66
Degree of specialization	25 8	21 7	24 2
-VALUE ADDED: (millions of dollars)			
311/2 Food products	110	114 /e	143 e
313 Beverages	83	141	196 e
314 Tobacco products	30	35	63 e
321 Textiles	106	69	115 e
322 Wearing apparel	3	11	11 e
323 Leather and fur products	14	13	36 e
324 Footwear	10	10	12 e
331 Wood and wood products	8	6	9 e
332 Furniture and fixtures	2	4	5 e
341 Paper and paper products	9	9	7 e
342 Printing and publishing	11	17	18 e
351 Industrial chemicals	1	1	2 e
352 Other chemical products	13	21	27 e
353 Petroleum refineries	20	54	129 e
354 Miscellaneous petroleum and coal products	-	-	- e
355 Rubber products	8	13	13 e
356 Plastic products	3	11	12 e
361 Pottery, china and earthenware	-	-	- e
362 Glass and glass products	2	4	5 e
369 Other non-metal mineral products	8	19	21 e
371 Iron and steel	9	8	10 /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	7	12	13 e
382 Non-electrical machinery	-	-	- /e
333 Electrical machinery	-	1	1 /e
384 Transport equipment	-	7	13 e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	-	-	- e

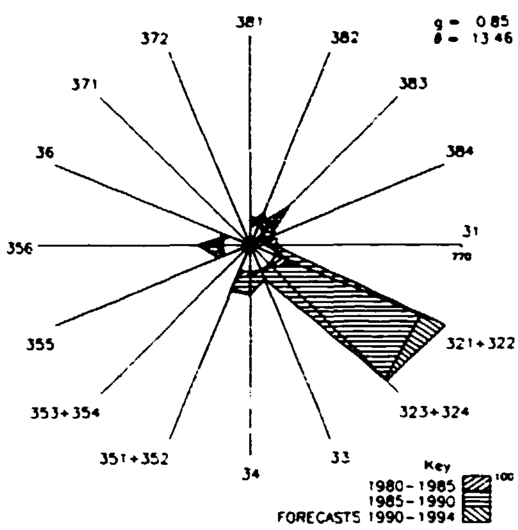
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.



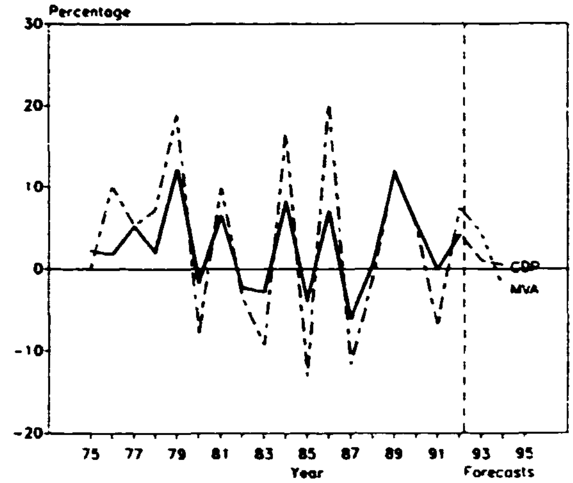




Industrial structural change (Index of value added 1980=100)



Annual growth rates of GDP and MVA (Constant 1980 prices)



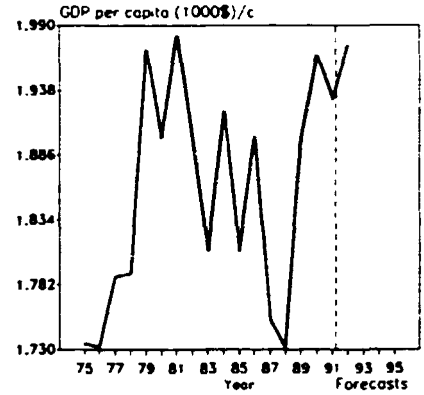
Source National Accounts Statistics from UN/UNSO

Estimated by UNIDO/PPD/IPP/GLO

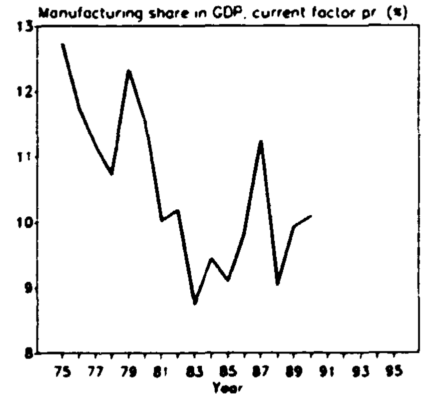
	1980	1985	1990
GDP: /na,c (millions of 1980-dollars)	1204	1266	1506
Per capita (1980-dollars) /na,c	1900	1809	1966
Manufacturing share (%) /na (current factor prices)	11.5	9.1	10.1 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	127	124	154
Industrial production index	100	89	98
Value added (millions of dollars)	121	90	142
Gross output (millions of dollars)	489	395	642
Employment (thousands)	13	13	21
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	75	77	78
Wages and salaries including supplements (%)	11	13	11
Gross operating surplus (%)	14	9	12
-PRODUCTIVITY: (dollars)			
Gross output / worker	37145	28851	30433
Value added / worker	9230	6605	6731
Average wage (including supplements)	4114	3990	3253
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.75	6.63 /e	6.83
as a percentage of average θ in 1970-1975	76	133 /e	137
MVA growth rate / θ	1.43	-0.68	1.48
Degree of specialization	40.4	24.3	27.3
-VALUE ADDED: (millions of dollars)			
311/2 Food products	71	37	60
313 Beverages	6	7	11
314 Tobacco products	2	2	3
321 Textiles	-	-	-
322 Wearing apparel	2	4	16
323 Leather and fur products	-	-	-
324 Footwear	-	-	1
331 Wood and wood products	7	6	11
332 Furniture and fixtures	3	3	3
341 Paper and paper products	2	2 /e	5
342 Printing and publishing	4	5	6
351 Industrial chemicals	-	-	-
352 Other chemical products	4	5	7
353 Petroleum refineries	-	-	-
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	1	1	1
356 Plastic products	2	2	3
361 Pottery, china and earthenware	-	-	-
362 Glass and glass products	-	-	-
369 Other non-metal mineral products	6	7	5
371 Iron and steel	-	-	-
372 Non-ferrous metals	-	-	-
381 Metal products	6	4	5
382 Non-electrical machinery	1	1	1
383 Electrical machinery	-	1	-
384 Transport equipment	4	3	1
385 Professional and scientific equipment	-	-	-
390 Other manufacturing industries	-	1	1

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

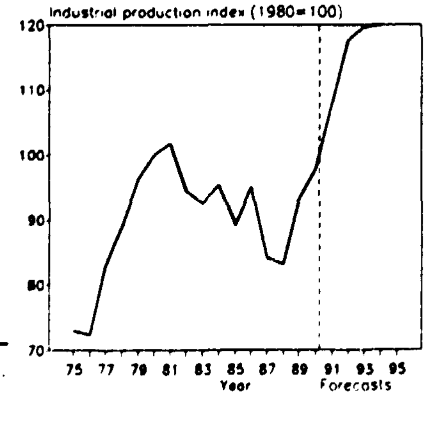
GDP per capita (1000$)/c



Manufacturing share in GDP, current factor pr (%)

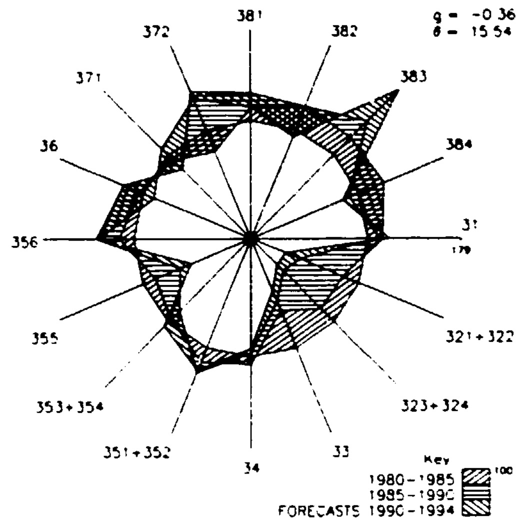


Industrial production index (1980=100)

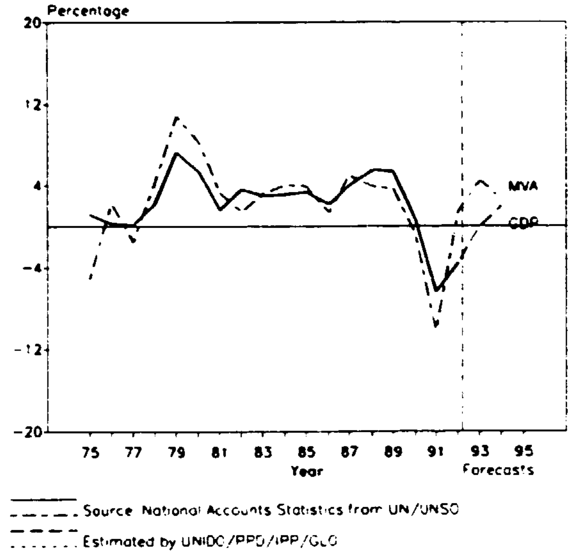


FINLAND

Industrial structural change
(Index of value added 1980=100)



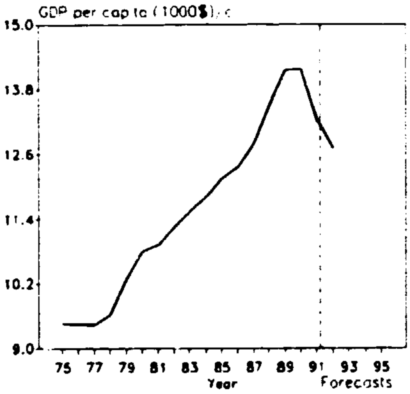
Annual growth rates of GDP and MVA
(Constant 1980 prices)



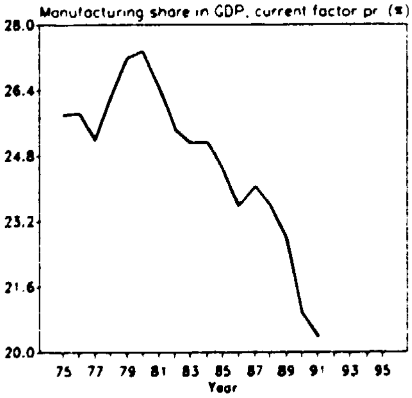
	1980	1985	1990
GDP: /na,c (millions of 1980-dollars)	51637	59582	70565
Per capita (1980-dollars) /na,c	10803	12152	14172
Manufacturing share (%) /na current factor prices)	27 4	24 5	21 0
MANUFACTURING:			
Value added /na,c millions of 1980-dollars)	12998	15184	17233
Industrial production index	100	115	131
Value added (millions of dollars)	14343	13598	26433
Gross output (millions of dollars)	40839	36968	74422
Employment (thousands)	531	496	432
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	65	63	64
Wages and salaries including supplements (%)	19	20	21
Gross operating surplus (%)	16	17	14
-PRODUCTIVITY: (dollars)			
Gross output / worker	76435	74040	171270
Value added / worker	26845	27234	60849
Average wage (including supplements)	14694	14601	36654
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6 33	5 51	5 63
as a percentage of average θ in 1970-1975	82	71	73
MVA growth rate / θ	0.58	0 17	-0 15
Degree of specialization	13 3	13 8	13 9
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1402	1418	2582
313 Beverages	225	227	667
314 Tobacco products	46	58	177
321 Textiles	469	310	386
322 Wearing apparel	499	434	428
323 Leather and fur products	54	37	47
324 Footwear	134	106	88
331 Wood and wood products	1196	652	1053
332 Furniture and fixtures	257	215	515
341 Paper and paper products	2088	1846	3618
342 Printing and publishing	1080	1223	2120
351 Industrial chemicals	555	561	1371
352 Other chemical products	349	371	707
353 Petroleum refineries	445	384	675
354 Miscellaneous petroleum and coal products	46	47	121
355 Rubber products	105	84	129
356 Plastic products	164	168	407
361 Pottery, china and earthenware	46	40	73
362 Glass and glass products	105	77	167
369 Other non-metal mineral products	434	432	1050
371 Iron and steel	544	463	849
372 Non-ferrous metals	142	103	359
381 Metal products	756	766	1754
382 Non-electrical machinery	1469	1618	3339
383 Electrical machinery	694	763	1831
384 Transport equipment	823	915	1406
385 Professional and scientific equipment	110	166	344
390 Other manufacturing industries	107	11	169

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

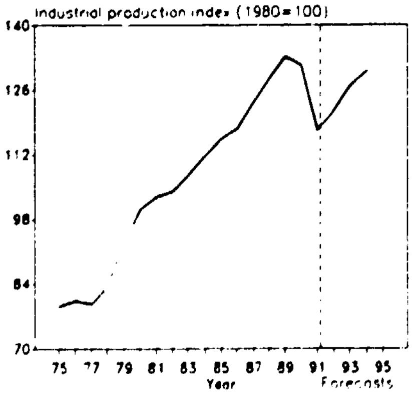
GDP per capita (1000$)/c



Manufacturing share in GDP, current factor pr (%)

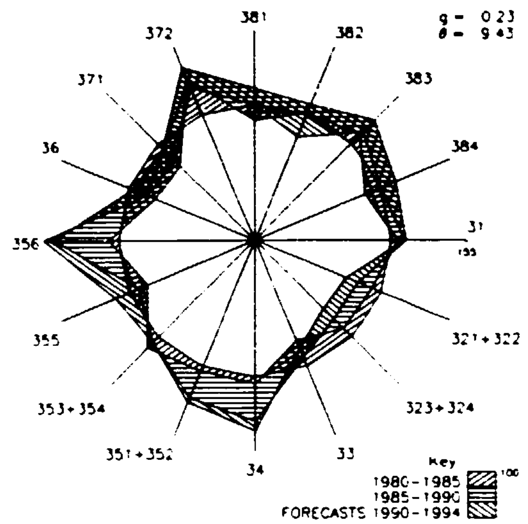


Industrial production index (1980=100)

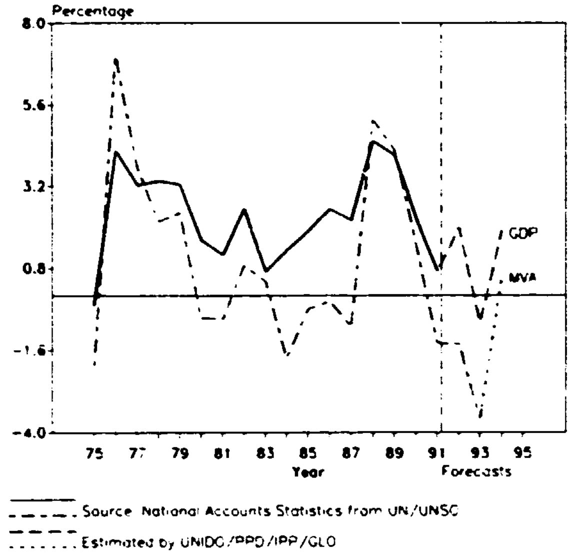


FRANCE

Industrial structural change
(index of value added 1980=100)



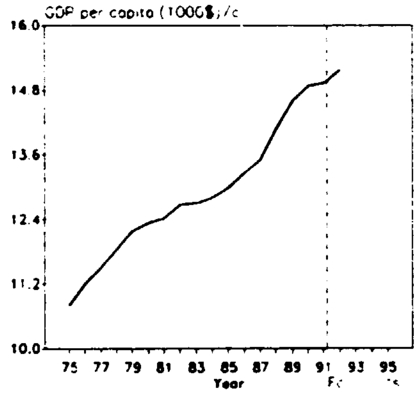
Annual growth rates of GDP and MVA
(Constant 1980 prices)



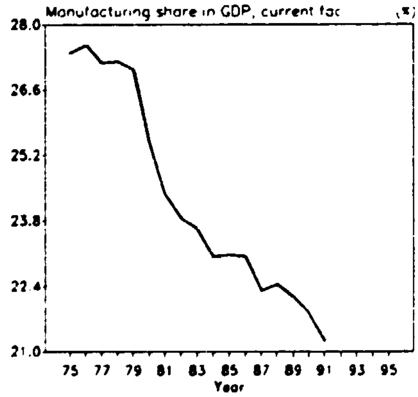
	1980	1985	1990
GDP: (na.c. millions of 1980-dollars)	664529	716607	835089
Per capita (1980-dollars) (na.c	12333	12989	14873
Manufacturing share (%) (na (current factor prices)	25.5	23.1	21.8
MANUFACTURING:			
Value added (na.c. millions of 1980-dollars)	160795	158170	174014
Industrial production index	100	94	108
Value added (millions of dollars)	161552	115430	256663
Gross output (millions of dollars)	453636	326412	676345
Employment (thousands)	5103	4470	4243
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	65	62
Wages and salaries including supplements (%)	24	23	23
Gross operating surplus (%)	11	12	15
-PRODUCTIVITY: (dollars)			
Gross output / worker	84523	69176	151193
Value added / worker	30101	24463	57376
Average wage (including supplements)	21643	17129	36111
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.70 /e	2.83	2.74
as a percentage of average θ in 1970-1975	81 /e	62	60
MVA growth rate / θ	0.47	-0.15	0.92
Degree of specialization	10.4	11.1	11.2
-VALUE ADDED: (millions of dollars)			
311/2 Food products	15952	12825	25508
313 Beverages	3486	2268	5856
314 Tobacco products	1497	948	1862
321 Textiles	6130	4239	7149
322 Wearing apparel	4742	3104	5581
323 Leather and fur products	757	527	1066
324 Footwear	1411	929	1480
331 Wood and wood products	2888	1704	3812
332 Furniture and fixtures	2846	1632	3841
341 Paper and paper products	3592	2817	6513
342 Printing and publishing	6660	5069	12991
351 Industrial chemicals	6462	4669	10047
352 Other chemical products	6302	4996	12860
353 Petroleum refineries	9973	8127	15153
354 Miscellaneous petroleum and coal products	118	78	180
355 Rubber products	2483	1544	3285
356 Plastic products	3083	2415	6530
361 Pottery, china and earthenware	639	387	821
362 Glass and glass products	2170	1365	3124
369 Other non-metal mineral products	5653	3153	7852
371 Iron and steel	6741	3788	9209
372 Non-ferrous metals	2479	2340	4891
381 Metal products	12119	7792	19445
382 Non-electrical machinery	16245	11998	25094
383 Electrical machinery	14411	11491	25777
384 Transport equipment	17733	11316	28442
385 Professional and scientific equipment	2206	1752	4125
390 Other manufacturing industries	2772	2178	4177

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

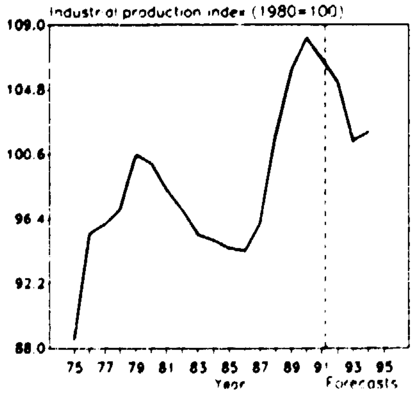
GDP per capita (1000$)/c



Manufacturing share in GDP, current fac (%)

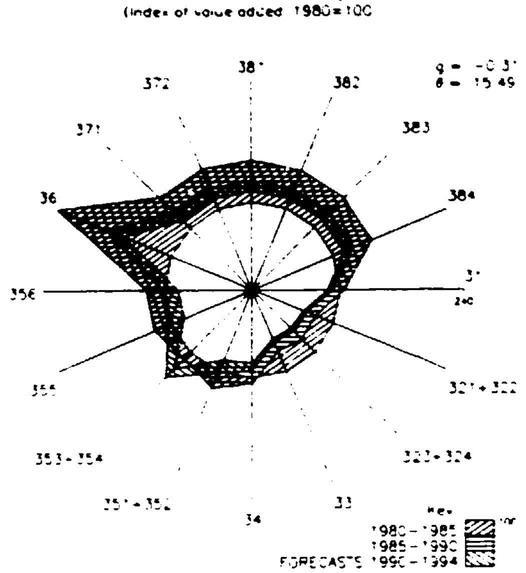


Industrial production index (1980=100)

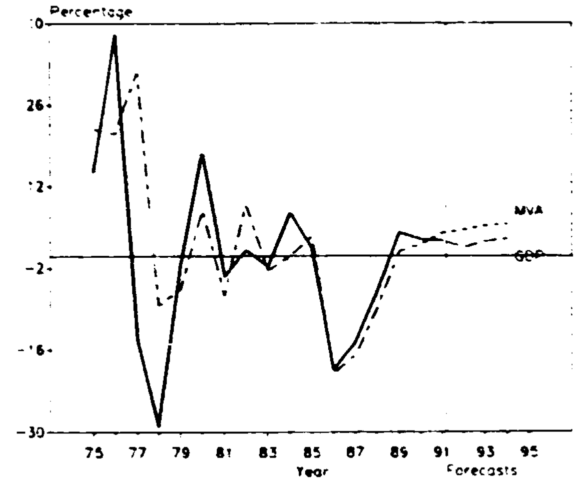


GABON

Industrial structural change
(Index of value added: 1980=100)

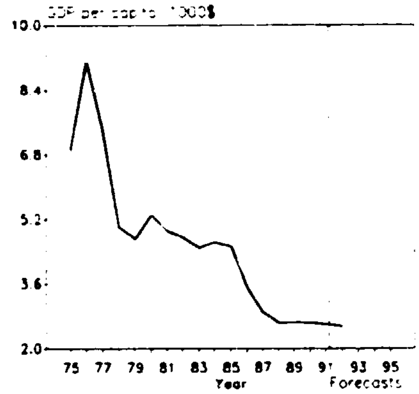


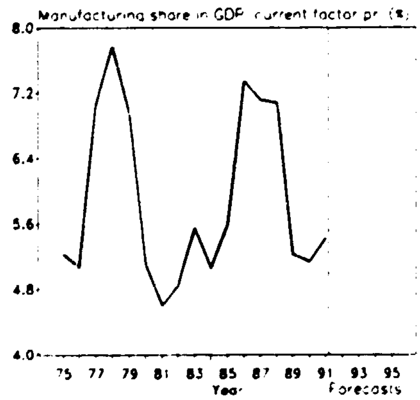
Annual growth rates of GDP and MVA
(Constant 1980 prices)

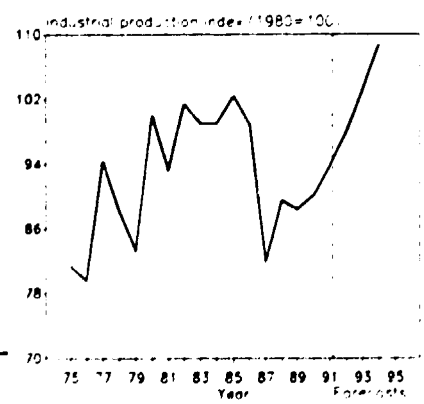


	1980	1985	1990
GDP: (na.c) millions of 1980-dollars	4281	4459	3076
Per capita (1980-dollars) (na.c)	5305	4522	2622
Manufacturing share (%) (na) (current factor prices)	5.1	5.6	5.1
MANUFACTURING:			
Value added (na.c) millions of 1980-dollars	239	245	52
Industrial production index	100	102	90
Value added (millions of dollars)	224	182 e	258 e
Gross output (millions of dollars)	690	515 e	843 e
Employment (thousands)	18 e	15 e	15 e
-PROFITABILITY: in percent of gross output			
Intermediate input (%)	68 e	70 e	68 e
Wages and salaries including supplements (%)	16 e	17 e	19 /e
Gross operating surplus (%)	16 e	13 e	13 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	38481 /e	34305 e	53905 e
Value added / worker	12470 e	10360 e	17264 /e
Average wage (including supplements)	6283 /e	5783 e	10333 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	13.60 /e	4.65 e	1.78 e
as a percentage of average θ in 1970-1975	164 /e	56 e	22 e
MVA growth rate (θ)	0.14	0.40	-2.25
Degree of specialization	21.0	16.5	17.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	18 e	17 e	25 e
313 Beverages	19	13 e	20 e
314 Tobacco products	17	12 e	17 e
321 Textiles	3	2 e	3 e
322 Wearing apparel	5	3 e	5 e
323 Leather and fur products	1	- e	1 e
324 Footwear	1	- e	1 e
331 Wood and wood products	54	36 e	53 e
332 Furniture and fixtures	9	5 e	7 e
341 Paper and paper products	2	1 e	2 e
342 Printing and publishing	3	3 e	4 e
351 Industrial chemicals	6	6 e	7 e
352 Other chemical products	3	2 e	3 e
353 Petroleum refineries	18	15 e	31 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	2 e	3 e
369 Other non-metal mineral products	8	14 /e	17 e
371 Iron and steel	3	3 e	4 /e
372 Non-ferrous metals	3	3 e	4 e
381 Metal products	13	15 /e	20 /e
382 Non-electrical machinery	2	2 /e	3 e
383 Electrical machinery	8	9 /e	12 e
384 Transport equipment	11	12 /e	17 /e
385 Professional and scientific equipment	1	1 e	1 e
390 Other manufacturing industries	5	5 e	7 e

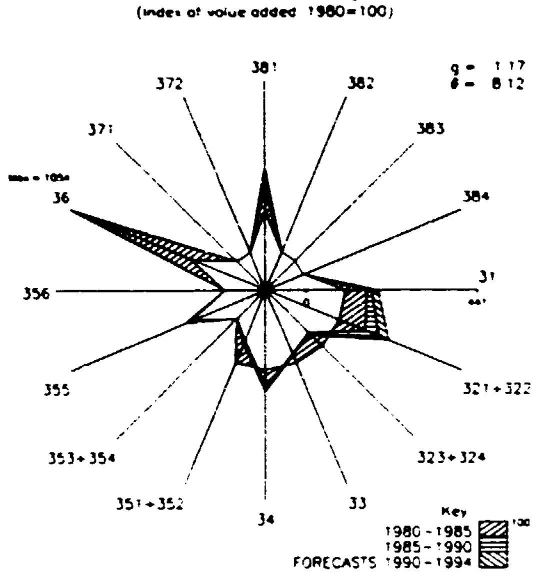
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex



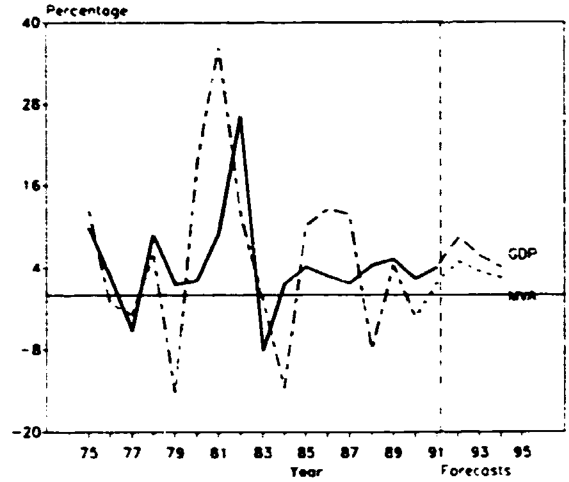




Industrial structural change
(Index of value added 1980=100)



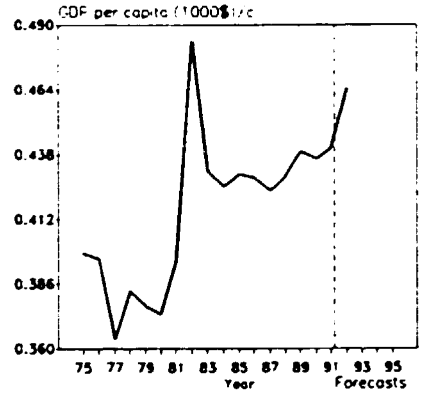
Annual growth rates of GDP and MVA
(Constant 1980 prices)



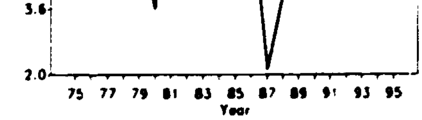
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	239	320	376
Per capita (1980-dollars) /na.c	374	430	436
Manufacturing share (%) /na (current factor prices)	3.6	7.7	5.8
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	16	23	28
Industrial production index	100	107	125
Value added (millions of dollars)	11	9 /e	13 /e
Gross output (millions of dollars)	30	40 /e	52 /e
Employment (thousands)	2	3 /e	2 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	62	78 /e	76 /e
Wages and salaries including supplements (%)	10	7 /e	8 /e
Gross operating surplus (%)	28	14 /e	17 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	16115	13431 /e	15916 /e
Value added / worker	6094	3052 /e	4230 /e
Average wage (including supplements)	1566	1111 /e	1628 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	17.04	9.93 /e	2.99 /e
as a percentage of average θ in 1970-1975	1626	947 /e	286 /e
MVA growth rate / θ	1.31	-0.17	0.97
Degree of specialization	36.7	33.1	30.6
-VALUE ADDED: (millions of dollars)			
311/2 Food products	3	4 /e	5 /e
313 Beverages	1	1 /e	2 /e
314 Tobacco products	-	- /e	- /e
321 Textiles	-	- /e	- /e
322 Wearing apparel	-	- /e	- /e
323 Leather and fur products	-	- /e	- /e
324 Footwear	-	- /e	- /e
331 Wood and wood products	-	- /e	- /e
332 Furniture and fixtures	1	- /e	1 /e
341 Paper and paper products	-	- /e	- /e
342 Printing and publishing	- /e	- /e	- /e
351 Industrial chemicals	-	- /e	- /e
352 Other chemical products	-	- /e	- /e
353 Petroleum refineries	-	- /e	- /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	- /e	- /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	-	- /e	- /e
371 Iron and steel	-	- /e	- /e
372 Non-ferrous metals	-	- /e	- /e
381 Metal products	-	- /e	- /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	6	2 /e	3 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

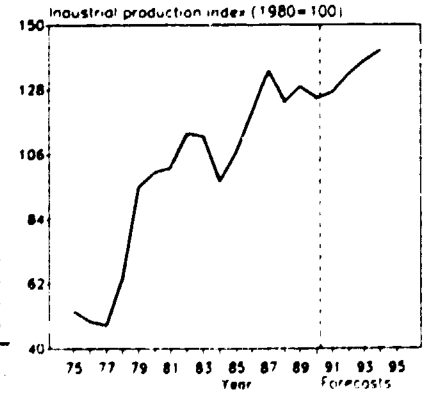
GDP per capita (1000$)/c



Manufacturing share in GDP, current factor pr. (%)

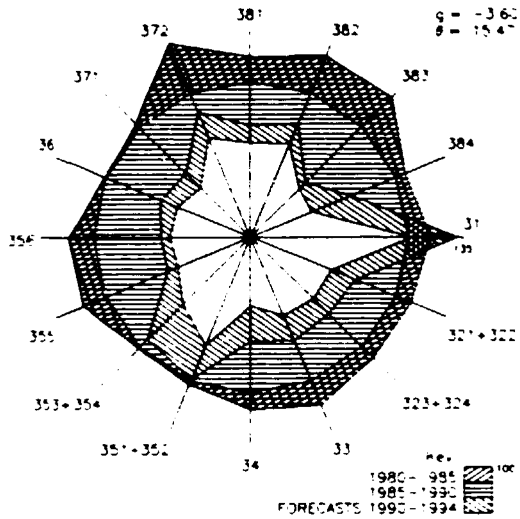


Industrial production index (1980=100)

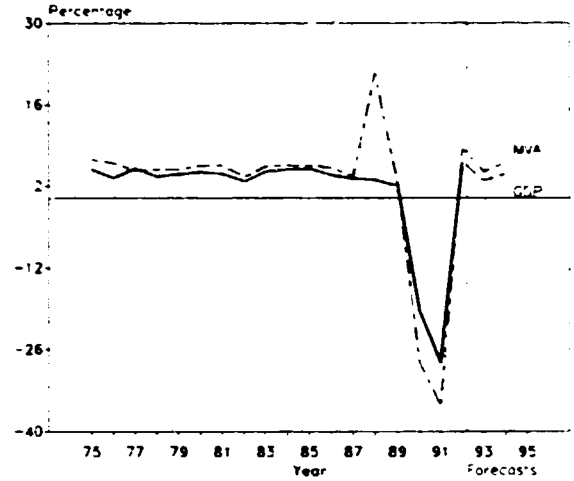


GERMANY, EASTERN PART

Industrial structural change
(Index of value added: 1980=100)



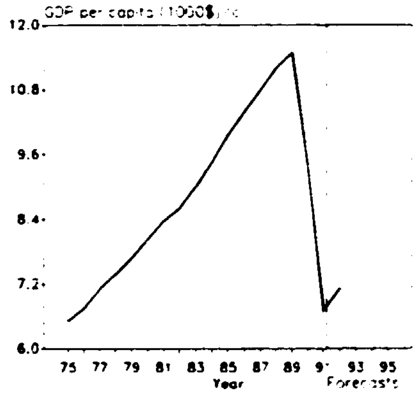
Annual growth rates of GDP and MVA
(Constant 1980 prices)

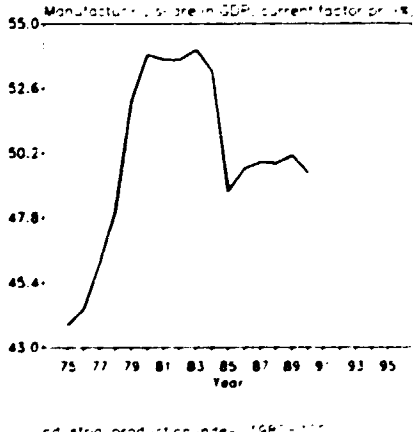


Source: National Accounts Statistics from UN, UNSO
Estimated by UNIDO/PPD/IPP/GLO

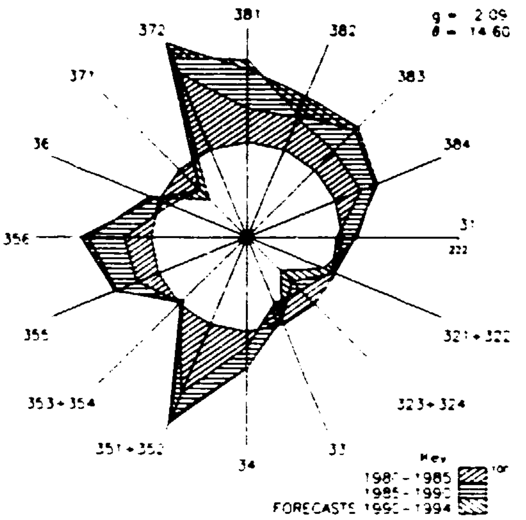
	1980		1985		1990	
GDP: (na.c) millions of 1980-dollars	134459		165880		150819	
Per capita (1980-dollars) (na.c)	8033		9966		9294	
Manufacturing share (%) (na) current factor prices	53.8	/e	48.8	e	49.4	e
MANUFACTURING:						
Value added (na.c) millions of 1980-dollars)	60486	/e	77757	e	76121	
Industrial production index	100		112		77	
Value added (millions of 1980-dollars)	76600		85952		59134	e
Gross output (millions of dollars)	132645		159661		318177	e
Employment (thousands)	2895		2988		2770	/e
-PROFITABILITY: in percent of gross output						
Intermediate input (%)						
Wages and salaries including supplements (%)	15	/e	9	e	9	e
Gross operating surplus (%)						
-PRODUCTIVITY: (dollars)						
Gross output / worker	45819		53434		114156	e
Value added / worker (c)	25460		28766		21242	e
Average wage (including supplements)	6771	e	4836	e	10054	e
-STRUCTURAL INDICES:						
Structural change θ 5-year average in degrees	1.99		1.57		5.79	e
as a percentage of average θ in 1970-1975	105		88		306	e
MVA growth rate θ	1.49		1.40		-1.01	
Degree of specialization	13.2		13.9		17.0	
-VALUE ADDED: millions of 1980-dollars						
311/2 Food products	6043		5949		3641	
313 Beverages	1040		1207		811	e
314 Tobacco products	254		224		211	
321 Textiles	5275		5841		4544	
322 Wearing apparel	2199		2485		1473	
323 Leather and fur products	839		923		537	
324 Footwear	631		634		441	
331 Wood and wood products	1178		1378		846	
332 Furniture and fixtures	1081		1265		778	
341 Paper and paper products	331		1089		438	
342 Printing and publishing	727		748		576	
351 Industrial chemicals	3697		3671		3219	
352 Other chemical products	1220		1269		598	e
353 Petroleum refineries	2353		2381		2553	
354 Miscellaneous petroleum and coal products	141		145		124	
355 Rubber products	3202		3115		1825	
356 Plastic products	1528		1773		971	
361 Pottery, china and earthenware	516		629		230	e
362 Glass and glass products	473		477		236	e
369 Other non-metal mineral products	1768		1758		1215	
371 Iron and steel	2571		2730		1537	
372 Non-ferrous metals	884		1133		753	
381 Metal products	3171		3679		2231	e
382 Non-electrical machinery	9950		12537		7861	e
383 Electrical machinery	7480		9499		3665	e
384 Transport equipment	6898		7311		4759	
385 Professional and scientific equipment	3264		3035		1110	e
390 Other manufacturing industries	608		538		529	e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

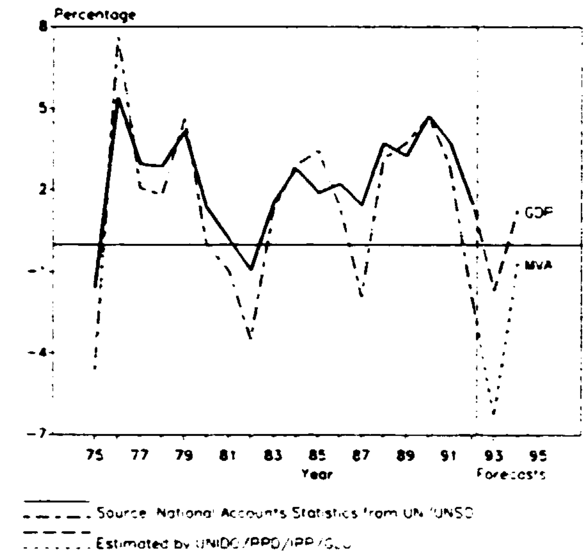




Industrial structural change
(Index of value added: 1980=100)



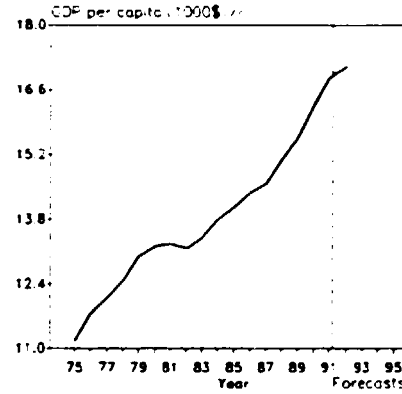
Annual growth rates of GDP and MVA
(Constant 1980 prices)



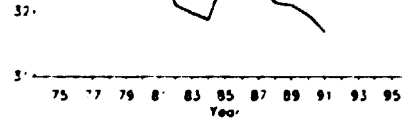
	1980	1985	1990	
GDP: (na.c) (millions of 1980-dollars)	813496	858550	998198	
Per capita (1980-dollars) (na.c)	13213	14069	16273	
Manufacturing share (%) (na) (current factor prices)	33.6	32.6	31.9	
MANUFACTURING:				
Value added (na.c) (millions of 1980-dollars)	265589	273829	305136	
Industrial production index	100	104	124	
Value added (millions of dollars)	265588	224215	543666	
Gross output (millions of dollars)	632161	490047	1095480	
Employment (thousands)	7229	6614	7119	
-PROFITABILITY: in percent of gross output				
Intermediate input (%)	58	54	50	
Wages and salaries including supplements (%)	26	24	25	e
Gross operating surplus (%)	16	22	25	e
-PRODUCTIVITY: dollars				
Gross output / worker	87448	74092	153881	
Value added / worker	36739	33926	76368	
Average wage (including supplements)	22606	17567	38440	e
-STRUCTURAL INDICES:				
Structural change θ (5-year average in degrees)	2.73	3.47	1.70	
as a percentage of average θ in 1970-1975	81	104	51	
MVA growth rate / θ	0.83	0.95	1.34	
Degree of specialization	12.1	14.5	15.1	
-VALUE ADDED: millions of dollars				
311/2 Food products	18570	10829	28236	
313 Beverages	5452	5048	12715	
314 Tobacco products	5909	5720	12885	
321 Textiles	6964	5510	11996	
322 Wearing apparel	4934	2802	5689	
323 Leather and fur products	935	499	956	
324 Footwear	1205	727	1158	
331 Wood and wood products	4485	2429	5378	e
332 Furniture and fixtures	5548	3084	8615	e
341 Paper and paper products	5099	5221	12781	
342 Printing and publishing	5150	4141	10309	
351 Industrial chemicals	13944	15569	39324	e
352 Other chemical products	8003	11596	28030	e
353 Petroleum refineries	14537	10125	19676	
354 Miscellaneous petroleum and coal products	990	385	2250	
355 Rubber products	3201	2880	7170	e
356 Plastic products	6095	5639	15612	e
361 Pottery, china and earthenware	1304	569	1537	e
362 Glass and glass products	2492	1916	4887	
369 Other non-metal mineral products	7937	4874	12016	
371 Iron and steel	13872	9538	19685	
372 Non-ferrous metals	2508	3414	8284	
381 Metal products	14455	14161	38187	
382 Non-electrical machinery	34263	33811	82039	
383 Electrical machinery	30501	28329	74395	
384 Transport equipment	31232	29076	68629	
385 Professional and scientific equipment	6205	3448	8167	e
390 Other manufacturing industries	1700	1175	3063	e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

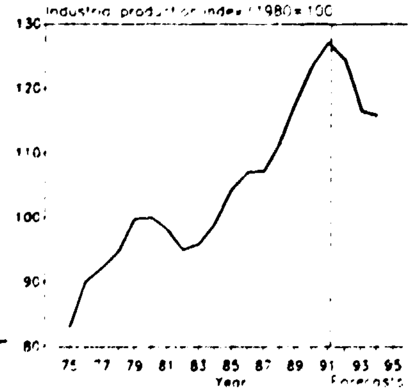
GDP per capita (1000$)



Manufacturing share in GDP (current factor pr.) (%)

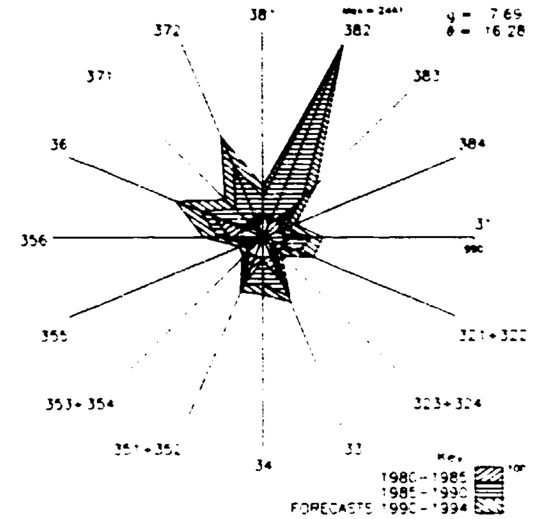


Industrial production index (1980=100)

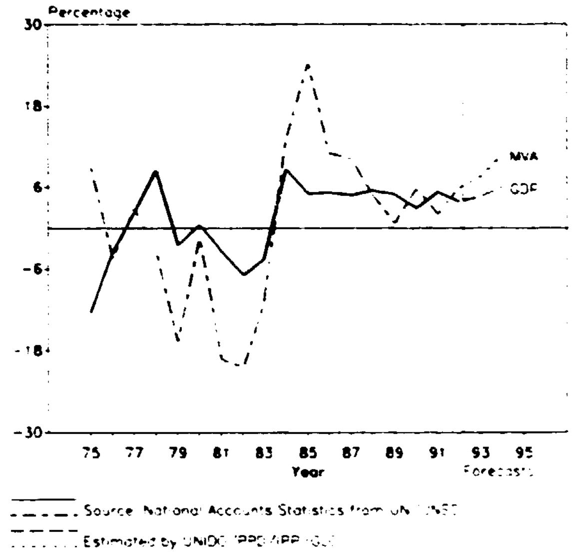


GHANA

Industrial structural change
(index of value added 1980=100)

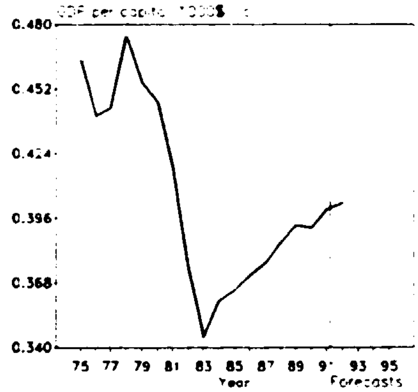


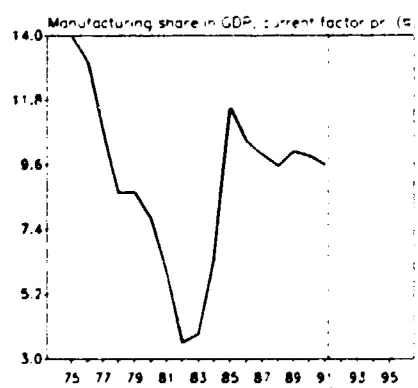
Annual growth rates of GDP and MVA
(Constant 1980 prices)

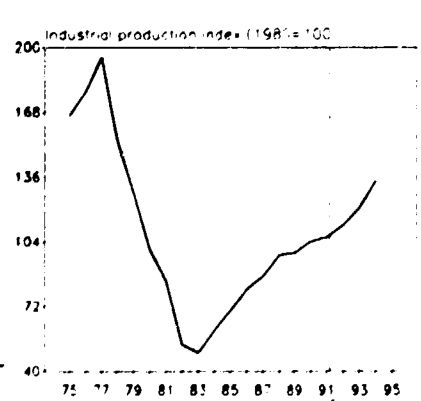


	1980	1985	1990	
GDP: (na.c) millions of 1980-dollars	4788	4686	5893	
Per capita (1980-dollars) (na.c)	446	365	392	
Manufacturing share (%) (na) current factor prices	7.3	11.5	9.9	
MANUFACTURING:				
Value added (na.c) (millions of 1980-dollars)	374	299	409	
Industrial production index	100	70	104	
Value added (millions of dollars)	244	338	520	e
Gross output (millions of dollars)	505	696	1309	e
Employment (thousands)	80	61	95	e
-PROFITABILITY: (in percent of gross output)				
Intermediate input (%)	52	51	53	e
Wages and salaries including supplements (%)	10	6	7	e
Gross operating surplus (%)	39	42	40	e
-PRODUCTIVITY: (dollars)				
Gross output / worker	6293	11306	13685	e
Value added / worker	3034	5495	6531	e
Average wage (including supplements)	606	711	970	e
-STRUCTURAL INDICES:				
Structural change θ (5-year average in degrees)	13.44	14.29	7.94	e
as a percentage of average θ in 1970-1975	112	119	66	e
MVA growth rate / θ	-0.69	1.03	1.32	
Degree of specialization	23.1	26.3	25.2	
-VALUE ADDED: (millions of dollars)				
311/2 Food products	20	35	76	e
313 Beverages	38	51	87	e
314 Tobacco products	32	58	70	e
321 Textiles	22	18	50	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	56	e
332 Furniture and fixtures	2	2	7	e
341 Paper and paper products	1	2	4	e
342 Printing and publishing	5	4	10	e
351 Industrial chemicals	2	1	5	e
352 Other chemical products	9	26	27	e
353 Petroleum refineries	37	34	45	e
354 Miscellaneous petroleum and coal products	-	-	-	e
355 Rubber products	5	2	5	e
356 Plastic products	.	2	3	e
361 Pottery, china and earthenware	.		-	e
362 Glass and glass products	-	1	1	e
369 Other non-metal mineral products	6	16	23	e
371 Iron and steel	1	1	3	e
372 Non-ferrous metals	23	16	121	e
381 Metal products	7	8	14	e
382 Non-electrical machinery	.	-	2	e
383 Electrical machinery	2	3	5	e
384 Transport equipment	3	2	4	e
385 Professional and scientific equipment	1	1	1	e
390 Other manufacturing industries	-	-	1	e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

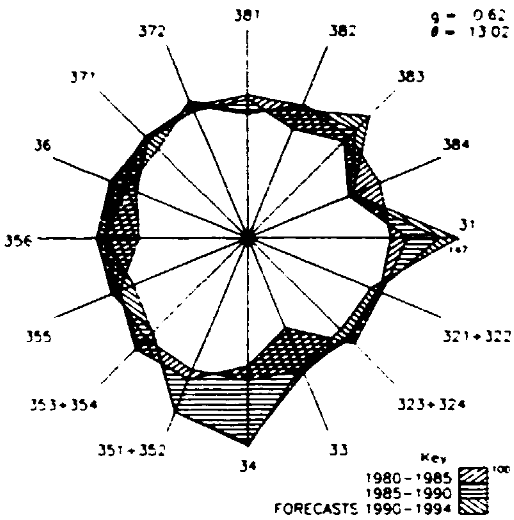




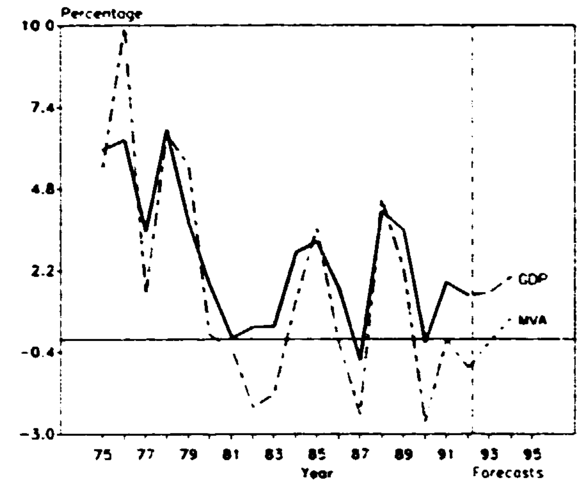


GREECE

Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

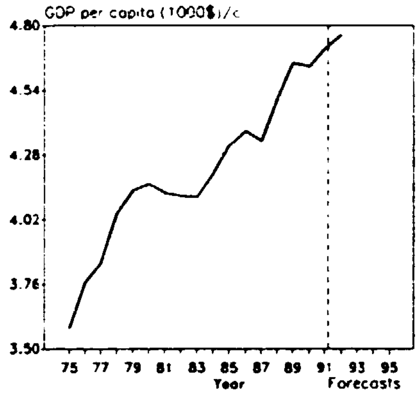


Source National Accounts Statistics from UN/UNSO
Estimated by UNIDO/PPD/IPP/GLO

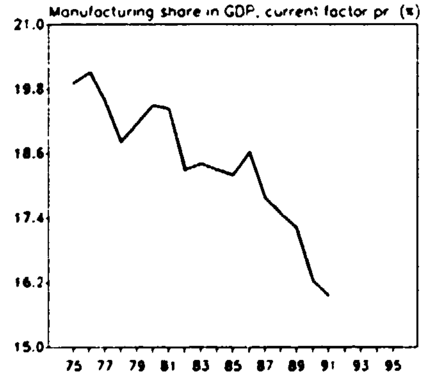
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	40147	42902	46588
Per capita (1980-dollars) /na.c	4163	4318	4633
Manufacturing share (%) /na (current factor prices)	19.5	18.2	16.2
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	6968	7000	7096
Industrial production index	100	98	99
Value added (millions of dollars)	7591	5759	11645
Gross output (millions of dollars)	25525	20633	37186
Employment (thousands)	474	441	439
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	70	72	69
Wages and salaries including supplements (%)	13	14	15 /e
Gross operating surplus (%)	16	14	16 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	53854	46760	84686
Value added / worker	20069	16348	33631
Average wage (including supplements)	7266	6610	12941 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.56	4.41	5.24
as a percentage of average θ in 1970-1975	61	75	90
MVA growth rate / θ	1.68	-0.10	0.42
Degree of specialization	10.9	11.8	11.1
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1039	897	1919
313 Beverages	264	246	536
314 Tobacco products	138	114	280
321 Textiles	1063	820	1194
322 Wearing apparel	494	409	962
323 Leather and fur products	105	88	155
324 Footwear	111	88	144
331 Wood and wood products	241	114	306
332 Furniture and fixtures	148	93	253
341 Paper and paper products	126	101	290
342 Printing and publishing	216	138	403
351 Industrial chemicals	185	197	297
352 Other chemical products	339	241	679
353 Petroleum refineries	153	140	218
354 Miscellaneous petroleum and coal products	37	22	32
355 Rubber products	77	58	111
356 Plastic products	214	126	317
361 Pottery, china and earthenware	67	48	79
362 Glass and glass products	53	24	53
369 Other non-metal mineral products	483	321	748
371 Iron and steel	203	155	284
372 Non-ferrous metals	245	184	347
381 Metal products	512	387	629
382 Non-electrical machinery	181	116	258
383 Electrical machinery	334	248	499
384 Transport equipment	483	285	520
385 Professional and scientific equipment	10	7	22
390 Other manufacturing industries	73	91	109

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

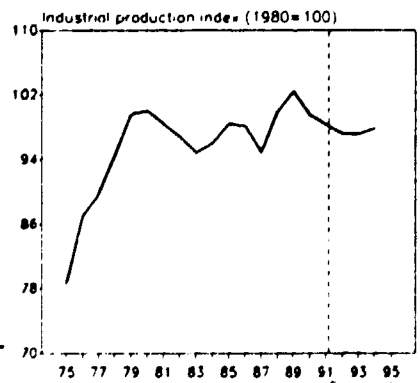
GDP per capita (1000$)/c



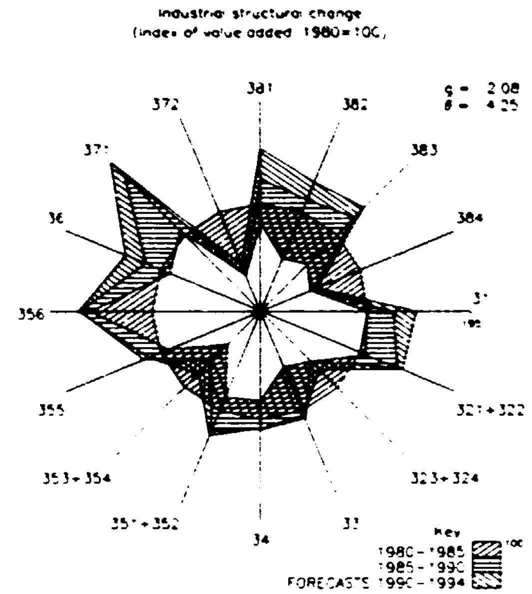
Manufacturing share in GDP, current factor pr (%)

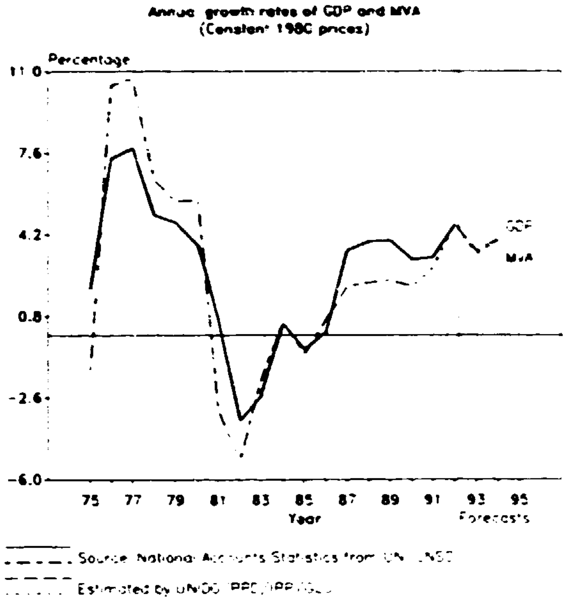


Industrial production index (1980=100)



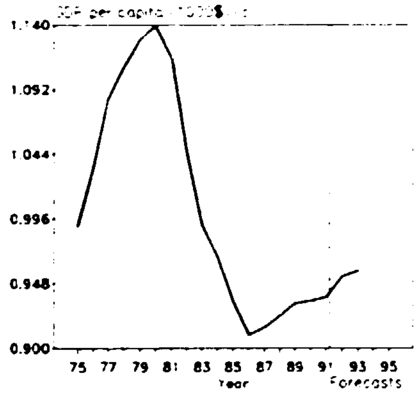
GUATEMALA

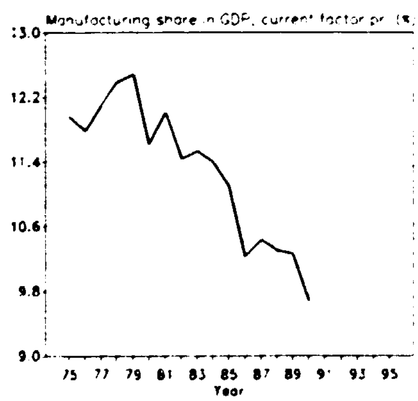


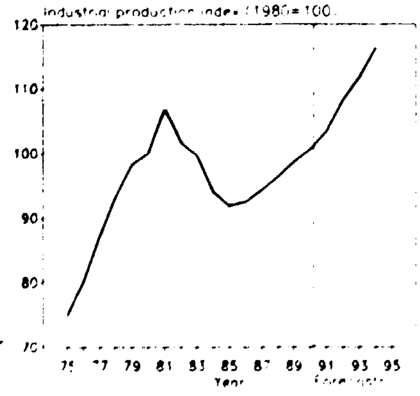


	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	7879	7446	8599
Per capita (1980-dollars) /na.c	1139	935	935
Manufacturing share (%) /na (current factor prices	11 5	11.1	9 7 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1312	1179	1291
Industrial production index	100	92	101
Value added (millions of dollars)	794	906	821 /e
Gross output (millions of dollars)	1968	2195	2018 /e
Employment (thousands)	82	73	94 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	59	59 /e
Wages and salaries including supplements (%)	11 /e	10 /e	8 /e
Gross operating surplus (%)	30 /e	31 /e	32 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	23209	28308	19731 /e
Value added / worker	9560	11685	8032 /e
Average wage (including supplements)	2513 /e	3079 /e	1812 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5 23 /e	6 85	5 58 /e
as a percentage of average θ in 1970-1975	91 /e	119	97 /e
MVA growth rate / θ	0 71	-0 22	1 43
Degree of specialization	20 4	24 6	22 8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	204	276	250 /e
313 Beverages	91	90	52 /e
314 Tobacco products	14	15	24 /e
321 Textiles	45	71	51 /e
322 Wearing apparel	19	13	14 /e
323 Leather and fur products	3	3	3 /e
324 Footwear	15	12	7 /e
331 Wood and wood products	10	7	8 /e
332 Furniture and fixtures	4	3	5 /e
341 Paper and paper products	19	21	15 /e
342 Printing and publishing	34	34	35 /e
351 Industrial chemicals	28	28	28 /e
352 Other chemical products	110	121	114 /e
353 Petroleum refineries	14	8	9 /e
354 Miscellaneous petroleum and coal products	2	-	- /e
355 Rubber products	21	24	21 /e
356 Plastic products	19	37	27 /e
361 Pottery, china and earthenware	2	8	8 /e
362 Glass and glass products	22	17	13 /e
369 Other non-metal mineral products	34	41	38 /e
371 Iron and steel	16	21	24 /e
372 Non-ferrous metals	1	-	- /e
381 Metal products	23	23	24 /e
382 Non-electrical machinery	6	4	6 /e
383 Electrical machinery	25	19	26 /e
384 Transport equipment	8	5	4 /e
385 Professional and scientific equipment	1	1	1 /e
390 Other manufacturing industries	4	3	4 /e

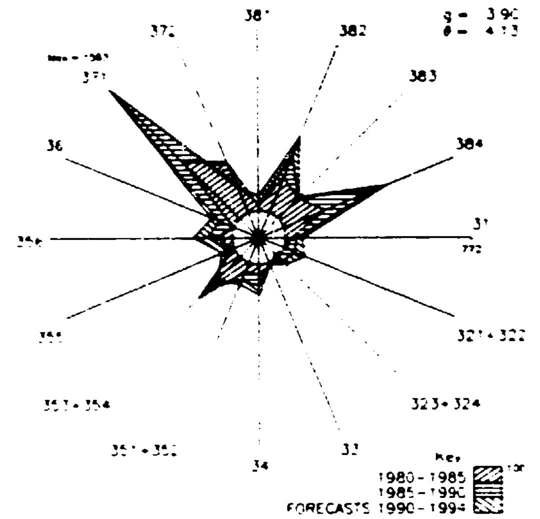
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex



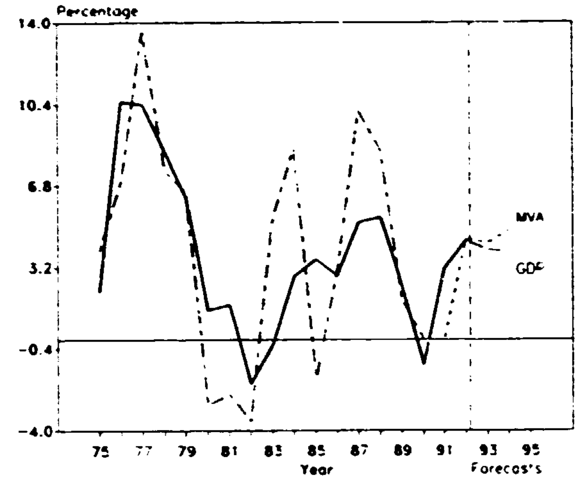




Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

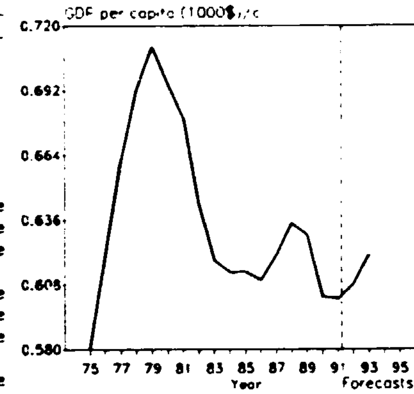


Source National Accounts Statistics from UN/UNSO
Estimated by UNIDO/PPD/IPP/GLO

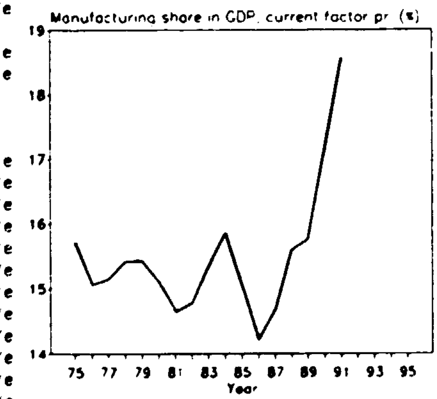
	1980	1985	1990
GDP: na.c millions of 1980-dollars	2544	2689	3101
Per capita 1980-dollars /na.c	695	613	603
Manufacturing share % na current factor prices	15.1	15.0	17.1
MANUFACTURING:			
Value added /na.c millions of 1980-dollars	344	363	453
Industrial production index	100	111	134
Value added millions of dollars	280 /e	493	425 /e
Gross output millions of dollars	1021 /e	1611	1464 /e
Employment thousands	55 /e	64	69 /e
-PROFITABILITY: in percent of gross output			
Intermediate input %	73 /e	69	71 /e
Wages and salaries including supplements %	12 /e	13	12 /e
Gross operating surplus %	15 /e	18	17 /e
-PRODUCTIVITY: dollars			
Gross output / worker	18518 /e	25167	20727 /e
Value added / worker	5073 /e	7707	6051 /e
Average wage including supplements	2147 /e	3173	2443 /e
-STRUCTURAL INDICES:			
Structural change θ 5-year average in degrees	2.55 /e	4.01 /e	2.45 /e
as a percentage of average θ in 1970-1975	46 /e	73 /e	44 /e
MVA growth rate θ	2.05	1.29	1.34
Degree of specialization	25.3	22.4	22.5
-VALUE ADDED: millions of dollars			
311/2 Food products	75 /e	129	120 /e
313 Beverages	57 /e	78	70 /e
314 Tobacco products	19 /e	42	27 /e
321 Textiles	12 /e	13 /e	16 /e
322 Wearing apparel	6 /e	14	10 /e
323 Leather and fur products	2 /e	2	2 /e
324 Footwear	1 /e	2	3 /e
331 Wood and wood products	20 /e	30	19 /e
332 Furniture and fixtures	5 /e	8	6 /e
341 Paper and paper products	4 /e	9	11 /e
342 Printing and publishing	8 /e	13	10 /e
351 Industrial chemicals	1 /e	2	2 /e
352 Other chemical products	11 /e	20	19 /e
353 Petroleum refineries	9 /e	38	23 /e
354 Miscellaneous petroleum and coal products	- /e	-	- /e
355 Rubber products	5 /e	8	7 /e
356 Plastic products	8 /e	18	16 /e
361 Pottery, china and earthenware	- /e	-	- /e
362 Glass and glass products	- /e	-	- /e
369 Other non-metal mineral products	16 /e	24	26 /e
371 Iron and steel	- /e	1	3 /e
372 Non-ferrous metals	- /e	1	1 /e
381 Metal products	13 /e	21	16 /e
382 Non-electrical machinery	1 /e	3	4 /e
383 Electrical machinery	3 /e	8	6 /e
384 Transport equipment	- /e	2	2 /e
385 Professional and scientific equipment	- /e	1	1 /e
390 Other manufacturing industries	1 /e	5	5 /e

For sources, footnotes and comments see Technical notes at the beginning of this Annex

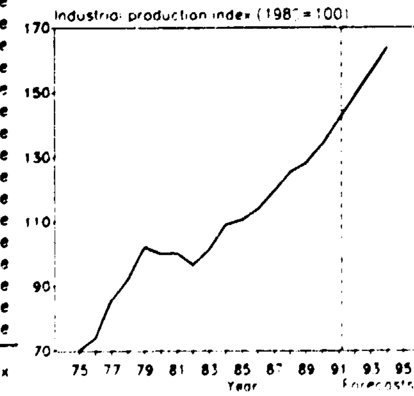
GDP per capita (1000$)/c



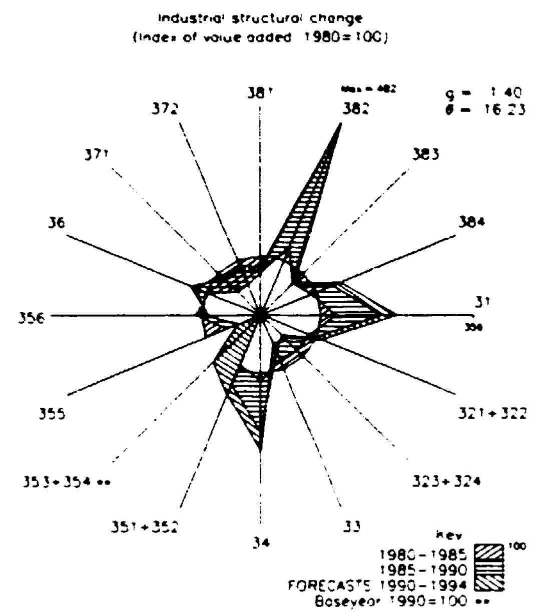
Manufacturing share in GDP, current factor pr (%)

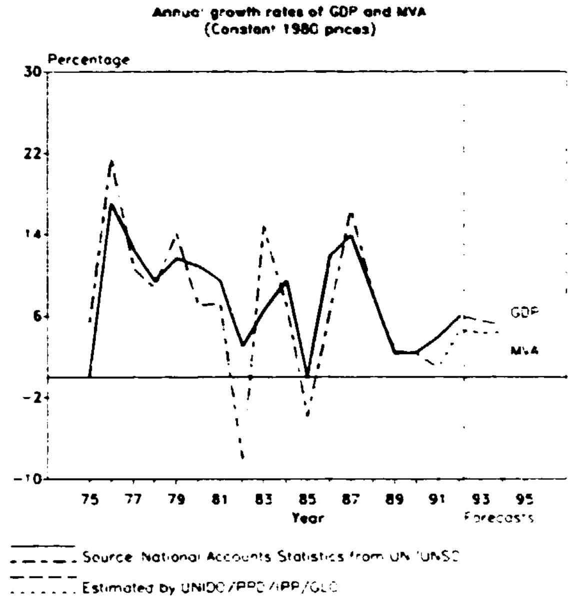


Industrial production index (1980=100)



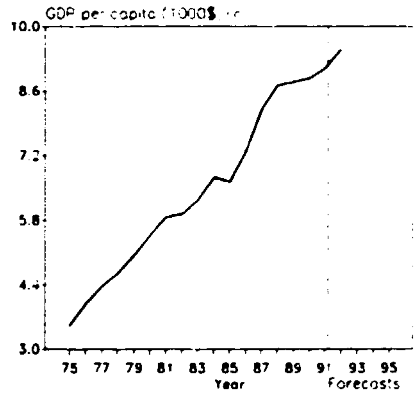
HONG KONG

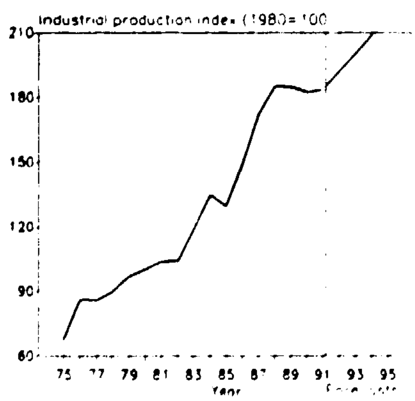


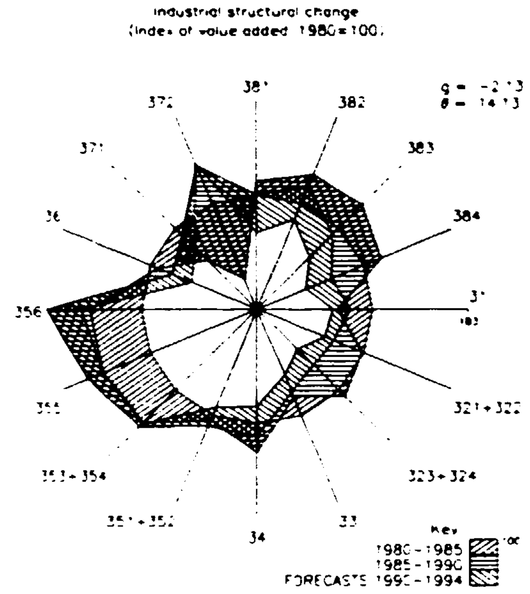


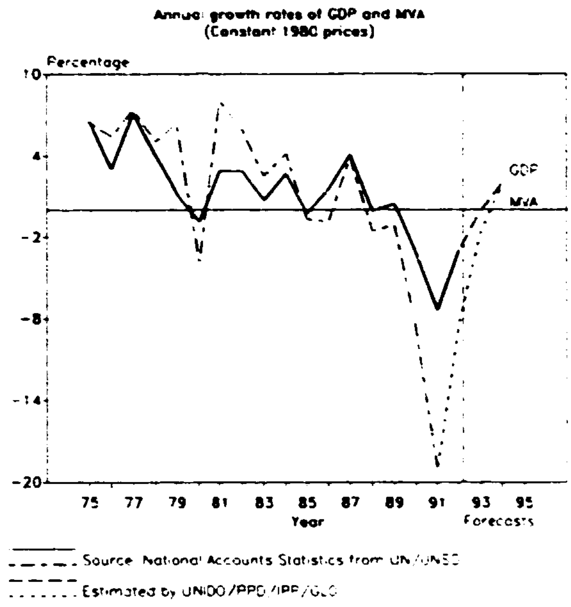
	1980	1985	1990
GDP: (na.c.) (millions of 1980-dollars)	27526	36134	52061
Per capita (1980-dollars) (na.c)	5463	6622	8873
Manufacturing share (%) (na. current factor prices)	22.0	20.4	16.1
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	6134	7132	9996
Industrial production index	100	129	182
Value added (millions of dollars)	7343	6582	12032
Gross output (millions of dollars)	22187	22835	41513
Employment (thousands)	937	908	763
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67	71	71
Wages and salaries including supplements (%)	18 /e	19	17 /e
Gross operating surplus (%)	15 /e	10	12 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	23686	25140	54430
Value added / worker	7840	7246	15775
Average wage (including supplements)	4238 /e	4808	9182 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.55	4.42	5.34
as a percentage of average θ in 1970-1975	66	64	77
MVA growth rate / θ	3.20	-0.35	0.95
Degree of specialization	24.2	22.6	21.3
-VALUE ADDED: (millions of dollars)			
311/2 Food products	161	171	397
313 Beverages	99	125	200
314 Tobacco products	81	127	394
321 Textiles	1027	964	1801
322 Wearing apparel	1920	1594	2455
323 Leather and fur products	43	26	38
324 Footwear	59	62	35
331 Wood and wood products	45	32	38
332 Furniture and fixtures	62	54	66
341 Paper and paper products	110	90	275
342 Printing and publishing	290	350	877
351 Industrial chemicals	40	36	64
352 Other chemical products	77	71	153
353 Petroleum refineries	-	-	-
354 Miscellaneous petroleum and coal products	-	-	13
355 Rubber products	29	17	16
356 Plastic products	563	612	759
361 Pottery, china and earthenware	5	3	6
362 Glass and glass products	10	17	19
369 Other non-metal mineral products	55	47 /e	35
371 Iron and steel	31	17	44
372 Non-ferrous metals	35	20	40
381 Metal products	638	460	716
382 Non-electrical machinery	188	236	1077
383 Electrical machinery	387	752	1151
384 Transport equipment	176	157	333
385 Professional and scientific equipment	362	289	536
390 Other manufacturing industries	260	253	432

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



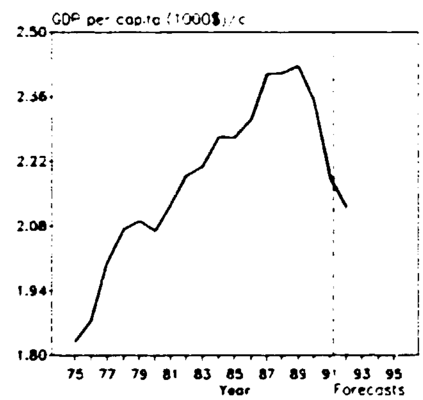


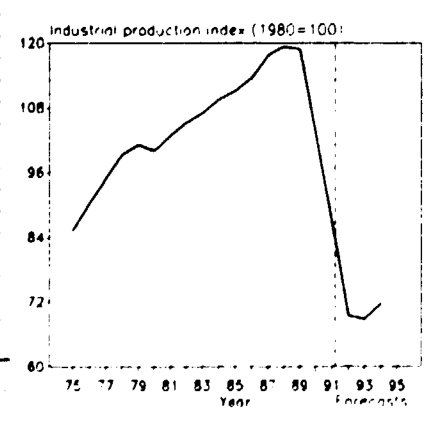




	1980	1985	1990
GDP: na.c (millions of 1980-dollars)	22165	24184	24795
Per capita (1980-dollars) na.c	2069	2271	2351
Manufacturing share (%) na current factor prices	28.9	28.7	24.8
MANUFACTURING:			
Value added na.c (millions of 1980-dollars	5856	7101	6485
Industrial production index	100	111	103
Value added (millions of dollars)	5907	5356	7838 /e
Gross output (millions of dollars)	24898	21690	25081
Employment (thousands)	1384	1278	1117
-PROFITABILITY: (in percent of gross output			
Intermediate input (%)	76	75	69 /e
Wages and salaries including supplements (%)	8	8	11
Gross operating surplus (%)	16	16	20 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	17990	16972	22454
Value added / worker	4268	4191	7017 /e
Average wage (including supplements)	1437	1403	2495
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.34	4.99	6.76 /e
as a percentage of average θ in 1970-1975	105	98	133 /e
MVA growth rate / θ	-1.29	0.05	-0.19
Degree of specialization	9.9	10.9	9.6
-VALUE ADDED: (millions of dollars)			
311/2 Food products	555	281	584 /e
313 Beverages	83	107	137 /e
314 Tobacco products	27	28	42 /e
321 Textiles	353	325	355 /e
322 Wearing apparel	194	158	203 /e
323 Leather and fur products	48	39	43 /e
324 Footwear	79	85	82 /e
331 Wood and wood products	81	42	80 /e
332 Furniture and fixtures	101	92	121 /e
341 Paper and paper products	94	106	125 /e
342 Printing and publishing	83	94	156 /e
351 Industrial chemicals	417	320	533 /e
352 Other chemical products	242	303	468 /e
353 Petroleum refineries	153 /e	193 /e	314 /e
354 Miscellaneous petroleum and coal products	2 /e	2 /e	4 /e
355 Rubber products	55	71	124 /e
356 Plastic products	61	80	159 /e
361 Pottery, china and earthenware	57	46	63 /e
362 Glass and glass products	70	71	96 /e
369 Other non-metal mineral products	204	161	215 /e
371 Iron and steel	370	200	480 /e
372 Non-ferrous metals	215	54	415 /e
381 Metal products	214	215	303 /e
382 Non-electrical machinery	497	569	817 /e
383 Electrical machinery	655	758	861 /e
384 Transport equipment	486	507	463 /e
385 Professional and scientific equipment	272	287	392 /e
390 Other manufacturing industries	237	164	152 /e

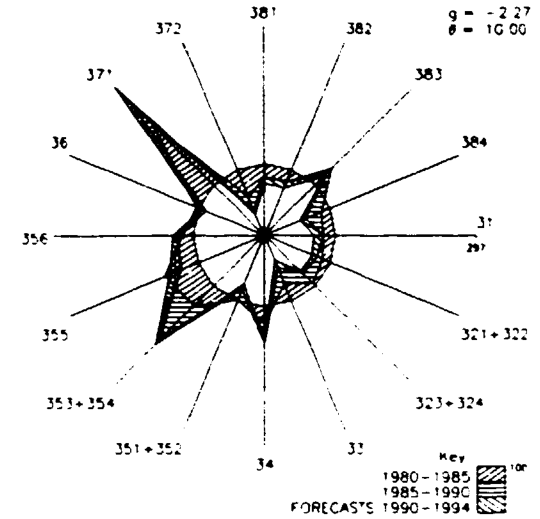
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex.



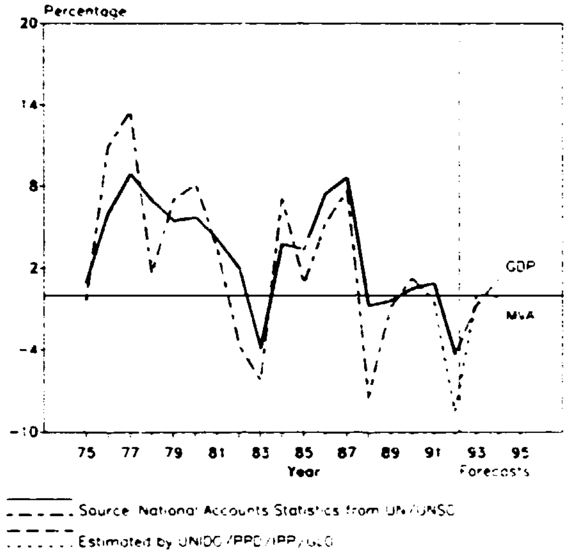


ICELAND

Industrial structural change
(index of value added 1980=100)

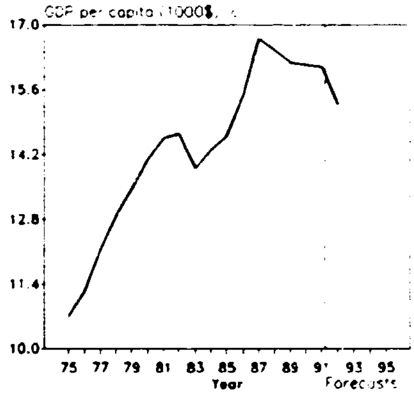


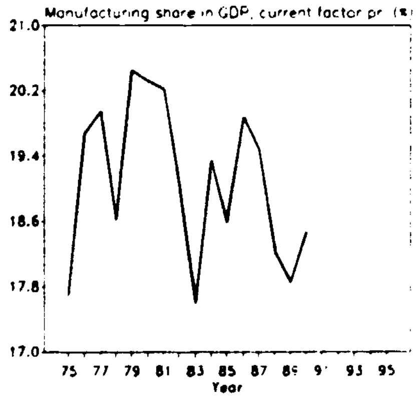
Annual growth rates of GDP and MVA
(Constant 1980 prices)

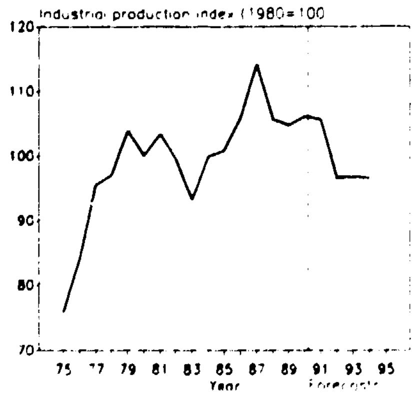


	1980	1985	1990
GDP: na.c (millions of 1980-dollars)	3230	3534	4098
Per capita (1980-dollars) /na.c	14104	14605	16134
Manufacturing share (%) /na (current factor prices)	20.3	18.6	18.5 /e
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	502	506	533
Industrial production index	100	101	106
Value added (millions of dollars)	765	553	939 /e
Gross output (millions of dollars)	1969	1629	2956 /e
Employment (thousands)	28	30	26 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	66	68 /e
Wages and salaries including supplements (%)	20 /e	19 /e	20 /e
Gross operating surplus (%)	19 /e	15 /e	12 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	69708	54610	111225 /e
Value added / worker	27097	18555	35330 /e
Average wage (including supplements)	13687 /e	10407 /e	22317 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.43	4.37	2.40 /e
as a percentage of average θ in 1970-1975	75	135	74 /e
MVA growth rate / θ	4.07	-0.42	-0.43
Degree of specialization	31.7	27.7	30.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	330	221	402 /e
313 Beverages	11	10	14 /e
314 Tobacco products			
321 Textiles	26	21	41 /e
322 Wearing apparel	17	11	10 /e
323 Leather and fur products	8	6	10 /e
324 Footwear	1	1	1 /e
331 Wood and wood products	-	-	1 /e
332 Furniture and fixtures	53	32	38 /e
341 Paper and paper products	5	5	8 /e
342 Printing and publishing	36	37	84 /e
351 Industrial chemicals	11	9	14 /e
352 Other chemical products	11	9	13 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	5	6	11 /e
356 Plastic products	12	11	23 /e
361 Pottery, china and earthenware	1	-	1 /e
362 Glass and glass products	4	3	3 /e
369 Other non-metal mineral products	22	19	33 /e
371 Iron and steel	6	11	25 /e
372 Non-ferrous metals	50	24	28 /e
381 Metal products	24 /e	16 /e	29 /e
382 Non-electrical machinery	46 /e	31 /e	55 /e
383 Electrical machinery	15	16	27 /e
384 Transport equipment	65	47	59 /e
385 Professional and scientific equipment	2	1	2 /e
390 Other manufacturing industries	3	4	7 /e

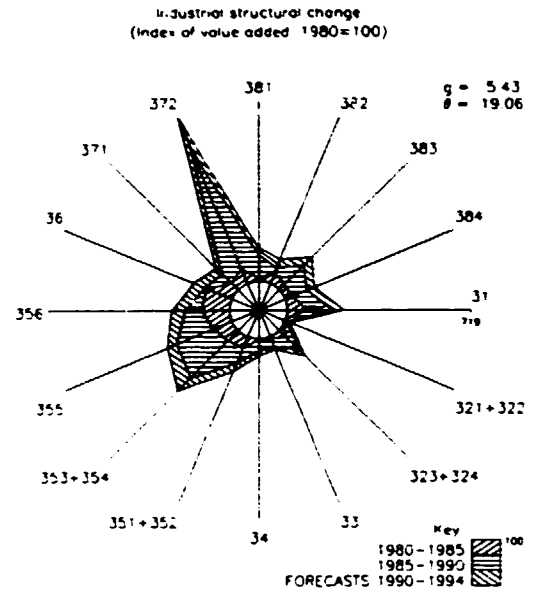
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

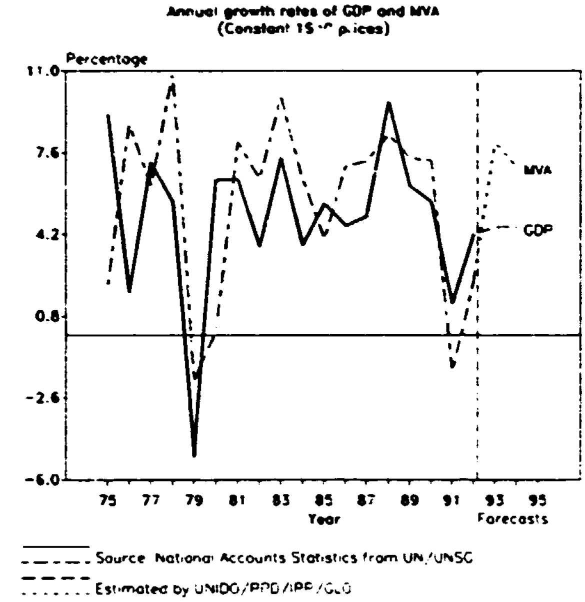






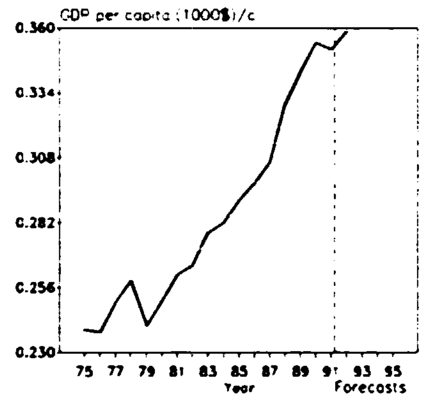
INDIA

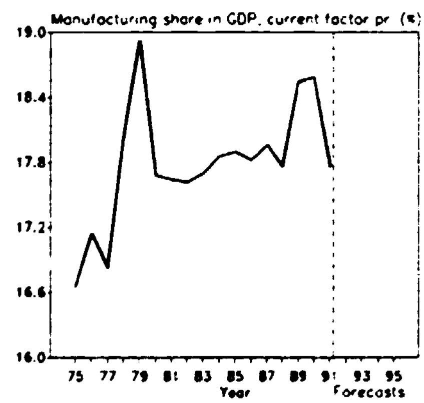


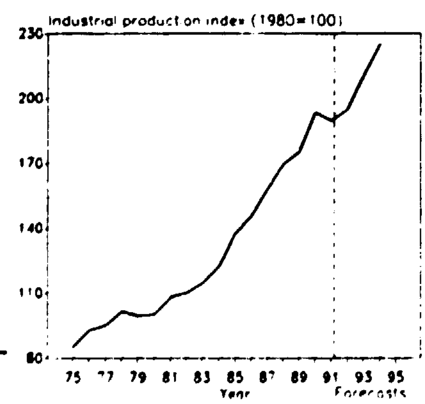


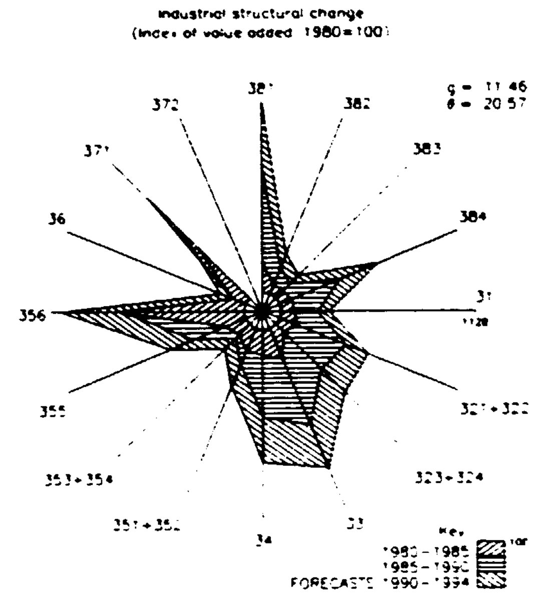
	1980	1985	1990
GDP: (na.c millions of 1980-dollars)	172723	224026	302102
Per capita (1980-dollars) /na.c	251	291	354
Manufacturing share (%) /na (current factor prices)	17.7	17.9	18.6
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	27526	38560	55238
Industrial production index	100	137	193
Value added (millions of dollars)	13086	15526	22598 /e
Gross output (millions of dollars)	71387	88304	129450 /e
Employment (thousands)	6992	6578	7309 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	82	82	83 /e
Wages and salaries including supplements (%)	11 /e	10	8 /e
Gross operating surplus (%)	8 /e	8	9 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	10210	[illegible]	[illegible] /e
Value added / worker	1872	2360	3098 /e
Average wage (including supplements)	1088 /e	1298	1502 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.85	7.59	4.98 /e
as a percentage of average θ in 1970-1975	83	130	85 /e
MVA growth rate / θ	0.42	0.68	1.46
Degree of specialization	19.3	16.9	14.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	899	1436	2128 /e
313 Beverages	99	135	258 /e
314 Tobacco products	196	230	453 /e
321 Textiles	2642	2135	2443 /e
322 Wearing apparel	62	87	261 /e
323 Leather and fur products	48	52	94 /e
324 Footwear	37	52	54 /e
331 Wood and wood products	74	73	36 /e
332 Furniture and fixtures	8	7	9 /e
341 Paper and paper products	296	233	354 /e
342 Printing and publishing	256	280	377 /e
351 Industrial chemicals	778	1200	1744 /e
352 Other chemical products	1062	1146	1677 /e
353 Petroleum refineries	203	344	837 /e
354 Miscellaneous petroleum and coal products	151	152	272 /e
355 Rubber products	234	363	675 /e
356 Plastic products	93	166	221 /e
361 Pottery, china and earthenware	47	27	64 /e
362 Glass and glass products	67	101	106 /e
369 Other non-metal mineral products	399	775	791 /e
371 Iron and steel	1483	1790	2501 /e
372 Non-ferrous metals	81	115	465 /e
381 Metal products	421	425	748 /e
382 Non-electrical machinery	1130	1506	1674 /e
383 Electrical machinery	1061	1201	2184 /e
384 Transport equipment	1088	1231	1821 /e
385 Professional and scientific equipment	92	118	180 /e
390 Other manufacturing industries	72	146	100 /e

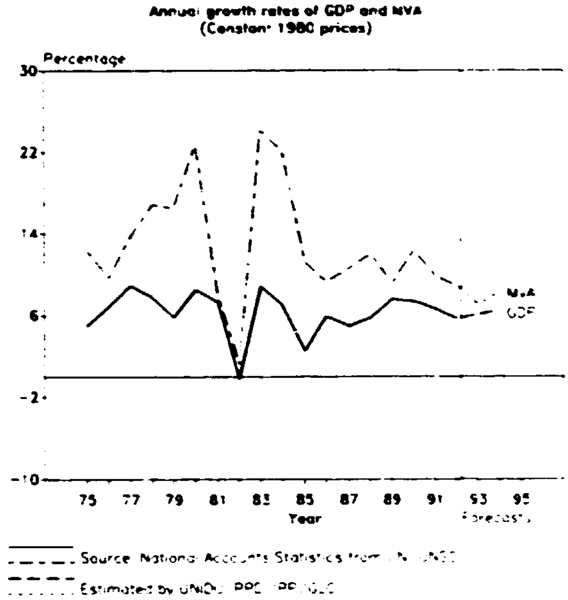
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





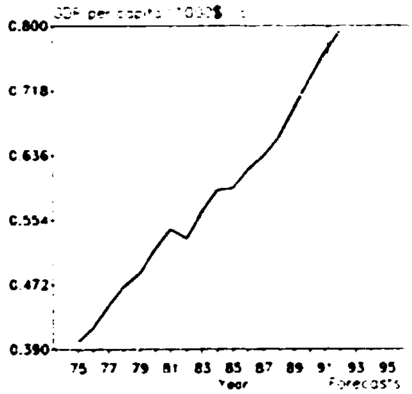


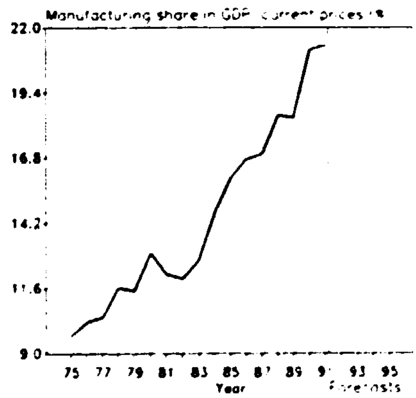


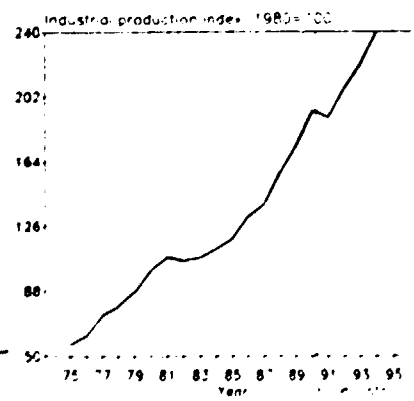


	1980	1985	1990
GDP: (n.a.c. millions of 1980-dollars)	78013	99479	134922
Per capita (1980-dollars) (n.a.c.)	517	595	732
Manufacturing share (%) (n.a. current factor prices)	13.0	16.0	21.1
MANUFACTURING:			
Value added (n.a.c. millions of 1980-dollars)	10133	18632	30905
Industrial production index	100	119	193
Value added (millions of dollars)	4368	8098 e	12258 /e
Gross output (millions of dollars)	13205	23111	39467 /e
Employment (thousands)	963	1572	2378 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	69	69	71 e
Wages and salaries including supplements (%)	7	7	6 /e
Gross operating surplus (%)	25	24	23 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	11219	12255	15322 /e
Value added / worker	3497	3850	4451 /e
Average wage (including supplements)	743	921	941 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.26	11.69 /e	7.13 /e
as a percentage of average θ in 1970-1975	105	100 /e	61 e
MVA growth rate / θ	1.10	1.36	1.64
Degree of specialization	20.5	16.6	15.2
-VALUE ADDED: (millions of dollars)			
311/2 Food products	376	870	1287 e
313 Beverages	51	77	31 e
314 Tobacco products	549	741	1158 e
321 Textiles	420	687	1378 e
322 Wearing apparel	15	105	271 e
323 Leather and fur products	5	14	15 e
324 Footwear	26	31	34 e
331 Wood and wood products	239	612	1230 e
332 Furniture and fixtures	6	18	51 e
341 Paper and paper products	43	110	269 e
342 Printing and publishing	51	92	156 e
351 Industrial chemicals	145	385	475 e
352 Other chemical products	241	430	488 e
353 Petroleum refineries	978	1611 /e	1596 e
354 Miscellaneous petroleum and coal products	-	-	- e
355 Rubber products	164	328	516 e
356 Plastic products	25	175	148 e
361 Pottery, china and earthenware	3	24	49 e
362 Glass and glass products	36	98	53 e
369 Other non-metal mineral products	200	262	212 e
371 Iron and steel	107	469b	742 e
372 Non-ferrous metals	-	b	- e
381 Metal products	118	278	132 e
382 Non-electrical machinery	53	76	128 e
383 Electrical machinery	180	246	292 e
384 Transport equipment	217	331	759 e
385 Professional and scientific equipment	2	4	7 e
390 Other manufacturing industries	13	24	54 e

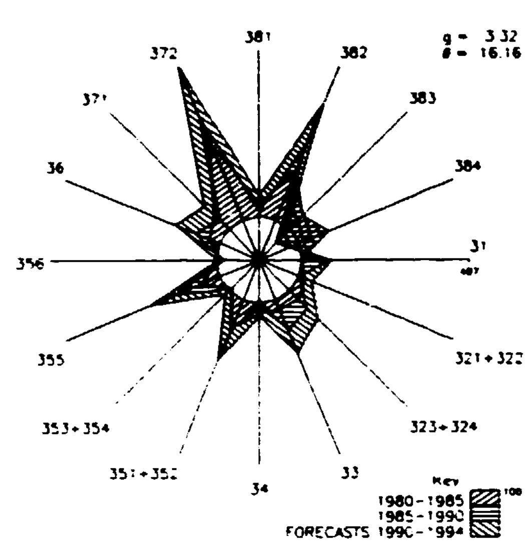
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



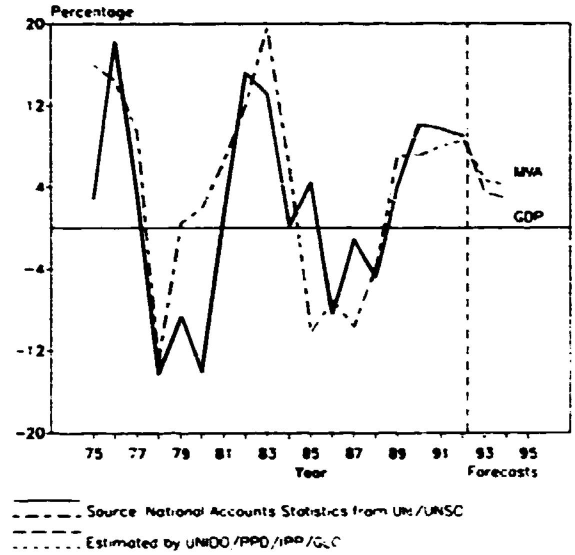




Industrial structural change
(Index of value added 1980=100)



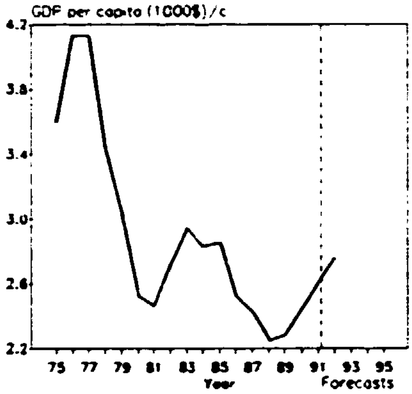
Annual growth rates of GDP and MVA
(Constant 1980 prices)



	1980	1985	1990
GDP: (na.c (millions of 1980-dollars)	98081	135805	134074
Per capita (1980-dollars) /na.c	2521	2852	2441
Manufacturing share (%) (na. current factor prices)	8.5	8.5	7.6
MANUFACTURING:			
Value added (na.c (millions of 1980-dollars)	8528	11581	10683
Industrial production index	100	140	122
Value added (millions of dollars)	8186	13336 /e	44607 /e
Gross output (millions of dollars)	15871	26458	81835 /e
Employment (thousands)	470	614	741 /e
-PROFITABILITY: in percent of gross output)			
Intermediate input (%)	48	50 /e	45 /e
Wages and salaries including supplements (%)	29	26 /e	24 /e
Gross operating surplus (%)	23	24 /e	31 /e
-PRODUCTIVITY (dollars)			
Gross output / worker	33756	43070 /e	108954 /e
Value added / worker	17411	21709 /e	61839 /e
Average wage (including supplements)	9668	11294	26415 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	10.92 /e	5.64 /e	7.70 /e
as a percentage of average θ in 1970-1975	166 /e	86 /e	117 /e
MVA growth rate / θ	0.46	0.75	0.22
Degree of specialization	20.3	17.3	16.3
-VALUE ADDED: millions of dollars)			
311/2 Food products	930	1259	3712 /e
313 Beverages	145	302	972 /e
314 Tobacco products	190 /e	133	4133 /e
321 Textiles	1329	2119	5640 /e
322 Wearing apparel	78	76	471 /e
323 Leather and fur products	36	67	379 /e
324 Footwear	100	165	540 /e
331 Wood and wood products	68	123	587 /e
332 Furniture and fixtures	33	48	177 /e
341 Paper and paper products	135	261	362 /e
342 Printing and publishing	80	97	517 /e
351 Industrial chemicals	93	232	806 /e
352 Other chemical products	278	606	2037 /e
353 Petroleum refineries	1652	1977 /e	6444 /e
354 Miscellaneous petroleum and coal products	2	32	245 /e
355 Rubber products	93	180	841 /e
356 Plastic products	198	235	691 /e
361 Pottery, china and earthenware	45	76	191 /e
362 Glass and glass products	115	167	485 /e
369 Other non-metal mineral products	819	1368	6030 /e
371 Iron and steel	367	713	2056 /e
372 Non-ferrous metals	48	191	742 /e
381 Metal products	319	555	1551 /e
382 Non-electrical machinery	208	632	2584 /e
383 Electrical machinery	391	749	946 /e
384 Transport equipment	399	927	1270 /e
385 Professional and scientific equipment	24	55	98 /e
390 Other manufacturing industries	11	26	103 /e

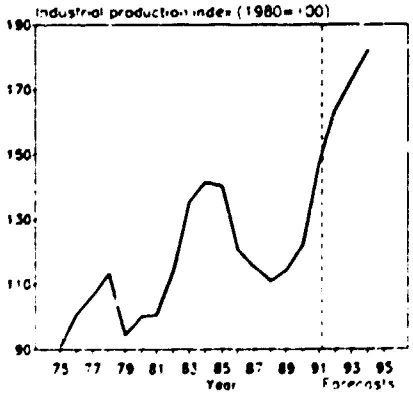
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

GDP per capita (1000$)/c



Manufacturing share in GDP, current factor pr (%)

Industrial production index (1980=100)



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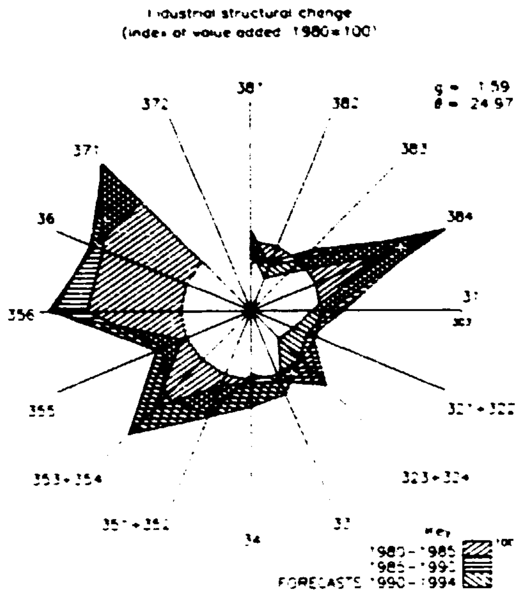
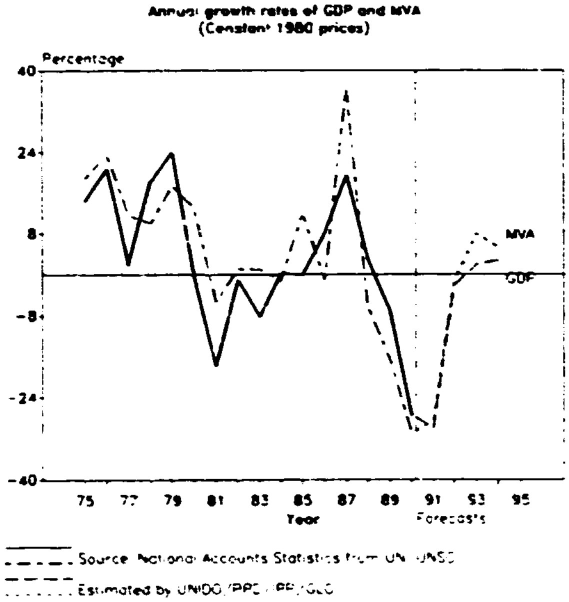
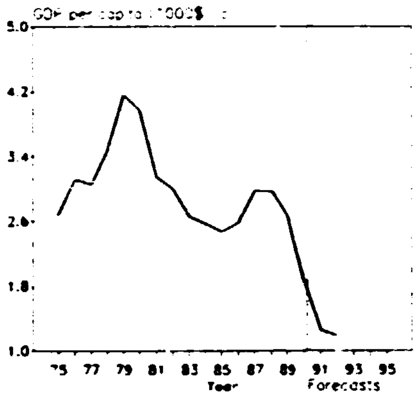
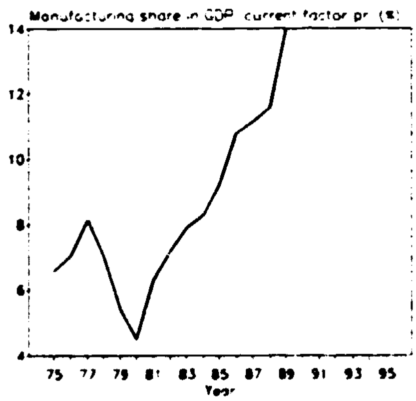


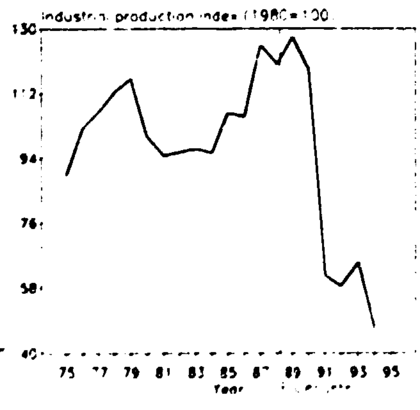


Indicator	1980	1985	1990
GDP: (nat.c. millions of 1980-dollars)	52749	39316	35145
Per capita (1980-dollars) (nat.c)	3369	2473	1857
Manufacturing share (%) (nat. current factor prices)	4.5	9.2	
MANUFACTURING:			
Value added (nat.c. millions of 1980-dollars)	2363	2520	1838
Industrial production index	100	107	113 e
Value added (millions of dollars)	2068 /e	3676	3807 /e
Gross output (millions of dollars)	5393 /e	7162	7056 /e
Employment (thousands)	177	174	169 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	62 /e	49	46 /e
Wages and salaries including supplements (%)	12 /e	13	13 e
Gross operating surplus (%)	26 /e	39	41 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	30443 /e	41090	41407 /e
Value added / worker	11673 /e	21088	22386 e
Average wage (including supplements)	3700	5242	5330 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.61 /e	5.13 /e	3.78 /e
as a percentage of average θ in 1970-1975	43 /e	34 e	25 e
MVA growth rate / θ	1.90	1.68	0.59
Degree of specialization	20.2	24.2	27.3
-VALUE ADDED: (millions of dollars)			
311/2 Food products	225 /e	396	288 /e
313 Beverages	74 /e	125	112 /e
314 Tobacco products	105 /e	140	124 e
321 Textiles	230 /e	248	219 /e
322 Wearing apparel	30 /e	53	45 /e
323 Leather and fur products	24 /e	1	1 /e
324 Footwear	19 /e	81	49 e
331 Wood and wood products	1 /e	1	2 /e
332 Furniture and fixtures	10 /e	13	14 e
341 Paper and paper products	48 /e	52	79 /e
342 Printing and publishing	27 /e	33	42 /e
351 Industrial chemicals	78 /e	151	153 e
352 Other chemical products	192 /e	389	370 /e
353 Petroleum refineries	392 /e	868	1185 /e
354 Miscellaneous petroleum and coal products	27 /e	40	41 /e
355 Rubber products	5 e	10	11 e
356 Plastic products	11 /e	33	38 /e
361 Pottery, china and earthenware	1 /e	1	1 e
362 Glass and glass products	21 /e	35	31 /e
369 Other non-metal mineral products	190 /e	565	537 /e
371 Iron and steel	5 /e	20 /e	19 /e
372 Non-ferrous metals	- /e	- /e	- /e
381 Metal products	55 /e	47	15 /e
382 Non-electrical machinery	160 /e	149	129 /e
383 Electrical machinery	122 /e	185	150 /e
384 Transport equipment	12 /e	40	42 /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

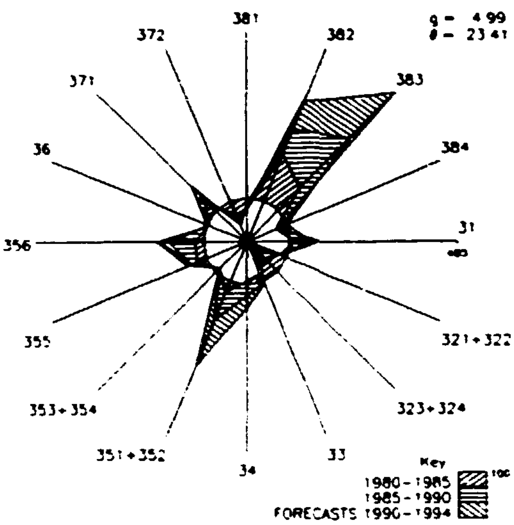




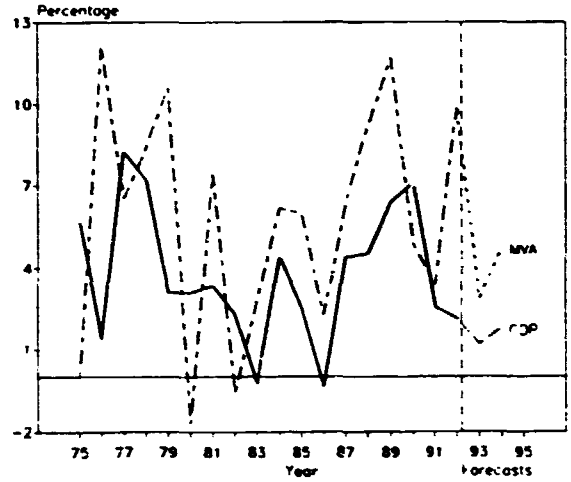


IRELAND

Industrial structural change (Index of value added 1980=100)



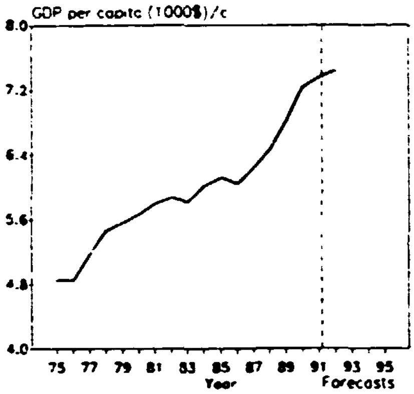
Annual growth rates of GDP and MVA (Constant 1980 prices)



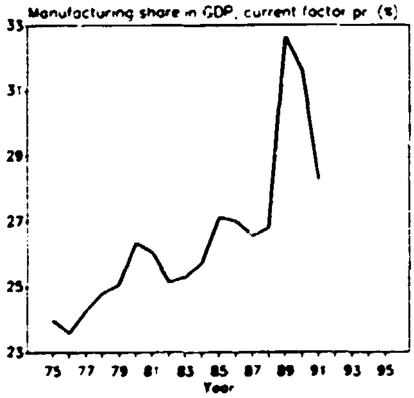
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	19261	21722	26899
Per capita (1980-dollars) /na.c	5662	6114	7233
Manufacturing share (%) /na (current factor prices)	26.3	27.1	31.6
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	4481	5535	7692
Industrial production index	100	122	176
Value added (millions of dollars)	5700	5809 /e	14741
Gross output (millions of dollars)	15905	15394	33081
Employment (thousands)	225	186	194 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	62 /e	55
Wages and salaries including supplements (%)	17 /e	14 /e	14 /e
Gross operating surplus (%)	19 /e	24 /e	31 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	70068	82191	170065 /e
Value added / worker	25112	31015 /e	75869
Average wage (including supplements)	11894 /e	11580 /e	23878 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.50	4.65 /e	4.32
as a percentage of average θ in 1970-1975	94	97 /e	90
MVA growth rate / θ	1.41	0.71	1.50
Degree of specialization	14.9	18.4	20.5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1264	1194	3065
313 Beverages	325	331	756
314 Tobacco products	83	83	166
321 Textiles	266	181	349
322 Wearing apparel	147	118	207
323 Leather and fur products	28	12	22
324 Footwear	42	22	19
331 Wood and wood products	93	66	170
332 Furniture and fixtures	59	40	86
341 Paper and paper products	105	75	187
342 Printing and publishing	265	219	561
351 Industrial chemicals	236	275 /e	1050
352 Other chemical products	536	575 /e	1391
353 Petroleum refineries	22	17 /e	31
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	52	56 /e	118
356 Plastic products	113	119 /e	332
361 Pottery, china and earthenware	28	13	28
362 Glass and glass products	109	113	144
369 Other non-metal mineral products	322	260	560
371 Iron and steel	31	37	92
372 Non-ferrous metals	15	8	10
381 Metal products	335	216	470
382 Non-electrical machinery	449	854	2034
383 Electrical machinery	337	512	1843
384 Transport equipment	190	116	309
385 Professional and scientific equipment	168	261	611
390 Other manufacturing industries	79	39	132

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

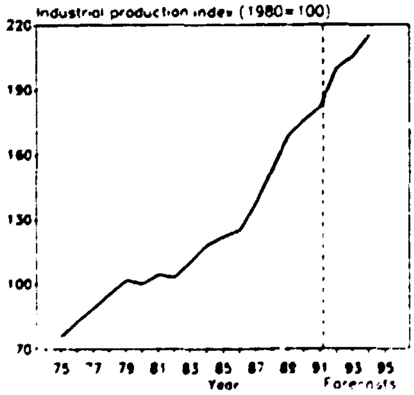
GDP per capita (1000$)/c



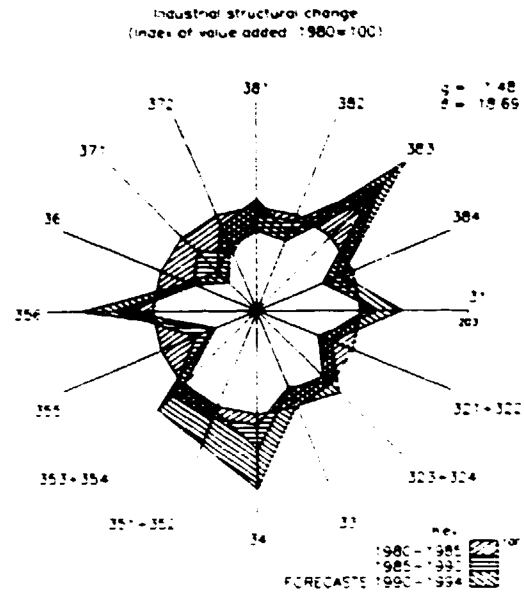
Manufacturing share in GDP, current factor pr. (%)

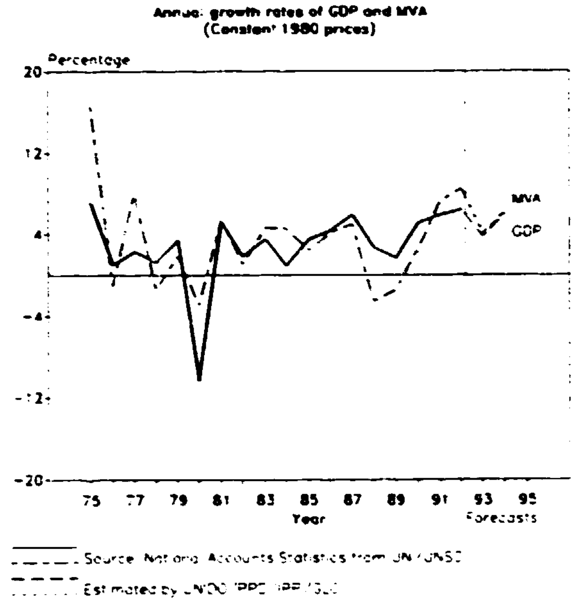


Industrial production index (1980=100)



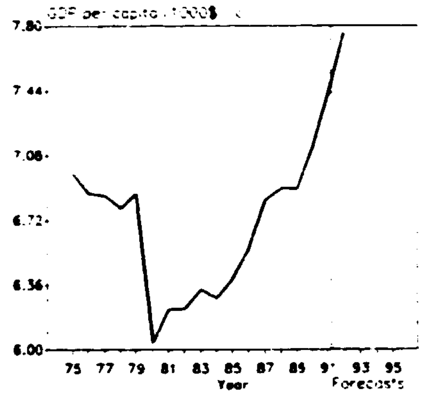
ISRAEL

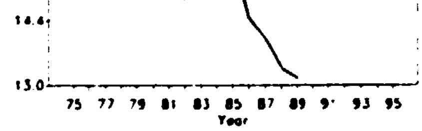


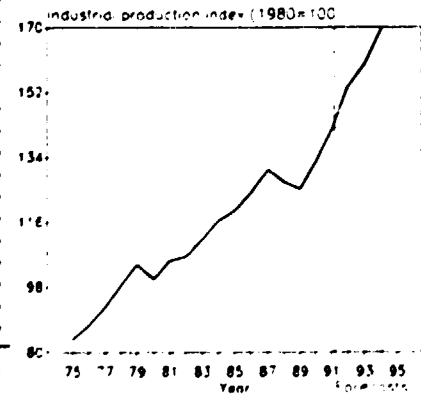


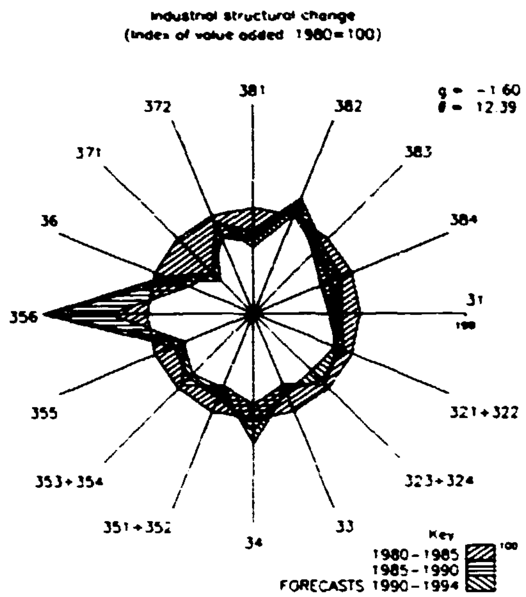
	1980	1985	1990
GDP: (n.a.c., millions of 1980-dollars)	23400	27066	32796
Per capita (1980-dollars, n.a.c.)	6034	5394	7123
Manufacturing share (%, n.a., current factor prices)	15.5	15.7	
MANUFACTURING:			
Value added (n.a.c., millions of 1980-dollars)	4200	5006	5388
Industrial production index	100	119	133
Value added (millions of dollars)	5490	5655	10497 e
Gross output (millions of dollars)	14332	16351	29404
Employment (thousands)	259	292	293
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	55	59	64 e
Wages and salaries including supplements (%)	30 e	30 e	21 e
Gross operating surplus (%)	15 e	11 e	14 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	54619	55297	93942
Value added / worker	24770	22506	33535 e
Average wage (including supplements)	16751 e	16350 e	21499 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.50	6.41	4.54 e
as a percentage of average θ in 1970-1975	99	115	81 e
MVA growth rate (%)	1.76	0.87	-0.36
Degree of specialization	14.8	18.3	17.9
-VALUE ADDED: (millions of dollars)			
311/2 Food products	706	748	1392 e
313 Beverages	66	56	155 e
314 Tobacco products	24	10	17 e
321 Textiles	422	243	381 e
322 Wearing apparel	293	229	395 e
323 Leather and fur products	18	13	21 e
324 Footwear	38	42	55 e
331 Wood and wood products	112	78	124 e
332 Furniture and fixtures	90	81	160 e
341 Paper and paper products	150	135	297 e
342 Printing and publishing	184	227	461 e
351 Industrial chemicals	256	317	472 e
352 Other chemical products	250	241	425 e
353 Petroleum refineries	93	106	154 e
354 Miscellaneous petroleum and coal products	93	106	154 e
355 Rubber products	104	64	76 e
356 Plastic products	212	290	450 e
361 Pottery, china and earthenware	26	25	25 e
362 Glass and glass products	30	23	24 e
369 Other non-metal mineral products	239	143	271 e
371 Iron and steel	148	113	97 e
372 Non-ferrous metals	61	36	70 e
381 Metal products	1060	967	1382 e
382 Non-electrical machinery	245	224	301 e
383 Electrical machinery	831	1415	2144 e
384 Transport equipment	610	522	707 e
385 Professional and scientific equipment	66	129	161 e
390 Other manufacturing industries	63	67	114 e

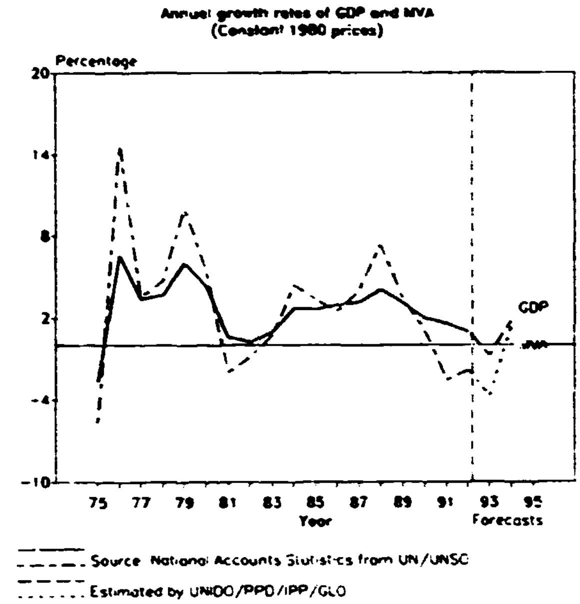
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





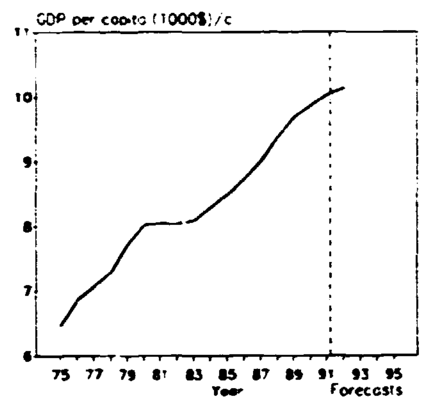


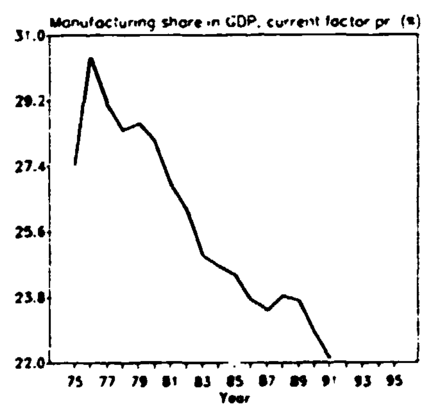


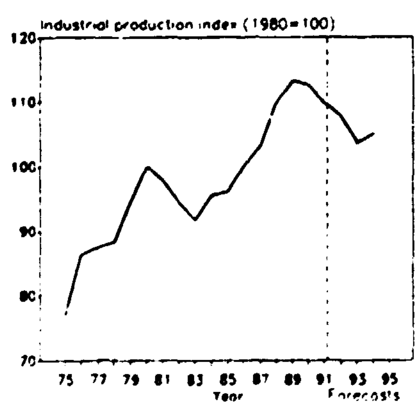


	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	452646	485199	563011
Per capita (1980-dollars) /na.c	8021	8491	9865
Manufacturing share (%) /na (current factor prices)	28.1	24.4	22.8
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	122239	129123	154259
Industrial production index	100	96	113
Value added (millions of dollars)	97022	64726	164069
Gross output (millions of dollars)	250912	212913	501092 /e
Employment (thousands)	3333	2875	2858 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	70	67 /e
Wages and salaries including supplements (%)	21 /e	18 /e	19 /e
Gross operating surplus (%)	18 /e	12 /e	14 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	74433	73098	173539 /e
Value added / worker	28784	22227	56876 /e
Average wage (including supplements)	15647 /e	13630 /e	32527 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.82	6.13	1.99 /e
as a percentage of average θ in 1970-1975	67	145	47 /e
MVA growth rate / θ	0.89	-0.80	1.45
Degree of specialization	10.1	10.9	10.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	6362	3618	8793
313 Beverages	1572	1354	3661
314 Tobacco products	307	224	695
321 Textiles	6716	5062	11734
322 Wearing apparel	3197	2322	5541
323 Leather and fur products	718	560	1394
324 Footwear	1495	1260	2401
331 Wood and wood products	1318	786	1745 /e
332 Furniture and fixtures	1936	1257	3215 /e
341 Paper and paper products	2260	1661	3976
342 Printing and publishing	3017	2271	7129
351 Industrial chemicals	5983	3994	9527 /e
352 Other chemical products	4439	2696	7605
353 Petroleum refineries	1275	1065	2106
354 Miscellaneous petroleum and coal products	58	42	79 /e
355 Rubber products	1832	1107	2848 /e
356 Plastic products	1465	1729	5579 /e
361 Pottery, china and earthenware	1897	1139	3381 /e
362 Glass and glass products	1116	666	1868
369 Other non-metal mineral products	3667	2043	6327
371 Iron and steel	8354	3846	8535
372 Non-ferrous metals	1315	875	2286
381 Metal products	5687	3405	8543
382 Non-electrical machinery	9326	8914	20985
383 Electrical machinery	5435	5813	14796
384 Transport equipment	10280	6172	17597
385 Professional and scientific equipment	2032	550	1229 /e
390 Other manufacturing industries	871	297	497 /e

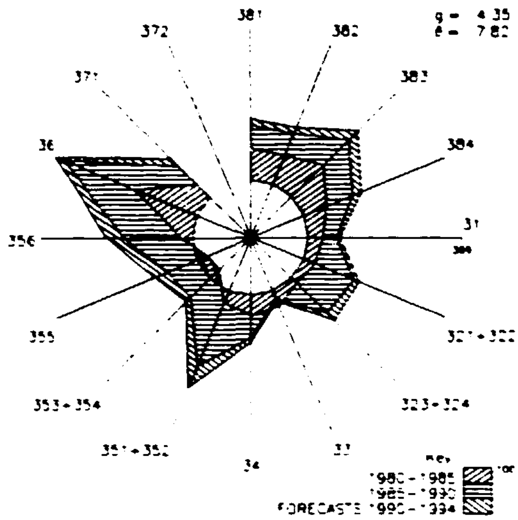
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



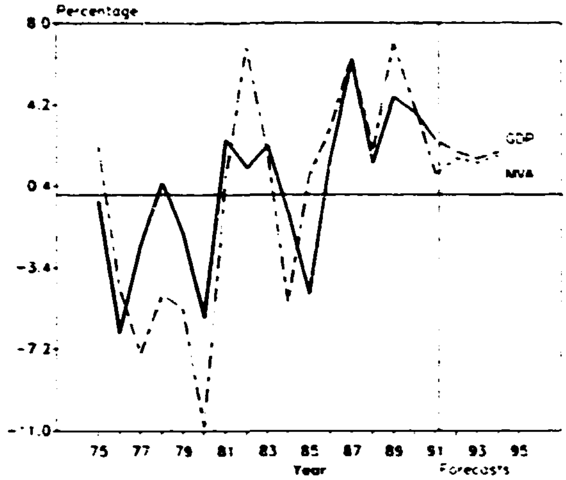




Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

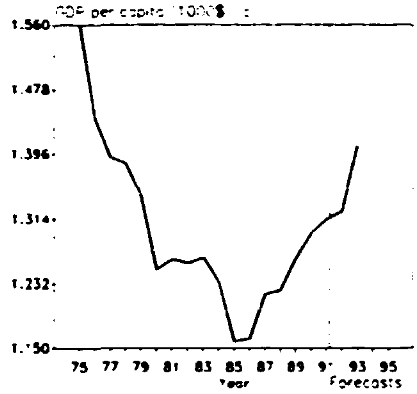


Source: National Accounts Statistics from UN (UNSO)
Estimated by UNIDO/PPD

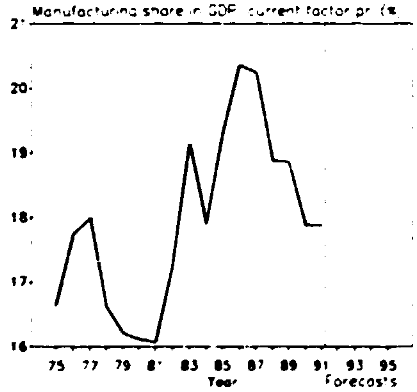
	1980		1985	1990	
GDP: (n.a.c. millions of 1980-dollars)	2667		2578	3187	
Per capita (1980-dollars) (n.a.c.)	1250		1158	1296	
Manufacturing share (%) (at current factor prices)	16.1		19.3	18.4	
MANUFACTURING:					
Value added (n.a.c. millions of 1980-dollars)	446		469	535	
Industrial production index	100		105	122	
Value added (millions of dollars)	436		370	734	e
Gross output (millions of dollars)	1661		1464	2497	e
Employment (thousands)	44		46	64	
-PROFITABILITY: (in percent of gross output)					
Intermediate input (%)	74	e	75	71	e
Wages and salaries (including supplements) (%)	12		10	11	e
Gross operating surplus (%)	14	e	16	18	e
-PRODUCTIVITY: (dollars)					
Gross output / worker	37512	e	31521	39259	e
Value added / worker	3842	e	7959	11543	e
Average wage (including supplements)	4560	e	3066	4484	e
-STRUCTURAL INDICES:					
Structural change θ (5-year average in degrees)	5.35		7.01	4.49	e
as a percentage of average θ in 1970-1975	127		147	94	e
MVA growth rate / θ	-1.34		0.54	1.53	
Degree of specialization	18.5		17.0	14.9	
-VALUE ADDED: (millions of dollars)					
311/2 Food products	78		74	122	e
313 Beverages	53		51	30	e
314 Tobacco products	61		48	84	e
321 Textiles	3		2	5	e
322 Wearing apparel	15		12	28	e
323 Leather and fur products	2		3	6	e
324 Footwear	8		5	11	e
331 Wood and wood products	3		3	4	e
332 Furniture and fixtures	12		12	14	e
341 Paper and paper products	7		5	10	e
342 Printing and publishing	15		14	26	e
351 Industrial chemicals	24	e	20	55	e
352 Other chemical products	4	e	4	10	e
353 Petroleum refineries	55		28	78	e
354 Miscellaneous petroleum and coal products	2	e	1	3	e
355 Rubber products	10	e	5	15	e
356 Plastic products	11	e	9	24	e
361 Pottery, china and earthenware	1		2	5	e
362 Glass and glass products	2		3	7	e
369 Other non-metal mineral products	8		12	27	e
371 Iron and steel	5		5	9	e
372 Non-ferrous metals	-		-	-	e
381 Metal products	10		11	19	e
382 Non-electrical machinery	5		1	13	e
383 Electrical machinery	6		7	14	e
384 Transport equipment	23		23	44	e
385 Professional and scientific equipment	-		-	-	e
390 Other manufacturing industries	4		4	8	e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

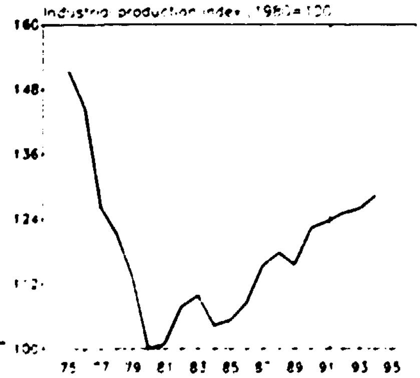
GDP per capita (1000$)

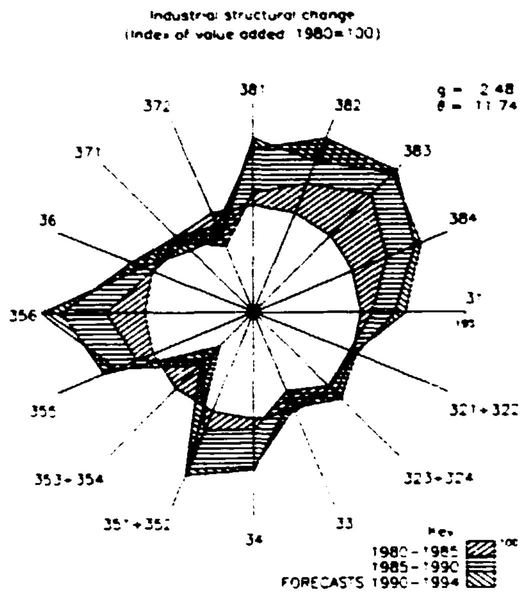


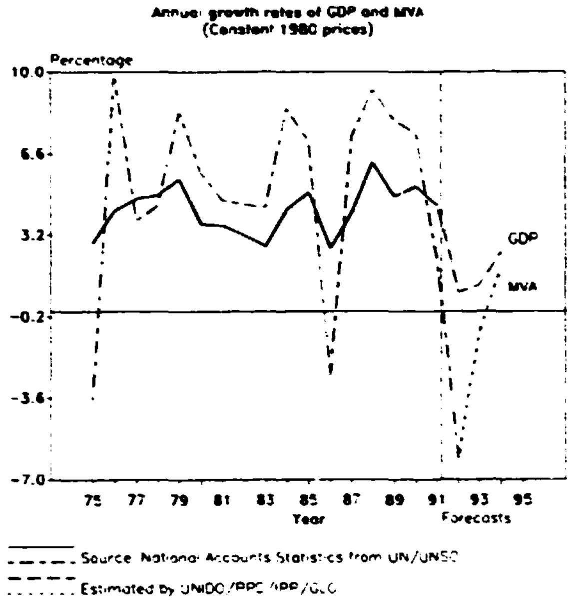
Manufacturing share in GDP (current factor pr.) (%)



Industrial production index (1980=100)

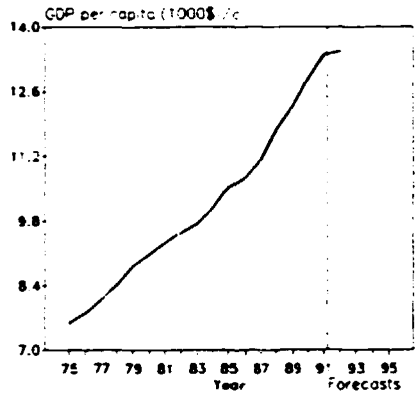


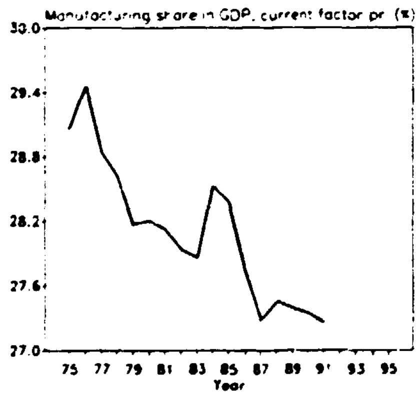


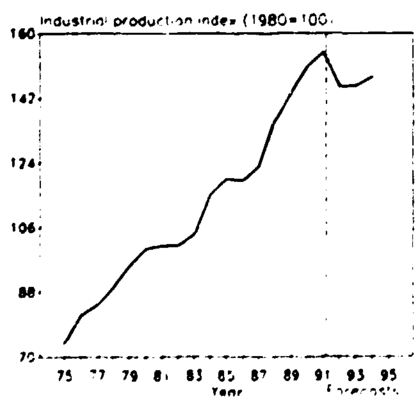


	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	1059262	1272427	1592076
Per capita (1980-dollars) (na.c)	9068	10530	12889
Manufacturing share (%) (na) (current factor prices)	28.2	28.4	27.3
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	309747	410238	542540
Industrial production index	100	119	151
Value added (millions of dollars)	339234	412505	891779
Gross output (millions of dollars)	970568	:'4673	2245740
Employment (thousands)	10253	10646	10980
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	55	63	60
Wages and salaries including supplements (%)	12	13	13
Gross operating surplus (%)	23	24	27
-PRODUCTIVITY: (dollars)			
Gross output / worker	88443	102348	200997
Value added / worker	30912	37876	79816
Average wage (including supplements)	11522	13653	26828
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.96	3.12	2.29
as a percentage of average θ in 1970-1975	70	74	54
MVA growth rate / θ	1.82	0.95	1.92
Degree of specialization	11.8	15.1	15.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	25689	32032	66676
313 Beverages	5015	5307	10305
314 Tobacco products	1888	700	2003
321 Textiles	15436	15259	27046
322 Wearing apparel	5156	5622	11921
323 Leather and fur products	886	981	1871
324 Footwear	597	558	1478
331 Wood and wood products	8997	6886	14000
332 Furniture and fixtures	3788	3798	8730
341 Paper and paper products	9310	9759	22287
342 Printing and publishing	17099	20789	47938
351 Industrial chemicals	13809	16811	38083
352 Other chemical products	15471	19758	46764
353 Petroleum refineries	6620	4595	4841
354 Miscellaneous petroleum and coal products	1063	713	1540
355 Rubber products	4150	5017	11403
356 Plastic products	9478	13570	30796
361 Pottery, china and earthenware	1623	1627	2984
362 Glass and glass products	2876	4029	8467
369 Other non-metal mineral products	12565	121	26659
371 Iron and steel	26444	25424	46539
372 Non-ferrous metals	7458	5236	11976
381 Metal products	22409	26356	62905
382 Non-electrical machinery	39270	53580	126569
383 Electrical machinery	38868	53176	133877
384 Transport equipment	32107	45158	95594
385 Professional and scientific equipment	5685	5972	12738
390 Other manufacturing industries	5173	6510	13730

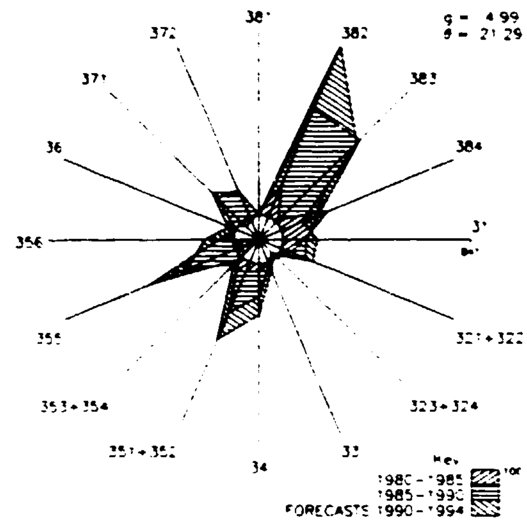
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

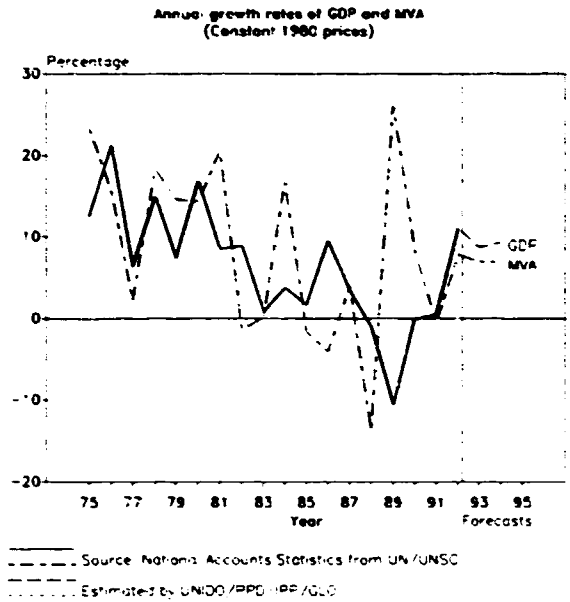






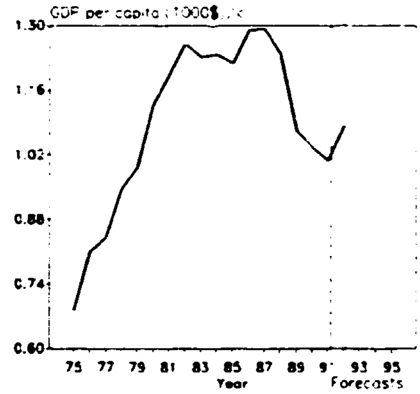
JORDAN

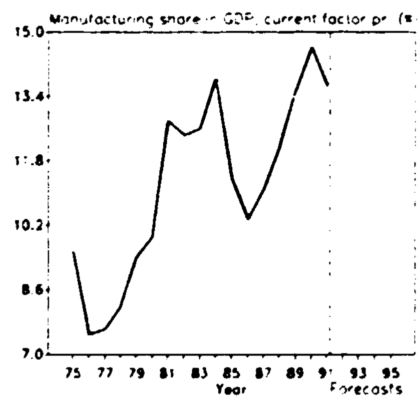


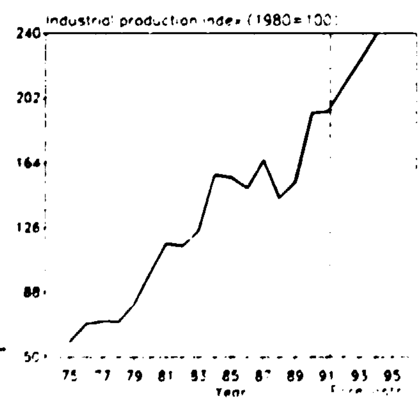


	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	3303	4147	4148
Per capita (1980-dollars) (na.c)	1130	1217	1035
Manufacturing share (%) (na) (current factor prices)	9.9	11.3	14.6 e
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	363	497	584
Industrial production index	100	155	193
Value added (millions of dollars)	406	581	583
Gross output (millions of dollars)	917	1997	1846
Employment (thousands)	25	42	44
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	56	71	68
Wages and salaries including supplements (%)	12	9	8
Gross operating surplus (%)	32	20	24
-PRODUCTIVITY: (dollars)			
Gross output / worker	26455	38009	32641
Value added / worker	11819	11193	10303
Average wage (including supplements)	4418	4326	3175
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.80	6.91	13.92
as a percentage of average θ in 1970-1975	88	47	95
MVA growth rate / θ	1.23	1.16	0.20
Degree of specialization	19.5	21.1	15.3
-VALUE ADDED: (millions of dollars)			
311/2 Food products	24	48	58
313 Beverages	20	27	23
314 Tobacco products	50	92	75
321 Textiles	10	14	20
322 Wearing apparel	8	10	13
323 Leather and fur products	2	2	4
324 Footwear	8	8	3
331 Wood and wood products	7	7	4
332 Furniture and fixtures	11	11	14
341 Paper and paper products	9	9	20
342 Printing and publishing	7	11	12
351 Industrial chemicals	10	14	44
352 Other chemical products	20	28	42
353 Petroleum refineries	53	87	55
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	-	-	1
356 Plastic products	12	13	17
361 Pottery, china and earthenware	2	3	3
362 Glass and glass products	2	3	3
369 Other non-metal mineral products	98	123	85
371 Iron and steel	11 /e	8	24
372 Non-ferrous metals	5 /e	4	9
381 Metal products	27 /e	31	23
382 Non-electrical machinery	2 /e	4	9
383 Electrical machinery	2	2	11
384 Transport equipment	-	1	1
385 Professional and scientific equipment	-	-	2
390 Other manufacturing industries	1	23	2

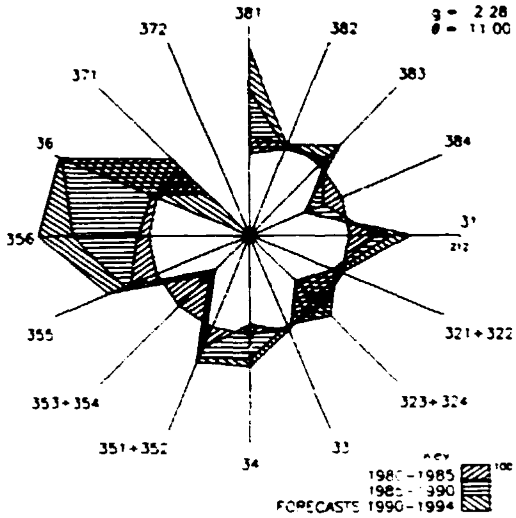
For sources, footnotes and comments see Technical notes at the beginning of this Annex



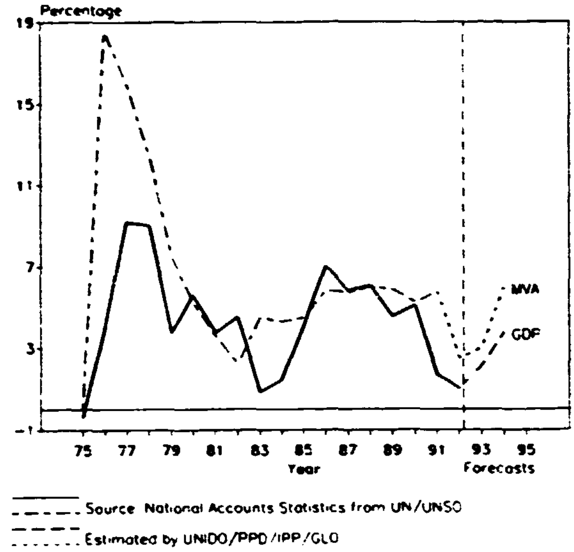




Industrial structural change
(Index of value added 1980=100)

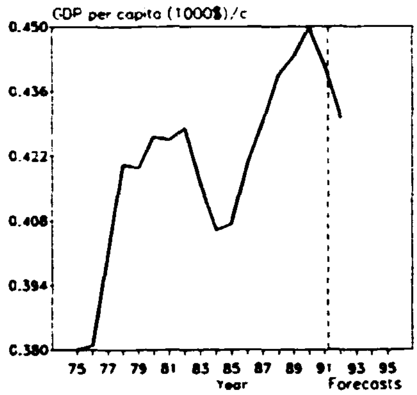


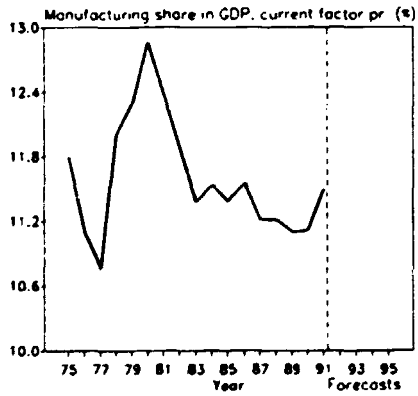
Annual growth rates of GDP and MVA
(Constant 1980 prices)

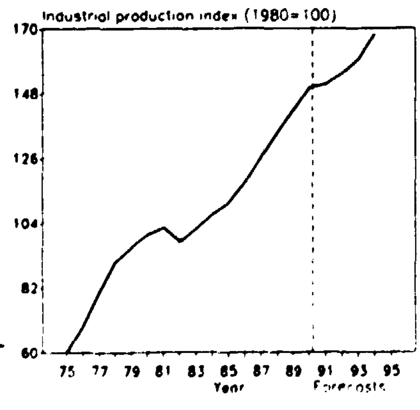


	1980	1985	1990
GDP: /na,c (millions of 1980-dollars)	7088	8185	10801
Per capita (1980-dollars) /na,c	426	407	450
Manufacturing share (%) /na (current factor prices)	12.9	11.4	11.1
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	796	960	1268
Industrial production index	100	111	150
Value added (millions of dollars)	744	670	921
Gross output (millions of dollars)	3656	4301	7767
Employment (thousands)	143 /e	163	190
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	80	84	88
Wages and salaries including supplements (%)	9	7	5 /e
Gross operating surplus (%)	11	9	7 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	22102 /e	22384 /e	40907 /e
Value added / worker	4594	3491 /e	4850 /e
Average wage (including supplements)	2269 /e	1795	2046 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.07	4.87	3.22
as a percentage of average θ in 1970-1975	88	61	40
MVA growth rate / θ	0.67	0.28	1.06
Degree of specialization	15.8	18.7	18.1
-VALUE ADDED: (millions of dollars)			
311/2 Food products	177	185	252
313 Beverages	65	72	90
314 Tobacco products	10	13	12
321 Textiles	59	40	55
322 Wearing apparel	17	19	16
323 Leather and fur products	6	3	4
324 Footwear	9	6	13
331 Wood and wood products	20	17	17
332 Furniture and fixtures	9	8	11
341 Paper and paper products	34	23	42
342 Printing and publishing	22	19	27
351 Industrial chemicals	25	16	17
352 Other chemical products	39	50	67
353 Petroleum refineries	15	6	7
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	25	27	33
356 Plastic products	14	13	24
361 Pottery, china and earthenware	1	-	1
362 Glass and glass products	3	4	5
369 Other non-metal mineral products	20	17	42
371 Iron and steel	12a/e	6a/e	12a
372 Non-ferrous metals	a	a	a
381 Metal products	44	31	64
382 Non-electrical machinery	6	4	5
383 Electrical machinery	40	36	44
384 Transport equipment	64	43	39
385 Professional and scientific equipment	1	1	2
390 Other manufacturing industries	6	8	18

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

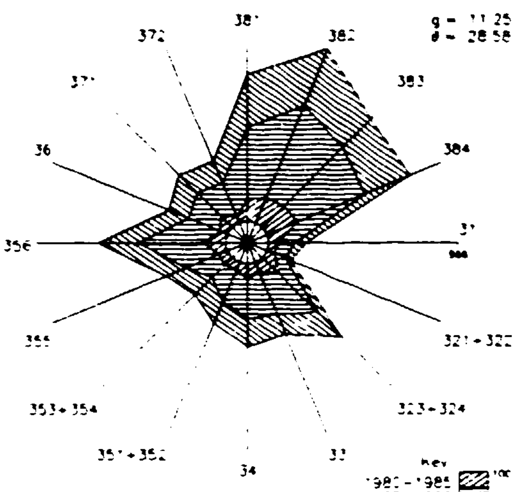




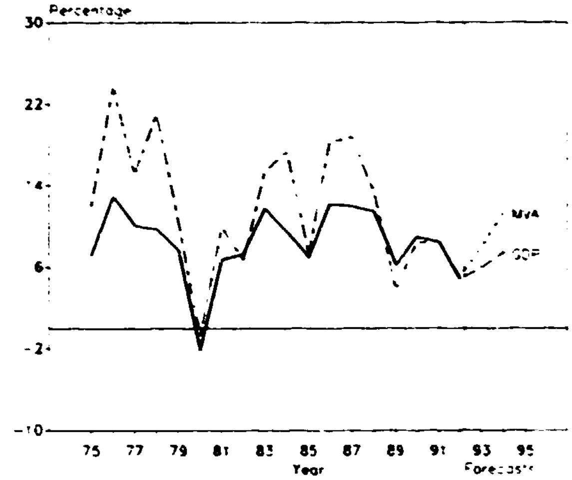


KOREA, REPUBLIC OF

Industrial structural change
(index of value added: 1980=100)



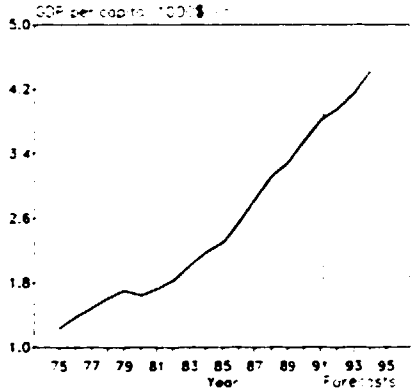
Annual growth rates of GDP and MVA
(Constant 1980 prices)



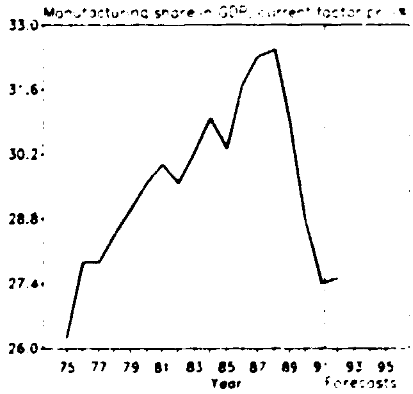
	1980	1985	1990
GDP: (n.a.c.: millions of 1980-dollars)	62626	93782	151349
Per capita (1980-dollars) (n.a.c.)	1643	2298	3545
Manufacturing share (%) (n.a. current factor prices)	29.6	30.3	28.8
MANUFACTURING:			
Value added (n.a.c.: millions of 1980-dollars)	18600	31629	56573
Industrial production index	100	171	332
Value added (millions of dollars)	19520	30731	100210
Gross output (millions of dollars)	59725	88541	250507
Employment (thousands)	2015	2395	2958
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67	55	60
Wages and salaries (including supplements) (%)	10	9	11
Gross operating surplus (%)	23	25	29
-PRODUCTIVITY: (dollars)			
Gross output / worker	29206	36314	82955
Value added / worker	9545	12604	33185
Average wage (including supplements)	2837	3476	9353
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees	7.55	4.81	4.36
as a percentage of average θ in 1970-1975	80	51	46
MVA growth rate / θ	1.58	2.16	3.58
Degree of specialization	9.1	9.5	10.4
-VALUE ADDED: millions of dollars			
311/2 Food products	1526	2048	6047
313 Beverages	571	764	1389
314 Tobacco products	1143	1442	2793
321 Textiles	2649	3295	6833
322 Wearing apparel	905	1293	3401
323 Leather and fur products	138	270	1144
324 Footwear	112	211	593
331 Wood and wood products	239	262	876
332 Furniture and fixtures	100	203	972
341 Paper and paper products	426	682	2122
342 Printing and publishing	440	732	2531
351 Industrial chemicals	998	1275	4182
352 Other chemical products	1016	1422	4925
353 Petroleum refineries	757	1079	2865
354 Miscellaneous petroleum and coal products	211	291	517
355 Rubber products	657	910	3063
356 Plastic products	359	709	2734
361 Pottery, china and earthenware	89	107	274
362 Glass and glass products	198	307	992
369 Other non-metal mineral products	838	1064	3698
371 Iron and steel	1256	2040	6187
372 Non-ferrous metals	265	334	1201
381 Metal products	535	1237	5144
382 Non-electrical machinery	672	1453	7004
383 Electrical machinery	1587	3621	15066
384 Transport equipment	1152	2791	10247
385 Professional and scientific equipment	214	290	1144
390 Other manufacturing industries	167	598	1759

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

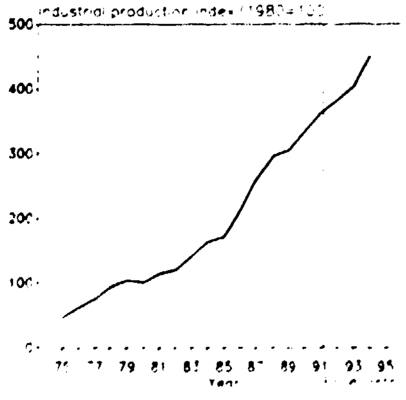
GDP per capita (1000$)



Manufacturing share in GDP, current factor prices

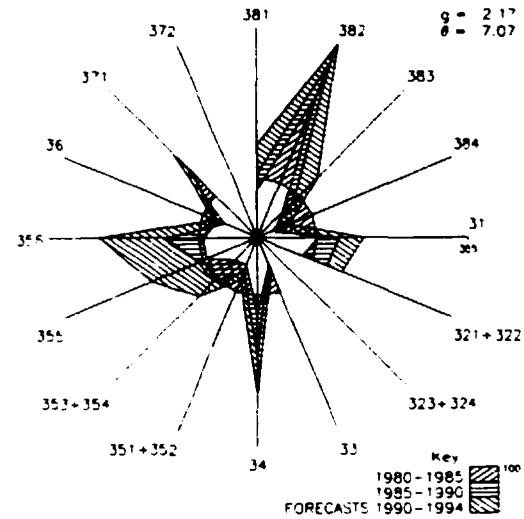


Industrial production index (1980=100)

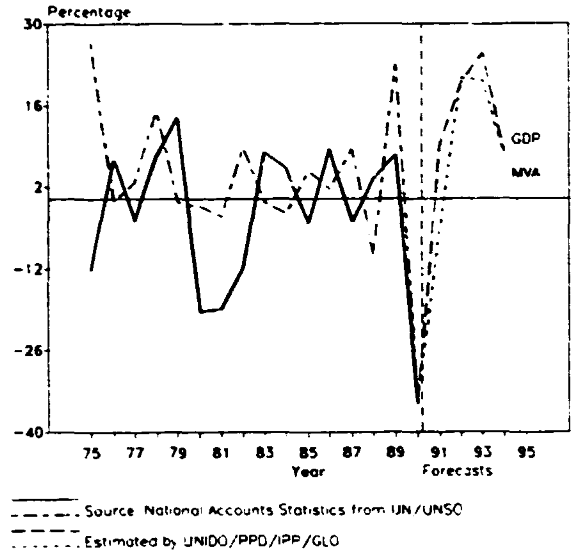


KUWAIT

Industrial structural change
(Index of value added 1980=100)



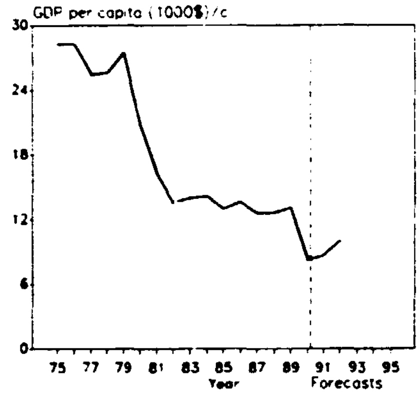
Annual growth rates of GDP and MVA
(Constant 1980 prices)



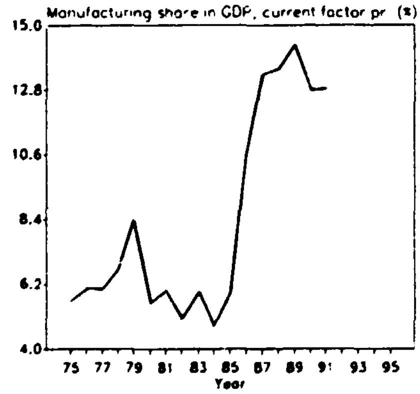
	1980	1985	1990
GDP: /na,c (millions of 1980-dollars)	28722	22346	16800
Per capita (1980-dollars) /na,c	20889	12984	8207
Manufacturing share (%) /na (current factor prices)	5.6	5.9	12.8 /e
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	1581	1689	1355
Industrial production index	100	142	125
Value added (millions of dollars)	1752	1280	2213 /e
Gross output (millions of dollars)	6218	7445	5233 /e
Employment (thousands)	43	46	51 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	72	83	58 /e
Wages and salaries including supplements (%)	7 /e	8	17 /e
Gross operating surplus (%)	21 /e	9	25 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	144786	151758	91050 /e
Value added / worker	40801	26095	38511 /e
Average wage (including supplements)	9771 /e	13015	17277 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.80	17.44	4.32 /e
as a percentage of average θ in 1970-1975	69	177	44 /e
MVA growth rate / θ	2.84	-0.25	3.02
Degree of specialization	39.7	31.0	40.0
-VALUE ADDED: (millions of dollars)			
311/2 Food products	96	101	162 /e
313 Beverages	20	31	38 /e
314 Tobacco products	-	-	- /e
321 Textiles	7	8	20 /e
322 Wearing apparel	84	75	123 /e
323 Leather and fur products	-	-	- /e
324 Footwear	-	-	- /e
331 Wood and wood products	40	14	16 /e
332 Furniture and fixtures	41	31	36 /e
341 Paper and paper products	5	12	28 /e
342 Printing and publishing	40	52	84 /e
351 Industrial chemicals	118	56	72 /e
352 Other chemical products	13	16	30 /e
353 Petroleum refineries	915	561	1199 /e
354 Miscellaneous petroleum and coal products	1	1	2 /e
355 Rubber products	5	5	7 /e
356 Plastic products	24	24	47 /e
361 Pottery, china and earthenware	2	-	1 /e
362 Glass and glass products	2	4 /e	8 /e
369 Other non-metal mineral products	143	115	103 /e
371 Iron and steel	7	14	16 /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	99	88	132 /e
382 Non-electrical machinery	10	30	41 /e
383 Electrical machinery	22	15	24 /e
384 Transport equipment	45	16 /e	16 /e
385 Professional and scientific equipment	5	5 /e	1 /e
390 Other manufacturing industries	7	5	9 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

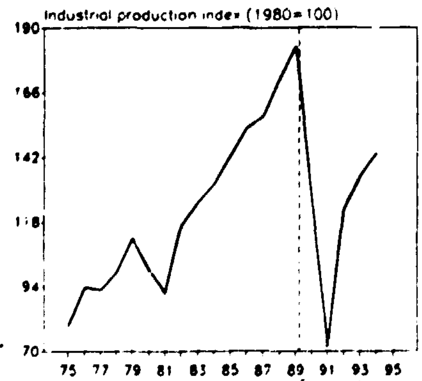
GDP per capita (1000$)/c



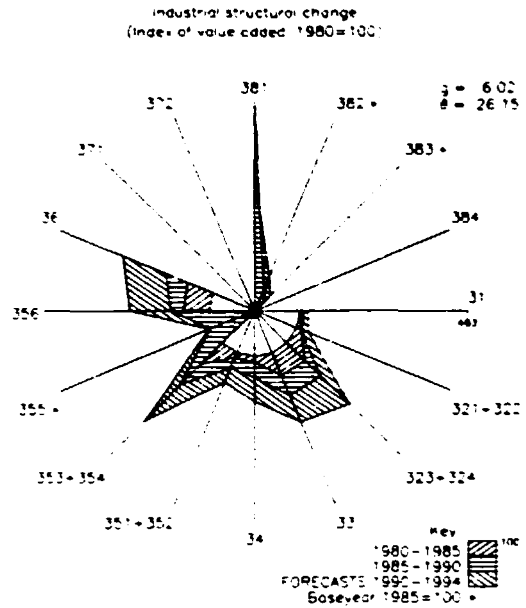
Manufacturing share in GDP, current factor pr (%)

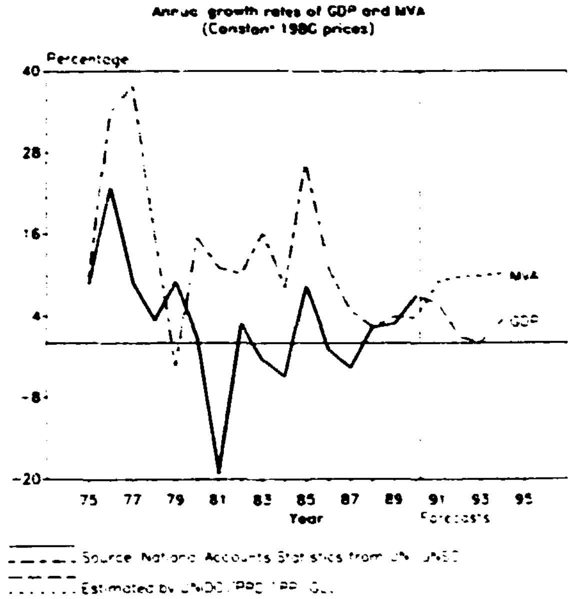


Industrial production index (1980=100)



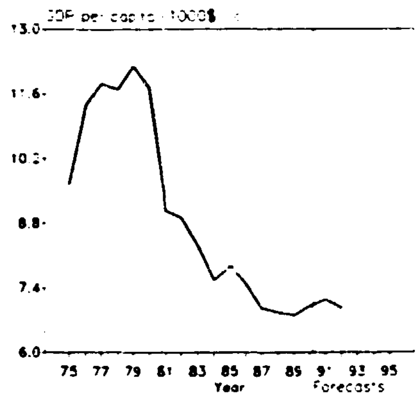
LIBYAN ARAB JAMAHIRIYA

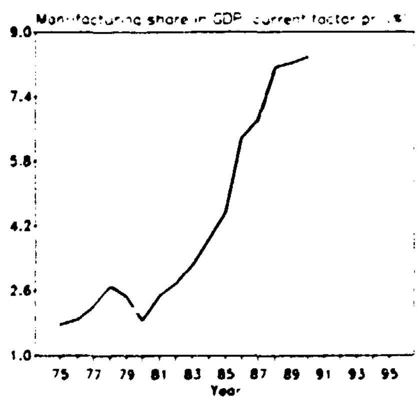


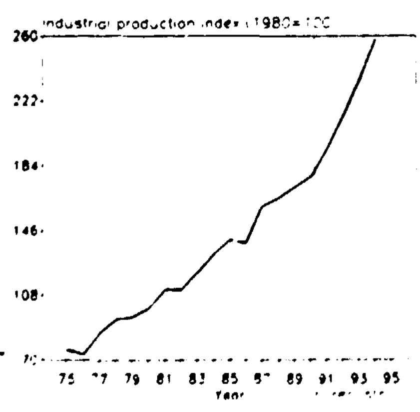


	1980	1985	1990
GDP: (na,c millions of 1980-dollars)	35727	29777	31908
Per capita (1980-dollars) (na,c	11737	7865	7014
Manufacturing share (%) (na current factor prices)	1 9	4 5	8 4 .e
MANUFACTURING:			
Value added (na,c millions of 1980-dollars	649	1262	1617
Industrial production index	100	140	178
Value added (millions of dollars)	358	638 e	1211 e
Gross output (millions of dollars	1177	1953 e	3830 e
Employment (thousands)	18	22 e	28 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	70	67 e	68 /e
Wages and salaries including supplements (%)	13	12 e	12 e
Gross operating surplus (%)	17	20 e	20 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	63982 /e	84676 e	133325 e
Value added / worker	19492 /e	28750 e	45851 e
Average wage (including supplements	8325 e	10746 e	16121 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12 51 /e	2 64 e	' 15 /e
as a percentage of average θ in 1970-1975	173 /e	37 e	16 e
MVA growth rate / θ	0 47	2 27	3 99
Degree of specialization	18 9	26 1	27 5
-VALUE ADDED: (millions of dollars			
311/2 Food products	35	42 e	67 e
313 Beverages	17	20 e	34 /e
314 Tobacco products	55	83 e	131 /e
321 Textiles	14	22 e	33 /e
322 Wearing apparel	5 /e	6 /e	9 e
323 Leather and fur products	7	16 e	33 /e
324 Footwear	14	28 e	53 /e
331 Wood and wood products	3 /e	6 e	11 e
332 Furniture and fixtures	2 /e	4 /e	9 /e
341 Paper and paper products	3	3 e	5 e
342 Printing and publishing	-	1 e	3 e
351 Industrial chemicals	35	46 e	87 e
352 Other chemical products	21	38 /e	70 e
353 Petroleum refineries	81	179 e	374 e
354 Miscellaneous petroleum and coal products	-	- e	- e
355 Rubber products	-	1 e	1 e
356 Plastic products	2	5 e	9 e
361 Pottery, china and earthenware	1	1 e	1 e
362 Glass and glass products	-	- e	- /e
369 Other non-metal mineral products	51	110 e	222 e
371 Iron and steel	-	- e	- e
372 Non-ferrous metals	-	- e	- /e
381 Metal products	3	8 e	21 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	19 e	39 e

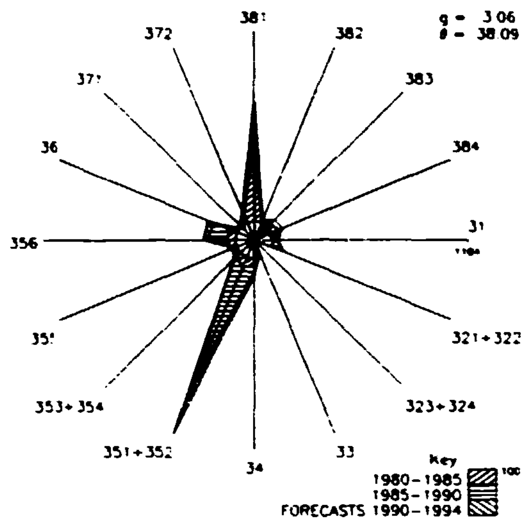
For sources, footnotes and comments see Technical notes at the beginning of this Annex



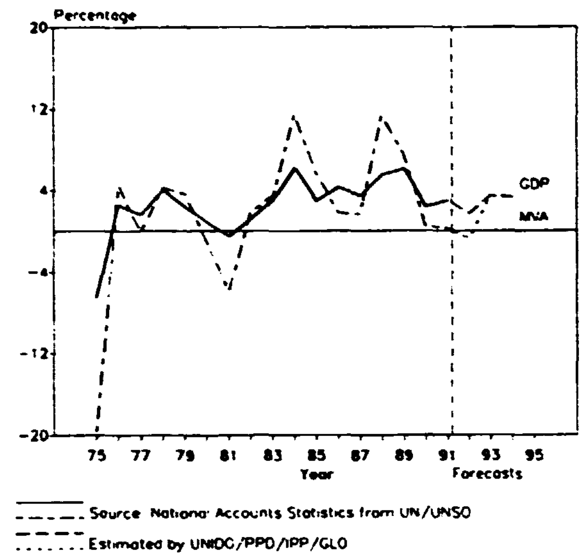




Industrial structural change
(index of value added 1980=100)



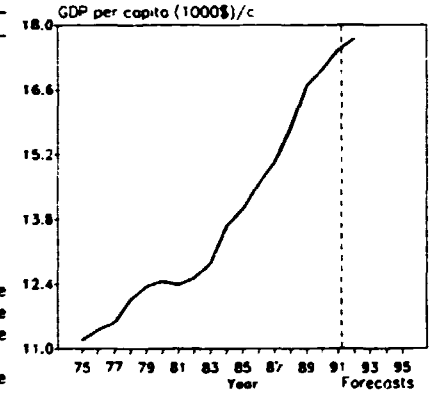
Annual growth rates of GDP and MVA
(Constant 1980 prices)



	1980	1985	1990
GDP: /na,c (millions of 1980-dollars)	4546	5146	6356
Per capita (1980-dollars) /na,c	12454	14021	17039
Manufacturing share (%) /na (current factor prices)	27.6	26.2	26.7
MANUFACTURING:			
Value added /na,c (millions of 1980-dollars)	1293	1507	1871
Industrial production index	100	118	141
Value added (millions of dollars)	1168	933	2208
Gross output (millions of dollars)	3269	2806	5854
Employment (thousands)	38	35	36
-PROFITABILITY:(in percent of gross output)			
Intermediate input (%)	64	67	62 /e
Wages and salaries including supplements (%)	27 /e	20 /e	21 /e
Gross operating surplus (%)	9 /e	14 /e	17 /e
-PRODUCTIVITY:(dollars)			
Gross output / worker	84018	77088	156281 /e
Value added / worker	30461	26420	66306 /e
Average wage (including supplements)	23529 /e	15888 /e	34210 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.14 /e	3.05 /e	5.93 /e
as a percentage of average θ in 1970-1975	111 /e	107 /e	209 /e
MVA growth rate / θ	-0.76	1.20	0.63
Degree of specialization	38.1	34.8	23.3
-VALUE ADDED:(millions of dollars)			
311/2 Food products	31	20	47
313 Beverages	32 /e	24 /e	54 /e
314 Tobacco products	10 /e	7 /e	13 /e
321 Textiles	24	14	59w
322 Wearing apparel	5	3	13w
323 Leather and fur products	-	-	w
324 Footwear	-	-	w
331 Wood and wood products	2 /e	1 /e	2 /e
332 Furniture and fixtures	2 /e	1 /e	3 /e
341 Paper and paper products	14 /e	12 /e	31 /e
342 Printing and publishing	18 /e	14 /e	38 /e
351 Industrial chemicals	31 /e	31 /e	258 /e
352 Other chemical products	3	7	131 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	1 /e	1 /e	3 /e
355 Rubber products	127 /e	113 /e	185 /e
356 Plastic products	13 /e	14 /e	45 /e
361 Pottery, china and earthenware	9 /e	6 /e	16 /e
362 Glass and glass products	16 /e	14 /e	50 /e
369 Other non-metal mineral products	45 /e	40 /e	153 /e
371 Iron and steel	592	415	643
372 Non-ferrous metals	32	34	62
381 Metal products	24	78	213
382 Non-electrical machinery	98	69	135
383 Electrical machinery	19	7	31 /e
384 Transport equipment	7	4	13 /e
385 Professional and scientific equipment	10	4	11 /e
390 Other manufacturing industries	- /e	- /e	1 /e

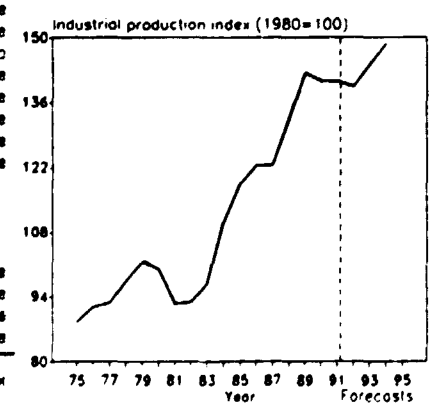
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

GDP per capita (1000$)/c



Manufacturing share in GDP, current factor pr (%)

Industrial production index (1980=100)



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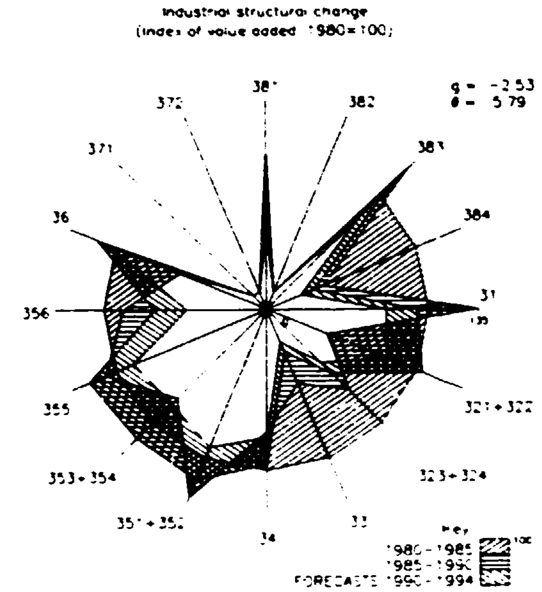
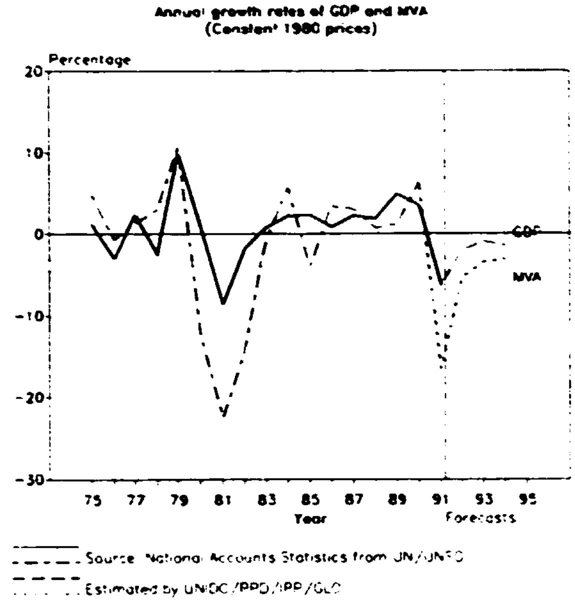
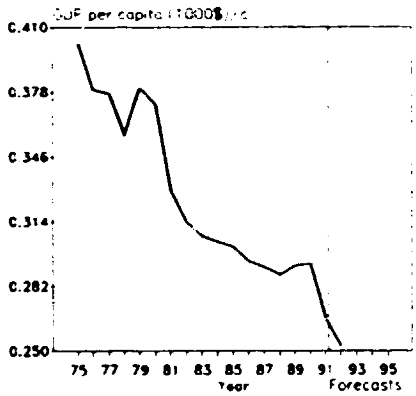
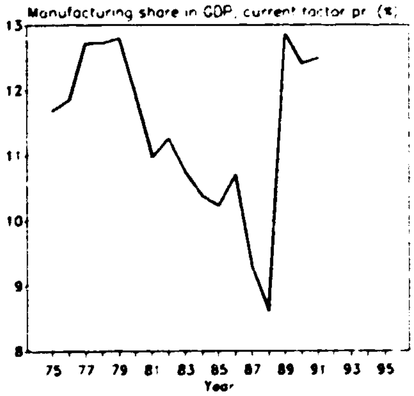


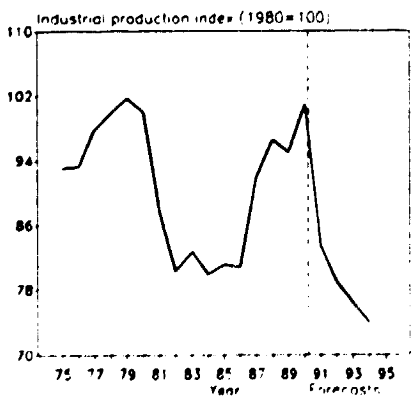


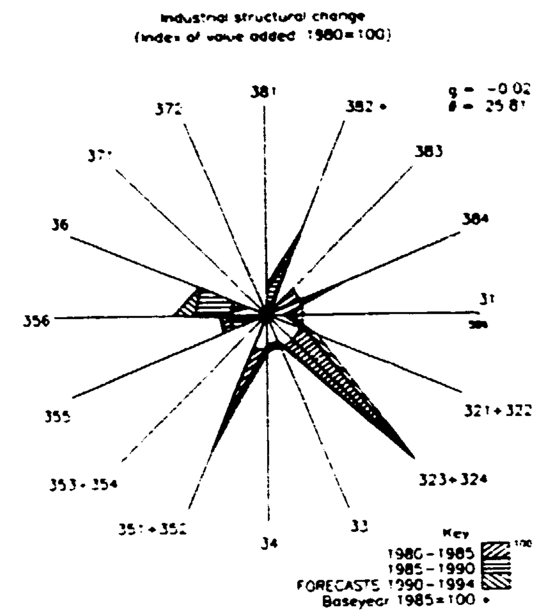
	1980	1985	1990
GDP: (n.a.c. millions of 1980-dollars)	3265	3086	3514
Per capita (1980-dollars) (n.a.c.)	372	301	293
Manufacturing share (%) (n.a. current factor prices)	11.9 /e	10.2 /e	12.4
MANUFACTURING:			
Value added (n.a.c. millions of 1980-dollars)	365	244	282
Industrial production index	100	81	101
Value added (millions of dollars)	221	132	147 e
Gross output (millions of dollars)	569	328	353 e
Employment (thousands)	41	47	46 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	60	58 /e
Wages and salaries including supplements (%)	15	16	13 e
Gross operating surplus (%)	24	25	28 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	14005	6891	7672 /e
Value added / worker	5439	2798	3200 /e
Average wage (including supplements)	2083	1039	1010 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.69	14.30	10.24 /e
as a percentage of average θ in 1970-1975	106	197	141 /e
MVA growth rate / θ	0.15	-0.34	0.41
Degree of specialization	22.4	25.1	32.5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	23	45	22 /e
313 Beverages	34	16	16 /e
314 Tobacco products	3	3	1 /e
321 Textiles	67	16	60 /e
322 Wearing apparel	19	6	4 /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	5 /e
342 Printing and publishing	6	2	1 /e
351 Industrial chemicals	1	1	- /e
352 Other chemical products	10	11	9 /e
353 Petroleum refineries	11 /e	7 /e	9 /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	1	1	1 /e
356 Plastic products	3	2	1 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	2	- /e	1 /e
369 Other non-metal mineral products	2 /e	1	3 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	9	5	4 /e
382 Non-electrical machinery	-	-	- /e
383 Electrical machinery	3	3	2 /e
384 Transport equipment	7	2 /e	1 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	2	1	- /e

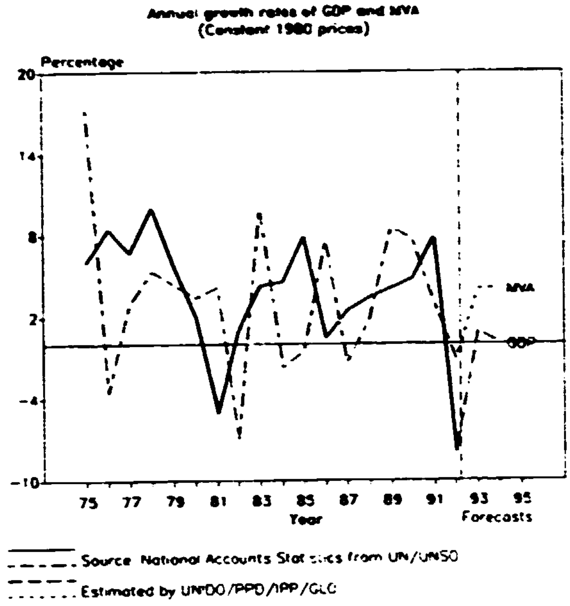
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





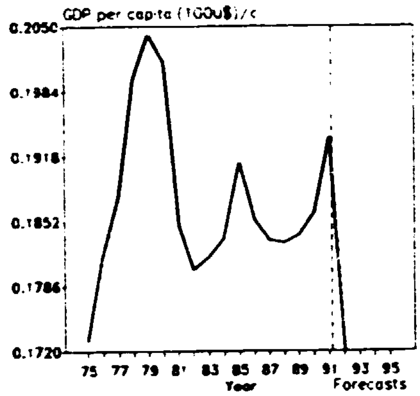


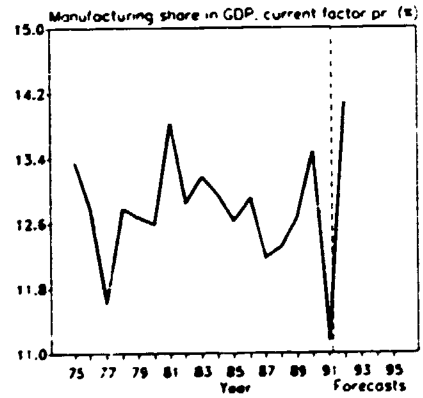


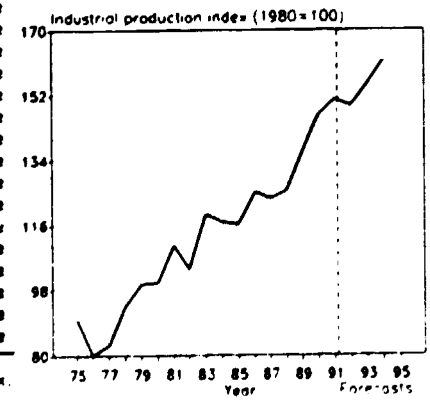


	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	1245	1403	1627
Per capita (1980-dollars) /na.c	201	191	186
Manufacturing share (%) /na (current factor prices)	12 6	12.6	13.5
MANUFACTURING.			
Value added /na.c (millions of 1980-dollars)	149	155	196
Industrial production index	100	116	146
Value added (millions of dollars)	123	90	133 /e
Gross output (millions of dollars)	340	330	586 /e
Employment (thousands)	39	31	46 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	64	73	77 /e
Wages and salaries including supplements (%)	12	10	10 /e
Gross operating surplus (%)	24	18	13 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	8783	10745	12767 /e
Value added / worker	3174	2923	3041 /e
Average wage (including supplements)	1046	1035	1244 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	10 51 /e	14.12	4.66 /e
as a percentage of average θ in 1970-1975	130 /e	174	58 /e
MVA growth rate / θ	1 25	-0.07	0.22
Degree of specialization	27 7	16.7	18.1
-VALUE ADDED: (millions of dollars)			
311/2 Food products	54	14	26 /e
313 Beverages	8	7	12 /e
314 Tobacco products	9	5	8 /e
321 Textiles	12	14	18 /e
322 Wearing apparel	2	1	1 /e
323 Leather and fur products	-	- /e	- /e
324 Footwear	1 /e	3	4 /e
331 Wood and wood products	2	2	2 /e
332 Furniture and fixtures	1	1	1 /e
341 Paper and paper products	2	2	1 /e
342 Printing and publishing	8	6	9 /e
351 Industrial chemicals	2	8	5 /e
352 Other chemical products	5	14	23 /e
353 Petroleum refineries	-	-	- /e
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	1	1	- /e
356 Plastic products	2	2	5 /e
361 Pottery, china and earthenware	-	-	- /e
362 Glass and glass products	-	-	- /e
369 Other non-metal mineral products	3	1	8 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	6	6	5 /u
382 Non-electrical machinery	-	1	3 /e
383 Electrical machinery	5	1	1 /e
384 Transport equipment	1 /e	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.

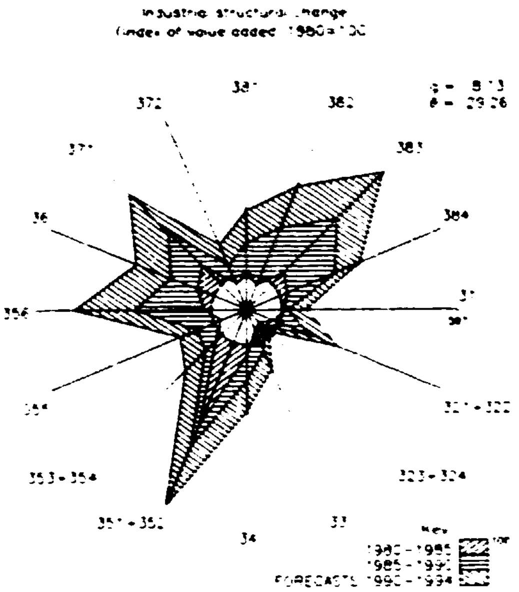




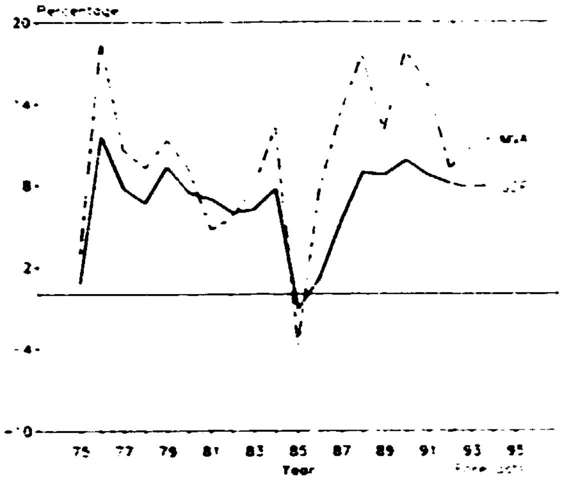


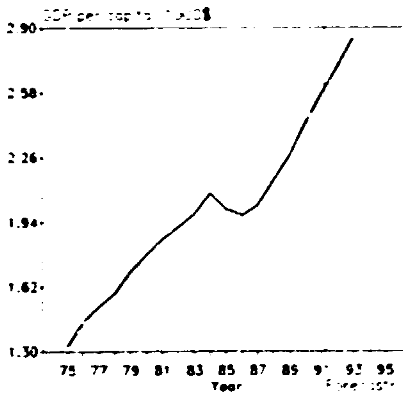
MALAYSIA

Industrial structural change
(index of value added 1980=100)



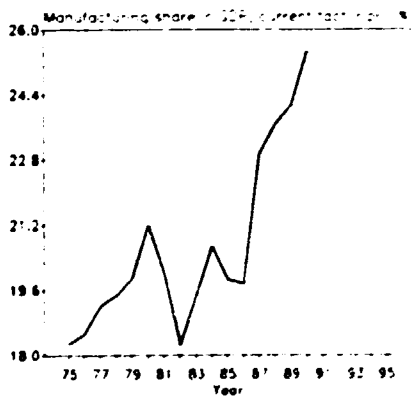
Annual growth rates of GDP and MVA
(Constant 1980 prices)

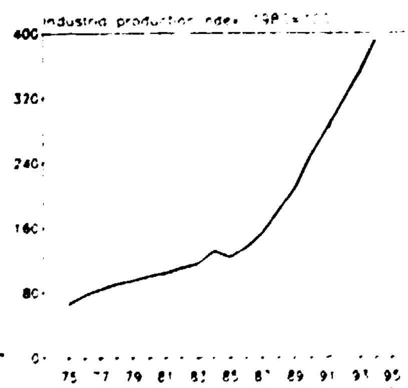


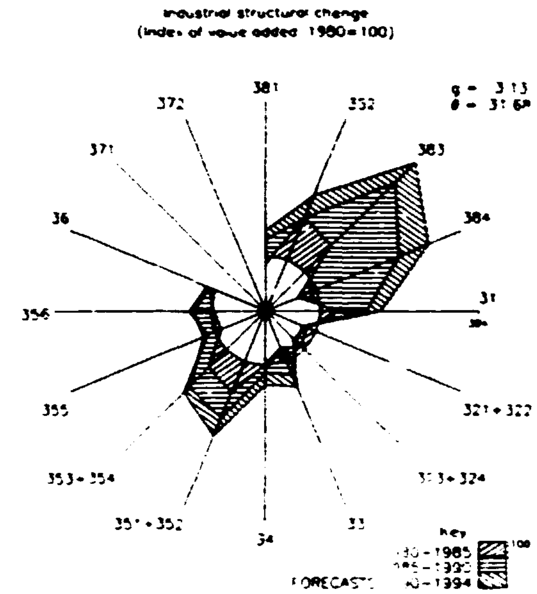


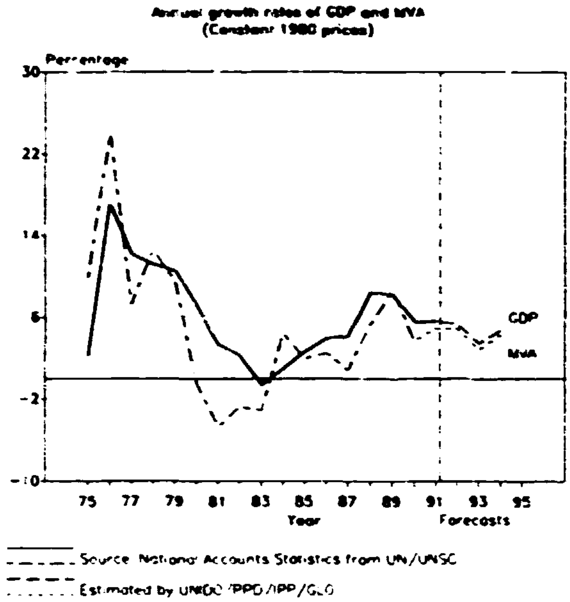
	1980		1985	1990	
GDP: (real, millions of 1980-dollars)	24487		31408	43541	
Per capita (1980-dollars) (real)	1779		2003	2430	
Manufacturing share (%) (in current factor prices)	21.2		19.9	25.5	e
MANUFACTURING:					
Value added (real, millions of 1980-dollars)	5054		6511	12327	
Industrial production index	100		123	249	
Value added (millions of dollars)	3727	e	4879	9066	
Gross output (millions of dollars)	13400	e	18359	35421	
Employment (thousands)	455	e	473	831	
-PROFITABILITY: in percent of gross output					
Intermediate input (%)	72	e	73	74	
Wages and salaries including supplements (%)	8	e	9	8	e
Gross operating surplus (%)	20	e	18	18	e
-PRODUCTIVITY: dollars					
Gross output / worker	28564	e	38561	42489	
Value added / worker	8231	e	10248	10878	
Average wage (including supplements)	2253	e	3377	3226	e
-STRUCTURAL INDICES:					
Structural change B (5-year average in degrees)	4.98	e	8.15	6.84	
as a percentage of average B in 1970-1975	51	e	34	71	
MVA growth rate / B	3.11		0.45	1.73	
Degree of specialization	15.7		15.3	14.8	
-VALUE ADDED: millions of dollars					
311/2 Food products	686	e	703	865	
313 Beverages	108	e	122	201	
314 Tobacco products	97	e	205	127	
321 Textiles	192	e	133	237	
322 Wearing apparel	69	e	100	230	
323 Leather and fur products	3	e	2	6	
324 Footwear	11	e	5	4	
331 Wood and wood products	405	e	253	584	
332 Furniture and fixtures	35	e	40	70	
341 Paper and paper products	35	e	55	155	
342 Printing and publishing	147	e	197	266	
351 Industrial chemicals	81	e	616	748	
352 Other chemical products	120	e	153	232	
353 Petroleum refineries	118	e	137	139	
354 Miscellaneous petroleum and coal products	2	e	21	32	
355 Rubber products	301	e	250	528	
356 Plastic products	70	e	92	261	
361 Pottery, china and earthenware	10	e	13	36	
362 Glass and glass products	24	e	23	73	
369 Other non-metal mineral products	172	e	297	441	
371 Iron and steel	80	e	153	237	
372 Non-ferrous metals	40	e	35	53	
381 Metal products	142	e	147	316	
382 Non-electrical machinery	119	e	99	349	
383 Electrical machinery	456	e	738	1945	
384 Transport equipment	156	e	211	434	
385 Professional and scientific equipment	26	e	30	37	
390 Other manufacturing industries	23	e	19	111	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



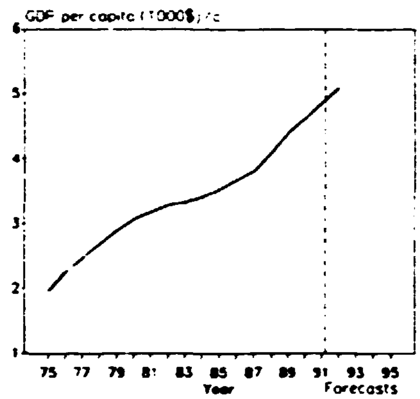


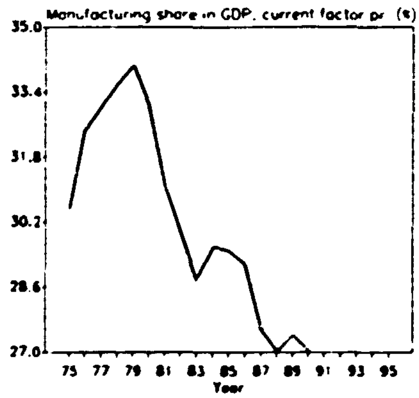


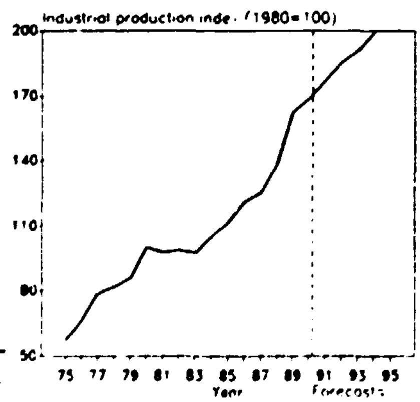


	1980	1985	1990
GDP: (n.a.c.) (millions of 1980-dollars)	1120	1218	1630
Per capita (1980-dollars) (n.a.c.)	3068	3530	4617
Manufacturing share (%) (n.a. current factor prices)	33.1	29.5	27.0
MANUFACTURING:			
Value added (n.a.c.) (millions of 1980-dollars)	330	315	386
Industrial production index	100	111	169
Value added (millions of dollars)	302	265	554 /e
Gross output (millions of dollars)	706	650	1422 /e
Employment (thousands)	29	26	28 /e
-PROFITABILITY: in percent of gross output			
Intermediate input (%)	57	59	62 /e
Wages and salaries including supplements (%)	23 /e	22	18 /e
Gross operating surplus (%)	20 /e	19	20 /e
-PRODUCTIVITY: dollars			
Gross output / worker	23266	24271	49778 /e
Value added / worker	9945	9914	19302 /e
Average wage (including supplements)	5652 /e	5561	9281 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.54	5.63	7.51 /e
as a percentage of average θ in 1970-1975	39	40	54 /e
MVA growth rate / θ	2.43	0.12	0.78
Degree of specialization	18.3	17.7	16.8
-VALUE ADDED: millions of dollars			
311/2 Food products	20	25	56 /e
313 Beverages	20	22	54 /e
314 Tobacco products	8	8	8 /e
321 Textiles	17	8	14 /e
322 Wearing apparel	88	65	90 /e
323 Leather and fur products	4	1	1 /e
324 Footwear	8	9	12 /e
331 Wood and wood products	2	1	2 /e
332 Furniture and fixtures	14	9	25 /e
341 Paper and paper products	2	3	6 /e
342 Printing and publishing	22	17	31 /e
351 Industrial chemicals	1	2	3 /e
352 Other chemical products	5	6	14 /e
353 Petroleum refineries	-	-	
354 Miscellaneous petroleum and coal products	-	-	- /e
355 Rubber products	10	7	17 /e
356 Plastic products	6	4	10 /e
361 Pottery, china and earthenware	1	-	1 /e
362 Glass and glass products	2	1	1 /e
369 Other non-metal mineral products	6	7	11 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	14	10	24 /e
382 Non-electrical machinery	5	8	12 /e
383 Electrical machinery	22	31	98 /e
384 Transport equipment	6	3	23 /e
385 Professional and scientific equipment	12	12	22 /e
390 Other manufacturing industries	9	5	21 /e

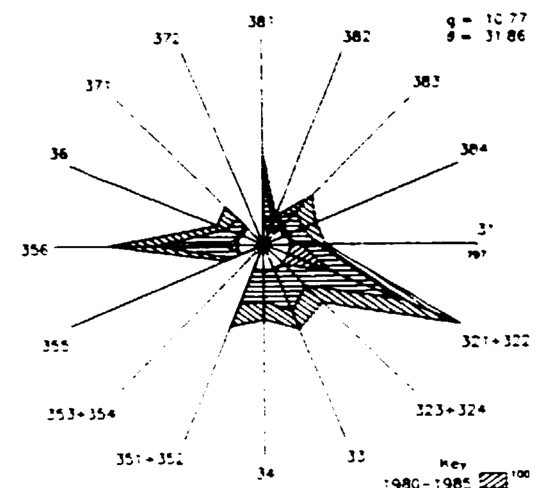
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex.



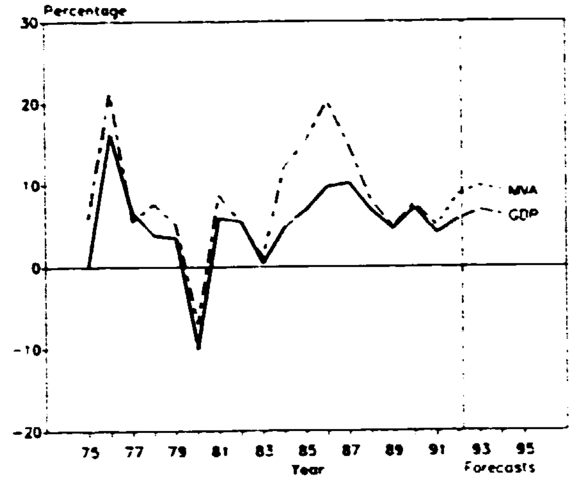




Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)



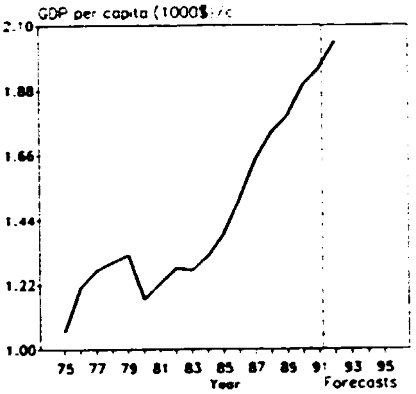
Source National Accounts Statistics from UN/UNSO

Estimated by UNIDO/PPD/IPP/GLO

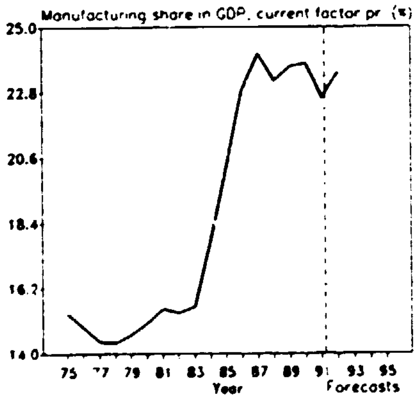
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	1132	1421	2055
Per capita (1980-dollars) /na.c	1170	1392	1898
Manufacturing share (%) /na (current factor prices)	15.0	20.3	23.8
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	147	219	368
Industrial production index	100	138 /e	176 /e
Value added (millions of dollars)	136	172	480
Gross output (millions of dollars)	633	729	1730
Employment (thousands)	43	75	115
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	79	76	72
Wages and salaries including supplements (%)	11	11	13
Gross operating surplus (%)	10	13	15
-PRODUCTIVITY: (dollars)			
Gross output / worker	14745	9771	15077
Value added / worker	3163	2307	4180
Average wage (including supplements)	1654	1063	1904
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.55	6.91	3.40
as a percentage of average θ in 1970-1975	211	194	95
MVA growth rate / θ	-0.22	1.59	4.19
Degree of specialization	21.2	35.1	32.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	36	43	80
313 Beverages	10	7	24
314 Tobacco products	2	4	8
321 Textiles	9	10	28
322 Wearing apparel	28	68	204
323 Leather and fur products	1	1	5
324 Footwear	2	2	3
331 Wood and wood products	1	1	3
332 Furniture and fixtures	2	1	4
341 Paper and paper products	1	2	3
342 Printing and publishing	5	4	12
351 Industrial chemicals	3	3	12
352 Other chemical products	4	4	10
353 Petroleum refineries	-	-	-
354 Miscellaneous petroleum and coal products	-	-	-
355 Rubber products	1	1	2
356 Plastic products	1	2	7
361 Pottery, china and earthenware	-	-	-
362 Glass and glass products	-	-	-
369 Other non-metal mineral products	6	4	11
371 Iron and steel	3	2	4
372 Non-ferrous metals	-	-	-
381 Metal products	5	3	14
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	16

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

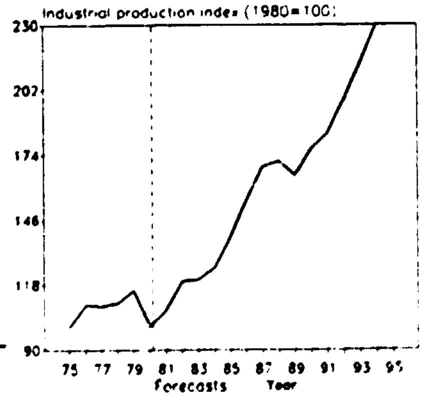
GDP per capita (1000$)/c



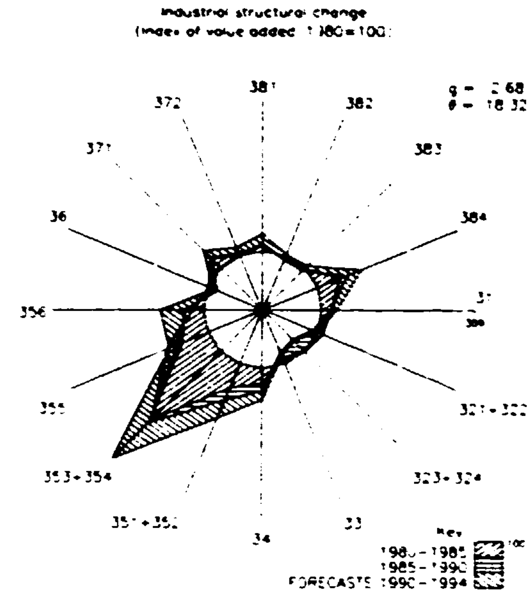
Manufacturing share in GDP, current factor pr. (%)

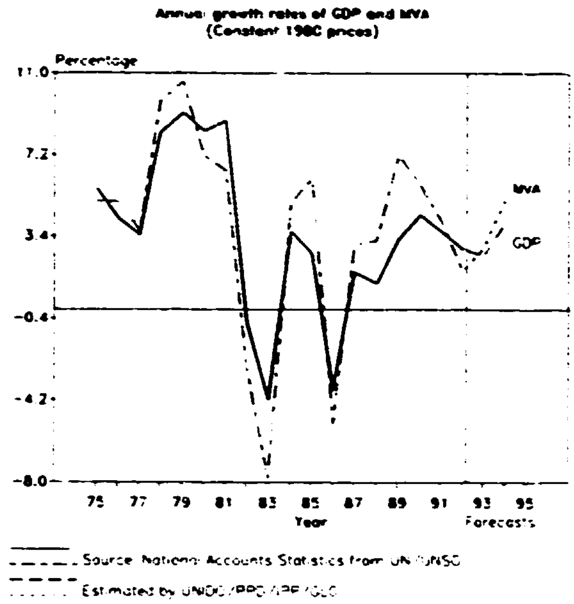


Industrial production index (1980=100)



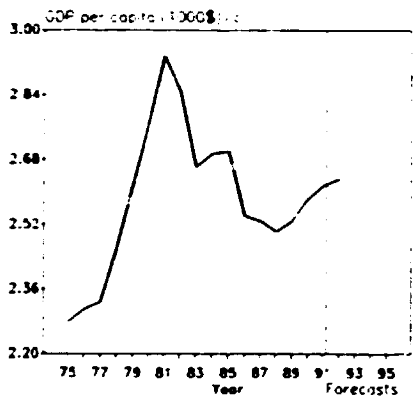
MEXICO

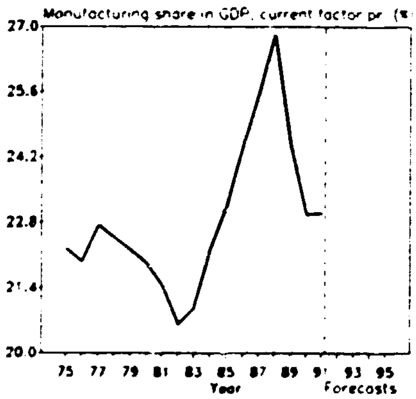


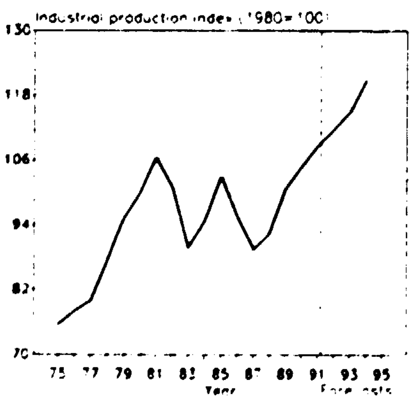


	1980	1985	1990
GDP: (n.a.c., millions of 1980-dollars)	194760	214370	229010
Per capita (1980-dollars) (n.a.c.)	2766	2701	2582
Manufacturing share (%) (n.a., current factor prices)	21.9	23.1	23.0
MANUFACTURING:			
Value added (n.a.c., millions of 1980-dollars)	43200	45924	52416
Industrial production index	100	103	105
Value added (millions of dollars)	43048	46373 /e	57482 e
Gross output (millions of dollars)	102047	106972 /e	132792 e
Employment (thousands)	2417	2314 /e	2145 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	58	57 /e	57 e
Wages and salaries including supplements (%)	14	9 e	9 e
Gross operating surplus (%)	28	34 e	35 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	42221	46227 /e	61903 e
Value added / worker	17811	20040 /e	26796 e
Average wage (including supplements)	5846	4192 /e	5373 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.56	5.53 /e	3.90 /e
as a percentage of average θ in 1970-1975	112	177 /e	122 e
MVA growth rate / θ	1.79	0.85	0.31
Degree of specialization	8.9	9.5	10.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	5989	7015 /e	8661 /e
313 Beverages	2723	2589 /e	3299 /e
314 Tobacco products	623	740 /e	793 e
321 Textiles	3133	3099 /e	3075 /e
322 Wearing apparel	1277	1094 /e	1198 /e
323 Leather and fur products	366	397 /e	347 e
324 Footwear	845	658 /e	575 /e
331 Wood and wood products	919	786 /e	845 e
332 Furniture and fixtures	784	498 /e	565 /e
341 Paper and paper products	1189	1180 /e	1660 e
342 Printing and publishing	1050	1250 /e	1654 /e
351 Industrial chemicals	2235	2982 /e	3801 /e
352 Other chemical products	2235	2562 /e	4124 e
353 Petroleum refineries	1917	4341 /e	5533 /e
354 Miscellaneous petroleum and coal products	222	529 /e	679 e
355 Rubber products	767	1164 /e	1201 /e
356 Plastic products	754	767 /e	1074 /e
361 Pottery, china and earthenware	383	420 /e	398 /e
362 Glass and glass products	566	529 /e	709 /e
369 Other non-metal mineral products	1464	1113 /e	1044 e
371 Iron and steel	2070	2227 /e	2713 /e
372 Non-ferrous metals	562	506 /e	597 e
381 Metal products	1961	1849 /e	2384 e
382 Non-electrical machinery	2074	1643 /e	2030 /e
383 Electrical machinery	1900	1635 /e	1907 /e
384 Transport equipment	2980	3621 /e	4915 /e
385 Professional and scientific equipment	305	381 /e	574 /e
390 Other manufacturing industries	754	798 /e	1024 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex







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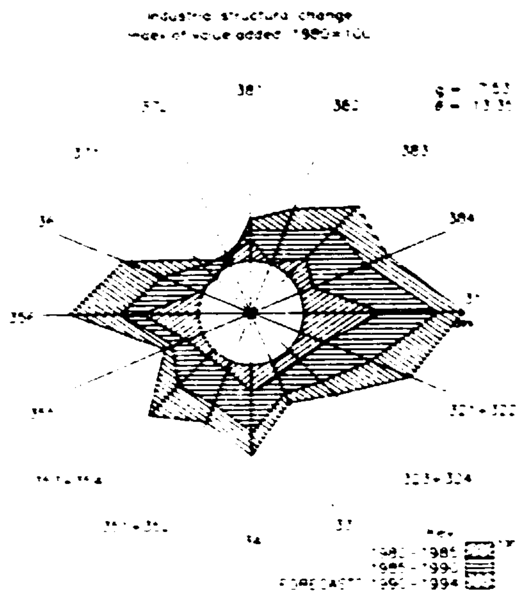
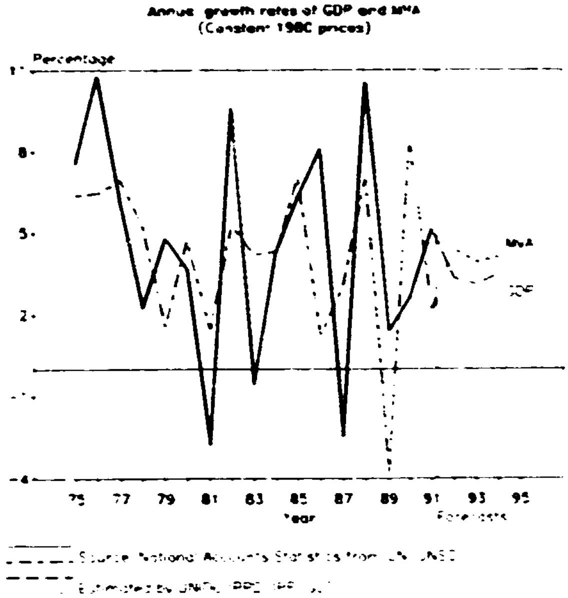
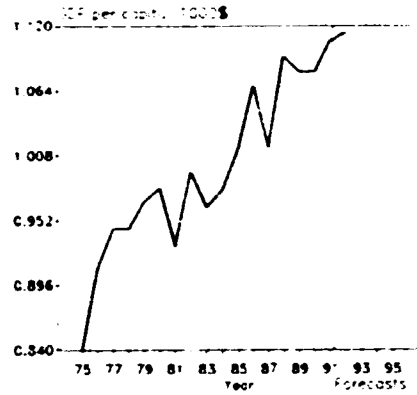
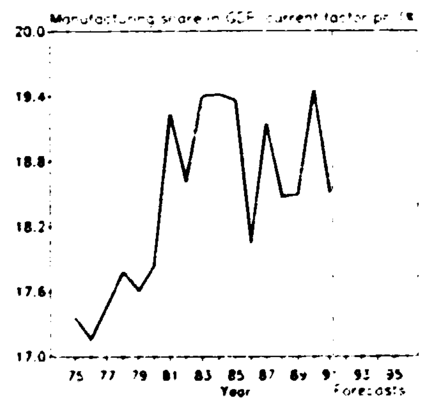


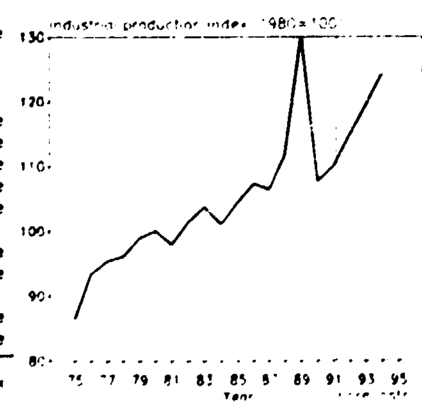


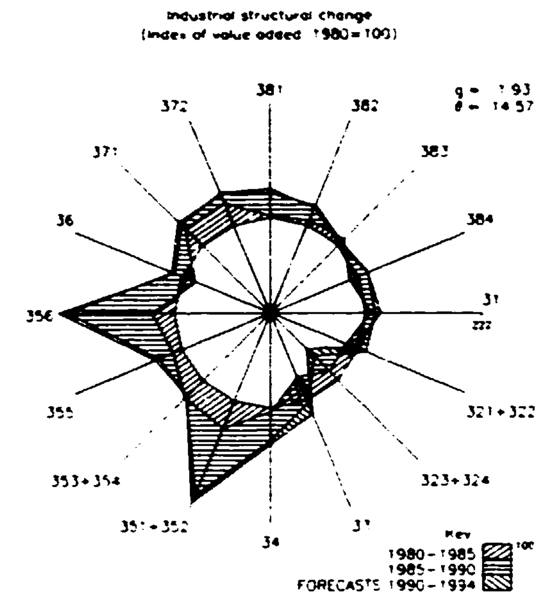
	1980	1985	1990
GDP (mio. millions of 1980-dollars)	13997	22336	27085
Per capita (1980-dollars) (mio.)	980	1014	1080
Manufacturing share (%) (in current factor prices)	17.8	19.4	19.4
MANUFACTURING:			
Value added (mio. millions of 1980-dollars)	3197	3374	4526
Industrial production index	100	104	108
Value added (millions of dollars)	1485	1374 e	3179 e
Gross output (millions of dollars)	5958	5052	10737 e
Employment (thousands)	176	227	315 e
-PROFITABILITY: in percent of gross output			
Intermediate input (%)	77	74 e	72 e
Wages and salaries including supplements (%)	13	11	9 e
Gross operating surplus (%)	10	15 e	18 e
-PRODUCTIVITY: dollars			
Gross output / worker	33920	22306	34060 e
Value added / worker	7801	5596 e	9442 e
Average wage (including supplements)	4363	2434	3182 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.25 e	6.75 e	7.24 e
as a percentage of average θ in 1970-1975	258 e	240 e	257 e
MVA growth rate / θ	0.46	1.24	1.19
Degree of specialization	12.8	13.0	13.2
-VALUE ADDED: millions of dollars			
311.2 Food products	130	110	144
313 Beverages	52	107	278
314 Tobacco products	38	136	354
321 Textiles	202	172	315
322 Wearing apparel	32	45	228
323 Leather and fur products	15	13	29
324 Footwear	24	18	39
331 Wood and wood products	30	25	49
332 Furniture and fixtures	19	16	30
341 Paper and paper products	64	64	151
342 Printing and publishing	26	19	43
351 Industrial chemicals	127	95	230
352 Other chemical products	97	71	173
353 Petroleum refineries	114 e	84 e	213 e
354 Miscellaneous petroleum and coal products			
355 Rubber products	34	28	52
356 Plastic products	20	26	48
36 Pottery, china and earthenware	6	3 e	8 e
362 Glass and glass products	10	5 e	13 e
369 Other non-metal mineral products	154	106 e	274 e
371 Iron and steel	7	4 e	9 e
372 Non-ferrous metals	8	6 e	9 e
381 Metal products	110	96	166
382 Non-electrical machinery	30	19 e	48 e
383 Electrical machinery	51	56	131 e
384 Transport equipment	52	49	140
385 Professional and scientific equipment	1	1 e	1 e
390 Other manufacturing industries	2	1	3 e

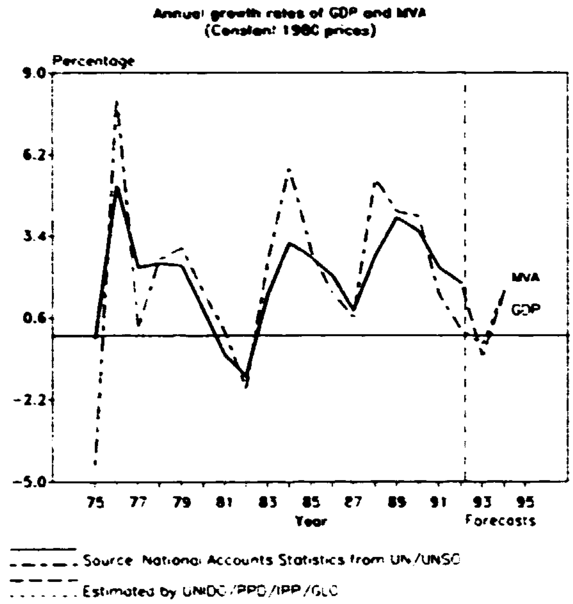
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





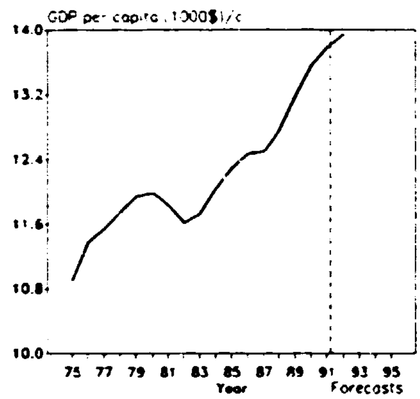


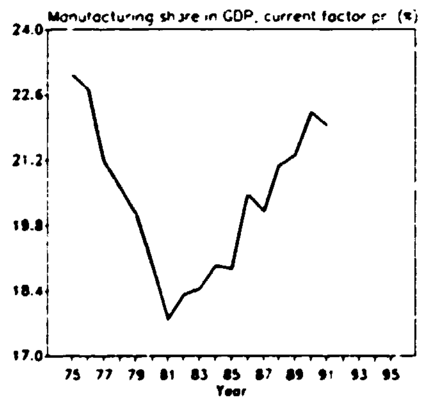


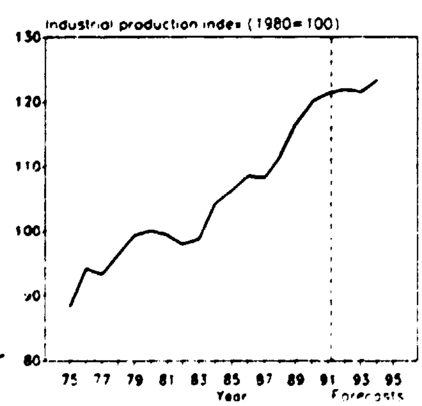


	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	169386	178038	202650
Per capita (1980-dollars) /na.c	11976	12291	13557
Manufacturing share (%) /na current factor prices)	18 9	18 9	22 2
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	30365	33253	38778
Industrial production index	100	106	120
Value added (millions of dollars)	29080	21919	51305
Gross output (millions of dollars)	109618	85085	169683
Employment (thousands)	944	847	915
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	73	74	70
Wages and salaries including supplements (%)	20 /e	17 /e	19 /e
Gross operating surplus (%)	7 /e	9 /e	11 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	108671	94039	185446
Value added / worker	29285	24824	56071
Average wage (including supplements)	23135 /e	16940 /e	35414 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.76	3 42	4 45
as a percentage of average θ in 1970-1975	74	91	119
MVA growth rate / θ	-0 45	0.38	0 89
Degree of specialization	15 0	15 7	14 4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	4562	3388	6475
313 Beverages	654	458	851
314 Tobacco products	282	238	952
321 Textiles	734	485	1075
322 Wearing apparel	372	190	578
323 Leather and fur products	68	46	82
324 Footwear	118	69	83
331 Wood and wood products	594	308	727 /e
332 Furniture and fixtures	418	216	690 /e
341 Paper and paper products	805	647	1711
342 Printing and publishing	2480	1771	4346
351 Industrial chemicals	2263	2163	6365 /e
352 Other chemical products	913	802	2668 /e
353 Petroleum refineries	533	515	887
354 Miscellaneous petroleum and coal products	101	54	198 /e
355 Rubber products	156	122	270 /e
356 Plastic products	472	413	1381 /e
361 Pottery, china and earthenware	134	81	199 /e
362 Glass and glass products	245	148	379 /e
369 Other non-metal mineral products	893	539	1361 /e
371 Iron and steel	882	784	1536 /e
372 Non-ferrous metals	371	330	687 /e
381 Metal products	2455	1780	4246
382 Non-electrical machinery	2369	1774	4001
383 Electrical machinery	3687	2864	5355
384 Transport equipment	1927	1244	2929
385 Professional and scientific equipment	237	198	447
390 Other manufacturing industries	346	296	725 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex







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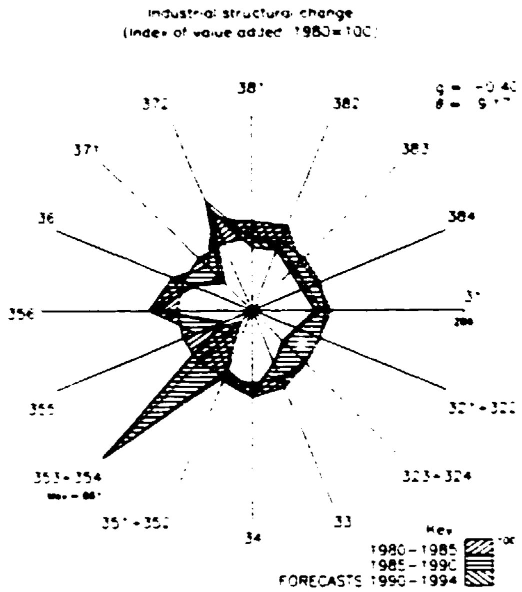
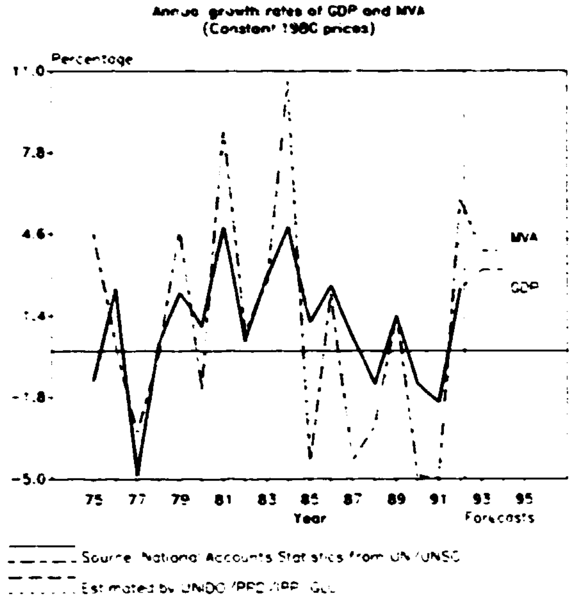
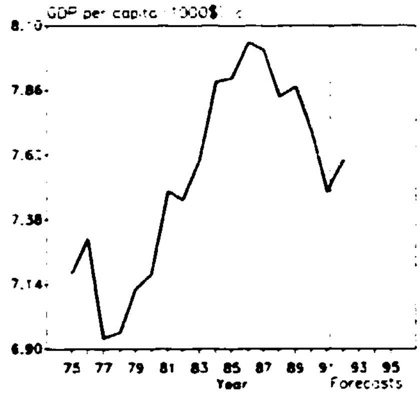
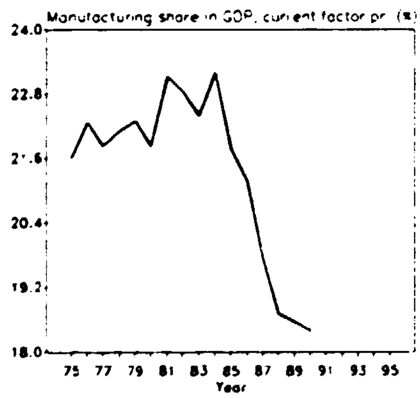


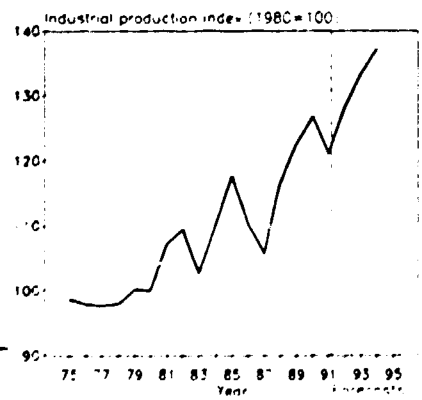


	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	22344	25670	26138
Per capita (1980-dollars) /na.c	7178	7903	7706
Manufacturing share (%) /na (current factor prices)	21.8	21.8	18.4 /e
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	4948	5635	5400
Industrial production index	100	118	127
Value added (millions of dollars)	4756	4657	7159 /e
Gross output (millions of dollars)	14700	15399	23293 /e
Employment (thousands)	285 /e	280	222
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	68	70	69 /e
Wages and salaries including supplements (%)	22 /e	18 /e	17 /e
Gross operating surplus (%)	10 /e	12 /e	14 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	51964 /e	50964	97456 /e
Value added / worker	16711 /e	15414	29963 /e
Average wage (including supplements)	11354 /e	10127 /e	17676 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.08 /e	2.29	4.77 /e
as a percentage of average θ in 1970-1975	39 /e	43	90 /e
MVA growth rate / θ	0.65	0.75	-0.79
Degree of specialization	14.6	14.7	13.7
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1098	1082	1530 /e
313 Beverages	110	93	191 /e
314 Tobacco products	30	19	50 /e
321 Textiles	222	193	225 /e
322 Wearing apparel	185	170	217 /e
323 Leather and fur products	45	46	56 /e
324 Footwear	55	46	42 /e
331 Wood and wood products	253	257	335 /e
332 Furniture and fixtures	92	95	124 /e
341 Paper and paper products	266	275	491 /e
342 Printing and publishing	294	326	546 /e
351 Industrial chemicals	140	134	227 /e
352 Other chemical products	155	142	208 /e
353 Petroleum refineries	26	-1	376 /e
354 Miscellaneous petroleum and coal products	9	7	13 /e
355 Rubber products	96	70	66 /e
356 Plastic products	110	138	230 /e
361 Pottery, china and earthenware	13	11	17 /e
362 Glass and glass products	44	41	61 /e
369 Other non-metal mineral products	114	127	177 /e
371 Iron and steel	93	71	81 /e
372 Non-ferrous metals	82	102	205 /e
381 Metal products	371	404	534 /e
382 Non-electrical machinery	235	254	330 /e
383 Electrical machinery	239	200	292 /e
384 Transport equipment	318	274	392 /e
385 Professional and scientific equipment	14	20	23 /e
390 Other manufacturing industries	45	48	93 /e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

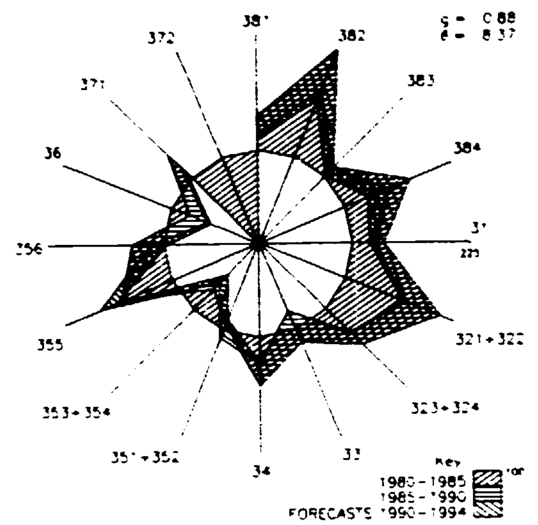




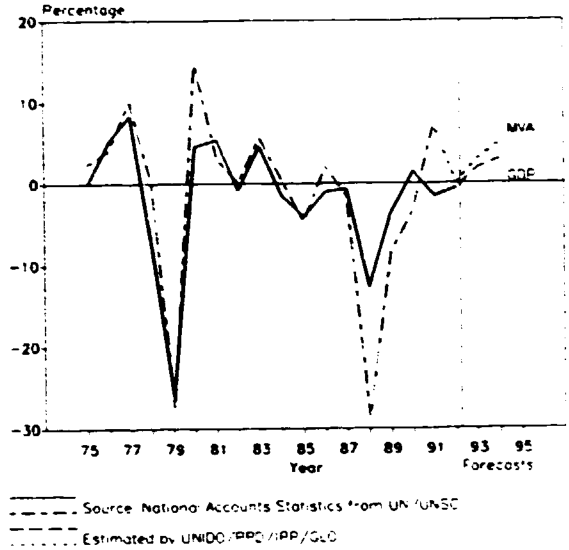


NICARAGUA

Industrial structural change
(index of value added 1980=100)

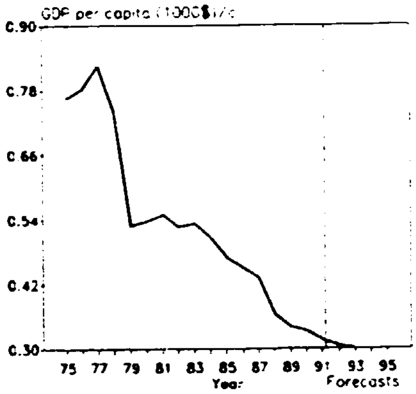


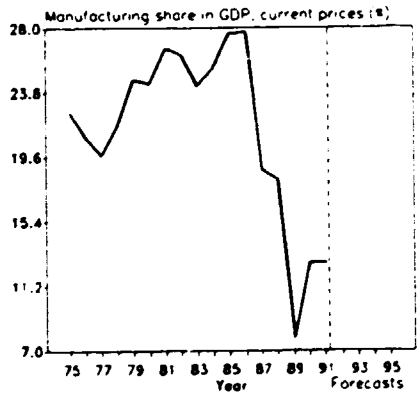
Annual growth rates of GDP and MVA
(Constant 1980 prices)

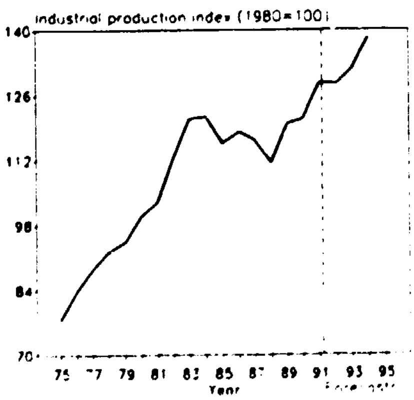


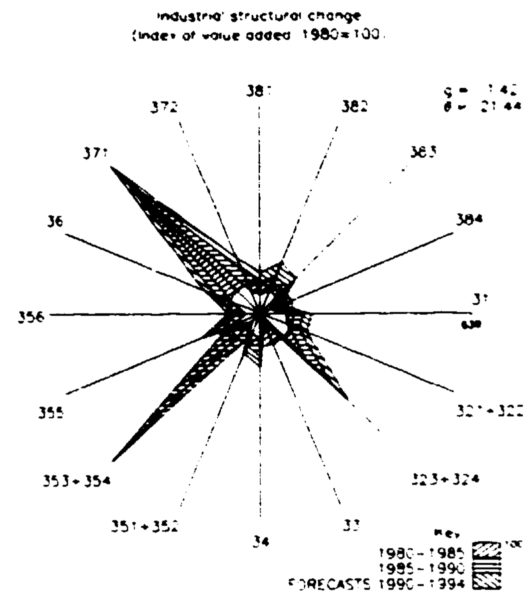
	1980	1985	1990
GDP: (na.c) millions of 1980-dollars)	1489	1537	1289
Per capita (1980-dollars) (na.c)	537	470	333
Manufacturing share (%) (na) (current factor prices)	24 4	27 6	12 7
MANUFACTURING:			
Value added (na.c) millions of 1980-dollars)	351	366	232
Industrial production index	100	116	121
Value added (millions of dollars)	242	982	1781 /e
Gross output (millions of dollars)	612	1587	2733 /e
Employment (thousands)	34	39	46 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	60	38	35 /e
Wages and salaries including supplements (%)	12	10	11 /e
Gross operating surplus (%)	28	52	54 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	18017	38009	55171 /e
Value added / worker	7131	23515	35959 /e
Average wage (including supplements)	2078	4152	6439 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7 80 /e	12 88	2 01 /e
as a percentage of average θ in 1970-1975	175 /e	289	45 /e
MVA growth rate / θ	-1 09	0 38	-1 45
Degree of specialization	27 7	29 6	31 0
-VALUE ADDED: (millions of dollars)			
311/2 Food products	52	268	451 /e
313 Beverages	48	227	474 /e
314 Tobacco products	28	54	[illegible] /e
321 Textiles	9	70	117 /e
322 Wearing apparel	4	23	40 /e
323 Leather and fur products	2	6	14 /e
324 Footwear	4	27	48 /e
331 Wood and wood products	3	10	16 /e
332 Furniture and fixtures	1	4	5 /e
341 Paper and paper products	1	2	3 /e
342 Printing and publishing	4	22	41 /e
351 Industrial chemicals	11	23	36 /e
352 Other chemical products	14	56	122 /e
353 Petroleum refineries	35	78	116 /e
354 Miscellaneous petroleum and coal products	-	1	2 /e
355 Rubber products	1	6	12 /e
356 Plastic products	4	20	31 /e
361 Pottery, china and earthenware	-	2	- /e
362 Glass and glass products	-	1	2 /e
369 Other non-metal mineral products	7	17	27 /e
371 Iron and steel	-	1	2 /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	9	40	70 /e
382 Non-electrical machinery	-	3	4 /e
383 Electrical machinery	1	5	9 /e
384 Transport equipment	1	3	5 /e
385 Professional and scientific equipment	1	-	- /e
390 Other manufacturing industries	-	2	3 /e

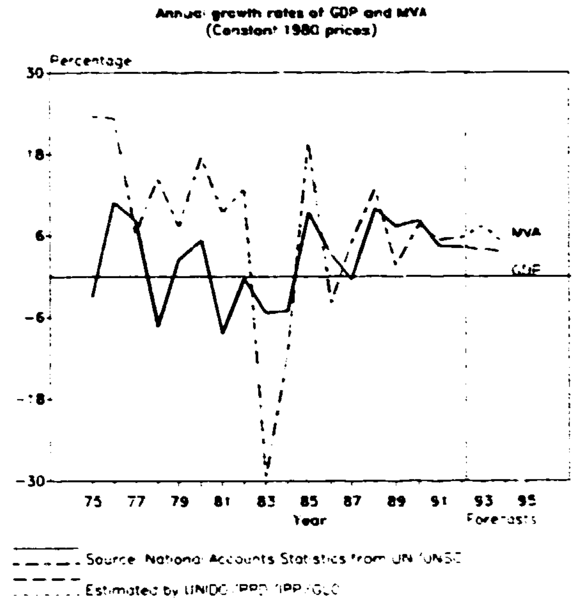
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex





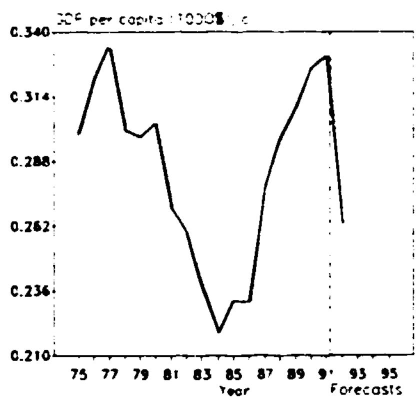


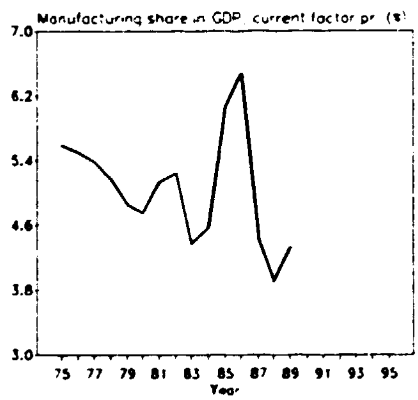


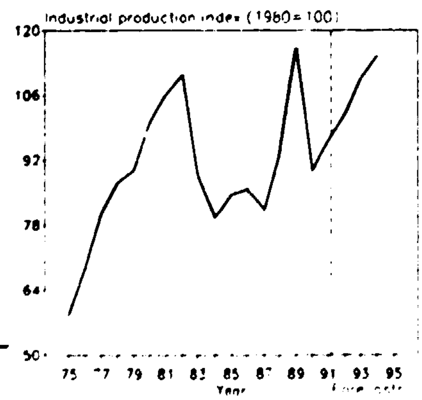


	1980	1985	1990
GDP: (na,c) (millions of 1980-dollars)	23795	21341	27976
Per capita (1980-dollars) (na,c)	303	232	325 /e
Manufacturing share (%) (na, current factor prices)	4 7	6 1 /e	
MANUFACTURING:			
Value added (na,c) (millions of 1980-dollars)	1161	1075	1344
Industrial production index	100	85	90 /e
Value added (millions of dollars)	2422	1667	3606 /e
Gross output (millions of dollars)	4740	3454	5797 /e
Employment (thousands)	432	330	418 /e
-PROFITABILITY: (in percent of gross output			
Intermediate input (%)	49	52	38 /e
Wages and salaries including supplements (%)	11 /	10 /e	10 /e
Gross operating surplus (%)	40 /e	38 /e	52 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	10273	10005	13472 /e
Value added / worker	5211	4844	8657 /e
Average wage (including supplements)	1226 /e	1037 /e	1422 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	16.42 /e	26 10 /e	2 77 /e
as a percentage of average θ in 1970-1975	135 /e	215 /e	23 /e
MVA growth rate / θ	1 13	-0 28	3 91
Degree of specialization	18 7	18.8	19 5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	149	251	505 /e
313 Beverages	267	173 /e	432 /e
314 Tobacco products	96	32 /e	71 /e
321 Textiles	231	233	449 /e
322 Wearing apparel	3	1	2 /e
323 Leather and fur products	12	23	47 /e
324 Footwear	12	28	61 /e
331 Wood and wood products	88	14	26 /e
332 Furniture and fixtures	16	14	33 /e
341 Paper and paper products	38	51	115 /e
342 Printing and publishing	75	45	107 /e
351 Industrial chemicals	30	9	19 /e
352 Other chemical products	265	213	461 /e
353 Petroleum refineries	75 /e	-7 /e	40 /e
354 Miscellaneous petroleum and coal products	3 /e	- /e	2 /e
355 Rubber products	26	31	67 /e
356 Plastic products	98	49	107 /e
361 Pottery, china and earthenware	-	2	2 /e
362 Glass and glass products	24	7	18 /e
369 Other non-metal mineral products	57	106	228 /e
371 Iron and steel	3	17	25 /e
372 Non-ferrous metals	33	27	73 /e
381 Metal products	140	92	201 /e
382 Non-electrical machinery	23	19	42 /e
383 Electrical machinery	46	36	78 /e
384 Transport equipment	526	193	386 /e
385 Professional and scientific equipment	-	-	1 /e
390 Other manufacturing industries	13	6	10 /e

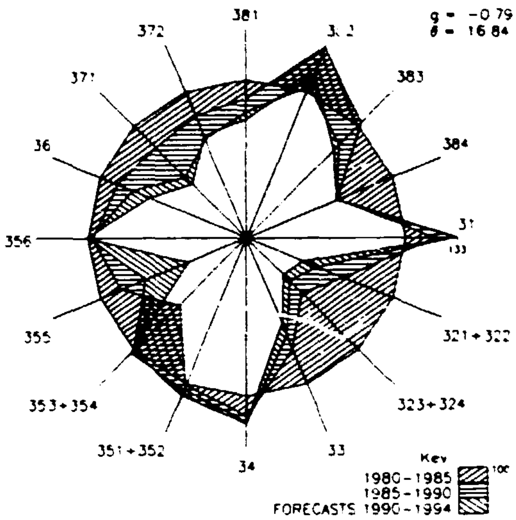
For sources, footnotes and comments see Technical notes at the beginning of this Annex



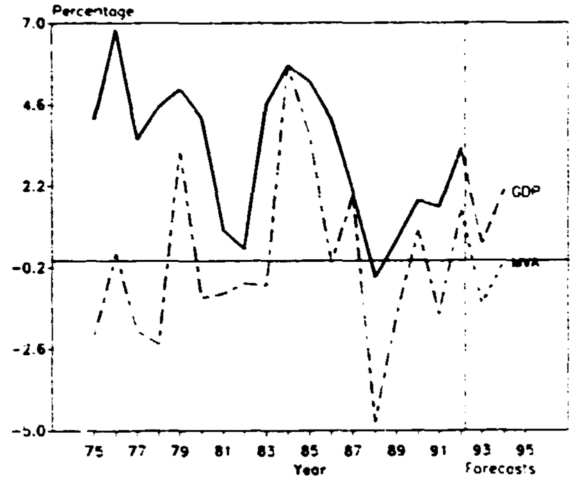




Industrial structural change
(Index of value added 1980=100)



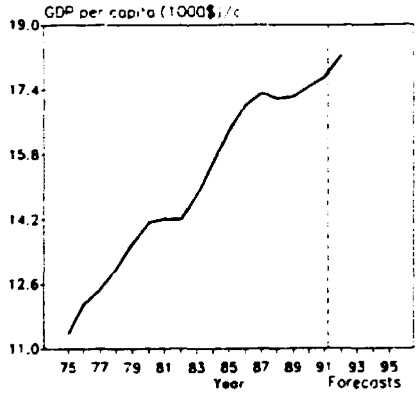
Annual growth rates of GDP and MVA
(Constant 1980 prices)



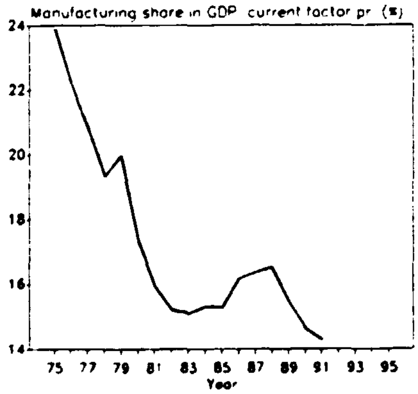
	1980	1985	1990
GDP: /na.c millions of 1980-dollars)	57713	68041	73638
Per capita (1980-dollars) /na.c	14125	16383	17479
Manufacturing share (%) /na (current factor prices)	17.3	15.3	14.6
MANUFACTURING:			
Value added /na.c millions of 1980-dollars)	9240	9889	9520
Industrial production index	100	109	113
Value added (millions of dollars)	8339	7948	14015
Gross output (millions of dollars)	31936	28185	50107
Employment (thousands)	354	312	271
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	71	72	72
Wages and salaries including supplements (%)	21	20	19
Gross operating surplus (%)	8	8	9
-PRODUCTIVITY: (dollars)			
Gross output / worker	89656	89848	184350
Value added / worker	26217	25335	51564
Average wage (including supplements)	19129	17851	35540
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.11	6.97	5.66
as a percentage of average θ in 1970-1975	84	115	93
MVA growth rate / θ	-0.19	-0.10	-0.18
Degree of specialization	12.2	13.9	13.7
-VALUE ADDED: (millions of dollars)			
311/2 Food products	908	922	1819
313 Beverages	292	297	560
314 Tobacco products	168	220	478
321 Textiles	213	126	191
322 Wearing apparel	101	59	58
323 Leather and fur products	18	9	16
324 Footwear	24	9	11
331 Wood and wood products	587	365	619
332 Furniture and fixtures	196	164	235
341 Paper and paper products	452	400	787
342 Printing and publishing	668	717	1381
351 Industrial chemicals	452	422	811
352 Other chemical products	227	184	393
353 Petroleum refineries	103	24	195
354 Miscellaneous petroleum and coal products	53	58	63
355 Rubber products	51	38	58
356 Plastic products	170	147	278
361 Pottery, china and earthenware	26	17	27
362 Glass and glass products	55	50	77
369 Other non-metal mineral products	281	215	361
371 Iron and steel	385	276	347
372 Non-ferrous metals	743	550	826
381 Metal products	595	465	784
382 Non-electrical machinery	933	1079	1590
383 Electrical machinery	547	498	751
384 Transport equipment	1000	555	1028
385 Professional and scientific equipment	32	38	82
390 Other manufacturing industries	59	42	89

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

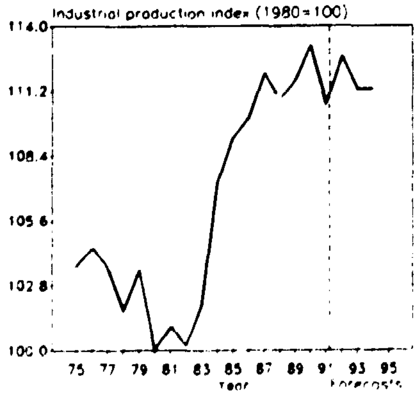
GDP per capita (1000$)/c



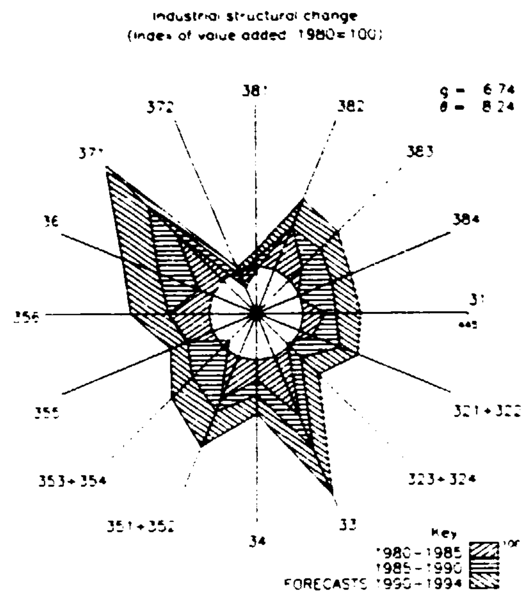
Manufacturing share in GDP current factor pr. (%)

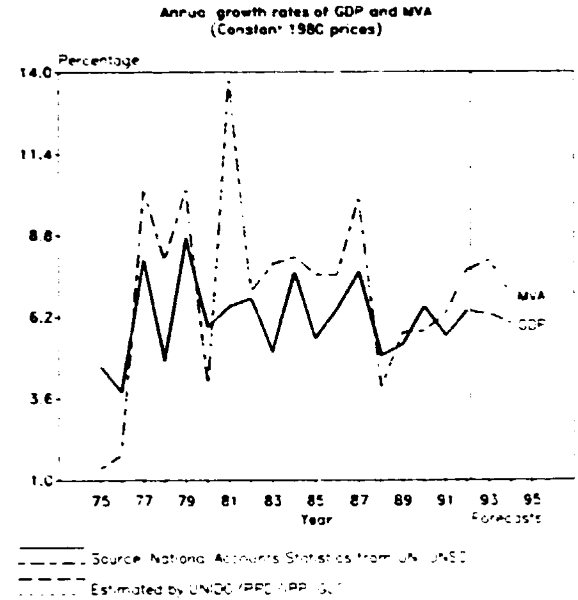


Industrial production index (1980=100)



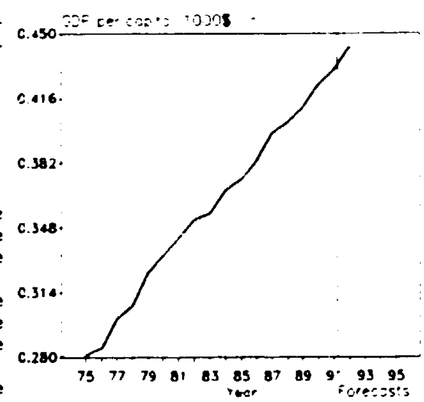
PAKISTAN

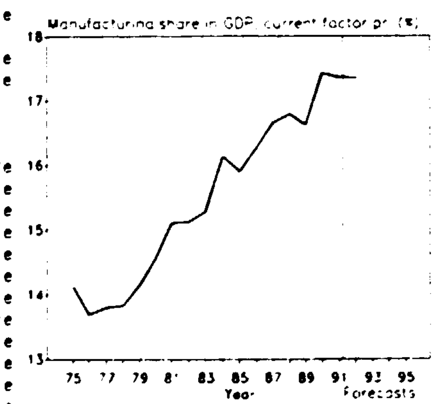


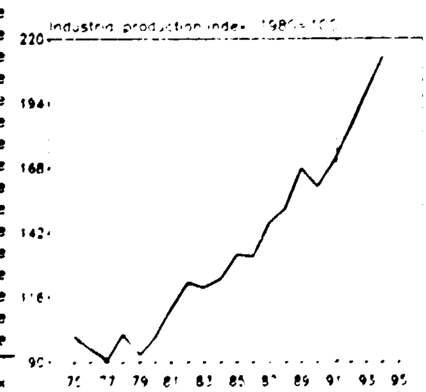


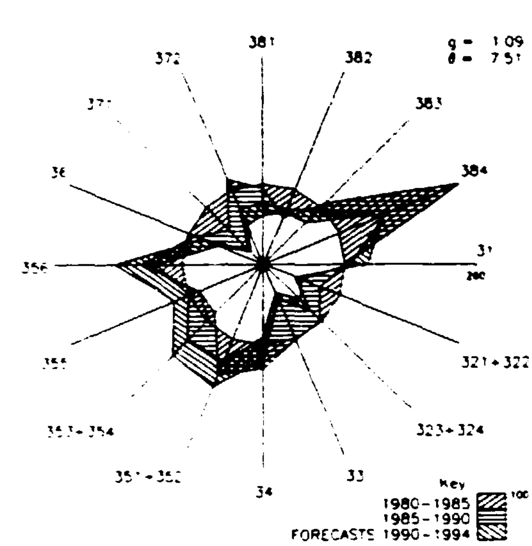
	1980	1985	1990
GDP: (na.c millions of 1980-dollars)	28418	38555	52017
Per capita (1980-dollars) (na.c	333	373	423
Manufacturing share (%) (na (current factor prices)	14.6	15.9	17.4
MANUFACTURING:			
Value added (na.c millions of 1980-dollars)	4294	6557	9010
Industrial production index	100	133	150
Value added (millions of dollars)	2423	3174	4299 e
Gross output (millions of dollars)	7144	10132	13354 e
Employment (thousands)	452	493	561 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	56	69	68 e
Wages and salaries including supplements (%)	7	6	7 e
Gross operating surplus (%)	27	25	25 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	14606	20486	23742 e
Value added / worker	4953	6418	7644 e
Average wage (including supplements)	1122	1324	1589 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6.88	7.24	5.13 e
as a percentage of average θ in 1970-1975	102	107	76 e
MVA growth rate / θ	0.71	1.02	1.19
Degree of specialization	23.2	22.6	20.9
-VALUE ADDED: (millions of dollars)			
311/2 Food products	431	580	590 e
313 Beverages	45	74	79 e
314 Tobacco products	300	372	440 e
321 Textiles	483	562	792 e
322 Wearing apparel	7	18	74 e
323 Leather and fur products	41	35	26 e
324 Footwear	4	3	30 e
331 Wood and wood products	4	9	14 e
332 Furniture and fixtures	3	6	5 e
341 Paper and paper products	29	33	46 e
342 Printing and publishing	24	36	39 e
351 Industrial chemicals	127	281	281 e
352 Other chemical products	156	230	308 e
353 Petroleum refineries	158	108	263 e
354 Miscellaneous petroleum and coal products	9	17	32 e
355 Rubber products	28	41	40 e
356 Plastic products	12	21	21 e
361 Pottery, china and earthenware	5	8	15 e
362 Glass and glass products	11	17	31 e
369 Other non-metal mineral products	171	199	338 e
371 Iron and steel	99	216	232 e
372 Non-ferrous metals	1	1	1 e
381 Metal products	38	33	42 e
382 Non-electrical machinery	43	80	19 e
383 Electrical machinery	78	98	138 e
384 Transport equipment	97	83	155 e
385 Professional and scientific equipment	6	6	11 e
390 Other manufacturing industries	11	11	15 e

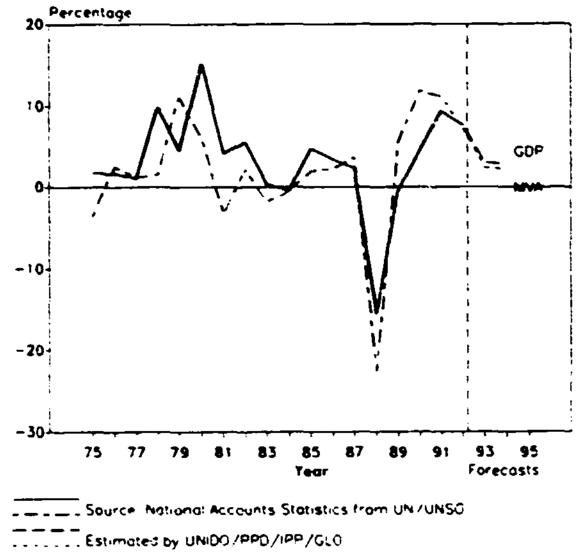
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





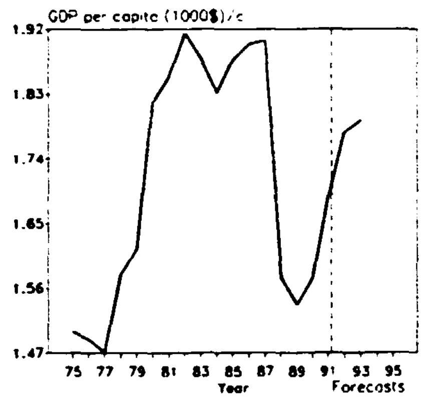


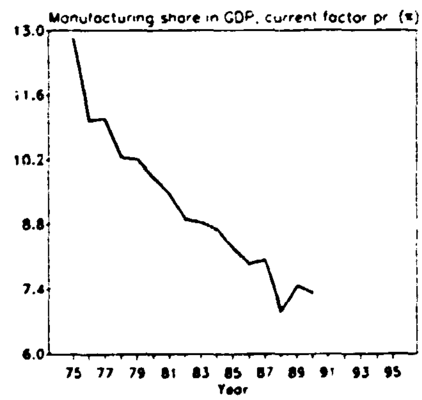


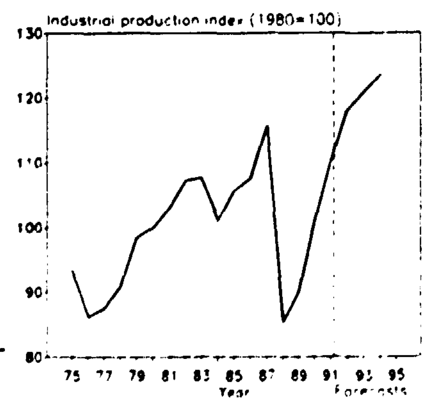


	1980	1985	1990
GDP: (na.c. millions of 1980-dollars)	3559	4094	3809
Per capita (1980-dollars) (na.c	1818	1877	1574
Manufacturing share (%) (na. current factor prices)	9.8	8.3	7.3 /e
MANUFACTURING:			
Value added (na.c. millions of 1980-dollars)	356	351	339
Industrial production index	100	106	101
Value added (millions of dollars)	477	585	547 /e
Gross output (millions of dollars)	1473 /e	1765	1504 /e
Employment (thousands)	31 /e	36	36 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	68 /e	67	64 /e
Wages and salaries including supplements (%)	9 /e	13 /e	14 /e
Gross operating surplus (%)	23 /e	20 /e	22 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	46756 /e	48648	41614 /e
Value added / worker	15159 /e	16134	15650 /e
Average wage (including supplements)	4238 /e	5270 /e	5868 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.56	4.46	3.12 /e
as a percentage of average θ in 1970-1975	85	69	48 /e
MVA growth rate / θ	0.74	0.25	-0.28
Degree of specialization	24.2	22.8	28.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	155	179	195 /e
313 Beverages	52	63	74 /e
314 Tobacco products	26	31	28 /e
321 Textiles	4	3	5 /e
322 Wearing apparel	31	27	15 /e
323 Leather and fur products	4	4	2 /e
324 Footwear	7	9	6 /e
331 Wood and wood products	8	8	2 /e
332 Furniture and fixtures	8	11	5 /e
341 Paper and paper products	20	33	22 /e
342 Printing and publishing	22	30	23 /e
351 Industrial chemicals	4	9	8 /e
352 Other chemical products	26	42	39 /e
353 Petroleum refineries	27	25	40 /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 /e	7	6 /e
369 Other non-metal mineral products	31	27	17 /e
371 Iron and steel	5	4	1 /e
372 Non-ferrous metals	2	3	2 /e
381 Metal products	19	21	14 /e
382 Non-electrical machinery	1	1	1 /e
383 Electrical machinery	3	4	3 /e
384 Transport equipment	4	13	8 /e
385 Professional and scientific equipment	1	3	3 /e
390 Other manufacturing industries	2	2	1 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

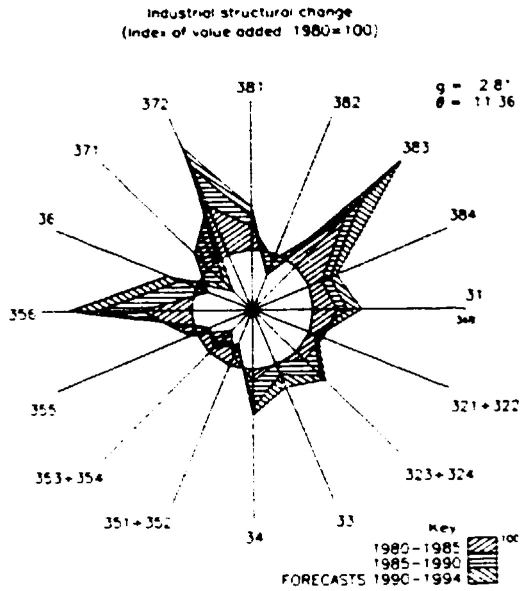




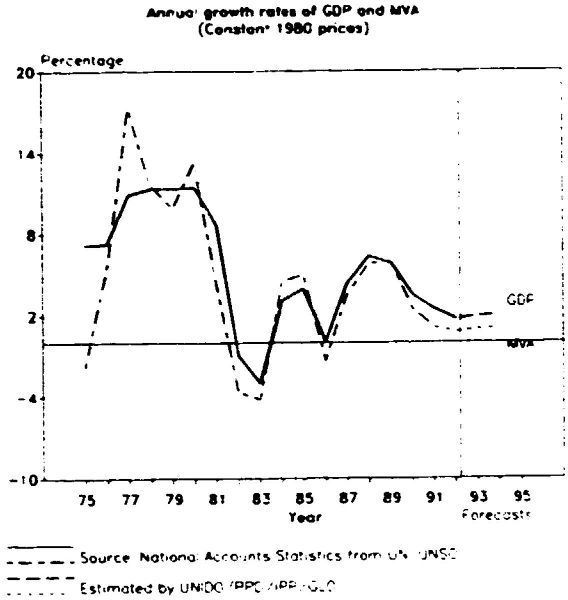


PARAGUAY

Industrial structural change
(Index of value added 1980=100)

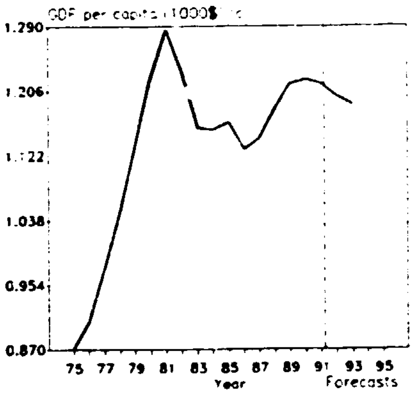


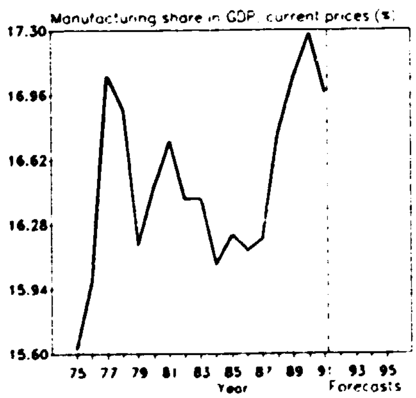
Annual growth rates of GDP and MVA
(Constant 1980 prices)

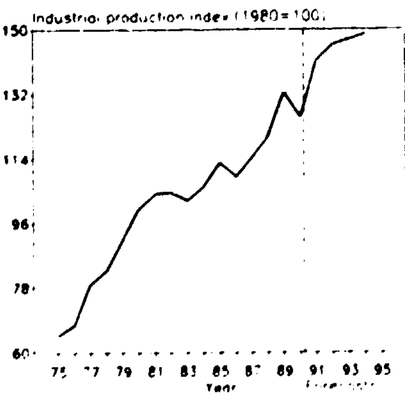


	1980	1985	1990
GDP: (na.c (millions of 1980-dollars)	3844	4302	5227
Per capita (1980-dollars) (na.c	1222	1164	1220
Manufacturing share (%) (na (current factor prices)	16.5	16.2	17.3
MANUFACTURING:			
Value added (na.c (millions of 1980-dollars)	633	669	784
Industrial production index	100	113	125
Value added (millions of dollars)	575	622 /e	633 /e
Gross output (millions of dollars)	1312	1395	1408
Employment (thousands)	146 /e	128 /e	153 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	.	.	
Wages and salaries including supplements (%)			
Gross operating surplus (%)			
-PRODUCTIVITY: (dollars)			
Gross output / worker	8962 /e	10740 /e	9102 /e
Value added / worker	4061 /e	4824 /e	4140 /e
Average wage (including supplements)	..		
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.33	5.74	5.54 /e
as a percentage of average θ in 1970-1975	137	107	104 /e
MVA growth rate / θ	1.19	0.35	0.63
Degree of specialization	31.7	33.0	32.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	170	232	224
313 Beverages	43	58	55
314 Tobacco products	6	9	9
321 Textiles	44	54	41
322 Wearing apparel	2	3	3
323 Leather and fur products	7	11	14
324 Footwear	18	18	18
331 Wood and wood products	95	87	92
332 Furniture and fixtures	6	10	9
341 Paper and paper products	-	1 /e	1 /e
342 Printing and publishing	24	27 /e	3[illegible] /e
351 Industrial chemicals	4	4 /e	2 /e
352 Other chemical products	10	8 /e	6 /e
353 Petroleum refineries	94	45	62
354 Miscellaneous petroleum and coal products	- /e	- /e	- /e
355 Rubber products	-	- /e	- /e
356 Plastic products	6	10 /e	12 /e
361 Pottery, china and earthenware	-	-	-
362 Glass and glass products	1	2 /e	2 /e
369 Other non-metal mineral products	26	18	26
371 Iron and steel	-	- /e	- /e
372 Non-ferrous metals	1	2 /e	2 /e
381 Metal products	9	12 /e	12 /e
382 Non-electrical machinery	1	1 /e	1 /e
383 Electrical machinery	-	- /e	- /e
384 Transport equipment	5	6 /e	6 /e
385 Professional and scientific equipment	1	1 /e	- /e
390 Other manufacturing industries	2	3 /e	3 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex







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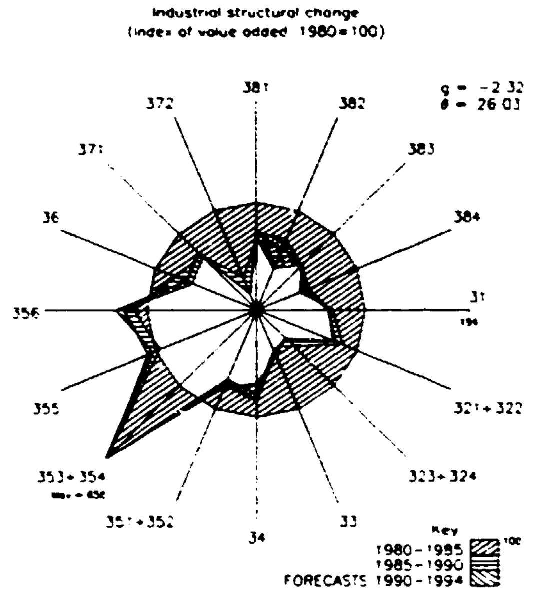
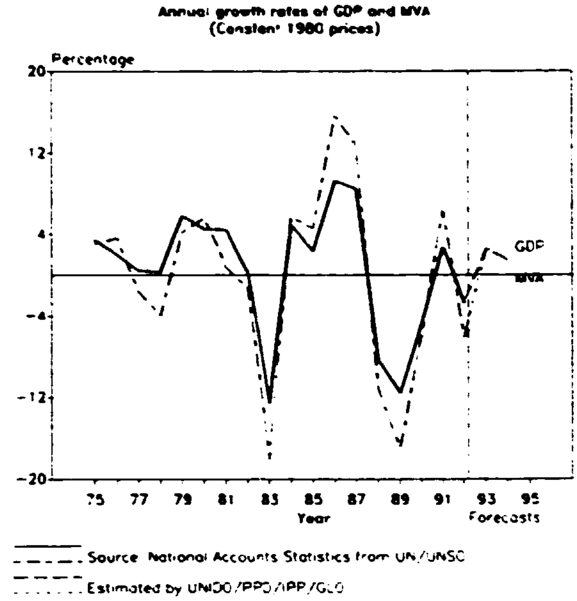
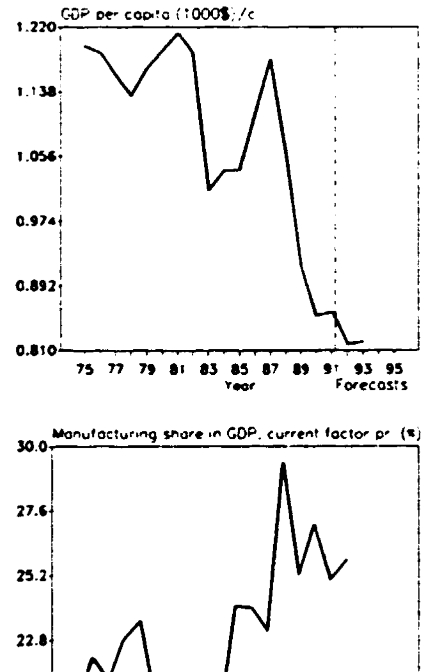
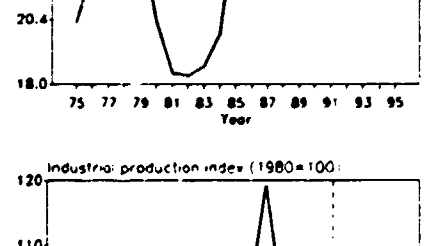


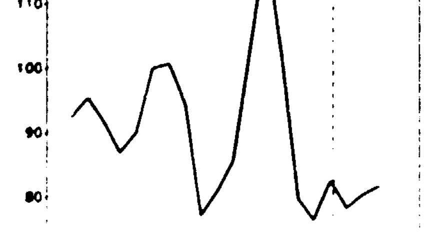


	1980	1985	1990
GDP: (na,c millions of 1980-dollars)	20579	20167	18418
Per capita (1980-dollars) (na,c	1190	1039	854
Manufacturing share (%) (na (current factor prices)	20.4	24.1	27.1
MANUFACTURING:			
Value added (na,c millions of 1980-dollars)	4159	3741	3386
Industrial production index	100	86	76
Value added (millions of dollars)	4984	3918	7265 /e
Gross output (millions of dollars)	12977	9573	14267 /e
Employment (thousands)	273	263	295 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	62	59	49 /e
Wages and salaries including supplements (%)	7 /e	6	10 /e
Gross operating surplus (%)	32 /e	35	41 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	47484	36350	48193 /e
Value added / worker	18238	14877	24575 /e
Average wage (including supplements)	3176 /e	2154	4519 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	10 22	16 82	9 45 /e
as a percentage of average θ in 1970-1975	150	246	138 /e
MVA growth rate / θ	0 32	-0 03	-0 44
Degree of specialization	12 7	21 3	13 7
-VALUE ADDED: (millions of dollars)			
311/2 Food products	767	402	1027 /e
313 Beverages	379	303	605 /e
314 Tobacco products	84	61	95 /e
321 Textiles	466	352	704 /e
322 Wearing apparel	65	52	181 /e
323 Leather and fur products	56	20	37 /e
324 Footwear	41	20	41 /e
331 Wood and wood products	81	32	59 /e
332 Furniture and fixtures	40	19	49 /e
341 Paper and paper products	156	77	209 /e
342 Printing and publishing	100	80	228 /e
351 Industrial chemicals	215	158	313 /e
352 Other chemical products	289	193	440 /e
353 Petroleum refineries	192	1154	1032 /e
354 Miscellaneous petroleum and coal products	6	1	1 /e
355 Rubber products	62	52	142 /e
356 Plastic products	89	90	233 /e
361 Pottery, china and earthenware	15	9	7 /e
362 Glass and glass products	47	15	55 /e
369 Other non-metal mineral products	129	113	197 /e
371 Iron and steel	192	123	285 /e
372 Non-ferrous metals	604	172	210 /e
381 Metal products	188	113	262 /e
382 Non-electrical machinery	156	58	210 /e
383 Electrical machinery	211	111	258 /e
384 Transport equipment	278	106	278 /e
385 Professional and scientific equipment	14	10	30 /e
390 Other manufacturing industries	58	25	74 /e

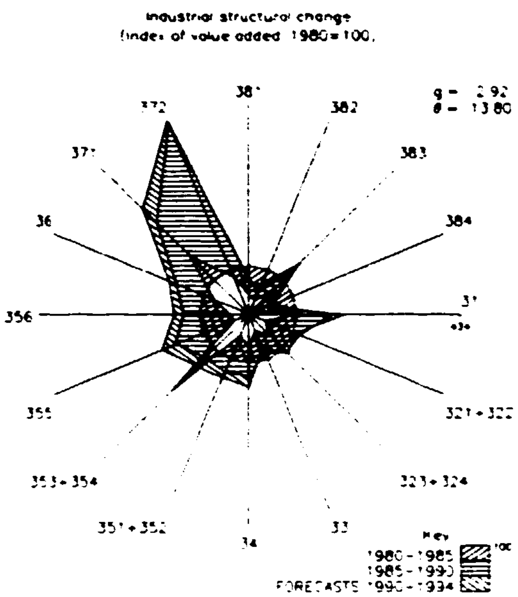
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

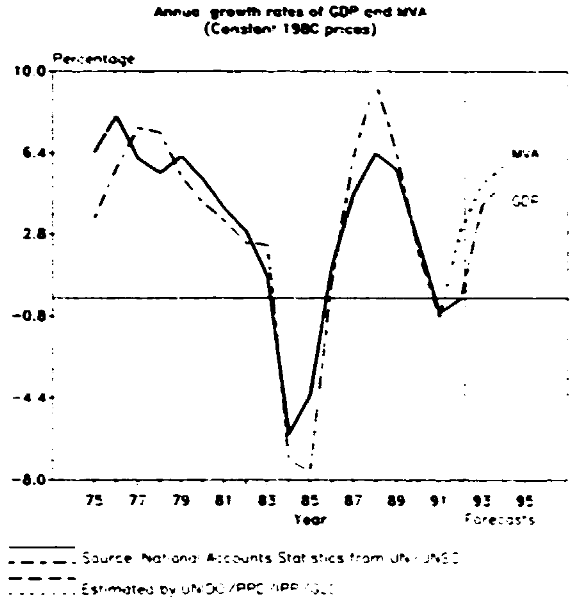






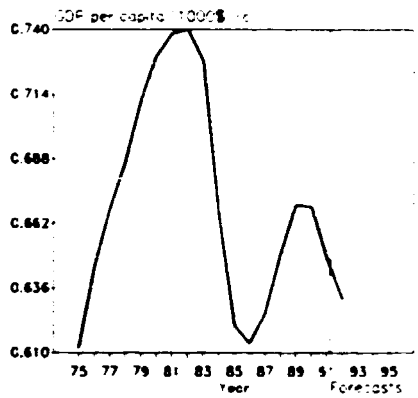
PHILIPPINES

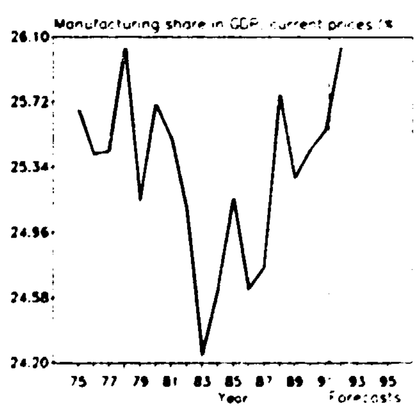


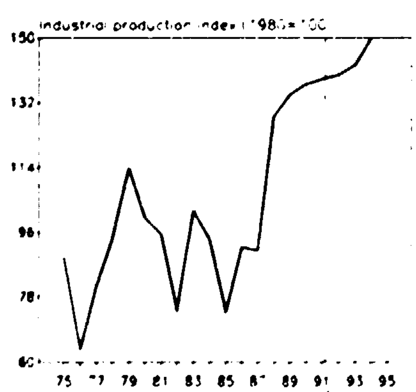


	1980	1985	1990
GDP (na.c millions of 1980-dollars)	35235	34221	41770
Per capita (1980-dollars) (na.c)	729	621	669
Manufacturing share (%) (na current factor prices)	25.7	25.2	25.4
MANUFACTURING:			
Value added (na.c millions of 1980-dollars)	8595	7983	10172
Industrial production index	100	74	137 /e
Value added (millions of dollars)	4861	3448	7215 /e
Gross output (millions of dollars)	17369	12081	21234 /e
Employment (thousands)	949	616	865 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	72	71	66 /e
Wages and salaries including supplements (%)	6	6	8 /e
Gross operating surplus (%)	22	22	26 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	16263	19386	24174 /e
Value added / worker	4552	5586	3221 /e
Average wage (including supplements)	1127	1258	1391 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.12	14.07	9.01 /e
as a percentage of average θ in 1970-1975	107	125	80 /e
MVA growth rate / θ	0.39	-0.27	1.59
Degree of specialization	14.4	22.0	15.5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	969	658	1343 /e
313 Beverages	195	423	913 /e
314 Tobacco products	309	209	457 /e
321 Textiles	395	109	315 /e
322 Wearing apparel	205	105	419 /e
323 Leather and fur products	3	3	11 /e
324 Footwear	13	9	14 /e
331 Wood and wood products	229	86	196 /e
332 Furniture and fixtures	75	22	89 /e
341 Paper and paper products	128	97	196 /e
342 Printing and publishing	89	46	102 /e
351 Industrial chemicals	296	101	302 /e
352 Other chemical products	389	205	553 /e
353 Petroleum refineries	328	715	444 /e
354 Miscellaneous petroleum and coal products	2	3	6 /e
355 Rubber products	103	34	182 /e
356 Plastic products	85	32	123 /e
361 Pottery, china and earthenware	33	9	26 /e
362 Glass and glass products	42	28	93 /e
369 Other non-metal mineral products	63	50	118 /e
371 Iron and steel	98	164	283 /e
372 Non-ferrous metals	35	28	159 /e
381 Metal products	127	49	98 /e
382 Non-electrical machinery	98	31	58 /e
383 Electrical machinery	260	156	410 /e
384 Transport equipment	234	35	124 /e
385 Professional and scientific equipment	5	5	19 /e
390 Other manufacturing industries	49	28	63 /e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

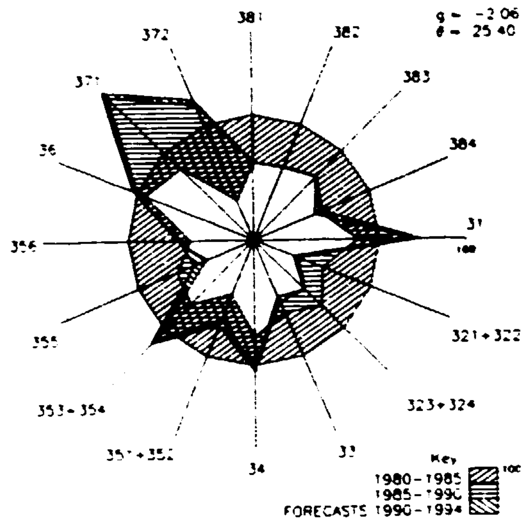




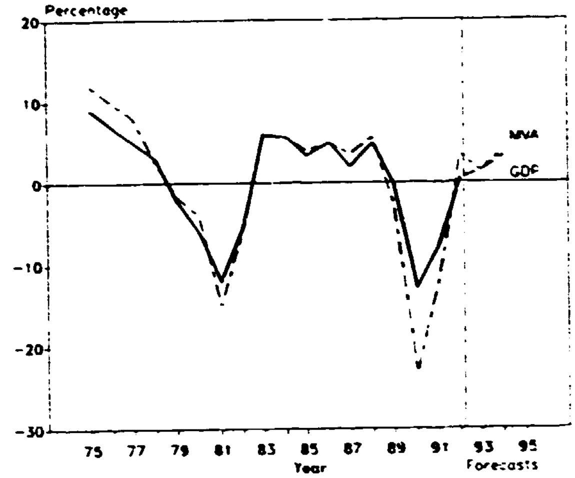


POLAND

Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

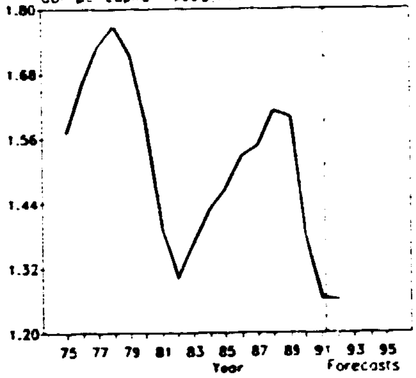


Source: National Accounts Statistics from UN/UNSO
Estimated by UNIDO/PPD/IPP/GLO

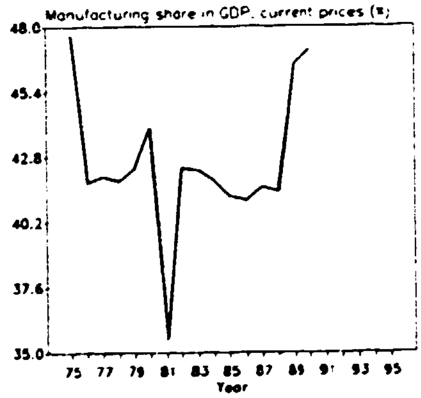
	1980	1985	1990
GDP: (na.c. millions of 1980-dollars)	56707	54570	53163
Per capita (1980-dollars) (na.c.)	1594	1457	1382
Manufacturing share (%) (na. current factor prices)	44.0	41.2	47.0
MANUFACTURING:			
Value added (na.c. millions of 1980-dollars)	26384	24563	21006
Industrial production index	100	98	84
Value added (millions of dollars)	22833	24432	23017
Gross output (millions of dollars)			
Employment (thousands)	4125	3578	3014
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)			
Wages and salaries including supplements (%)			
Gross operating surplus (%)			
-PRODUCTIVITY: (dollars)			
Gross output / worker			
Value added / worker	5361	6242	7637
Average wage (including supplements)	1551	1627	1257
-STRUCTURAL INDICES:			
Structural change θ 5-year average in degrees	6.03	14.02	11.51
as a percentage of average θ in 1970-1975	118	275	226
MVA growth rate / θ	0.06	-0.52	0.49
Degree of specialization	11.7	14.4	11.3
-VALUE ADDED: (millions of dollars)			
311/2 Food products	-889	144	2595
313 Beverages	3062	3582	1838
314 Tobacco products	636	74	379
321 Textiles	2795	2444	1222
322 Wearing apparel	572	801	432
323 Leather and fur products	122	221	120
324 Footwear	403	430	263
331 Wood and wood products	423	434	325
332 Furniture and fixtures	491	500	307
341 Paper and paper products	224	269	348
342 Printing and publishing	154	208	166
351 Industrial chemicals	837	734	1056
352 Other chemical products	961	644	649
353 Petroleum refineries	1058	1239	1419
354 Miscellaneous petroleum and coal products	54	50	249
355 Rubber products	317	341	209
356 Plastic products	360	296	274
361 Pottery, china and earthenware	97	146	107
362 Glass and glass products	269	282	227
369 Other non-metal mineral products	335	634	602
371 Iron and steel	868	1161	1887
372 Non-ferrous metals	602	336	951
381 Metal products	1343	1347	1081
382 Non-electrical machinery	3263	3360	2604
383 Electrical machinery	1558	1801	1420
384 Transport equipment	2436	2255	1855
385 Professional and scientific equipment	244	251	173
390 Other manufacturing industries	237	438	258

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

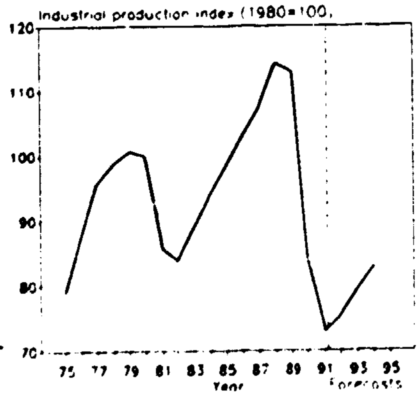
GDP per capita (1000$)/x



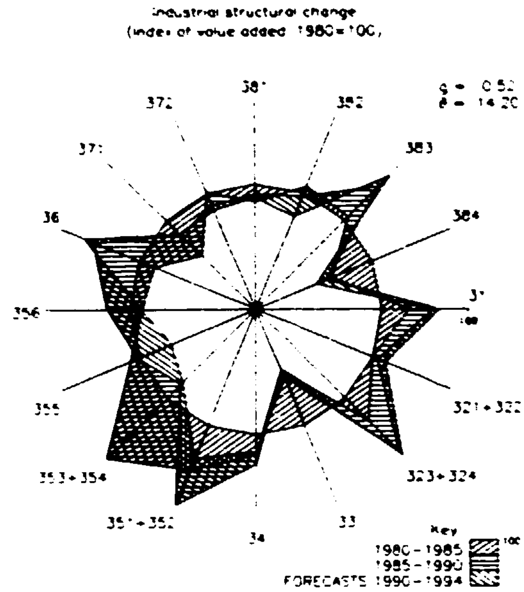
Manufacturing share in GDP, current prices (%)

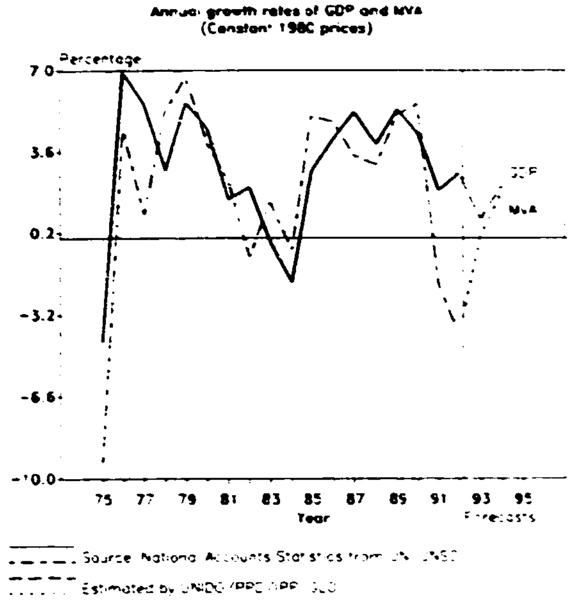


Industrial production index (1980=100)



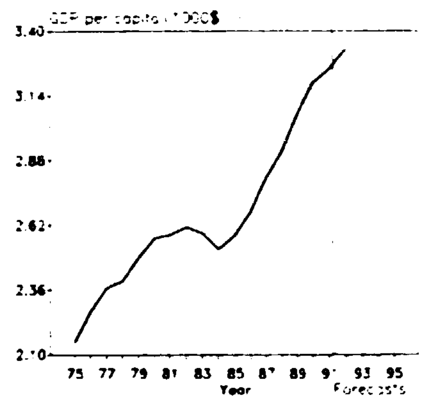
PORTUGAL

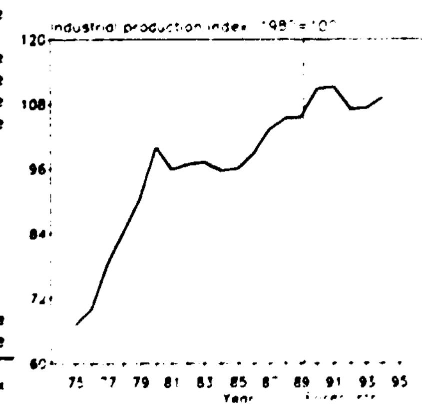


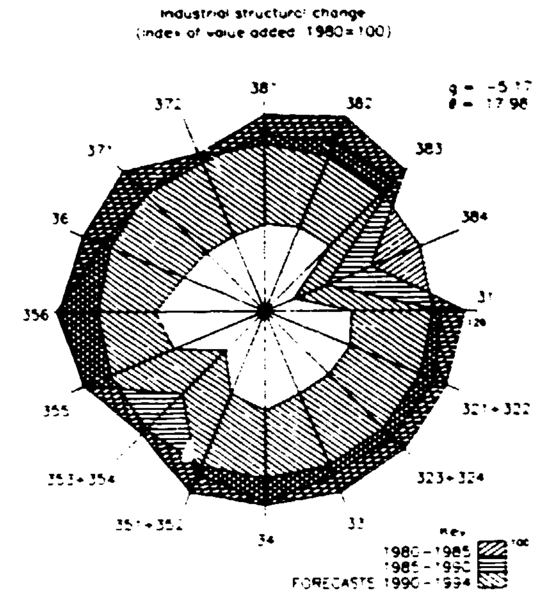


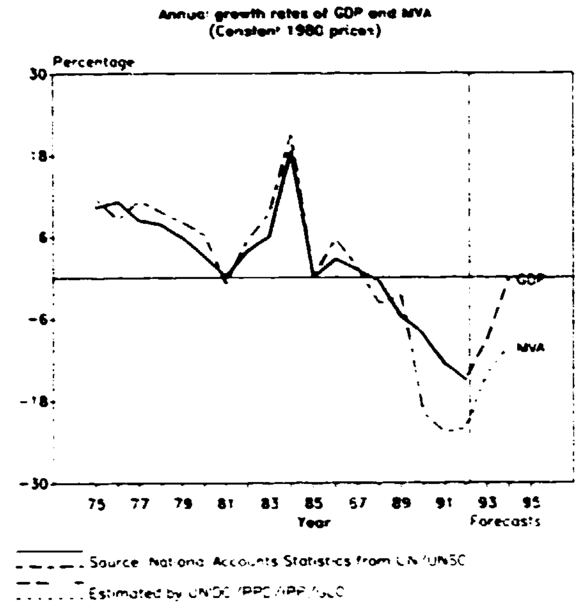
	1980	1985	1990
GDP: (n.a.) (millions of 1980-dollars)	25090	26223	32855
Per capita (1980-dollars) (n.a.)	2569	2581	3193
Manufacturing share (%) (n.a.) (current factor prices)	30.0	29.3	29.6 e
MANUFACTURING:			
Value added (n.a.) (millions of 1980-dollars)	7576	8169	10144
Industrial production index	100	96	111
Value added (millions of dollars)	5602	4147	11680 e
Gross output (millions of dollars)	17932	15793	37237 e
Employment (thousands)	630	623	577
-PROFITABILITY: in percent of gross output			
Intermediate input (%)	69	74	69 e
Wages and salaries including supplements (%)	17	14	16 e
Gross operating surplus (%)	14	12	15 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	25884	24974	53758 e
Value added / worker	8087	6559	19989 e
Average wage (including supplements)	4541	3490	10367 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.31	6.82	4.56 e
as a percentage of average θ in 1970-1975	83	107	71 e
MVA growth rate / θ	1.44	-0.19	0.89
Degree of specialization	11.2	10.4	10.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	544	490	1360
313 Beverages	135	133	408
314 Tobacco products	64	93	226
321 Textiles	905	679	1138
322 Wearing apparel	186	182	486
323 Leather and fur products	41	41	91
324 Footwear	83	86	293
331 Wood and wood products	325	150	292 e
332 Furniture and fixtures	106	30	135 e
341 Paper and paper products	274	276	694 e
342 Printing and publishing	180	140	330 e
351 Industrial chemicals	147	215	501
352 Other chemical products	224	190	541 e
353 Petroleum refineries	219 /e	-18 e	339
354 Miscellaneous petroleum and coal products	[illegible] /e	- e	- e
355 Rubber products	58	49 /e	108 e
356 Plastic products	128	92 e	278 e
361 Pottery, china and earthenware	80	67	250 e
362 Glass and glass products	87	53	215
369 Other non-metal mineral products	295	200	712
371 Iron and steel	207	98	318
372 Non-ferrous metals	33	26	55
381 Metal products	323	219	546
382 Non-electrical machinery	170	143	303
383 Electrical machinery	319	263	809
384 Transport equipment	428	222	477
385 Professional and scientific equipment	15	16	49 /e
390 Other manufacturing industries	20	11	28 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



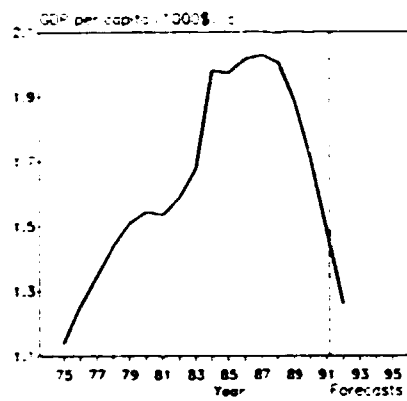


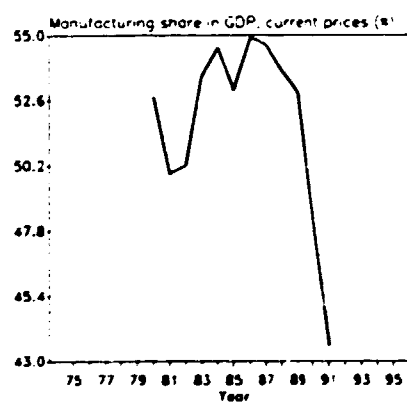


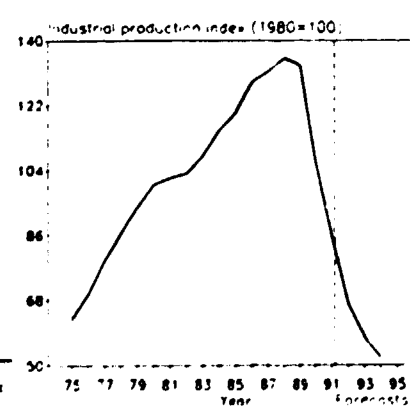


	1980	1985	1990
GDP: (real, millions of 1980-dollars)	34272	44851	39901
Per capita (1980-dollars) (real)	1544	1974	1715
Manufacturing share (%) (real, current factor prices)	52.7	53.0	48.2
MANUFACTURING:			
Value added (real, millions of 1980-dollars)	17333	24038	19351
Industrial production index	100	120	107
Value added (millions of dollars)	14815 /e	21752 e	15944
Gross output (millions of dollars)	34513 /e	60429	44146
Employment (thousands)	2384	3197	3599
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	57 /e	54 /e	64
Wages and salaries including supplements (%)	12 e	12 e	14
Gross operating surplus (%)	30 /e	24 e	22
-PRODUCTIVITY: (dollars)			
Gross output / worker	11967 /e	18902	11725
Value added / worker	5137 /e	6804 e	4305
Average wage (including supplements)	1487 /e	2247 e	1726
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.33 /e	2.53 e	3.42 e
as a percentage of average θ in 1970-1975	115 /e	87 e	118 e
MVA growth rate (%)	0.59	0.82	-0.34
Degree of specialization	12.1	11.3	11.0
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1162 /e	1830 e	1345
313 Beverages	536 e	853 e	660
314 Tobacco products	7 e	15 e	15
321 Textiles	1285 e	1969 e	1607
322 Wearing apparel	725 /e	1149 e	877
323 Leather and fur products	202 e	310 e	246
324 Footwear	226 e	357 /e	275
331 Wood and wood products	482 e	752 e	577
332 Furniture and fixtures	294 e	458 e	357
341 Paper and paper products	175 /e	262 e	205
342 Printing and publishing	39 /e	56 e	72
351 Industrial chemicals	353 e	538 e	439
352 Other chemical products	345 /e	545 e	393
353 Petroleum refineries	383 e	518 e	288
354 Miscellaneous petroleum and coal products	36 /e	61 e	43
355 Rubber products	176 /e	273 /e	231
356 Plastic products	146 /e	238 e	205
361 Pottery, china and earthenware	76 /e	114 e	98
362 Glass and glass products	128 /e	202 e	148
369 Other non-metal mineral products	412 /e	644 e	487
371 Iron and steel	615 /e	970 /e	693
372 Non-ferrous metals	205 /e	278 /e	225
381 Metal products	678 /e	1058 e	808
382 Non-electrical machinery	1844 /e	3093 e	2296
383 Electrical machinery	666 /e	1051 e	829
384 Transport equipment	2025 /e	1849 e	913
385 Professional and scientific equipment	585 /e	695 /e	397
390 Other manufacturing industries	1010 /e	1607 /e	1216

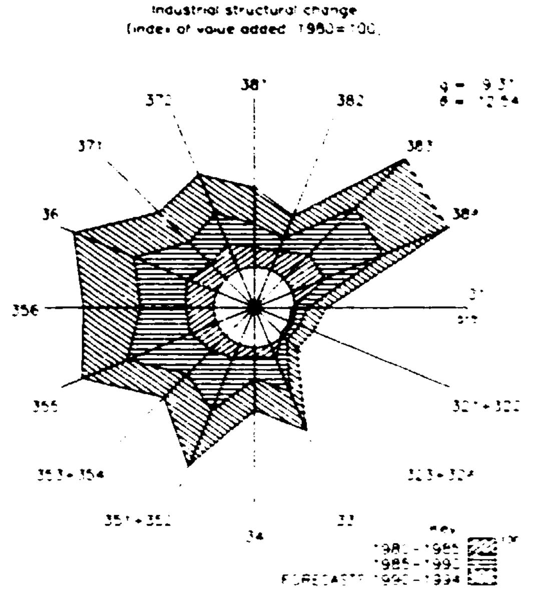
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

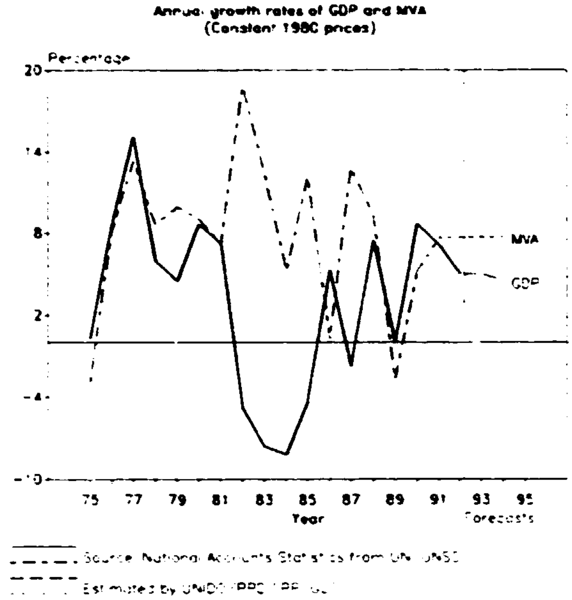






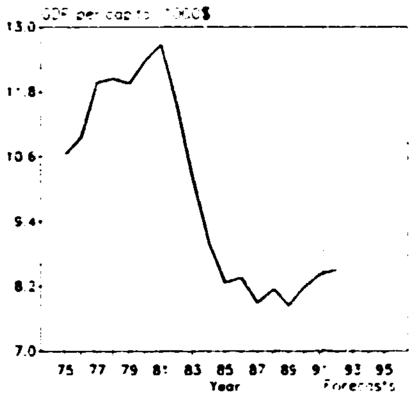
SAUDI ARABIA

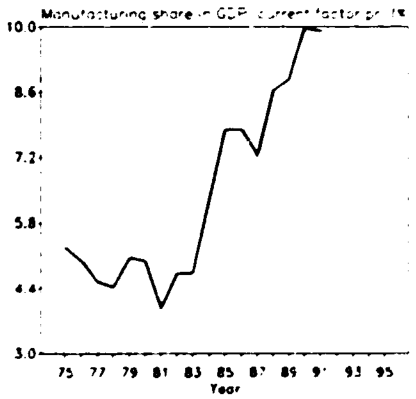


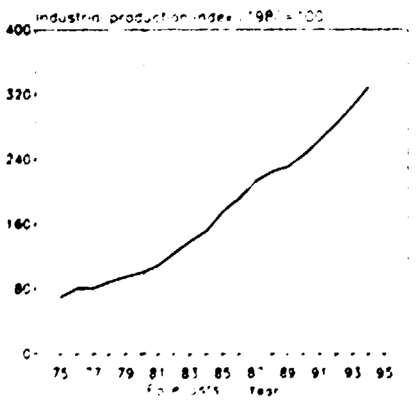


	1980		1985		1990	
GDP: (real, millions of 1980-dollars)	115962		95852		115756	
Per capita (1980-dollars) (real)	12372		5257		8153	
Manufacturing share (%) (real, current factor prices)	5.0		7.6		10.0	
MANUFACTURING:						
Value added (real, millions of 1980-dollars)	5800		9805		1240[illegible]	
Industrial production index	100		175		245	
Value added (millions of dollars)	2594	e	3236	e	5387	e
Gross output (millions of dollars)	10793	e	12741	e	17995	e
Employment (thousands)	79	e	138	e	127	e
-PROFITABILITY: (in percent of gross output)						
Intermediate input (%)						
Wages and salaries including supplements (%)						
Gross operating surplus (%)						
-PRODUCTIVITY: (dollars)						
Gross output / worker	137239	e	92275	e	141222	e
Value added / worker						
Average wage (including supplements)						
-STRUCTURAL INDICES:						
Structural change θ (5-year average in degrees)	2.40	e	3.1	e	.99	e
as a percentage of average θ in 1970-1975	65	e	34	e	54	e
MVA growth rate / θ	3.20		2.20		5.70	
Degree of specialization	30.8		29.9		32.6	
-VALUE ADDED: (millions of dollars)						
311/2 Food products	306	e	241	e	317	e
313 Beverages	15	e	25	e	42	e
314 Tobacco products	29	e	23	e	31	e
321 Textiles	23	e	17	e	21	e
322 Wearing apparel	3	e	4	e	5	e
323 Leather and fur products	5	e	4	e	5	e
324 Footwear	1	e	1	e	1	e
331 Wood and wood products	11	e	8	e	10	e
332 Furniture and fixtures	13	e	21	e	36	e
341 Paper and paper products	51	e	75	e	110	e
342 Printing and publishing	56	e	45	e	57	e
351 Industrial chemicals	302	e	363	e	1908	e
352 Other chemical products	63	e	39	e	167	e
353 Petroleum refineries	432	e	532	e	304	
354 Miscellaneous petroleum and coal products	25	e	46	e	119	e
355 Rubber products	3	e	4	e	8	e
356 Plastic products	61	e	32	e	148	e
361 Pottery, china and earthenware	10	e	14	e	25	e
362 Glass and glass products	12	e	16	e	23	e
369 Other non-metal mineral products	238	e	395	e	577	e
371 Iron and steel	175	e	241	e	344	e
372 Non-ferrous metals	8	e	12	e	17	e
381 Metal products	150	e	204	e	271	e
382 Non-electrical machinery	39	e	53	e	61	e
383 Electrical machinery	35	e	50	e	106	e
384 Transport equipment	11	e	18	e	32	e
385 Professional and scientific equipment	1	e	1	e	3	e
390 Other manufacturing industries	15	e	24	e	28	e

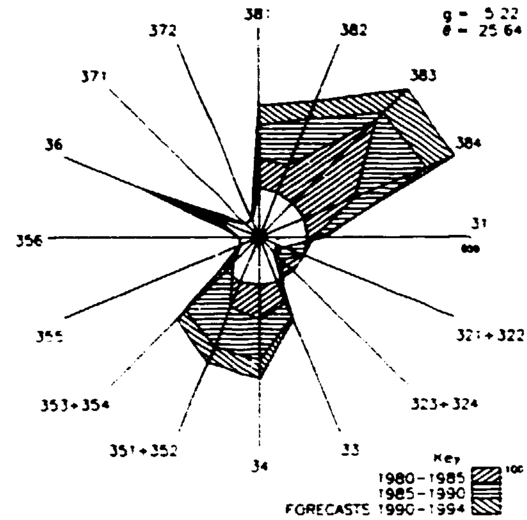
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



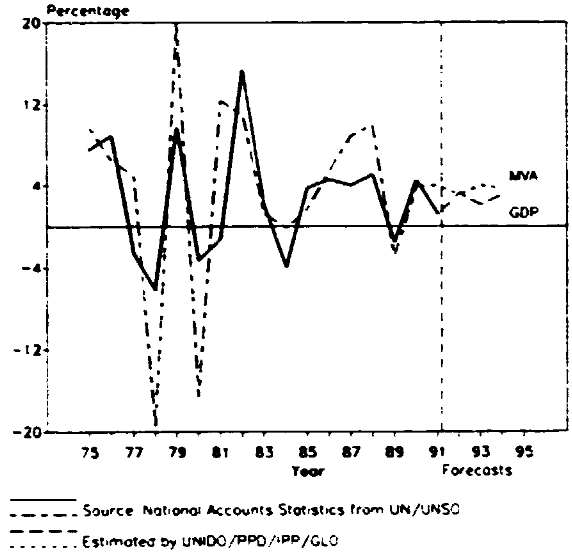




Industrial structural change
(Index of value added 1980=100)



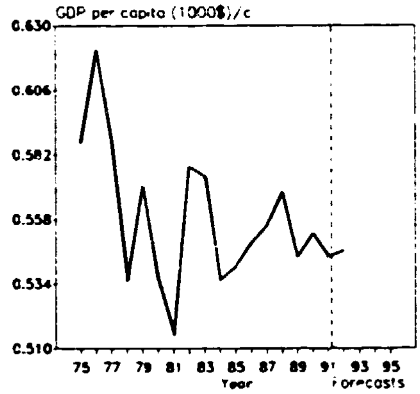
Annual growth rates of GDP and MVA
(Constant 1980 prices)



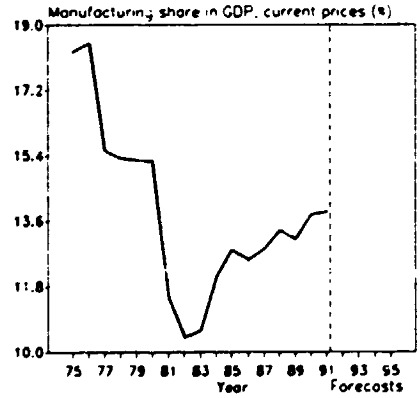
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	2970	3446	4050
Per capita (1980-dollars) /na.c	536	540	553
Manufacturing share (%) /na (current factor prices)	15.3	12.8	13.8
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	438	560	713
Industrial production index	100	94	115
Value added (millions of dollars)	258	268	639 /e
Gross output (millions of dollars)	1070	926	1475 /e
Employment (thousands)	32	30	26 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	76	71	57 /e
Wages and salaries including supplements (%)	10 /e	11 /e	12 /e
Gross operating surplus (%)	14 /e	18 /e	31 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	33812	22546	37211 /e
Value added / worker	8164	6528	16120 /e
Average wage (including supplements)	3508 /e	3282 /e	7075 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.47	5.39 /e	6.41 /e
as a percentage of average θ in 1970-1975	140	101 /e	120 /e
MVA growth rate / θ	-0.38	1.34	1.22
Degree of specialization	25.8	19.7	24.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	106	93 /e	232 /e
313 Beverages	11	13 /e	19 /e
314 Tobacco products	7	10 /e	6 /e
321 Textiles	33	26 /e	10 /e
322 Wearing apparel	10	7 /e	4 /e
323 Leather and fur products	5	1 /e	- /e
324 Footwear	2	1 /e	- /e
331 Wood and wood products	2	2 /e	5 /e
332 Furniture and fixtures	2	3 /e	6 /e
341 Paper and paper products	4	7 /e	19 /e
342 Printing and publishing	6	9 /e	26 /e
351 Industrial chemicals	16	22 /e	66 /e
352 Other chemical products	5	9 /e	26 /e
353 Petroleum refineries	18	8 /e	66 /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	19 /e	51 /e
371 Iron and steel	-	- /e	- /e
372 Non-ferrous metals	-	- /e	- /e
381 Metal products	10	16 /e	43 /e
382 Non-electrical machinery	3	5 /e	17 /e
383 Electrical machinery	1	4 /e	7 /e
384 Transport equipment	5	11 /e	35 /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.

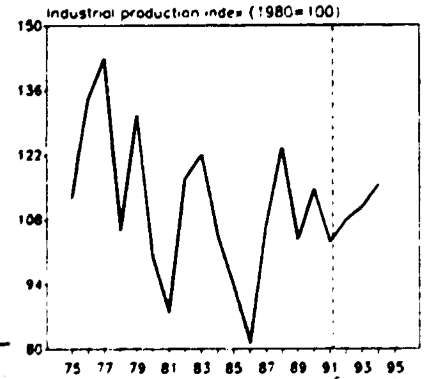
GDP per capita (1000$)/c

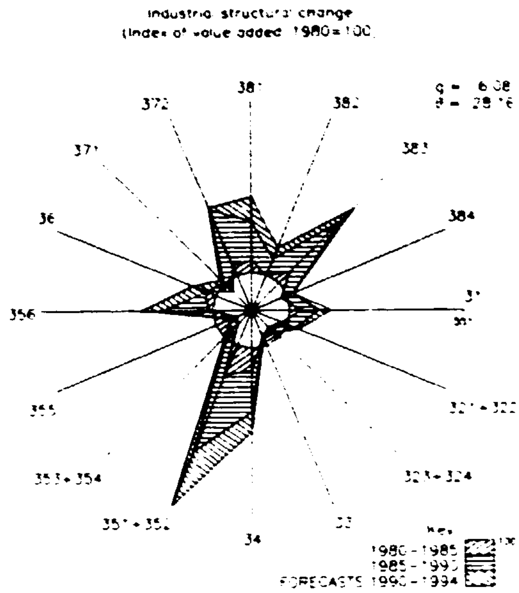


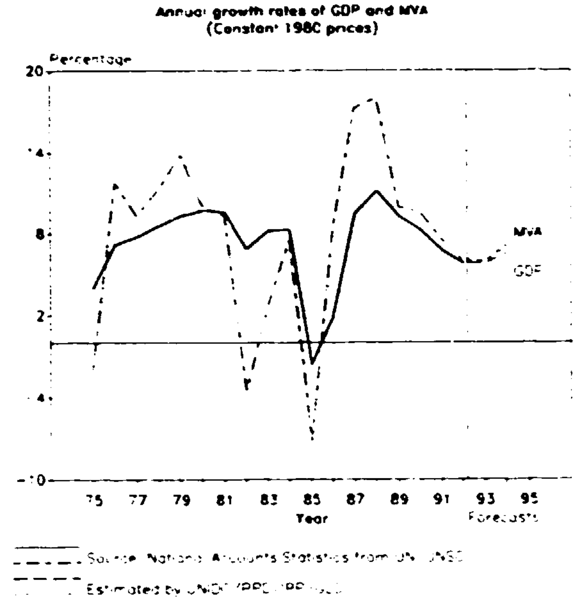
Manufacturing share in GDP, current prices (%)



Industrial production index (1980=100)

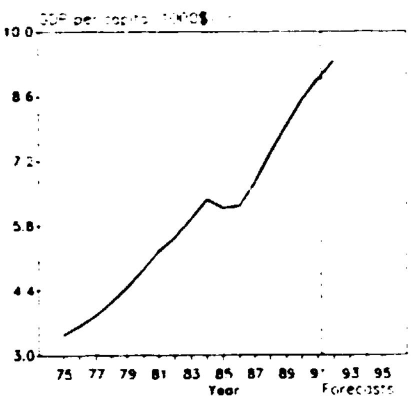


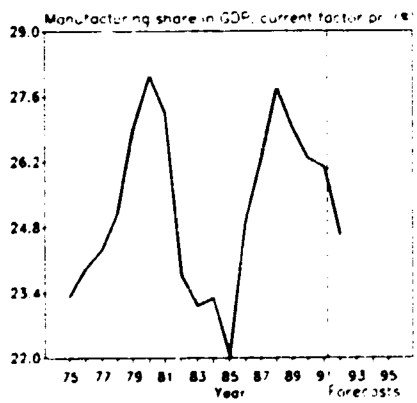


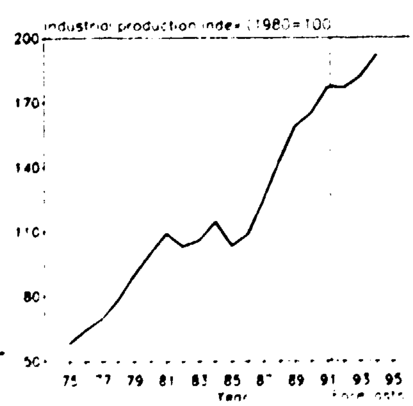


	1980	1985	1990
GDP: na.c millions of 1980-dollars	11779	15821	23179
Per capita (1980-dollars) na.c	4853	6182	8506
Manufacturing share (%) na current factor prices	28 0	22 0	26 3
MANUFACTURING:			
Value added na.c millions of 1980-dollars	3415	3589	6662
Industrial production index	100	103	165
Value added (millions of dollars)	4004	4868	11923
Gross output (millions of dollars)	15278	17570	39414
Employment (thousands)	285	252	350
-PROFITABILITY: in percent of gross output			
Intermediate input (%)	74	72	70
Wages and salaries including supplements (%)	8	11	10
Gross operating surplus (%)	18	17	21
-PRODUCTIVITY: dollars			
Gross output / worker	53196	69162	112015
Value added / worker	13942	19161	33885
Average wage (including supplements)	4170	7316	10790
-STRUCTURAL INDICES:			
Structural change θ 5-year average in degrees	5 07	7 55	3 73
as a percentage of average θ in 1970-1975	46	69	34
MVA growth rate / θ	3 14	0 20	3 48
Degree of specialization	21 5	23 4	29 4
-VALUE ADDED: millions of dollars			
311/2 Food products	121	130	322
313 Beverages	52	76	139
314 Tobacco products	25	35	54
321 Textiles	70	29	72
322 Wearing apparel	127	157	294
323 Leather and fur products	7	5	11
324 Footwear	9	6	9
331 Wood and wood products	34	43	55
332 Furniture and fixtures	40	60	89
341 Paper and paper products	45	82	189
342 Printing and publishing	128	232	515
351 Industrial chemicals	52	163	584
352 Other chemical products	143	244	600
353 Petroleum refineries	636 /e	362 e	843 /e
354 Miscellaneous petroleum and coal products	50 /e	35 e	74 /e
355 Rubber products	44	21	39
356 Plastic products	84	105	297
361 Pottery, china and earthenware	1 /e	- e	2 /e
362 Glass and glass products	10 /e	5 /e	31 e
369 Other non-metal mineral products	82	140	148
371 Iron and steel	62	49	97
372 Non-ferrous metals	9	14	41
381 Metal products	206	310	730
382 Non-electrical machinery	319	359	699
383 Electrical machinery	950	1527	4741
384 Transport equipment	500	470	890
385 Professional and scientific equipment	80	89	200
390 Other manufacturing industries	69	70	147

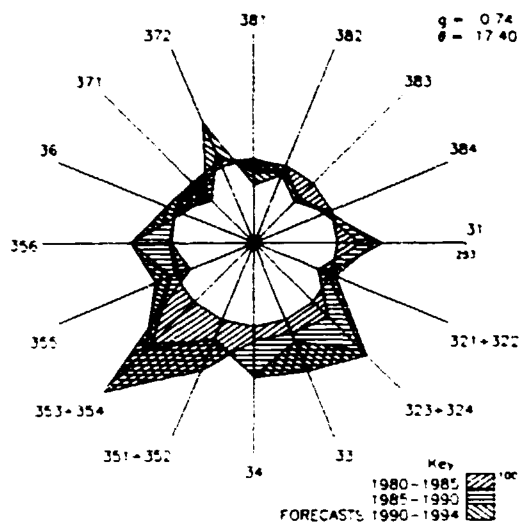
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



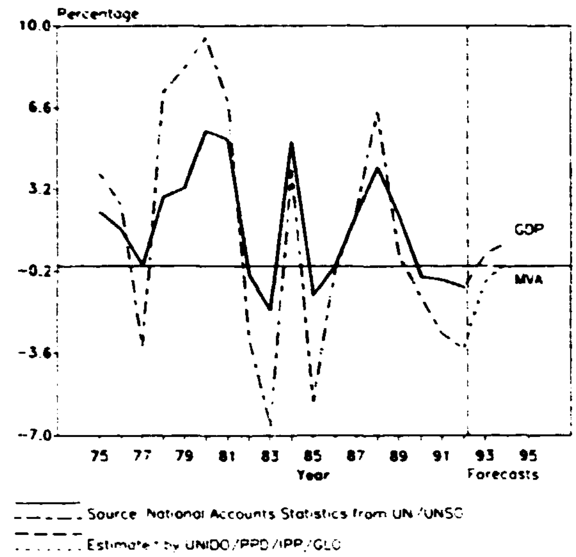




Industrial structural change
(Index of value added 1980=100)



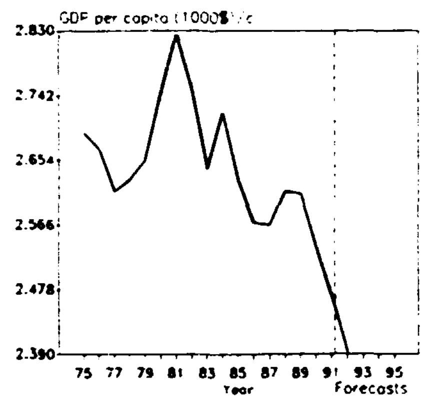
Annual growth rates of GDP and MVA
(Constant 1980 prices)



	1980	1985	1990
GDP: (na.c (millions of 1980-dollars)	77542	82915	89579
Per capita (1980-dollars) /na.c	2743	2626	2539
Manufacturing share (%) (na current factor prices)	22.5	22.4	24.7
MANUFACTURING:			
Value added (na.c millions of 1980-dollars)	16625	15765	16970
Industrial production index	100	100	105
Value added (millions of dollars)	17866	12584	22787
Gross output (millions of dollars)	53586 /e	36059	53685
Employment (thousands)	1392	1423	1461
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	67 /e	65	64
Wages and salaries including supplements (%)	16 /e	18 /e	18 /e
Gross operating surplus (%)	17 /e	17 /e	18 /e
-PRODUCTIVITY: dollars)			
Gross output / worker	38568 /e	25024	43590
Value added / worker	12835	8769	15597
Average wage (including supplements)	6118	4505 /e	7783 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.06 /e	6.23	7.74
as a percentage of average θ in 1970-1975	128 /e	196	243
MVA growth rate / θ	1.29	0.29	0.25
Degree of specialization	10.7	9.2	8.2
-VALUE ADDED: millions of dollars)			
311/2 Food products	1626	1277	2220
313 Beverages	458	418	1055
314 Tobacco products	111	108	83
321 Textiles	886	408	851
322 Wearing apparel	477	334	701
323 Leather and fur products	40	44	75
324 Footwear	152	113	316
331 Wood and wood products	213	190	469
332 Furniture and fixtures	219	138	307
341 Paper and paper products	591	471	1208
342 Printing and publishing	549	392	763
351 Industrial chemicals	1006	717	932
352 Other chemical products	639	1047	1255
353 Petroleum refineries	634	1038	1244
354 Miscellaneous petroleum and coal products	111	182	217
355 Rubber products	297	157	401
356 Plastic products	355	225	560
361 Pottery, china and earthenware	28	24	42
362 Glass and glass products	154	102	292
369 Other non-metal mineral products	754	481	794
371 Iron and steel	2135	986	2343
372 Non-ferrous metals	555	418	642
381 Metal products	1576	860	1697
382 Non-electrical machinery	1351	805	1432
383 Electrical machinery	1229	607	970
384 Transport equipment	125P	741	1311
385 Professional and scientific equipment	.9	54	160
390 Other manufacturing industries	415	246	448

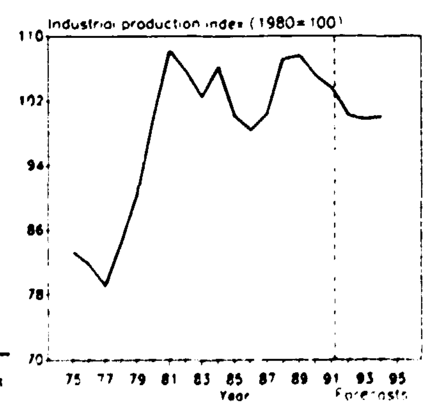
For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

GDP per capita (1000$)/c

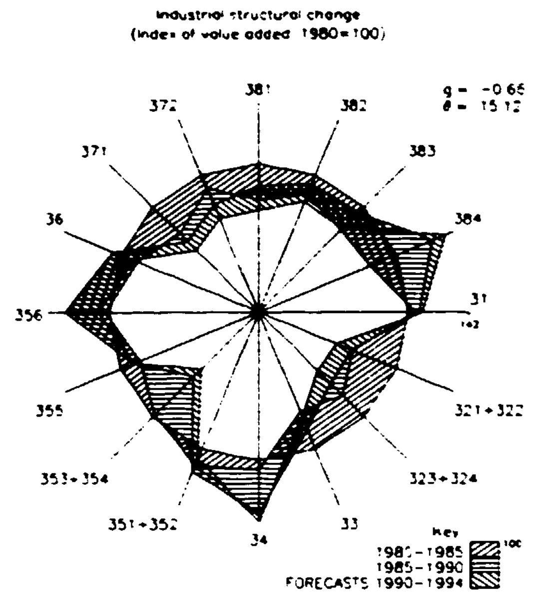


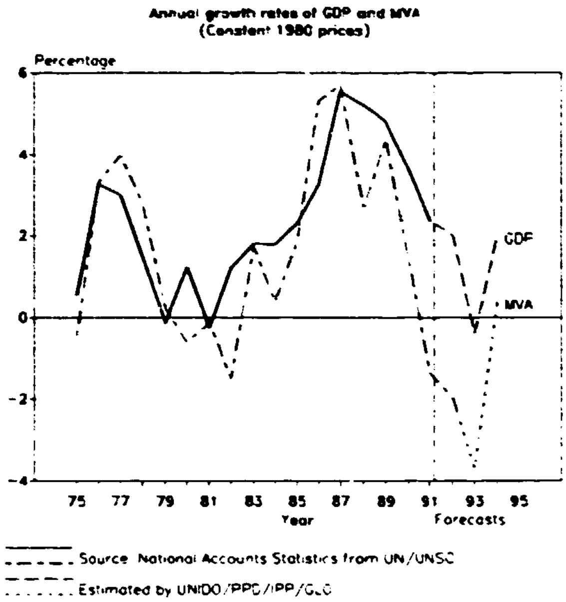
Manufacturing share in GDP current factor pr. (%)

Industrial production index (1980=100)



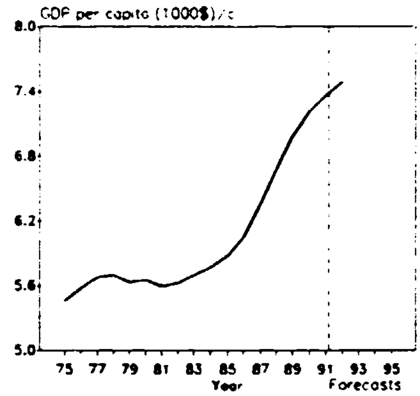
SPAIN

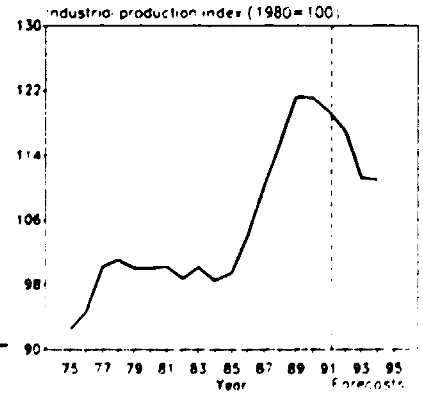




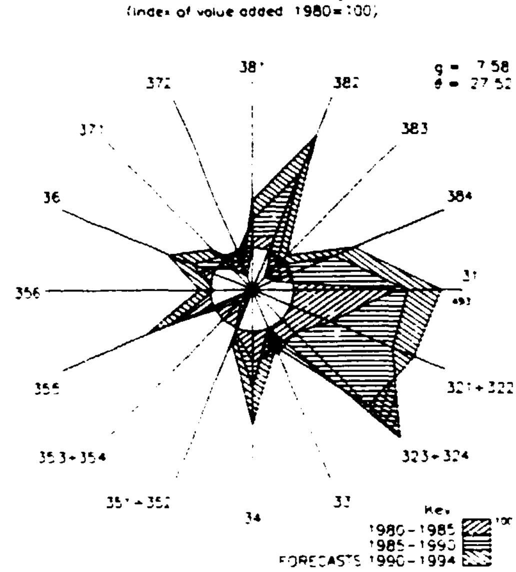
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	212115	227090	282754
Per capita (1980-dollars) /na.c	5650	5883	7216
Manufacturing share (%) /na (current factor prices)	26.7	25.4	25.4
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	59751	61143	74001
Industrial production index	100	99	121
Value added (millions of dollars)	51944	33140	87329
Gross output (millions of dollars)	149786	104581	259413
Employment (thousands)	2383	1792	1907
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	65	68	66
Wages and salaries including supplements (%)	20	17	18 /e
Gross operating surplus (%)	14	15	16 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	59041	53991	126977
Value added / worker	20475	17109	42746
Average wage (including supplements)	12852	9700	24115 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5.46	3.43	5.32
as a percentage of average θ in 1970-1975	95	60	93
MVA growth rate / θ	1.76	-0.70	0.40
Degree of specialization	8.4	8.5	10.1
-VALUE ADDED: (millions of dollars)			
311/2 Food products	5665	4193	10773
313 Beverages	1932	1576	3663
314 Tobacco products	649	471	911
321 Textiles	3289	1613	3314
322 Wearing apparel	1502	753	2242
323 Leather and fur products	375	269	614
324 Footwear	810	415	781
331 Wood and wood products	1258	707	2163
332 Furniture and fixtures	1252	617	1534
341 Paper and paper products	1278	947	2101
342 Printing and publishing	1506	1198	4403
351 Industrial chemicals	2006	1737	3427
352 Other chemical products	2506	1922	5609
353 Petroleum refineries	1409	969	1348
354 Miscellaneous petroleum and coal products	229	191	384
355 Rubber products	955	597	1490
356 Plastic products	1098	814	2452
361 Pottery, china and earthenware	346	174	432
362 Glass and glass products	640	442	1126
369 Other non-metal mineral products	2522	1617	4797
371 Iron and steel	3255	1756	3762
372 Non-ferrous metals	948	616	1275
381 Metal products	3720	2044	5437
382 Non-electrical machinery	3595	2225	5745
383 Electrical machinery	3669	2064	5378
384 Transport equipment	4743	2776	10320
385 Professional and scientific equipment	205	122	375
390 Other manufacturing industries	573	316	870

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

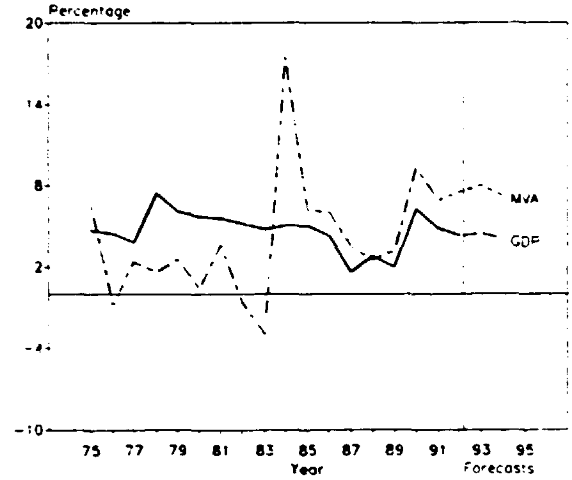




Industrial structural change (index of value added 1980=100)



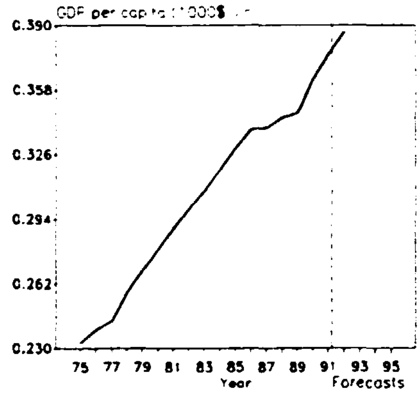
Annual growth rates of GDP and MVA (Constant 1980 prices)



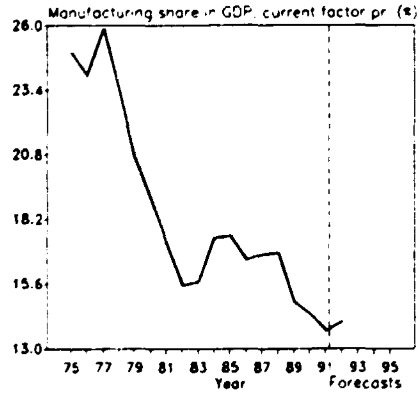
	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	4133	5303	6257
Per capita (1980-dollars) (na.c)	279	329	363
Manufacturing share (%) (na) (current factor prices)	19.0	17.5	14.4
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	751	936	1188
Industrial production index	100	109	138
Value added (millions of dollars)	307	628 /e	929 /e
Gross output (millions of dollars)	1129	1815	2218 /e
Employment (thousands)	163	211	251 /e
-PROFITABILITY: in percent of gross output			
Intermediate input (%)	73	65 /e	58 /e
Wages and salaries including supplements (%)	7	6	7 /e
Gross operating surplus (%)	20	28 /e	35 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	6934	8599	8830 /e
Value added / worker	1887	2973 /e	3703 /e
Average wage (including supplements)	485	529	642 /e
-STRUCTURAL INDICES:			
Structural change θ 5-year average in degrees	8.29 /e	12.14 /e	8.65 /e
as a percentage of average θ in 1970-1975	123 /e	181 /e	129 /e
MVA growth rate / θ	1.31	1.92	0.46
Degree of specialization	20.4	29.9	25.9
-VALUE ADDED: millions of dollars			
311/2 Food products	28	180 /e	250 /e
313 Beverages	6	34 /e	75 /e
314 Tobacco products	63	151 /e	150 /e
321 Textiles	27	49 /e	80 /e
322 Wearing apparel	12	33 /e	101 /e
323 Leather and fur products	1	2 /e	1 /e
324 Footwear	2	4 /e	22 /e
331 Wood and wood products	5	8 /e	7 /e
332 Furniture and fixtures	1	2 /e	1 /e
341 Paper and paper products	8	12 /e	23 /e
342 Printing and publishing	4	8 /e	11 /e
351 Industrial chemicals	6	4 /e	3 /e
352 Other chemical products	12	18 /e	25 /e
353 Petroleum refineries	55	23 /e	11 /e
354 Miscellaneous petroleum and coal products	-	- /e	- /e
355 Rubber products	14	30 /e	39 /e
356 Plastic products	4	4 /e	5 /e
361 Pottery, china and earthenware	4	6 /e	17 /e
362 Glass and glass products	2	2 /e	4 /e
369 Other non-metal mineral products	21	28 /e	34 /e
371 Iron and steel	3	2 /e	5 /e
372 Non-ferrous metals	2	1 /e	2 /e
381 Metal products	7	9 /e	14 /e
382 Non-electrical machinery	4	6 /e	15 /e
383 Electrical machinery	10	5 /e	11 /e
384 Transport equipment	4	2 /e	10 /e
385 Professional and scientific equipment	1	- /e	- /e
390 Other manufacturing industries	1	5 /e	14 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

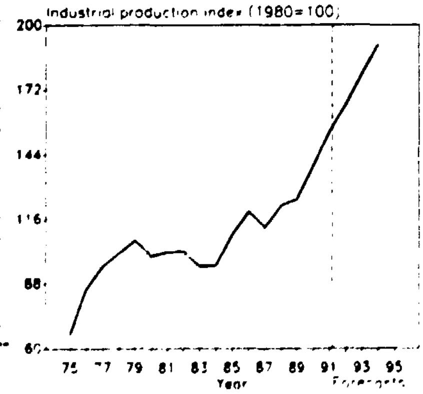
GDP per capita (1000$)



Manufacturing share in GDP, current factor pr. (%)

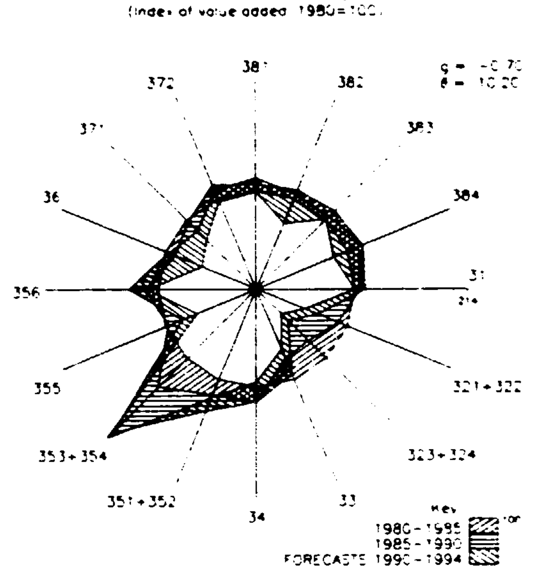


Industrial production index (1980=100)

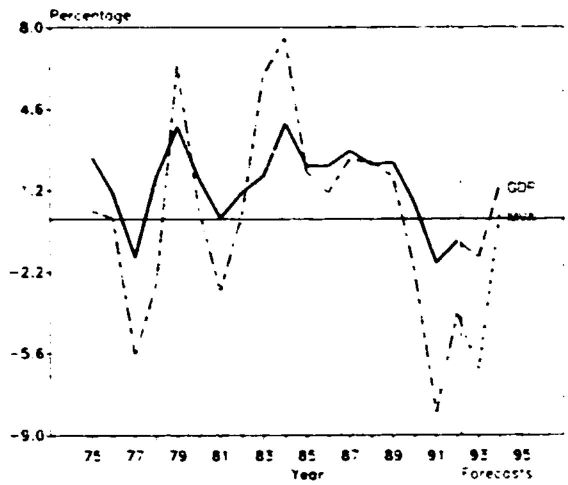


SWEDEN

Industrial structural change (Index of value added, 1980=100)



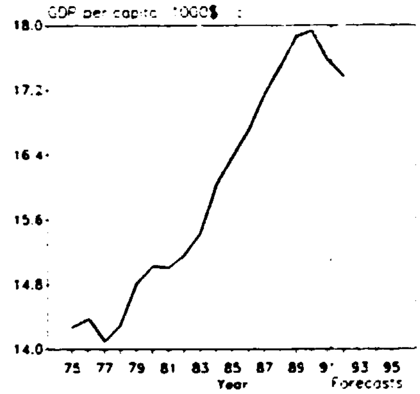
Annual growth rates of GDP and MVA (Constant 1980 prices)



Source: National Accounts Statistics from UN/UNSO

Estimated by UNIDO/PPD/IPP/GLO

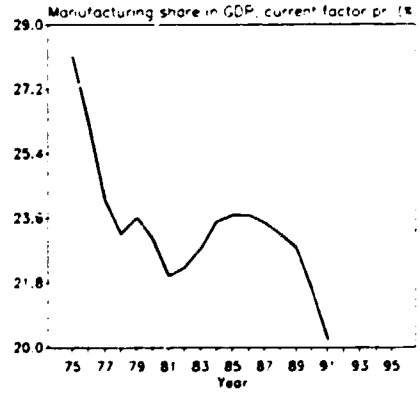
GDP per capita (1000$)



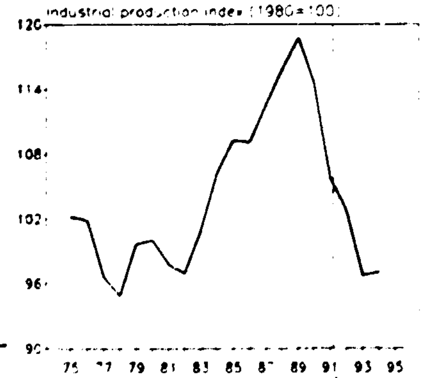
	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	124883	136691	151406
Per capita (1980-dollars) (na.c)	15026	16368	17928
Manufacturing share (%) (na) (current factor prices)	23.0	23.7	21.6
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	26351	29786	31454
Industrial production index	100	109	115
Value added (millions of dollars)	30905	24486	51429
Gross output (millions of dollars)	73194	59391	115465
Employment (thousands)	853	769	719
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	58	59	55
Wages and salaries including supplements (%)	18	15	15
Gross operating surplus (%)	24	26	29
-PRODUCTIVITY: (dollars)			
Gross output / worker	85747	77211	160524
Value added / worker	36206	31833	71499
Average wage (including supplements)	15835	11676	24885
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.84	4.04	3.48
as a percentage of average θ in 1970-1975	74	78	67
MVA growth rate / θ	-0.45	0.37	0.20
Degree of specialization	15.4	16.1	15.5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	2719	2107	4249
313 Beverages	338	250	743
314 Tobacco products	104	108	257
321 Textiles	534	379	613
322 Wearing apparel	274	157	199
323 Leather and fur products	54	40	52
324 Footwear	61	24	27
331 Wood and wood products	2102	1154	3046
332 Furniture and fixtures	452	285	551
341 Paper and paper products	2596	2230	4524
342 Printing and publishing	1842	1517	3158
351 Industrial chemicals	966	841	1983
352 Other chemical products	1246	1090	2546
353 Petroleum refineries	359	396	1325
354 Miscellaneous petroleum and coal products	137	122	218
355 Rubber products	314	225	387
356 Plastic products	402	334	786
361 Pottery, china and earthenware	87	71	123
362 Glass and glass products	175	124	294
369 Other non-metal mineral products	801	510	1129
371 Iron and steel	1650	1185	2097
372 Non-ferrous metals	390	331	640
381 Metal products	2598	2048	4448
382 Non-electrical machinery	3936	3135	6225
383 Electrical machinery	2570	2132	4023
384 Transport equipment	3652	3153	6457
385 Professional and scientific equipment	371	400	1166
390 Other manufacturing industries	154	87	157

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

Manufacturing share in GDP, current factor pr. (%)

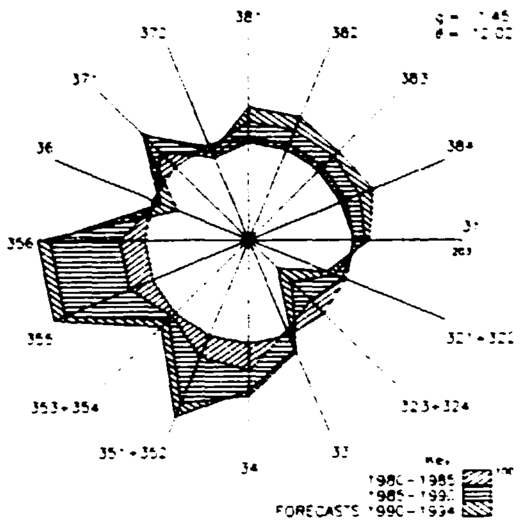


Industrial production index (1980=100)

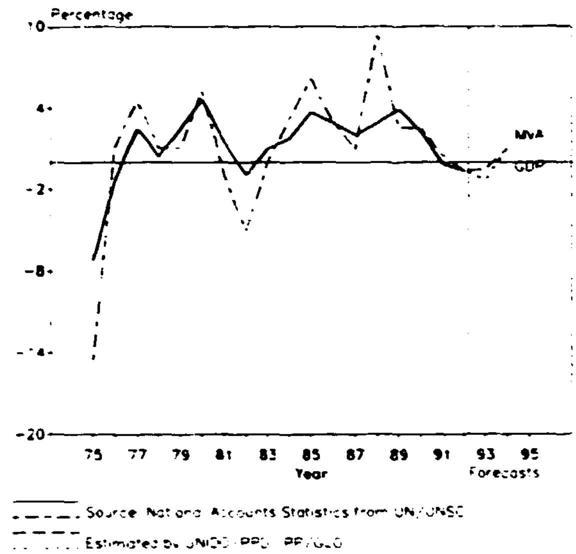


SWITZERLAND

Industrial structural change
(index of value added: 1980=100)



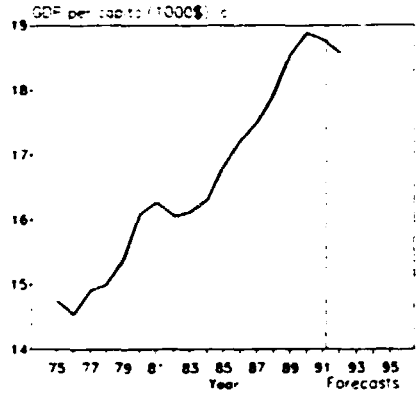
Annual growth rates of GDP and MVA
(Constant 1980 prices)



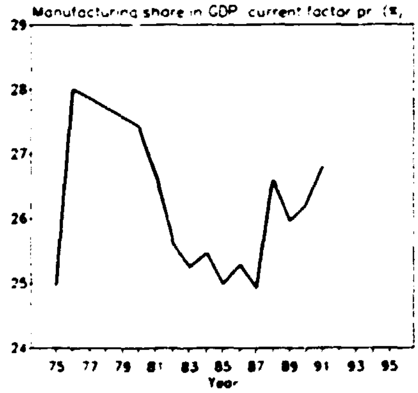
	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	101629	108881	124863
Per capita (1980-dollars) (na.c)	16081	16826	18873
Manufacturing share (%) (na) (current factor prices)	27.4	25.0	25.2 e
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	23371	29222	34896
Industrial production index	100	99	111
Value added (millions of dollars)	27450	23504	58051
Gross output (millions of dollars)			
Employment (thousands)	686	556	677
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)			
Wages and salaries including supplements (%)			
Gross operating surplus (%)			
-PRODUCTIVITY: (dollars)			
Gross output / worker			
Value added / worker	40025	35808	85691
Average wage (including supplements)			
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.25 e	2.64 e	2.27 e
as a percentage of average θ in 1970-1975	61 e	49 e	42 e
MVA growth rate / θ	1.13	0.05	1.53
Degree of specialization	11.6	11.6	12.5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	2905	2571 e	5874 e
313 Beverages	499	464 e	1130 e
314 Tobacco products	292	151 e	293 e
321 Textiles	972	878	1722
322 Wearing apparel	864	633	1140
323 Leather and fur products	124	61 e	95 e
324 Footwear	324	255	372
331 Wood and wood products	1079	873 e	2245 e
332 Furniture and fixtures	707	572 e	1472 e
341 Paper and paper products	624	558	1405
342 Printing and publishing	1471	1703	4222
351 Industrial chemicals	1530	1627 e	4257 e
352 Other chemical products	1332	1363 e	4405 e
353 Petroleum refineries	585	522 e	1138 e
354 Miscellaneous petroleum and coal products	95	85 e	186 e
355 Rubber products	226	240 e	768 e
356 Plastic products	625	665 e	2131 e
361 Pottery, china and earthenware	137	148 e	308 e
362 Glass and glass products	187	203 e	422 e
369 Other non-metal mineral products	651	433 e	861 e
371 Iron and steel	455	468 e	1163 e
372 Non-ferrous metals	584	428 e	1007 e
381 Metal products	1922	1545 e	3909 e
382 Non-electrical machinery	3777	3037 e	7683 e
383 Electrical machinery	2360	2300 e	5819 e
384 Transport equipment	508	409 e	1034 e
385 Professional and scientific equipment	1977	1217 e	2787 e
390 Other manufacturing industries	118	35	123

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

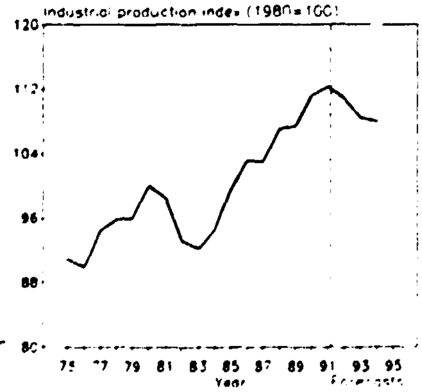
GDP per capita (1000$) (c)

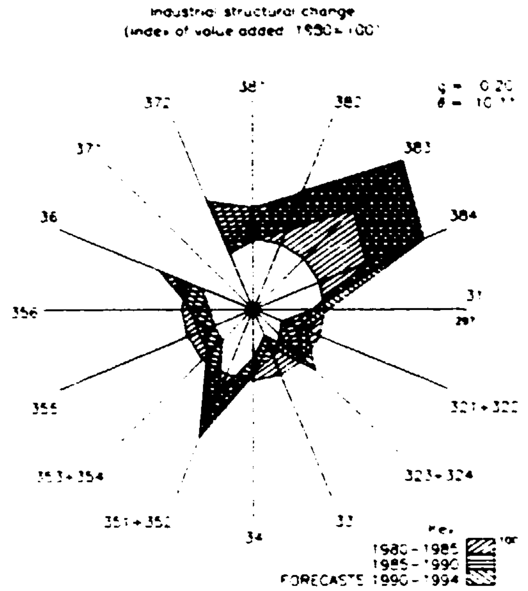


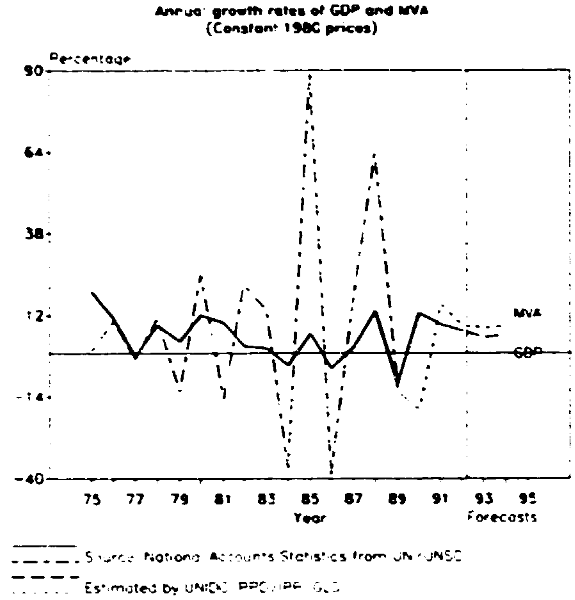
Manufacturing share in GDP (current factor pr.) (%)

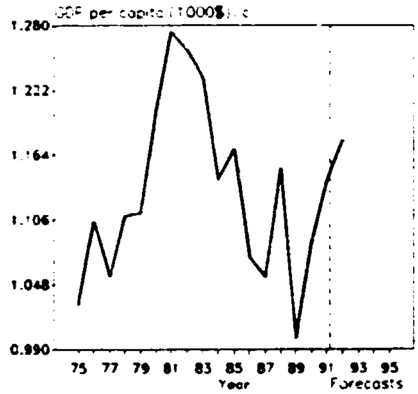


Industrial production index (1980=100)



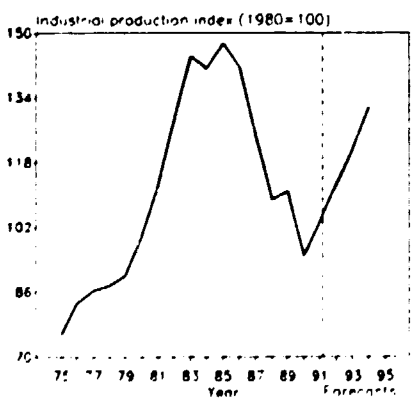




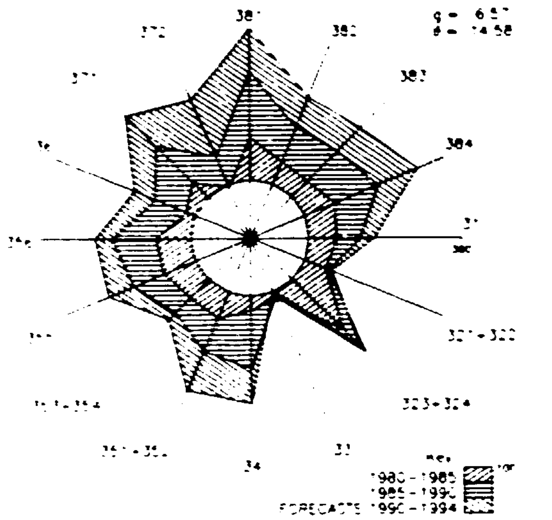


	1980	1985	1990
GDP: (na.c millions of 1980-dollars)	10593	12231	13598
Per capita (1980-dollars) (na.c)	1204	1169	1085
Manufacturing share (%) (na current factor prices)	3 6	7 7	
MANUFACTURING:			
Value added (na.c millions of 1980-dollars)	377	529	449
Industrial production index	100	147	95
Value added (millions of dollars)	1256	1435	1833
Gross output (millions of dollars)	3362	5914	9058
Employment (thousands)	195	182 /e	125
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	63	76	80
Wages and salaries including supplements (%)	10 /e	8 /e	5
Gross operating surplus (%)	27 /e	16 /e	15
-PRODUCTIVITY: (dollars)			
Gross output / worker	17278	32511 /e	72252
Value added / worker	6452	7892 /e	14617
Average wage (including supplements)	1788 /e	2738 /e	3843
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	6 56	12 60	8 30
as a percentage of average θ in 1970-1975	142	273	180
MVA growth rate / θ	1 17	-0 17	-0 24
Degree of specialization	20 0	14 7	19 1
-VALUE ADDED: (millions of dollars)			
311/2 Food products	214	235	325
313 Beverages	37	42	58
314 Tobacco products	146	163	225
321 Textiles	273	154	369
322 Wearing apparel	14	9	21
323 Leather and fur products	26	19	45
324 Footwear	43	28	67
331 Wood and wood products	29	27	21
332 Furniture and fixtures	74	69	55
341 Paper and paper products	6	8	8
342 Printing and publishing	14	16	18
351 Industrial chemicals	3	7	7
352 Other chemical products	31	73	75
353 Petroleum refineries	100	112	115
354 Miscellaneous petroleum and coal products	4	4	4
355 Rubber products	15	16	16
356 Plastic products	13	14	14
361 Pottery, china and earthenware	7	13	10
362 Glass and glass products	13	24	18
369 Other non-metal mineral products	72	135	103
371 Iron and steel	-	-	-
372 Non-ferrous metals	13	28	20
381 Metal products	53	100	97
382 Non-electrical machinery	18	42	41
383 Electrical machinery	16	62	60
384 Transport equipment	3	11	11
385 Professional and scientific equipment	-	-	-
390 Other manufacturing industries	19	23	26

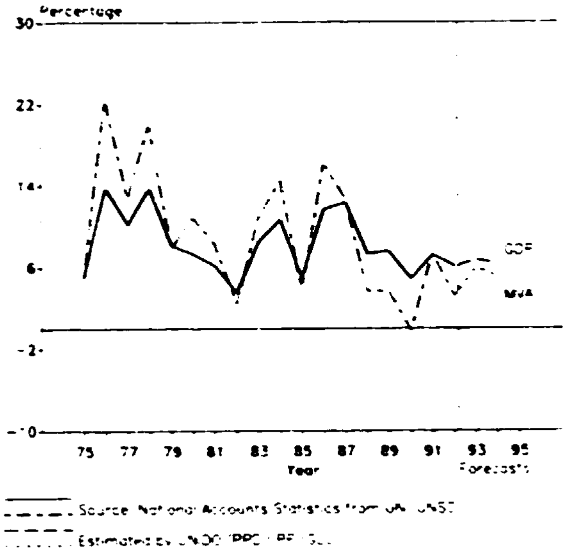
For sources, footnotes and comments see Technical notes at the beginning of this Annex



Industrial structural change
Index of value added (1980=100)

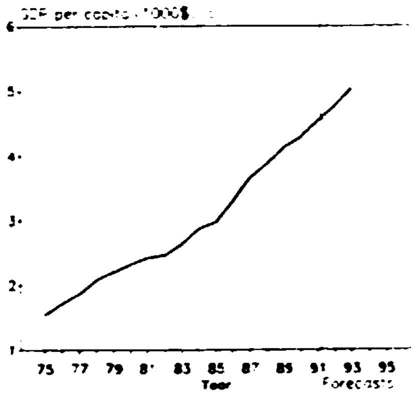


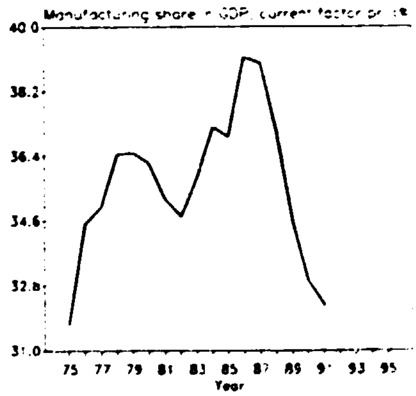
Annual growth rates of GDP and MVA
(Constant 1980 prices)

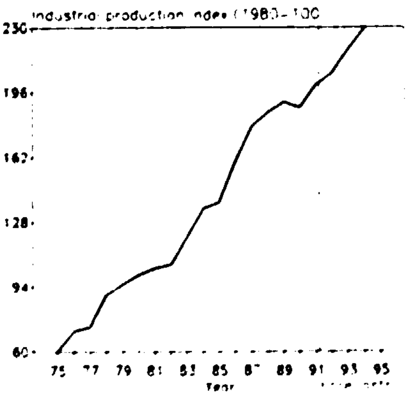


	1980	1985	1990
GDP (real, millions of 1980-dollars)	41384	57275	36947
Per capita (1980-dollars) (real)	2324	2974	4277
Manufacturing share (%) (real, current factor prices)	36.2	35.9	32.9
MANUFACTURING:			
Value added (real, millions of 1980-dollars)	14907	21734	30484
Industrial production index	100	138	188
Value added (millions of dollars)	14907	23557	55424
Gross output (millions of dollars)	55343	69206	143587
Employment (thousands)	1997	2459	2260
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	73	66	61
Wages and salaries including supplements (%)	10	14	16
Gross operating surplus (%)	17	20	23
-PRODUCTIVITY: (dollars)			
Gross output / worker	27719	28144	63575
Value added / worker	7466	9580	24523
Average wage (including supplements)	2678	3862	10168
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	4.59	2.90	3.97
as a percentage of average θ in 1970-1975	69	44	60
MVA growth rate / θ	3.16	2.60	1.92
Degree of specialization	11.6	11.5	11.3
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1454	2444	5239
313 Beverages	204	312	568
314 Tobacco products	170	223	408
321 Textiles	1885	2687	4680
322 Wearing apparel	337	720	1139
323 Leather and fur products	176	431	389
324 Footwear	46	119	236
331 Wood and wood products	316	394	547
332 Furniture and fixtures	119	146	325
341 Paper and paper products	424	647	1950
342 Printing and publishing	263	294	360
351 Industrial chemicals	718	1121	2435
352 Other chemical products	502	890	2245
353 Petroleum refineries	834	1340	2768
354 Miscellaneous petroleum and coal products	19	23	38
355 Rubber products	198	349	776
356 Plastic products	870	1535	3736
361 Pottery, china and earthenware	76	156	576
362 Glass and glass products	64	73	291
369 Other non-metal mineral products	542	656	1290
371 Iron and steel	828	1242	3392
372 Non-ferrous metals	139	146	385
381 Metal products	584	1115	3052
382 Non-electrical machinery	524	827	1973
383 Electrical machinery	1890	2882	7247
384 Transport equipment	686	1182	2959
385 Professional and scientific equipment	254	388	1144
390 Other manufacturing industries	774	1216	4176

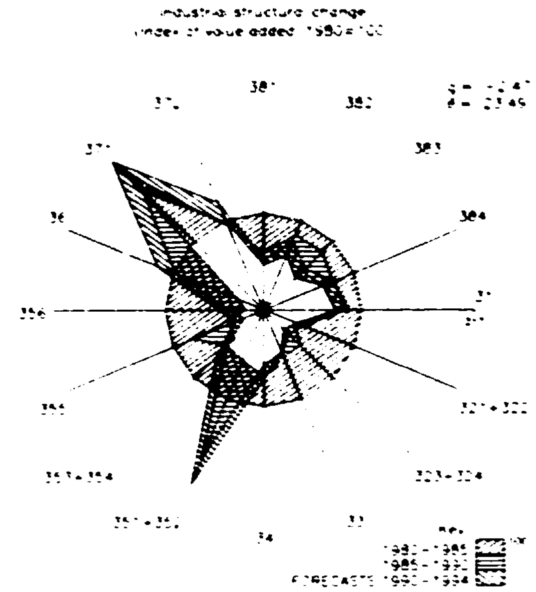
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



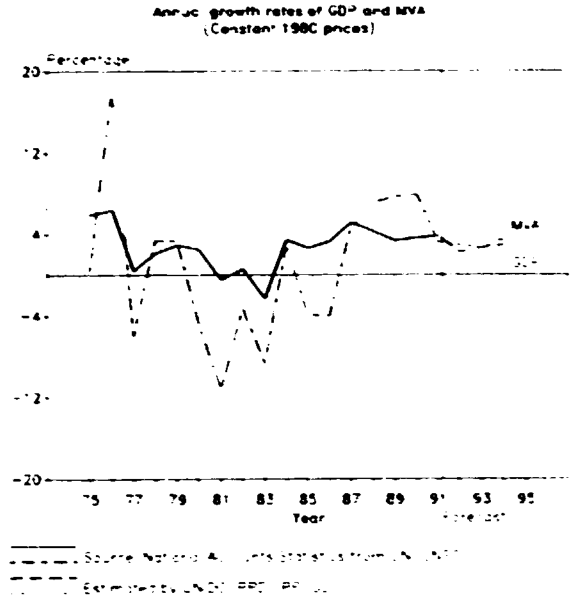




Industrial structure change
(index of value added 1980=100)

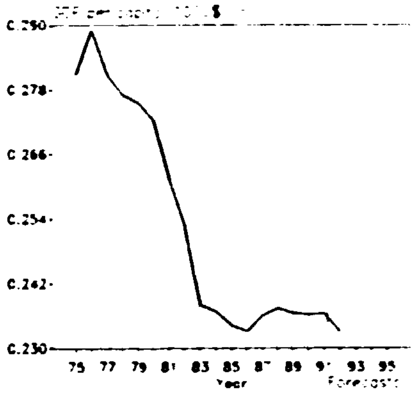


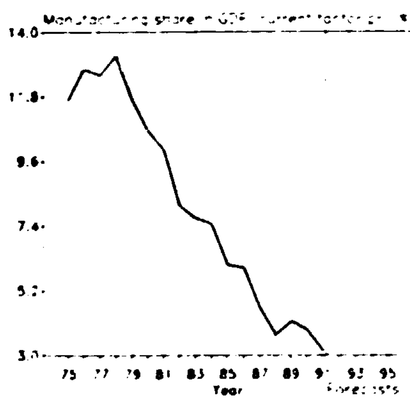
Annual growth rates of GDP and MVA
(Constant 1980 prices)

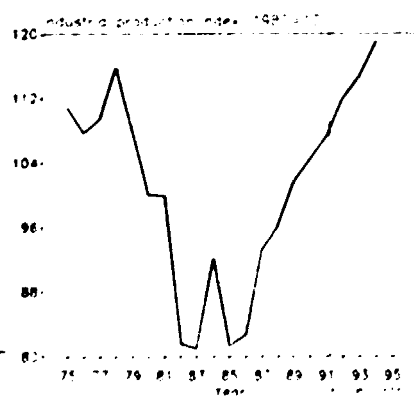


	1980	1985	1990
GDP, total millions of 1980-dollars	5138	5327	6450
Per capita (1980-dollars) total	272	234	236
Manufacturing share (%) total current factor prices	10.7	6.1	3.9
MANUFACTURING:			
Value added total millions of 1980-dollars	500	387	432
Industrial production index	100	81	104
Value added millions of dollars	361	278	87 e
Gross output millions of dollars	1266	1145	396 e
Employment thousands	101	94	123 e
-PROFITABILITY in percent of gross output			
Intermediate input (%)	71	76	78 e
Wages and salaries including supplements (%)	9	9	6 e
Gross operating surplus (%)	19	16	16 e
-PRODUCTIVITY: dollars			
Gross output / worker	12457	12141	3229 e
Value added / worker	3555	2952	707 e
Average wage (including supplements)	1174	1042	203 e
-STRUCTURAL INDICES:			
Structural change θ 5-year average in degrees	5.70 e	9.32	11.34 e
as a percentage of average θ in 1970-1975	83 e	143	172 e
MVA growth rate θ	1.38	-1.00	3.31
Degree of specialization	17.0	15.7	16.9
-VALUE ADDED: millions of dollars			
311/2 Food products	58	58	11 e
313 Beverages	14	21	5 e
314 Tobacco products	12	16	9 e
321 Textiles	35	43	15 e
322 Wearing apparel	10	4	1 e
323 Leather and fur products	7	4	1 e
324 Footwear	8	5	1 e
331 Wood and wood products	7	6	2 e
332 Furniture and fixtures	5	3	1 e
341 Paper and paper products	8	7	3 e
342 Printing and publishing	14	12	2 e
351 Industrial chemicals	11	9	12 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	1 e
356 Plastic products	8	2	1 e
361 Pottery, china and earthenware	-	-	- e
362 Glass and glass products	-	-	- e
369 Other non-metal mineral products	11	4	4 e
371 Iron and steel	2 e	6 e	2 e
372 Non-ferrous metals	4 e	4 e	1 e
381 Metal products	20	15	4 e
382 Non-electrical machinery	3	4	1 e
383 Electrical machinery	6	6	1 e
384 Transport equipment	19	19	5 e
385 Professional and scientific equipment	-	-	- e
390 Other manufacturing industries	2	2	- e

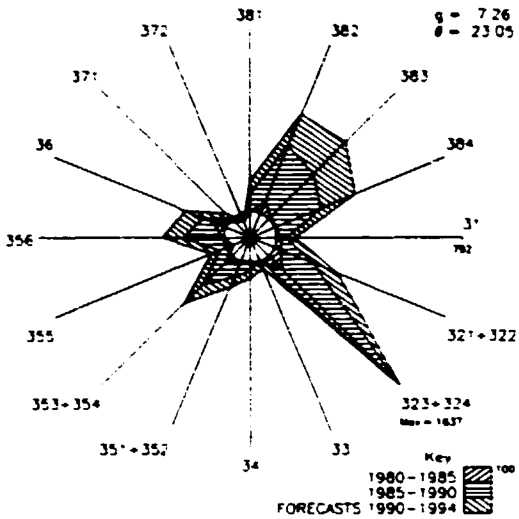
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



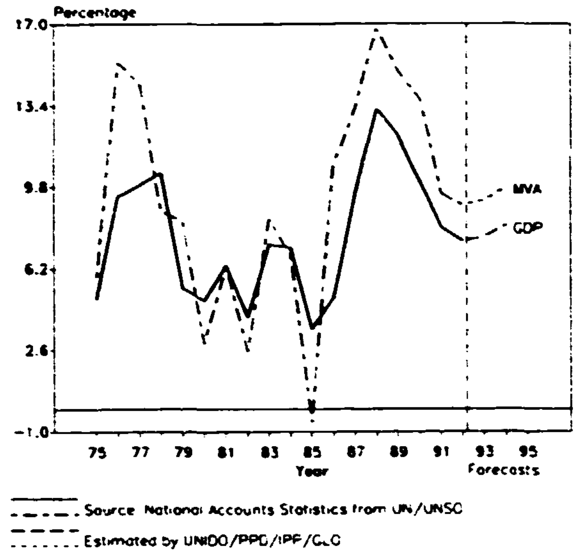




Industrial structural change
(Index of value added 1980=100)



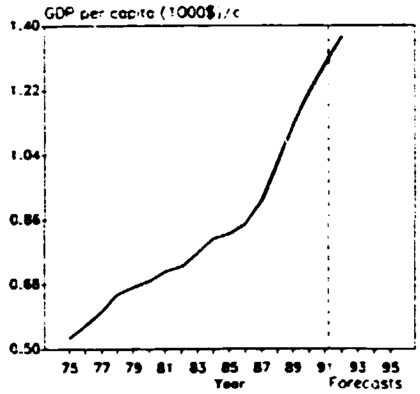
Annual growth rates of GDP and MVA
(Constant 1980 prices)



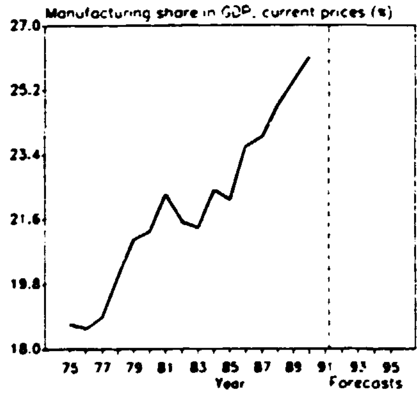
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	32160	42323	67828
Per capita (1980-dollars) /na.c	688	820	1216
Manufacturing share (%) /na (current factor prices)	21 3	22.1	26.1
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	6834	8567	16411
Industrial production index	100	117	211
Value added (millions of dollars)	9028 /e	10078	22670
Gross output (millions of dollars)	26353 /e	29388	62726
Employment (thousands)	1591 /e	1860 /e	2520 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	66 /e	66	64
Wages and salaries including supplements (%)	7 /e	9	9 /e
Gross operating surplus (%)	27 /e	25	27 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	16565 /e	15799 /e	24879 /e
Value added / worker	5675 /e	5418 /e	9990 /e
Average wage (including supplements)	1235 /e	1411 /e	2286 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	5 25 /e	3.26 /e	6.72 /e
as a percentage of average θ in 1970-1975	84 /e	52 /e	108 /e
MVA growth rate / θ	1 62	0 96	1.64
Degree of specialization	15 8	16.8	14 5
-VALUE ADDED: (millions of dollars)			
311/2 Food products	2039 /e	2274	3033
313 Beverages	682 /e	786	1671
314 Tobacco products	375 /e	470	728
321 Textiles	1118 /e	1044	2642
322 Wearing apparel	591 /e	1025	2882
323 Leather and fur products	38 /e	85	889 /e
324 Footwear	47 /e	54	276 /e
331 Wood and wood products	244 /e	180	98
332 Furniture and fixtures	132 /e	173	339
341 Paper and paper products	213 /e	120	207 /e
342 Printing and publishing	110 /e	161	310 /e
351 Industrial chemicals	94 /e	63	122
352 Other chemical products	245 /e	238	567
353 Petroleum refineries	537 /e	683	1791
354 Miscellaneous petroleum and coal products	27 /e	21	23
355 Rubber products	221 /e	147	352
356 Plastic products	102 /e	103	327
361 Pottery, china and earthenware	35 /e	48	78
362 Glass and glass products	64 /e	54	141
369 Other non-metal mineral products	267 /e	424	678
371 Iron and steel	316 /e	236	412 /e
372 Non-ferrous metals	115 /e	74	97 /e
381 Metal products	226 /e	208	481
382 Non-electrical machinery	168 /e	243	809
383 Electrical machinery	340 /e	355	1473
384 Transport equipment	338 /e	337	1245
385 Professional and scientific equipment	26 /e	56	122 /e
390 Other manufacturing industries	314 /e	414	877

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

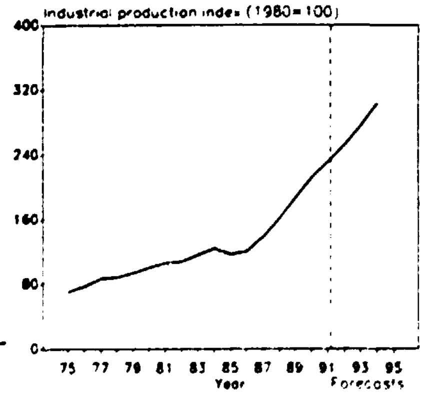
GDP per capita (1000$)/c



Manufacturing share in GDP, current prices (%)



Industrial production index (1980=100)



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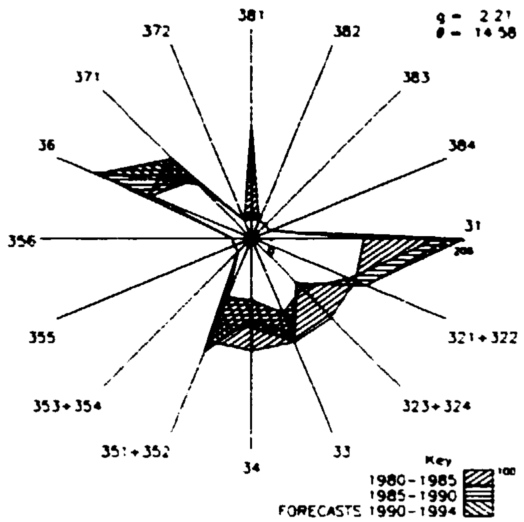
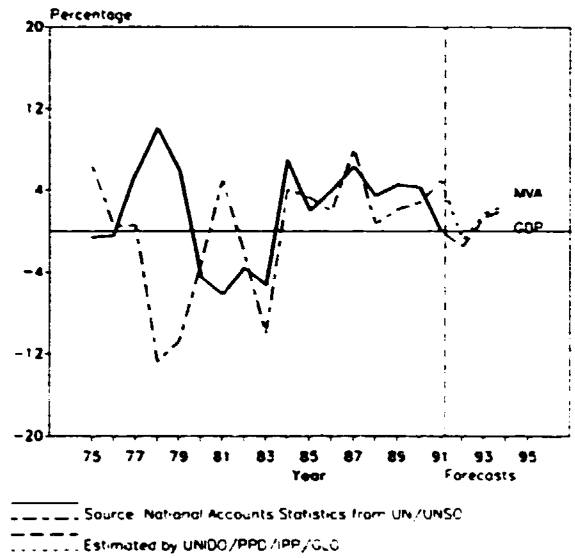
Industrial structural change
(Index of value added 1980=100)



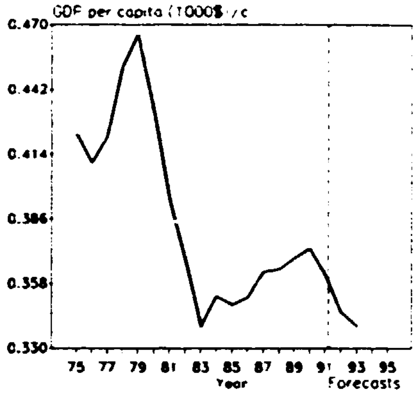
Annual growth rates of GDP and MVA
(Constant 1980 prices)



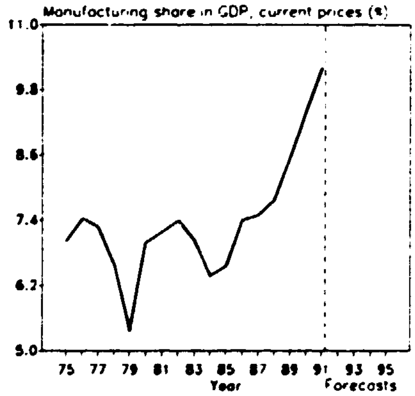
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	1131	1056	1317
Per capita (1980-dollars) /na.c	432	349	373
Manufacturing share (%) /na (current factor prices)	7.0	6.6	9.4
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	79	78	91
Industrial production index	100	92	114
Value added (millions of dollars)	52 /e	43 /e	102 /e
Gross output (millions of dollars)	155 /e	104	254
Employment (thousands)	5 /e	5 /e	6 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61 /e	71 /e	79 /e
Wages and salaries including supplements (%)	14 /e	12 /e	13 /e
Gross operating surplus (%)	25 /e	18 /e	8 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	28454 /e	23960 /e	53412 /e
Value added / worker	9532 /e	8800 /e	19640 /e
Average wage (including supplements)	3447 /e	2559 /e	5207 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	8.95 /e	27.77 /e	4.32 /e
as a percentage of average θ in 1970-1975	71 /e	222 /e	34 /e
MVA growth rate / θ	1.13	0.19	1.05
Degree of specialization	23.7	32.5	33.3
-VALUE ADDED: (millions of dollars)			
311/2 Food products	4	11 /e	11 /e
313 Beverages	16	15 /e	46 /e
314 Tobacco products			
321 Textiles	8 /e	5 /e	12 /e
322 Wearing apparel	-	- /e	- /e
323 Leather and fur products	- /e	- /e	- /e
324 Footwear	6	2 /e	4 /e
331 Wood and wood products	1	- /e	1 /e
332 Furniture and fixtures	-	- /e	1 /e
341 Paper and paper products	- /e	- /e	- /e
342 Printing and publishing	3	1 /e	3 /e
351 Industrial chemicals	3	1 /e	4 /e
352 Other chemical products	1 /e	- /e	1 /e
353 Petroleum refineries			
354 Miscellaneous petroleum and coal products			
355 Rubber products			
356 Plastic products			
361 Pottery, china and earthenware		3w	9w
362 Glass and glass products	1 /e	2 /e	7 /e
369 Other non-metal mineral products	6	w	w
371 Iron and steel	2	1v	3v
372 Non-ferrous metals		v	v
381 Metal products	1	u	u
382 Non-electrical machinery		u	u
383 Electrical machinery		u	u
384 Transport equipment		u	u
385 Professional and scientific equipment		u	u
390 Other manufacturing industries	-	- /e	-

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

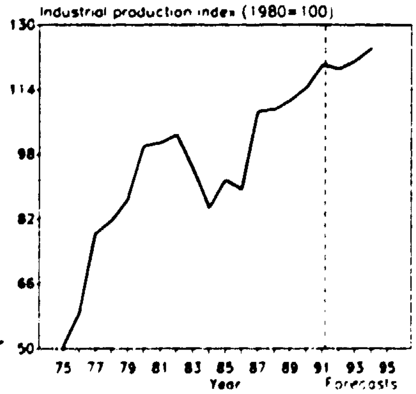
GDP per capita (1000$) /c



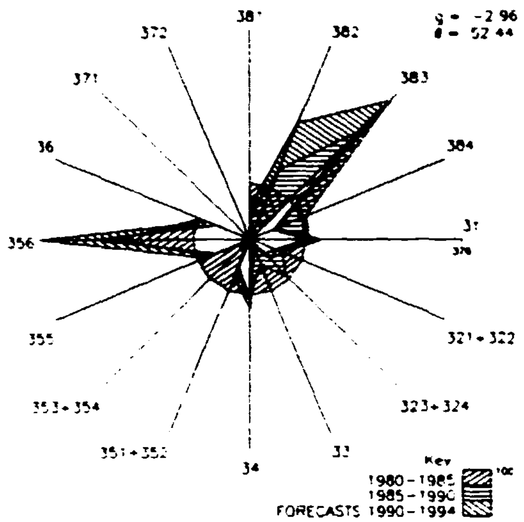
Manufacturing share in GDP, current prices (%)



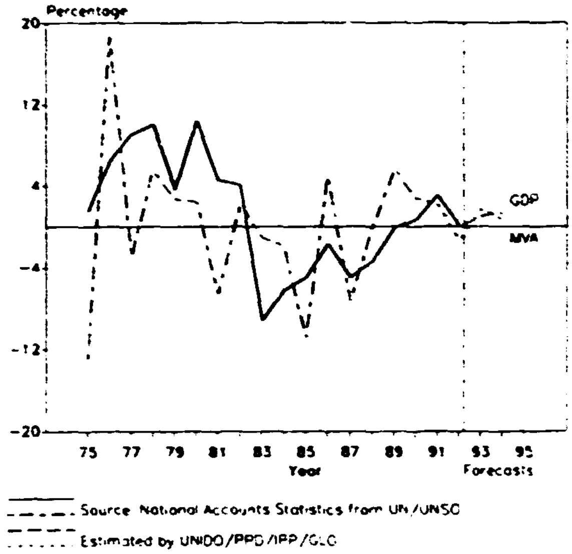
Industrial production index (1980=100)



Industrial structural change
(Index of value added 1980=100)



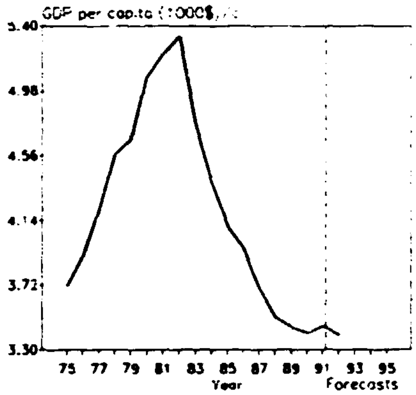
Annual growth rates of GDP and MVA
(Constant 1980 prices)



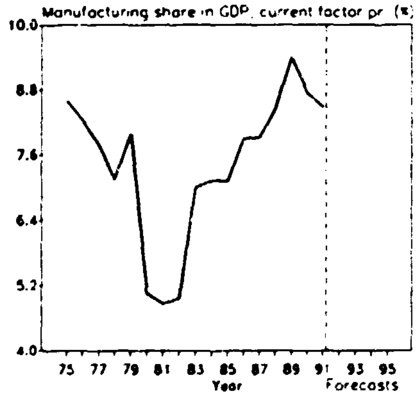
	1980	1985	1990
GDP: (na.c.) millions of 1980-dollars	5486	4828	4376
Per capita (1980-dollars) (na.c.)	5070	4095	3408
Manufacturing share (%) (na.) (current factor prices)	5.0	7.1	8.7
MANUFACTURING:			
Value added (na.c.) millions of 1980-dollars)	490	405	426
Industrial production index	100	86	104
Value added (millions of dollars)	492	387	471 /e
Gross output (millions of dollars)	1605 /e	1765	1885 /e
Employment (thousands)	44	34	31 /e
-PROFITABILITY: in percent of gross output:			
Intermediate input (%)	69 /e	78	75 /e
Wages and salaries including supplements (%)	15 /e	18 /e	17 /e
Gross operating surplus (%)	15 /e	4 /e	8 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	36225 /e	52667	56036 /e
Value added / worker	11099	11544	14091 /e
Average wage (including supplements)	5568 /e	9488 /e	9936 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.62 /e	20.14	7.34 /e
as a percentage of average θ in 1970-1975	111 /e	857	312 /e
MVA growth rate / θ	0.74	-0.52	-0.11
Degree of specialization	28.3	18.0	19.8
-VALUE ADDED: millions of dollars:			
311/2 Food products	67	95	131 /e
313 Beverages	27	34	40 /e
314 Tobacco products	14	35	33 /e
321 Textiles	1	2	2 /e
322 Wearing apparel	16	13	13 /e
323 Leather and fur products	-	-	- /e
324 Footwear	4	5	2 /e
331 Wood and wood products	6	4	4 /e
332 Furniture and fixtures	9	7	1 /e
341 Paper and paper products	9	14	24 /e
342 Printing and publishing	13	19	21 /e
351 Industrial chemicals	5	6	4 /e
352 Other chemical products	12	10	12 /e
353 Petroleum refineries	190 /e	17 /e	36 /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	26 /e
371 Iron and steel	-	-	- /e
372 Non-ferrous metals	-	-	- /e
381 Metal products	26	11	20 /e
382 Non-electrical machinery	13	-	31 /e
383 Electrical machinery	3	13	13 /e
384 Transport equipment	28	43	23 /e
385 Professional and scientific equipment	-	-	- /e
390 Other manufacturing industries	8	6	8 /e

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex.

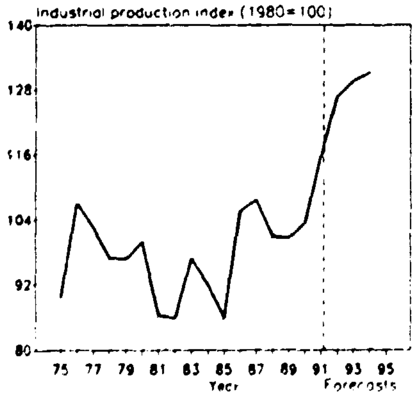
GDP per capita (1000$/c)

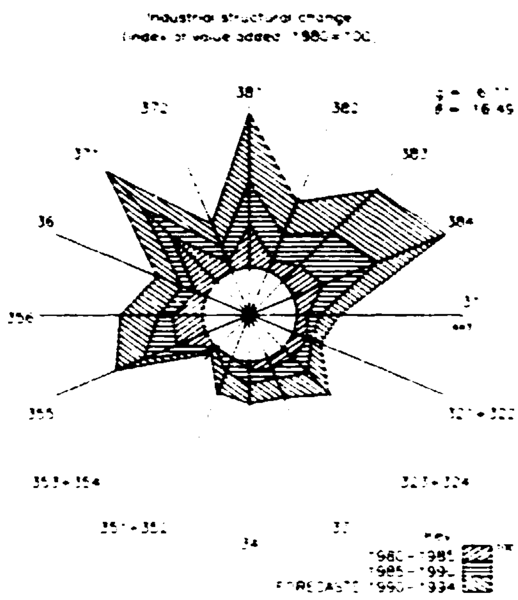


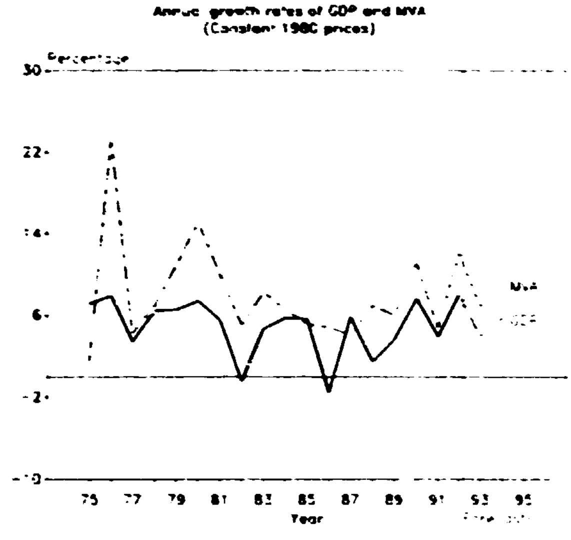
Manufacturing share in GDP, current factor pr. (%)



Industrial production index (1980=100)

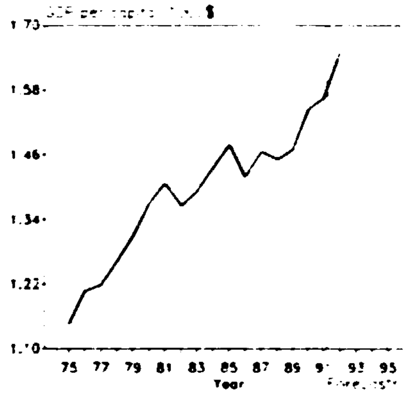


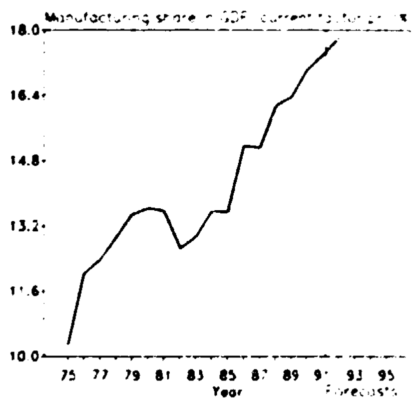


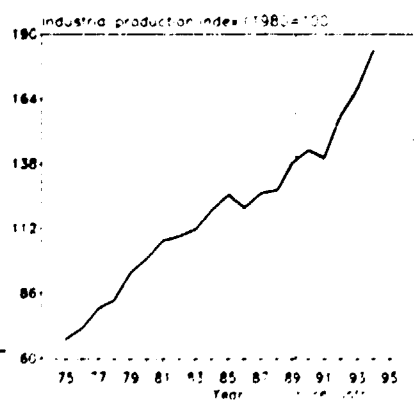


	1980		1985		1990	
GDP: mill. millions of 1980-dollars	8742		10733		12545	
Per capita (1980-dollars) mill.	1369		1473		1544	
Manufacturing share (%) mill. (current factor prices)	13.6		13.5		17.0	
MANUFACTURING:						
Value added mill. millions of 1980-dollars	1030		1443		1982	
Industrial production index	100		126		143	
Value added (millions of dollars)	939		949	e	1512	e
Gross output (millions of dollars)	3579		3449	e	5547	e
Employment (thousands)	125		165	e	213	e
-PROFITABILITY: (in percent of gross output)						
Intermediate input (%)	74		72	e	71	e
Wages and salaries including supplements (%)	12		13	e	15	e
Gross operating surplus (%)	14		14	e	14	e
-PRODUCTIVITY: (dollars)						
Gross output / worker	28669		20841	e	26013	e
Value added / worker	7525		5853	e	7905	e
Average wage (including supplements)	3499		2811	e	3834	e
-STRUCTURAL INDICES:						
Structural change θ (5-year average in degrees)	9.45	e	3.82	e	1.32	e
as a percentage of average θ in 1970-1975	84	e	34	e	17	e
MVA growth rate / θ	1.53		1.49		2.75	
Degree of specialization	13.3		13.7		13.6	
-VALUE ADDED: millions of dollars						
311/2 Food products	96		78	e	120	e
313 Beverages	49		54	e	93	e
314 Tobacco products	22		22	e	36	e
321 Textiles	55		60	e	83	e
322 Wearing apparel	92		87	e	122	e
323 Leather and fur products	6		6	e	10	e
324 Footwear	21		21	e	38	e
331 Wood and wood products	12		12	e	21	e
332 Furniture and fixtures	13		12	e	16	e
341 Paper and paper products	24		21	e	34	e
342 Printing and publishing	17		16	e	26	e
351 Industrial chemicals	42	/e	26	e	43	e
352 Other chemical products	96	e	77	e	140	e
353 Petroleum refineries	13		10	e	14	e
354 Miscellaneous petroleum and coal products	-		-	e	-	e
355 Rubber products	8		11	e	20	e
356 Plastic products	18		22	e	35	e
361 Pottery, china and earthenware	11		9	e	14	e
362 Glass and glass products	7		6	e	11	e
369 Other non-metal mineral products	156		149	e	246	e
371 Iron and steel	45		81	e	144	e
372 Non-ferrous metals	8		7	e	12	e
381 Metal products	53		77	e	151	e
382 Non-electrical machinery	2		2	e	4	e
383 Electrical machinery	35		38	e	85	e
384 Transport equipment	30		38	e	85	e
385 Professional and scientific equipment	1		1	e	2	e
390 Other manufacturing industries	5		6	e	9	e

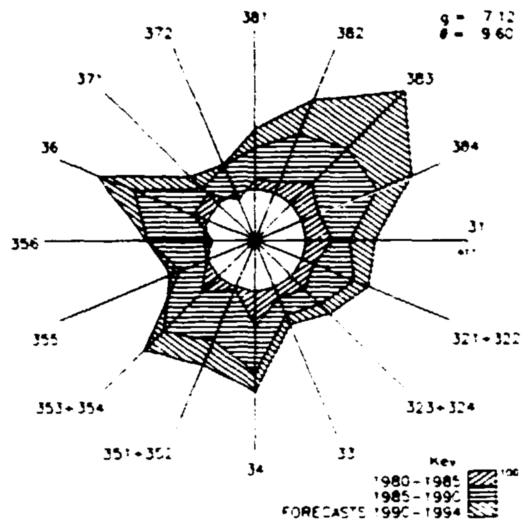
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



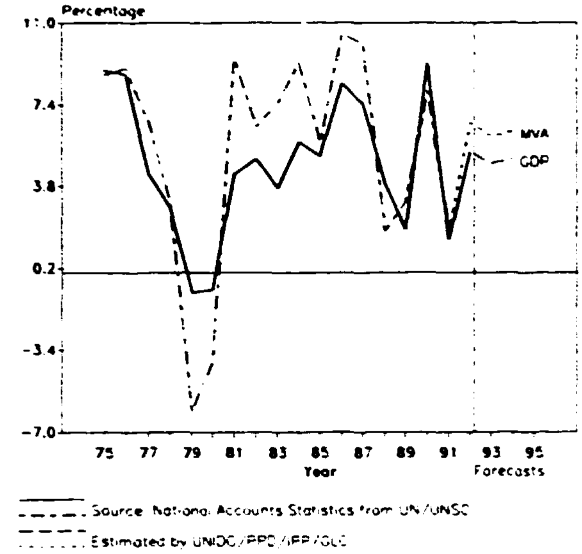




Industrial structural change
(Index of value added 1980=100)



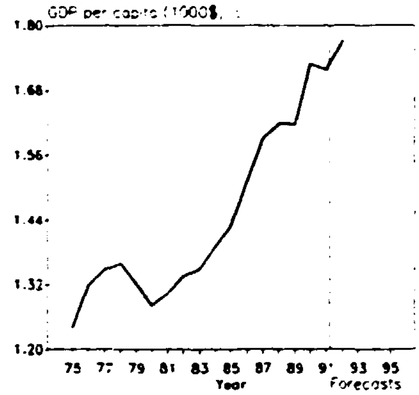
Annual growth rates of GDP and MVA
(Constant 1980 prices)



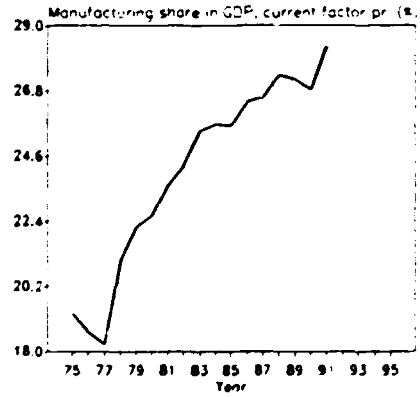
	1980	1985	1990
GDP: (na.c) millions of 1980-dollars	56918	71874	96659
Per capita (1980-dollars) (na.c)	1281	1428	1729
Manufacturing share (%) (na) current factor prices	22.6	25.6	26.8 e
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	12770	18457	25450
Industrial production index	100	174	243
Value added (millions of dollars)	10837	10449	28958
Gross output (millions of dollars)	29413	32471	73064
Employment (thousands)	787	844	975
-PROFITABILITY: (in percent of gross output			
Intermediate input (%)	63	68	60
Wages and salaries including supplements (%)	16	10	12 e
Gross operating surplus (%)	20	23	28 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	36960	38378	74807
Value added / worker	13617	12350	29649
Average wage (including supplements	6142	3716	9013 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	14.36	11.89	13.44
as a percentage of average θ in 1970-1975	155	129	145
MVA growth rate / θ	0.38	0.54	0.79
Degree of specialization	14.3	13.8	12.4
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1185	973	2541
313 Beverages	335	331	893
314 Tobacco products	467	877	1168
321 Textiles	1535	1289	3222
322 Wearing apparel	60	146	947
323 Leather and fur products	25	37	50
324 Footwear	33	22	69
331 Wood and wood products	118	64	187
332 Furniture and fixtures	16	55	81
341 Paper and paper products	205	241	559
342 Printing and publishing	97	133	434
351 Industrial chemicals	719	457	1517
352 Other chemical products	387	394	1449
353 Petroleum refineries	1352	1514	4525
354 Miscellaneous petroleum and coal products	222	152	458
355 Rubber products	201	151	452
356 Plastic products	125	76	328
361 Pottery, china and earthenware	93	102	467
362 Glass and glass products	110	167	531
369 Other non-metal mineral products	535	428	1365
371 Iron and steel	783	734	1403
372 Non-ferrous metals	292	181	580
381 Metal products	395	344	904
382 Non-electrical machinery	506	456	1423
383 Electrical machinery	463	531	1482
384 Transport equipment	541	534	1743
385 Professional and scientific equipment	8	9	87
390 Other manufacturing industries	28	49	84

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

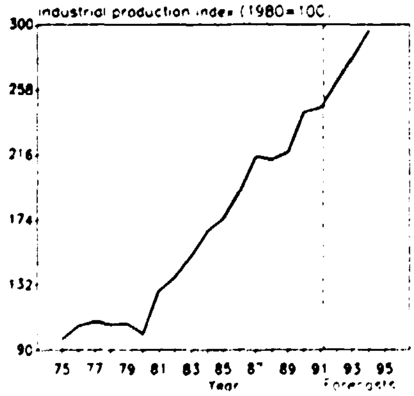
GDP per capita (1000$)



Manufacturing share in GDP, current factor pr. (%)

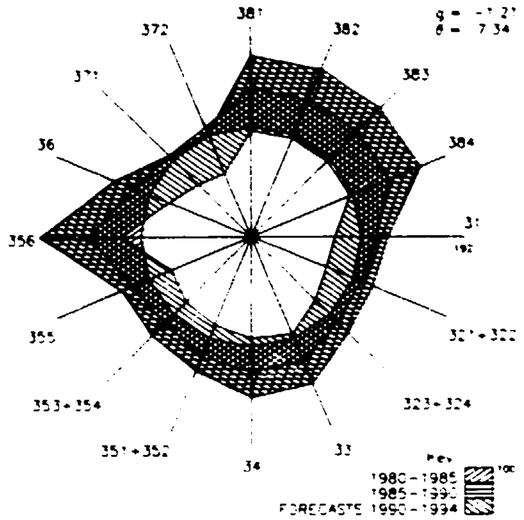


Industrial production index (1980=100)

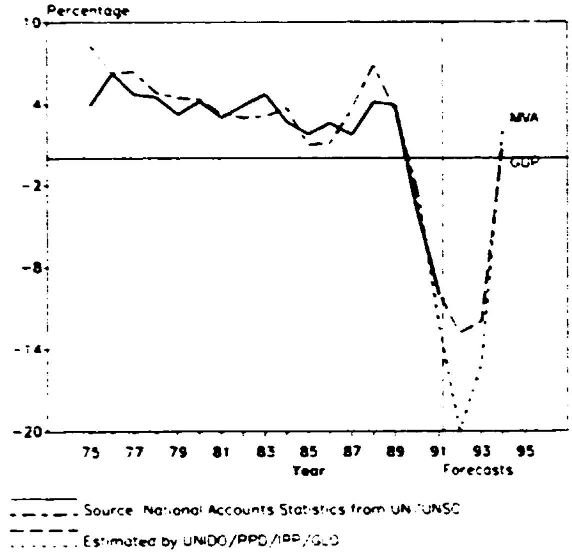


UNION OF SOVIET SOCIALIST REPUBLICS, FORMER

Industrial structural change
(Index of value added: 1980=100)

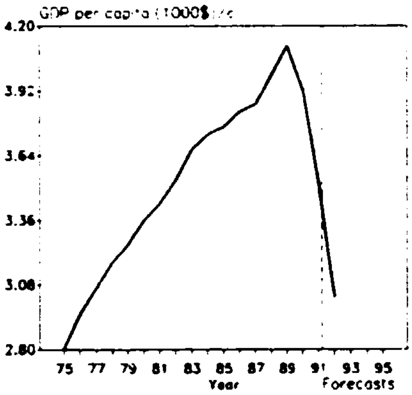


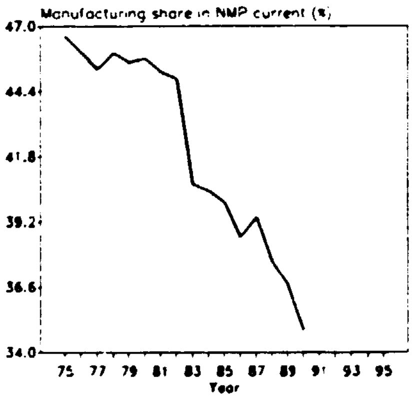
Annual growth rates of GDP and MVA
(Constant 1980 prices)

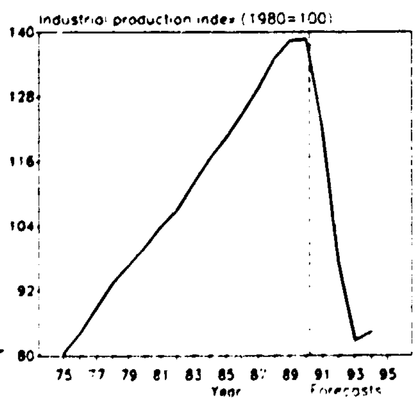


	1980	1985	1990
GDP: na.c (millions of 1980-dollars)	892879	1044668	1132755
Per capita (1980-dollars) na.c	3362	3754	3923
Manufacturing share (%) na (current factor prices)	45.7	40.0	34.9
MANUFACTURING:			
Value added na.c (millions of 1980-dollars)	404805	454867	524952
Industrial production index	100	120	139
Value added (millions of 1980-dollars)	362425	436103	502119
Gross output (millions of dollars)	834089	867602	568264 /e
Employment (thousands)	31464	32794	30596 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)			
Wages and salaries including supplements (%)	12	11	12 /e
Gross operating surplus (%)			
-PRODUCTIVITY: (dollars)			
Gross output / worker	26509	26456	18515 /e
Value added / worker /c	11519	13298	16512 /e
Average wage (including supplements)	3247	3002	2159 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	1.77	1.22	0.80
as a percentage of average θ in 1970-1975	93	64	42
MVA growth rate / θ	2.51	3.10	3.61
Degree of specialization	18.1	18.9	19.7
-VALUE ADDED: (millions of 1980-dollars)			
311/2 Food products	66053	75960	85868
313 Beverages	10336	9303	8786
314 Tobacco products	2032	2866	2398
321 Textiles	32553	34506	37435
322 Wearing apparel	19633	21792	24345
323 Leather and fur products	2443	2345	2245
324 Footwear	3892	459[illegible]	5488
331 Wood and wood products	4932	5771	6412
332 Furniture and fixtures	3457	4459	5669
341 Paper and paper products	2784	3424	4065
342 Printing and publishing	2613	3214 /e	3815 /e
351 Industrial chemicals	14704	17939	19703
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	5276
356 Plastic products	1546	2273	2969
361 Pottery, china and earthenware	2014	2457	3001
362 Glass and glass products	1204	1517	1914
369 Other non-metal mineral products	13769	15696	17761
371 Iron and steel	14418	15139	15139
372 Non-ferrous metals	7716	8333	7793
381 Metal products	7130	9625	11764
382 Non-electrical machinery	79367	107146	130956
383 Electrical machinery	9105	12292	15023
384 Transport equipment	11574	15626	19097
385 Professional and scientific equipment	9711	13110	16024
390 Other manufacturing industries	11210	15133 /e	18496 /e

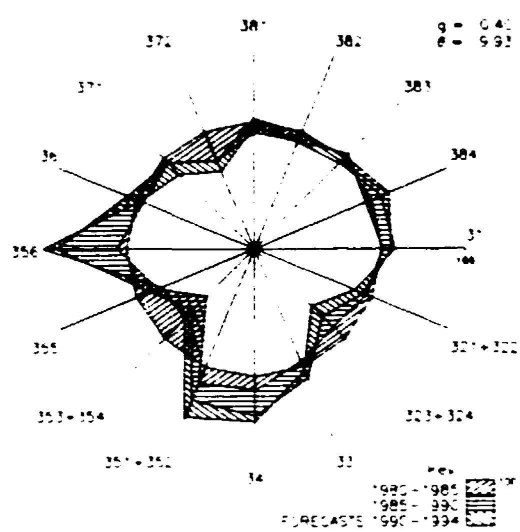
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex



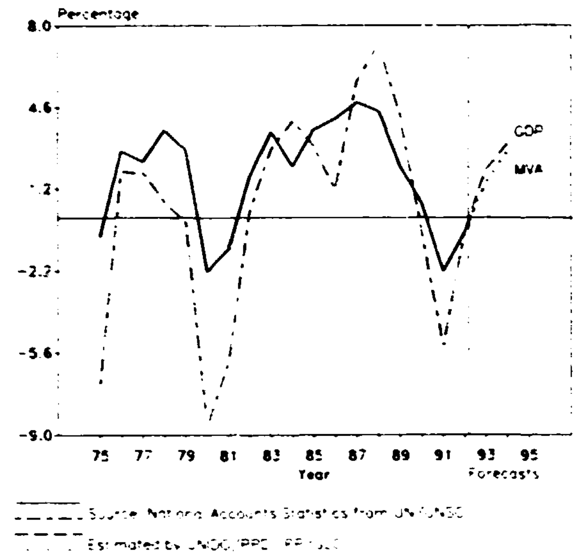




Industrial structural change
(index of value added 1980=100)



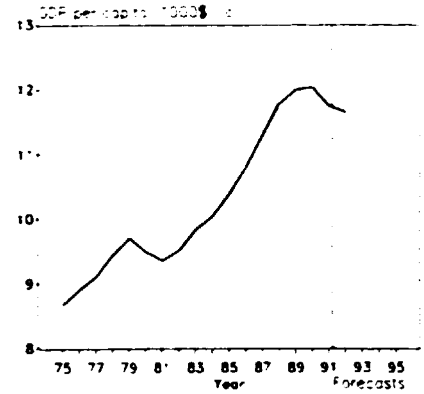
Annual growth rates of GDP and MVA
(Constant 1980 prices)



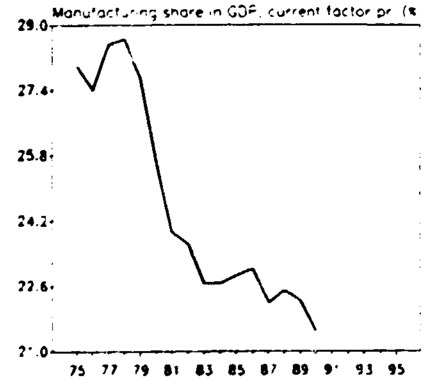
	1980	1985	1990	
GDP: (nat.c. millions of 1980-dollars)	536588	590146	591356	
Per capita (1980-dollars) (nat.c)	9493	10398	12038	
Manufacturing share (%) (nat. current factor prices)	25.7	22.9	21.5	e
MANUFACTURING:				
Value added (nat.c. millions of 1980-dollars)	124163	128881	152981	
Industrial production index	100	103	122	
Value added (millions of dollars)	163790	124409	253630	
Gross output (millions of dollars)	400929	306225	576765	
Employment (thousands)	6462	4932	4785	
-PROFITABILITY: (in percent of gross output)				
Intermediate input (%)	59	59	56	
Wages and salaries including supplements (%)	23	20	21	e
Gross operating surplus (%)	17	20	23	e
-PRODUCTIVITY: (dollars)				
Gross output / worker	51483	51368	118945	
Value added / worker	25117	24932	52306	
Average wage (including supplements)	14579	12528	25318	e
-STRUCTURAL INDICES:				
Structural change θ (5-year average in degrees)	3.83	2.57	2.28	
as a percentage of average θ in 1970-1975	109	73	65	
MVA growth rate / θ	-0.20	-0.14	0.93	
Degree of specialization	11.1	11.9	12.2	
-VALUE ADDED: millions of dollars				
311/2 Food products	14744	12179	25035	
313 Beverages	5419	3554	6620	
314 Tobacco products	1814	1479	2364	
321 Textiles	5419	3917	6995	
322 Wearing apparel	3395	2533	4682	
323 Leather and fur products	558	363	529	
324 Footwear	1093	752	1254	
331 Wood and wood products	2349	1556	3195	
332 Furniture and fixtures	2558	2101	4526	
341 Paper and paper products	4860	3800	7983	
342 Printing and publishing	9814	3807	19538	
351 Industrial chemicals	8233	7328	14094	
352 Other chemical products	7512	6641	14826	
353 Petroleum refineries	4512	1712	4398	
354 Miscellaneous petroleum and coal products	721	428	744	
355 Rubber products	2349	1505	2996	
356 Plastic products	3698	3087	8204	
361 Pottery, china and earthenware	977	765	1464	
362 Glass and glass products	1442	960	2078	
369 Other non-metal mineral products	5698	4215	8979	
371 Iron and steel	5860	4345	8050	
372 Non-ferrous metals	2581	1505	2759	
381 Metal products	10140	7211	14936	
382 Non-electrical machinery	21326	15110	29931	
383 Electrical machinery	15209	12399	22245	
384 Transport equipment	17512	12944	28805	
385 Professional and scientific equipment	2209	1803	3634	
390 Other manufacturing industries	1791	1310	2762	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

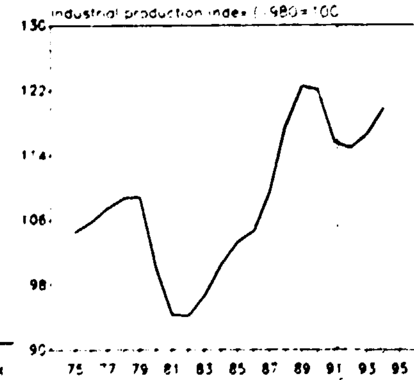
GDP per capita (1000$)



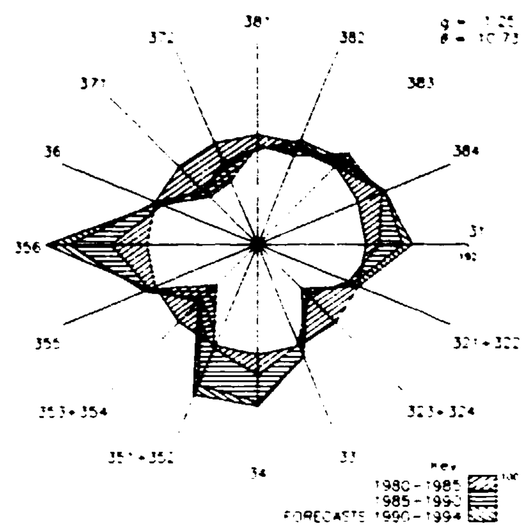
Manufacturing share in GDP, current factor pr. (%)



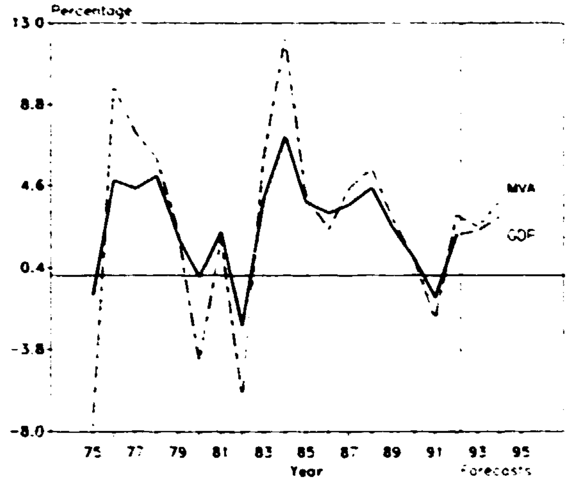
Industrial production index (1980=100)



Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

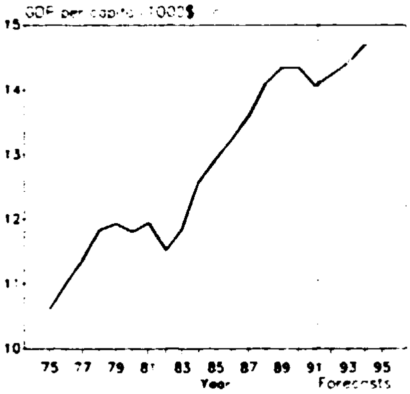


Source: National Accounts Statistics from UN (UNSO)
Estimated by UNIDO

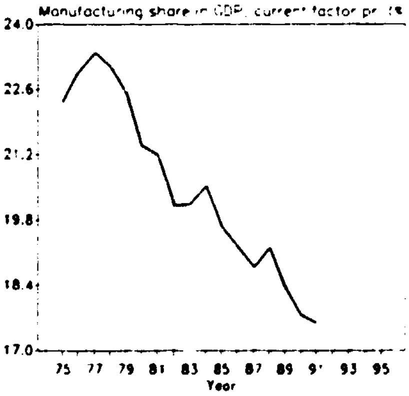
	1980	1985	1990
GDP: (na.c.) (millions of 1980-dollars)	2588470	3095550	3575117
Per capita (1980-dollars) (na.c.)	11804	12937	14336
Manufacturing share (%) (na) (current factor prices)	21.4	19.6	17.8 e
MANUFACTURING:			
Value added (na.c.) (millions of 1980-dollars)	586438	694514	812843
Industrial production index	100	113	132
Value added (millions of dollars)	769899	996378	1322060
Gross output (millions of dollars)	1857094	2256992	2861290
Employment (thousands)	19210	17422	17498
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	56	54
Wages and salaries including supplements (%)	21	21	21
Gross operating surplus (%)	21	22	26
-PRODUCTIVITY: (dollars)			
Gross output / worker	96673	130122	163521
Value added / worker	40078	57191	75555
Average wage (including supplements)	[illegible]	27955	33573
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	2.91	3.35	3.29
as a percentage of average θ in 1970-1975	84	96	95
MVA growth rate / θ	1.45	0.10	0.77
Degree of specialization	11.9	13.5	12.3
-VALUE ADDED: (millions of dollars)			
311.2 Food products	63460	87960	119840
313 Beverages	11810	16150	21140
314 Tobacco products	5160	11890	22560
321 Textiles	23030	26910	34950
322 Wearing apparel	19780	22150	25480
323 Leather and fur products	1850	1570	2210
324 Footwear	2950	2470	2320
331 Wood and wood products	12970	15390	20820
332 Furniture and fixtures	9840	13250	16910
341 Paper and paper products	29790	40390	57200
342 Printing and publishing	44390	73050	103180
351 Industrial chemicals	38920	43360	73480
352 Other chemical products	35530	54280	81750
353 Petroleum refineries	23010	13890	22820
354 Miscellaneous petroleum and coal products	2670	3450	4390
355 Rubber products	8030	10970	13430
356 Plastic products	14540	24740	37320
361 Pottery, china and earthenware	1210	1300	1840
362 Glass and glass products	6470	7660	10080
369 Other non-metal mineral products	15300	19880	23990
371 Iron and steel	30780	24070	31780
372 Non-ferrous metals	14340	11440	17510
381 Metal products	53180	61810	70350
382 Non-electrical machinery	102760	115550	145050
383 Electrical machinery	74850	111220	112400
384 Transport equipment	81280	128230	154020
385 Professional and scientific equipment	27940	40280	76510
390 Other manufacturing industries	12060	13050	18720

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

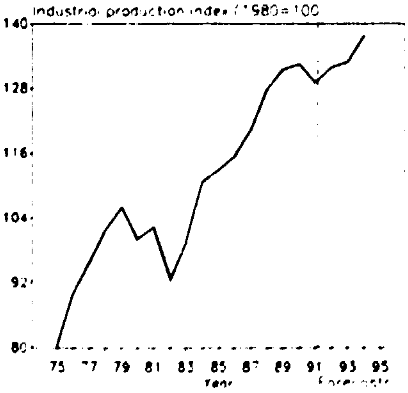
GDP per capita (1000$)



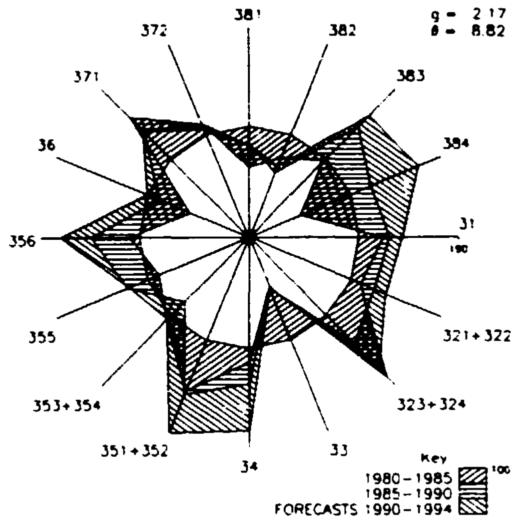
Manufacturing share in GDP, current factor prices (%)



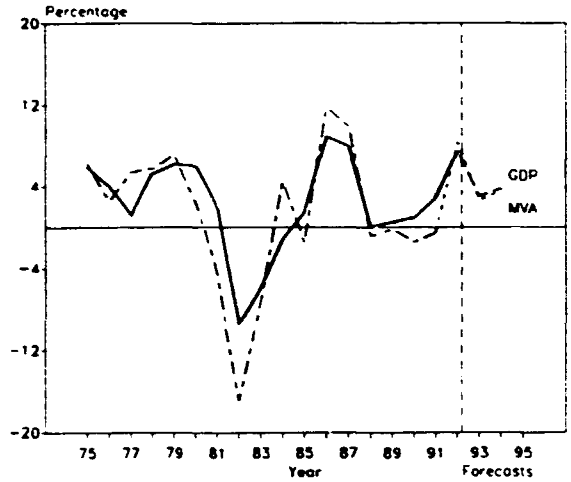
Industrial production index (1980=100)



Industrial structural change
(Index of value added 1980=100)



Annual growth rates of GDP and MVA
(Constant 1980 prices)

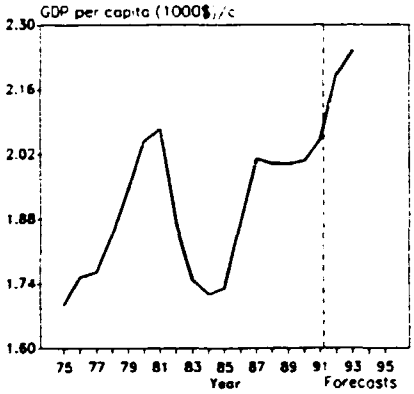


Source National Accounts Statistics from UN/UNSO
Estimated by UNIDO/PPD/IPP/GLO

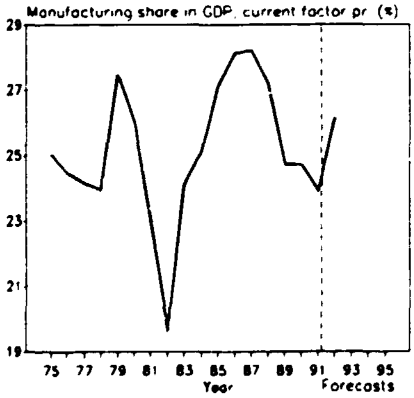
	1980	1985	1990
GDP: /na.c (millions of 1980-dollars)	5970	5208	6205
Per capita (1980-dollars) /na.c	2049	1731	2005
Manufacturing share (%) /na (current factor prices)	26.0	27.1	24.7
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	1334	1012	1211
Industrial production index	100	74	88
Value added (millions of dollars)	1286	1344	2251 /e
Gross output (millions of dollars)	3302	3189	5110 /e
Employment (thousands)	160	123	122 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	61	58	56 /e
Wages and salaries including supplements (%)	13 /e	9	11 /e
Gross operating surplus (%)	26 /e	33	33 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	20456	26012	41689 /e
Value added / worker	7971	10961	18504 /e
Average wage (including supplements)	2635 /e	2448	4529 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	12.10	14.61	4.87 /e
as a percentage of average θ in 1970-1975	123	149	50 /e
MVA growth rate / θ	-0.08	0.14	0.32
Degree of specialization	13.9	18.7	16.1
-VALUE ADDED: (millions of dollars)			
311/2 Food products	165	266	407 /e
313 Beverages	104	92	178 /e
314 Tobacco products	90	68	107 /e
321 Textiles	109	137	247 /e
322 Wearing apparel	59	43	65 /e
323 Leather and fur products	31	76	83 /e
324 Footwear	18	8	17 /e
331 Wood and wood products	14 /e	8	12 /e
332 Furniture and fixtures	7 /e	2	4 /e
341 Paper and paper products	30	47	82 /e
342 Printing and publishing	37	27	51 /e
351 Industrial chemicals	20	26	49 /e
352 Other chemical products	75	112	170 /e
353 Petroleum refineries	192	194	234 /e
354 Miscellaneous petroleum and coal products	2	4	5 /e
355 Rubber products	40	34	72 /e
356 Plastic products	24	25	51 /e
361 Pottery, china and earthenware	13	7	20 /e
362 Glass and glass products	14	7	34 /e
369 Other non-metal mineral products	41	24	37 /e
371 Iron and steel	10	14	19 /e
372 Non-ferrous metals	3	3	5 /e
381 Metal products	53 /e	32	66 /e
382 Non-electrical machinery	16 /e	12	15 /e
383 Electrical machinery	33	31	71 /e
384 Transport equipment	78	38	142 /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.

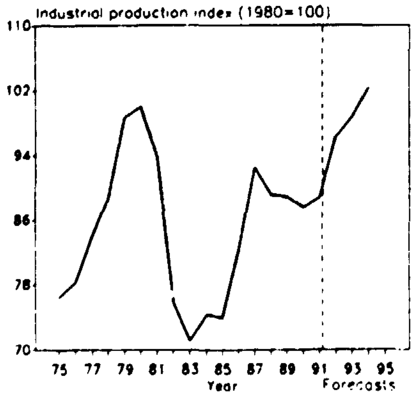
GDP per capita (1000$)/c



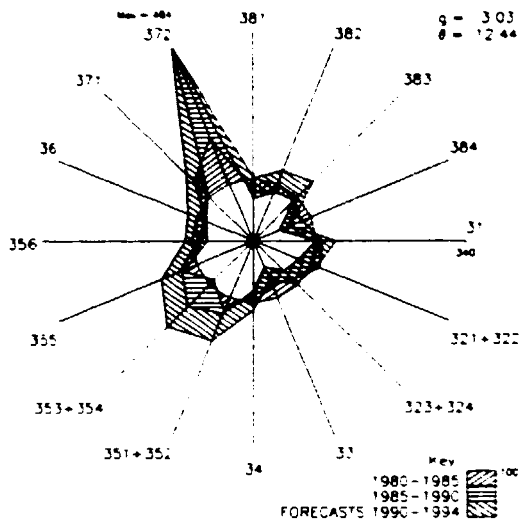
Manufacturing share in GDP, current factor pr. (%)



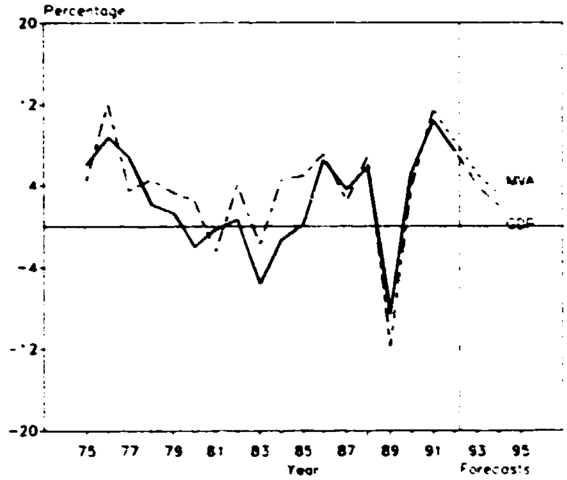
Industrial production index (1980=100)



Industrial structural change (Index of value added 1980=100)



Annual growth rates of GDP and MVA (Constant 1980 prices)



	1980	1985	1990
GDP: na.c (millions of 1980-dollars)	59213	55446	62315
Per capita (1980-dollars) na.c	3941	3202	3154
Manufacturing share (%) na (current factor prices)	18.6	22.5	20.8
MANUFACTURING:			
Value added /na.c (millions of 1980-dollars)	9596	10507	11314
Industrial production index	100	101	113
Value added (millions of dollars)	14461 /e	14071	12175
Gross output (millions of dollars)	30213 /e	30305	24128
Employment (thousands)	426 /e	406	464
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	52 /e	54	50
Wages and salaries including supplements (%)	15 /e	13	9
Gross operating surplus (%)	33 /e	34	42
-PRODUCTIVITY: (dollars)			
Gross output / worker	62664 /e	71154	51776
Value added / worker	30311 /e	33038	26127
Average wage (including supplements)	10359 /e	9495	4651
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	7.47 /e	9.86	16.09
as a percentage of average θ in 1970-1975	70 /e	93	151
MVA growth rate / θ	1.24	0.03	0.18
Degree of specialization	18.5	17.3	27.0
-VALUE ADDED: (millions of dollars)			
311/2 Food products	1425 /e	1597	1210
313 Beverages	953 /e	836	583
314 Tobacco products	409 /e	597	273
321 Textiles	430 /e	505	291
322 Wearing apparel	348 /e	359	160
323 Leather and fur products	57 /e	58	40
324 Footwear	197 /e	158	90
331 Wood and wood products	106 /e	80	36
332 Furniture and fixtures	188 /e	142	65
341 Paper and paper products	395 /e	357	277
342 Printing and publishing	376 /e	299	182
351 Industrial chemicals	325 /e	498	443
352 Other chemical products	858 /e	890	662
353 Petroleum refineries	4222 /e	3634	4734
354 Miscellaneous petroleum and coal products	25 /e	30	19
355 Rubber products	151 /e	188	139
356 Plastic products	394 /e	348	215
361 Pottery, china and earthenware	60 /e	39	18
362 Glass and glass products	137 /e	132	109
369 Other non-metal mineral products	489 /e	378	290
371 Iron and steel	651 /e	855	498
372 Non-ferrous metals	256 /e	447	788
381 Metal products	652 /e	503	336
382 Non-electrical machinery	287 /e	241	180
383 Electrical machinery	345 /e	307	245
384 Transport equipment	605 /e	486	198
385 Professional and scientific equipment	38 /e	26	37
390 Other manufacturing industries	82 /e	81	66

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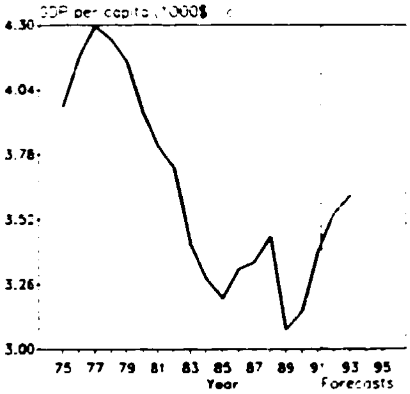
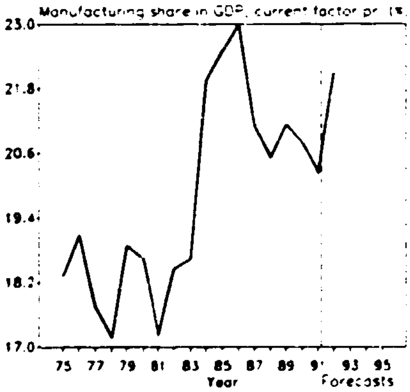
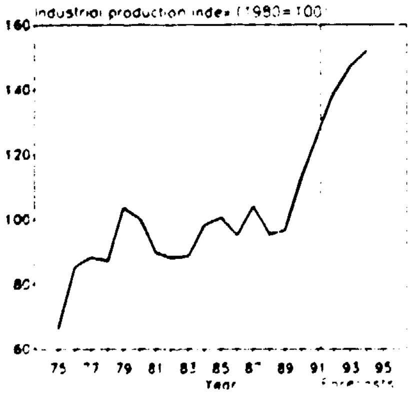
GDP per capita (1000$)

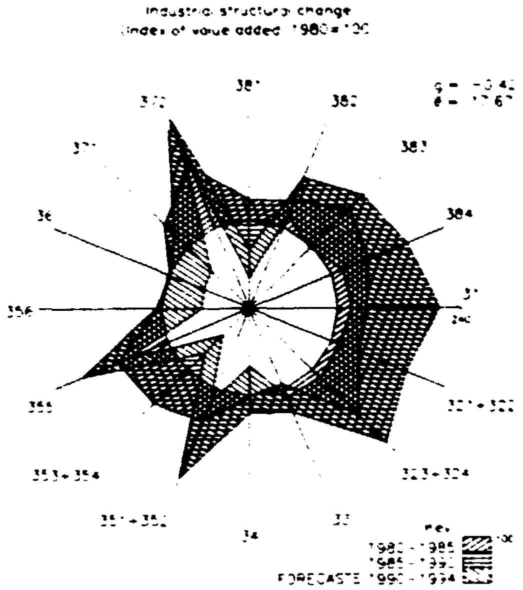


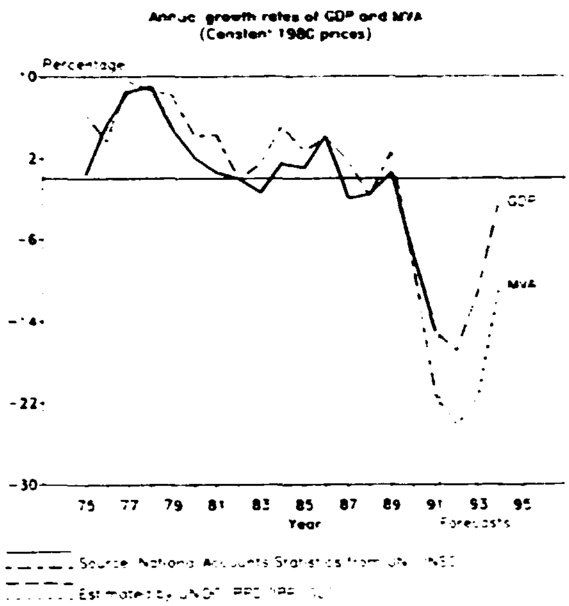
Manufacturing share in GDP, current factor pr. (%)



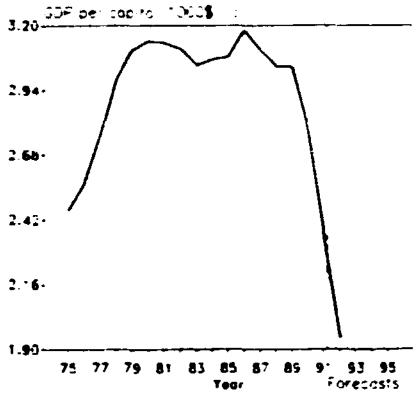
Industrial production index (1980=100)

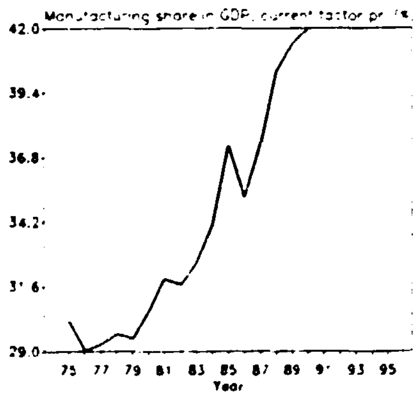


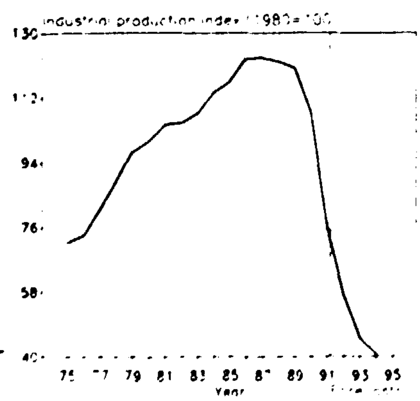




	1980	1985	1990	
GDP: real (millions of 1980-dollars)	63958	71058	56371	
Per capita (1980-dollars) real	3135	3073	2136	
Manufacturing share (%) real current factor prices	30.5	37.2	42.0	
MANUFACTURING:				
Value added real (millions of 1980-dollars)	19525	22283	21703	
Industrial production index	100	116	108	
Value added (millions of dollars)	21753	17171	27560	e
Gross output (millions of dollars)	72529	57020	52136	e
Employment (thousands)	2106	2467	2537	e
-PROFITABILITY: (in percent of gross output)				
Intermediate input	70	70	55	e
Wages and salaries including supplements	14	12	18	e
Gross operating surplus	15	18	26	e
-PRODUCTIVITY: dollars				
Gross output / worker	34487	23113	24248	e
Value added / worker	10323	5960	10796	e
Average wage including supplements	4991	2703	4488	e
-STRUCTURAL INDICES:				
Structural change θ (5-year average in degrees)	5.08	4.66	5.67	e
as a percentage of average θ in 1970-1975	72	65	81	e
MVA growth rate θ	1.13	1.20	0.74	
Degree of specialization	8.3	9.0	10.5	
-VALUE ADDED: millions of dollars				
311/2 Food products	1897	1458	3484	e
313 Beverages	459	353	539	e
314 Tobacco products	184	221	308	e
321 Textiles	1759	1428	2563	e
322 Wearing apparel	903	718	1427	e
323 Leather and fur products	226	231	340	e
324 Footwear	482	503	399	e
331 Wood and wood products	971	530	706	e
332 Furniture and fixtures	730	438	1065	e
341 Paper and paper products	529	394	674	e
342 Printing and publishing	376	462	578	e
351 Industrial chemicals	694	531	392	e
352 Other chemical products	681	525	1315	e
353 Petroleum refineries	454	415	233	e
354 Miscellaneous petroleum and coal products	101	101	91	e
355 Rubber products	275	269	456	e
356 Plastic products	413	258	350	e
361 Pottery, china and earthenware	128	72	144	e
362 Glass and glass products	163	113	204	e
369 Other non-metal mineral products	906	513	504	e
371 Iron and steel	1221	1000	1171	e
372 Non-ferrous metals	480	509	927	e
381 Metal products	2105	1577	1130	e
382 Non-electrical machinery	1828	1463	2378	e
383 Electrical machinery	1600	1544	2334	e
384 Transport equipment	1441	1263	2241	e
385 Professional and scientific equipment	101	93	146	e
390 Other manufacturing industries	174	38	114	e







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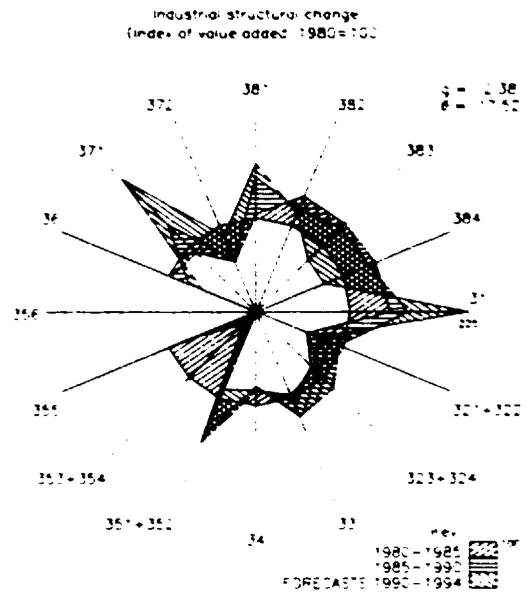
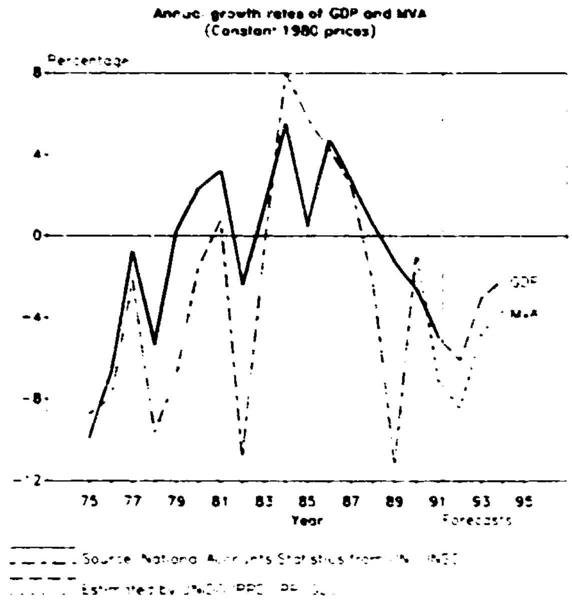
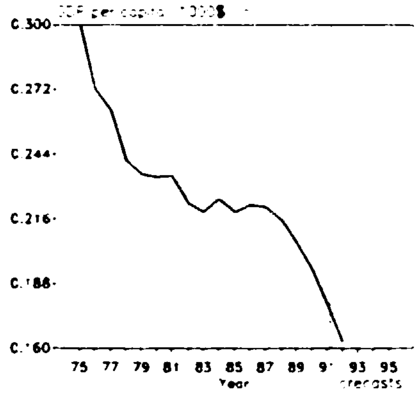
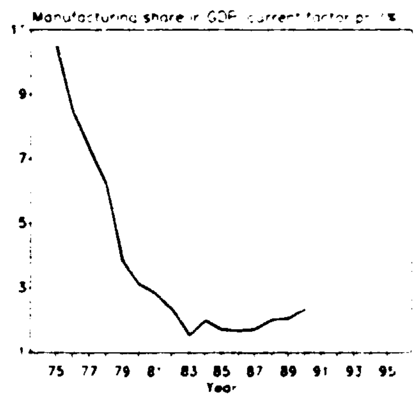


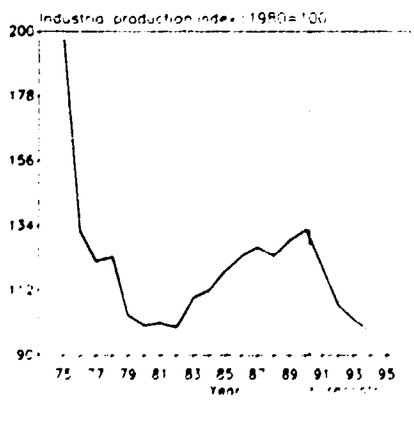


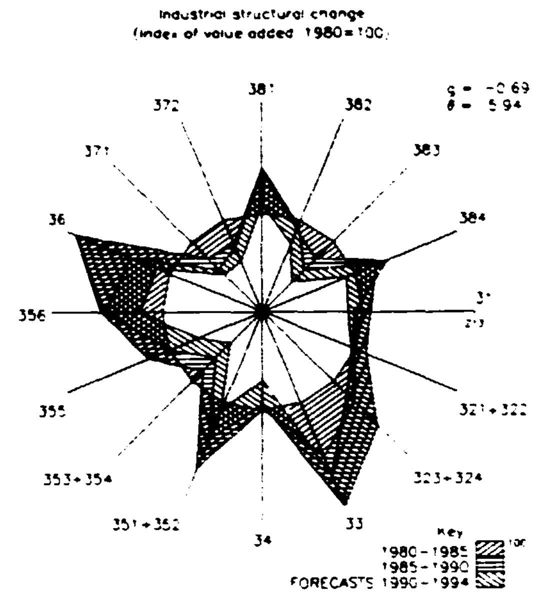
	1980	1985	1990
GDP: (n.a.c. millions of 1980-dollars)	6137	6653	6316
Per capita (1980-dollars) (n.a.c.)	234	219	195
Manufacturing share (%) (n.a. current factor prices)	3.1	1.7	2.3 e
MANUFACTURING:			
Value added (n.a.c. millions of 1980-dollars)	184	138	173
Industrial production index	100	119	133
Value added (millions of dollars)	[illegible]	56 e	96 e
Gross output (millions of dollars)			
Employment (thousands)	50 e	50 e	50 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)			
Wages and salaries including supplements (%)			
Gross operating surplus (%)			
-PRODUCTIVITY: (dollars)			
Gross output / worker			
Value added / worker	2929 e	1117 e	1516 e
Average wage (including supplements)	4535 e	1589 e	2092 e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.39 e	7.97 e	3.48 e
as a percentage of average θ in 1970-1975	54 e	131 e	57 e
MVA growth rate / θ	-4.13	0.33	0.59
Degree of specialization	16.8	23.7	23.8
-VALUE ADDED: (millions of dollars)			
311/2 Food products	20	5 e	5 e
313 Beverages	35	20 e	28 e
314 Tobacco products	9	7 e	15 e
321 Textiles	10	2 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	1 e	2 e
332 Furniture and fixtures	1	- e	- e
341 Paper and paper products	[illegible]	- e	[illegible] e
342 Printing and publishing	2	1 e	1 e
351 Industrial chemicals	12	6 e	8 e
352 Other chemical products	[illegible]	- e	- e
353 Petroleum refineries	14	1 e	1 e
354 Miscellaneous petroleum and coal products	-	- e	- e
355 Rubber products	-	- e	[illegible] e
356 Plastic products	-	- e	- e
361 Pottery, china and earthenware	[illegible]	- e	- e
362 Glass and glass products	1	- e	- e
369 Other non-metal mineral products	4	1 e	2 e
371 Iron and steel	4	1 e	2 e
372 Non-ferrous metals	2	- e	1 e
381 Metal products	5	2 e	3 e
382 Non-electrical machinery	5	2 e	3 e
383 Electrical machinery	3	1 e	2 e
384 Transport equipment	5	3 e	3 e
385 Professional and scientific equipment	-	- e	- e
390 Other manufacturing industries	15	7 e	9 e

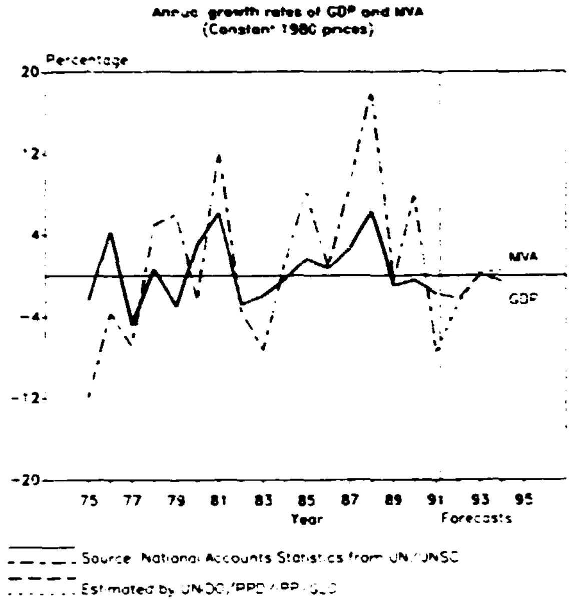
For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





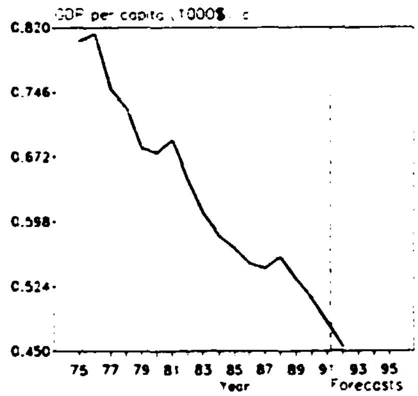


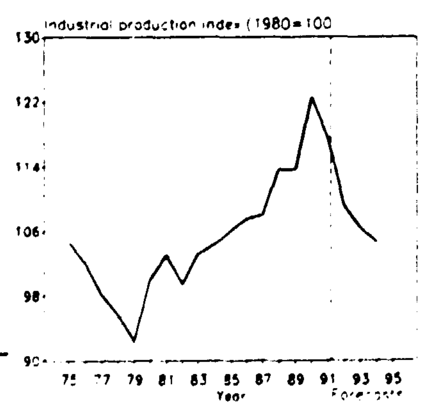




	1980	1985	1990
GDP: (na.c) (millions of 1980-dollars)	3883	3978	4307
Per capita (1980-dollars) (na.c)	677	568	510
Manufacturing share (%) (na) (current factor prices)	19.0	23.8	33.2
MANUFACTURING:			
Value added (na.c) (millions of 1980-dollars)	717	789	1098
Industrial production index	100	106	122
Value added (millions of dollars)	780	575 e	1028 /e
Gross output (millions of dollars)	1671	1378 e	2510 /e
Employment (thousands)	59	62 e	61 /e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	53	58 e	61 /e
Wages and salaries including supplements (%)	11	11 /e	11 /e
Gross operating surplus (%)	35	30 e	29 /e
-PRODUCTIVITY: (dollars)			
Gross output / worker	28232	22254 e	43052 /e
Value added / worker	13184	9280 /e	16966 /e
Average wage (including supplements)	3245	2542 e	4642 /e
-STRUCTURAL INDICES:			
Structural change θ (5-year average in degrees)	3.61 /e	5.05 /e	5.36 /e
as a percentage of average θ in 1970-1975	60 /e	85 /e	90 /e
MVA growth rate / θ	0.14	0.52	0.39
Degree of specialization	17.9	15.4	17.6
-VALUE ADDED: (millions of dollars)			
311/2 Food products	92	62 e	87 /e
313 Beverages	193	104 e	237 /e
314 Tobacco products	58	39 e	97 /e
321 Textiles	51	32 e	62 /e
322 Wearing apparel	34	23 e	46 /e
323 Leather and fur products	4	3 e	5 /e
324 Footwear	15	13 /e	29 /e
331 Wood and wood products	8	11 e	28 /e
332 Furniture and fixtures	12	10 e	21 /e
341 Paper and paper products	15	8 e	11 /e
342 Printing and publishing	17	13 e	24 /e
351 Industrial chemicals	22	26 /e	37 /e
352 Other chemical products	47	51 e	73 /e
353 Petroleum refineries	9	5 e	6 /e
354 Miscellaneous petroleum and coal products	3	2 /e	3 /e
355 Rubber products	20	16 e	23 /e
356 Plastic products	7	7 /e	12 /e
361 Pottery, china and earthenware	1	1 e	1 /e
362 Glass and glass products	3	3 e	4 /e
369 Other non-metal mineral products	33	45 e	55 /e
371 Iron and steel	10	5 e	7 /e
372 Non-ferrous metals	2	1 e	1 /e
381 Metal products	50	47 e	82 /e
382 Non-electrical machinery	18	11 /e	20 /e
383 Electrical machinery	26	13 /e	18 /e
384 Transport equipment	28	24 /e	39 /e
385 Professional and scientific equipment	-	- e	- /e
390 Other manufacturing industries	2	1 e	1 /e

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex





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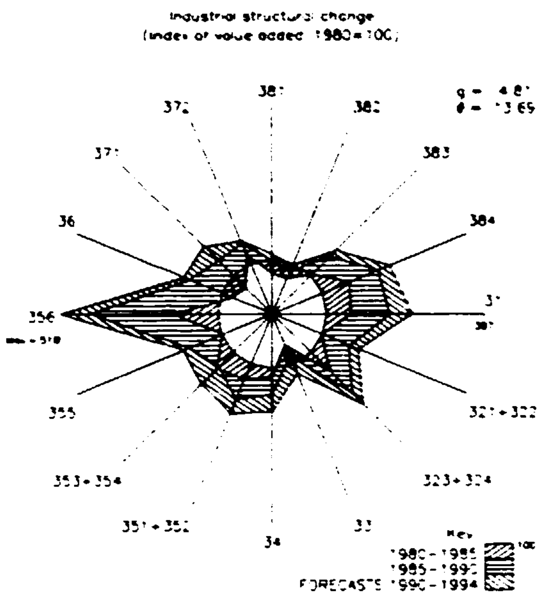

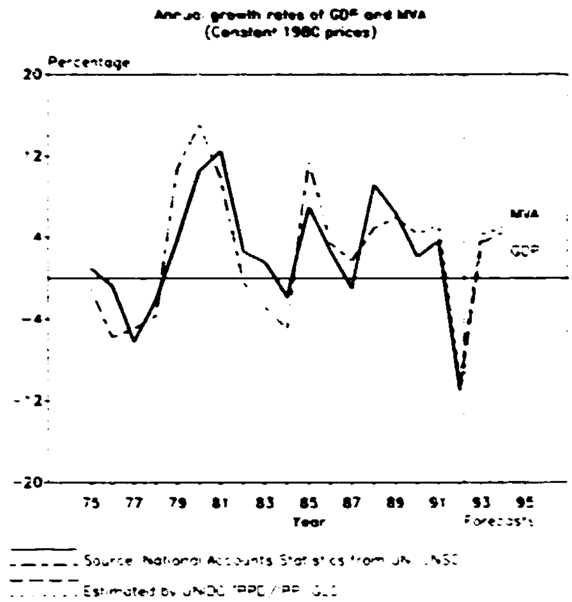

	1980	1985	1990
GDP: (na.c) millions of 1980-dollars	5351	6586	7930
Per capita (1980-dollars) (na.c)	751	794	817
Manufacturing share (%) (na) current factor prices.	24 1	22 2	24 2
MANUFACTURING:			
Value added (na.c) millions of 1980-dollars	1247	1403	1712
Industrial production index	100	112	139
Value added (millions of dollars)	1480	1278	2323 e
Gross output (millions of dollars)	3579	3020	4944 /e
Employment (thousands)	161	163	194 e
-PROFITABILITY: (in percent of gross output)			
Intermediate input (%)	59	58	53 e
Wages and salaries including supplements (%)	17	18	16 e
Gross operating surplus (%)	24	25	31 e
-PRODUCTIVITY: (dollars)			
Gross output / worker	22265	18449	25497 e
Value added / worker	9205	7808	11980 e
Average wage (including supplements)	3848	3241	4159 /e
-STRUCTURAL INDICES:			
Structural change θ 5-year average in degrees	6 17	12 05	7 36 e
as a percentage of average θ in 1970-1975	134	261	159 /e
MVA growth rate / θ	0 49	0 14	1 19
Degree of specialization	13 4	13 3	14 9
-VALUE ADDED: (millions of dollars)			
311/2 Food products	193	130	253 e
313 Beverages	92	189	352 e
314 Tobacco products	55	72	104 e
321 Textiles	147	114	218 e
322 Wearing apparel	70	55	100 e
323 Leather and fur products	4	4	8 e
324 Footwear	34	42	68 e
331 Wood and wood products	38	17	32 e
332 Furniture and fixtures	26	15	20 /e
341 Paper and paper products	30	37	56 e
342 Printing and publishing	59	45	71 /e
351 Industrial chemicals	58	67	78 e
352 Other chemical products	80	78	148 e
353 Petroleum refineries	-	1	1 e
354 Miscellaneous petroleum and coal products	7	8	10 /e
355 Rubber products	30	24	48 e
356 Plastic products	25	37	81 /e
361 Pottery, china and earthenware	3	2	3 e
362 Glass and glass products	9	5	11 /e
369 Other non-metal mineral products	44	28	74 e
371 Iron and steel	194	105	261 /e
372 Non-ferrous metals	10	9	13 e
381 Metal products	132	78	124 e
382 Non-electrical machinery	39	22	32 e
383 Electrical machinery	44	36	63 /e
384 Transport equipment	38	48	78 /e
385 Professional and scientific equipment	2	1	2 e
390 Other manufacturing industries	17	9	11 /e

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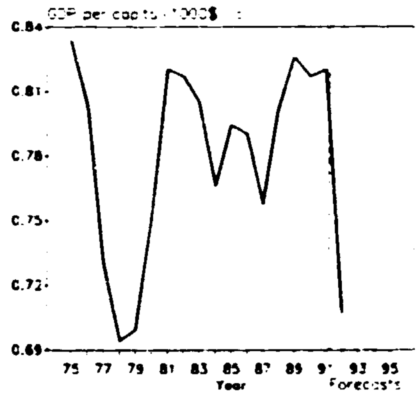

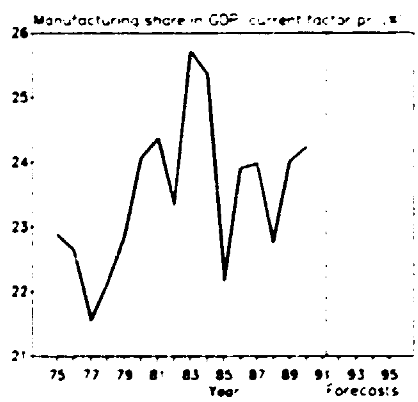

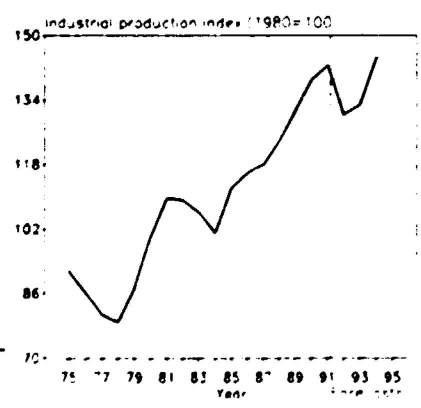

AFGHANISTAN	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	3852	4298	3221	3382	3483 e
Growth rate (%) /na.c	-3.70	0.20	-5.15	5.00	3.00 e
Per capita (in 1980-dollars) /na.c	239.8	296.1	[illegible]	207.1	209.2 e
MVA: /na.c (in million 1980-dollars)	[illegible]	258	254	255	267 e
Growth rate (%) /na.c	-5.06	0.63	-2.50	1.75	3.98 e
Manufacturing share (%) /na.current prices	...				

ALBANIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	2373	2711	3160	2718	2283 /e
Growth rate (%) /na.c	6.29	1.48	2.92	-14.00	-16.00 /e
Per capita (in 1980-dollars) /na.c	858.1	914.9	972.6	821.0	677.2 /e
MVA: /na.c (in million 1980-dollars)	912	1111	1350	776	621 /e
Growth rate (%) /na.c	5.08	1.57	3.50	-42.50	-20.00 /e
Manufacturing share (%) /na.current prices	36.1	34.8	33.8		

BAHAMAS	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1320	1709	2036	1991	1970 /e
Growth rate (%) /na.c	-3.77	13.51	3.00	-2.20	-1.09 /e
Per capita (in 1980-dollars) /na.c	6255.0	7335.6	8016.9	7689.0	7489.5 /e
MVA: /na.c (in million 1980-dollars)		...		...	
Growth rate (%) /na.c		.	.	.	
Manufacturing share (%) /na.current prices	7.5				

BAHRAIN	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	3072	2902	3334	3423	3469 e
Growth rate (%) /na.c	0.24	-3.94	1.24	2.58	1.34 e
Per capita (in 1980-dollars) /na.c	8827.2	6748.1	6435.9	6363.0	6217.1 e
MVA: /na.c (in million 1980-dollars)	498	457	577	591	600 e
Growth rate (%) /na.c	-3.38	-16.13	5.23	2.35	1.64 e
Manufacturing share (%) /na.current prices	14.8	8.5	15.9		

BELIZE	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	171	183	267	278	277 /e
Growth rate (%) /na.c	4.39	2.25	7.60	4.00	-0.27 /e
Per capita (in 1980-dollars) /na.c	1172.6	1093.2	1420.5	1439.0	1398.9 /e
MVA: /na.c (in million 1980-dollars)	22	21	27	28	28 /e
Growth rate (%) /na.c	14.91	0.89	4.97	4.06	1.38 /e
Manufacturing share (%) /na.current prices	17.9	12.3	11.3	10.0 /e	

BENIN	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1163	1225	1268	1306	1343 /e
Growth rate (%) /na.c	10.16	-2.47	3.30	3.03	2.80 /e
Per capita (in 1980-dollars) /na.c	336.1	307.3	274.0	274.0	273.4 /e
MVA: /na.c (in million 1980-dollars)	78	129	91	94	98 /e
Growth rate (%) /na.c	13.47	1.34	5.83	3.26	4.99 /e
Manufacturing share (%) /na.current prices	12.9	8.2	9.2	9.1	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

BERMUDA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	752	752	820	848	864 e
Growth rate (%) /na.c	2.51	5.57	1.86	3.38	1.90 e
Per capita (in 1980-dollars) /na.c	13678.2	13190.0	14137.4	14367.4	14540.3 /e
MVA: /na.c (in million 1980-dollars)	101	98	108	111	114 e
Growth rate (%) /na.c	4.52	2.80	1.81	2.71	2.30 e
Manufacturing share (%) /na,current prices					

BHUTAN	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	142	196	283	291	306
Growth rate (%) /na.c	17.63	3.69	4.56	2.96	5.00
Per capita (in 1980-dollars) /na.c	113.6	144.1	186.7	188.3	193.6
MVA: /na.c (in million 1980-dollars)	5	10	20	21	22 /e
Growth rate (%) /na.c	-11.49	12.20	21.44	4.00	6.00 /e
Manufacturing share (%) /na,current prices	3.2	5.3	9.7	9.7	

BRUNEI DARUSSALAM	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	4848	4115	3778	3846	3923
Growth rate (%) /na.c	-7.00	0.73	-1.15	1.80	2.00
Per capita (in 1980-dollars) /na.c	26063.3	18287.7	14150.1	13935.0	13715.8
MVA: /na.c (in million 1980-dollars)	573	339	367	376	385 e
Growth rate (%) /na.c	-8.35	-5.42	0.09	2.33	2.44 /e
Manufacturing share (%) /na,current prices	11.7	10.0			

CAPE VERDE	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	142	196	254	263	277 e
Growth rate (%) /na.c	3.32	8.53	4.00	3.56	5.35 /e
Per capita (in 1980-dollars) /na.c	490.5	604.5	691.2	696.8	[illegible] e
MVA: /na.c (in million 1980-dollars)	7	11	14	15	16 e
Growth rate (%) /na.c	7.14	31.07	4.98	6.75	6.50 e
Manufacturing share (%) /na,current prices	4.8	5.8	6.0 /e	5.9 /e	

CHAD	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1005	804	952	1017	1048 /e
Growth rate (%) /na.c	-7.40	6.86	-2.70	6.81	3.04 e
Per capita (in 1980-dollars) /na.c	224.5	160.2	167.8	174.8	175.8 /e
MVA: /na.c (in million 1980-dollars)	92	69	83	68	70 /e
Growth rate (%) /na.c	-12.00	5.39	-1.90	-18.00	2.61 e
Manufacturing share (%) /na,current prices	10.7 /e	11.1	15.4	11.1	

DJIBOUTI	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	339	357	397	404	415 e
Growth rate (%) /na.c	4.72	0.85	2.00	1.60	2.91 /e
Per capita (in 1980-dollars) /na.c	1116.3	1004.4	971.1	958.5	959.1 /e
MVA: /na.c (in million 1980-dollars)	34	36	43	45	47 /e
Growth rate (%) /na.c	2.98	0.49	5.10	4.22	3.98 /e
Manufacturing share (%) /na,current prices	9.7	9.4 /e			

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

EQUATORIAL GUINEA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	43	49	54	53	51 /e
Growth rate (%) /na.c	-9.14	7.31	3.14	-0.93	-4.30 /e
Per capita (in 1980-dollars) /na.c	198.9	157.2	151.3	146.5	136.8 /e
MVA: /na.c (in million 1980-dollars)	0	0	0	0	0 /e
Growth rate (%) /na.c	-9.33	4.27	3.90	-4.56	-4.86 /e
Manufacturing share (%) /na.current prices	3.3	1.9	1.3 /e		

FRENCH GUIANA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	183	196	219	221	224 /e
Growth rate (%) /na.c	0.00	3.00	2.20	0.96	1.44 /e
Per capita (in 1980-dollars) /na.c	2649.6	2356.6	2230.6	2153.6	2132.0 /e
MVA: /na.c (in million 1980-dollars)	11	10	11	12	12 /e
Growth rate (%) /na.c	4.52	2.81	0.43	1.97	2.26 /e
Manufacturing share (%) /na.current prices					

FRENCH POLYNESIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1260	1767	2276	2285	2376 /e
Growth rate (%) /na.c	-2.93	5.35	5.11	0.40	4.00 /e
Per capita (in 1980-dollars) /na.c	8458.8	10042.5	11048.2	10727.9	10802.0 /e
MVA: /na.c (in million 1980-dollars)	83	128	184	191	201 /e
Growth rate (%) /na.c	1.78	-1.09	7.12	3.49	5.17 /e
Manufacturing share (%) /na.current prices	6.6	8.5	7.3		

GUADELOUPE	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1387	1412	1873	1870	1904 /e
Growth rate (%) /na.c	-4.66	0.76	6.09	-0.12	1.80 /e
Per capita (in 1980-dollars) /na.c	4240.7	4226.4	5459.2	5436.8	5502.6 /e
MVA: /na.c (in million 1980-dollars)	85	97	105	104	105 /e
Growth rate (%) /na.c	1.32	3.19	1.54	-1.07	1.36 /e
Manufacturing share (%) /na.current prices	6.3	4.9			

GUINEA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1897	1807	2190	2267	2314 /e
Growth rate (%) /na.c	5.60	3.89	4.00	3.52	2.08 /e
Per capita (in 1980-dollars) /na.c	425.1	362.2	381.0	383.4	380.3 /e
MVA: /na.c (in million 1980-dollars)	60	76	68	70	72 /e
Growth rate (%) /na.c	2.70	33.33	2.90	2.93	2.48 /e
Manufacturing share (%) /na.current prices	2.9 /e	2.0 /e	4.3 /e		

GUINEA-BISSAU	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	154	171	218	224	229 /e
Growth rate (%) /na.c	-4.19	-2.30	3.04	2.80	2.17 /e
Per capita (in 1980-dollars) /na.c	193.6	195.7	225.9	227.8	228.1 /e
MVA: /na.c (in million 1980-dollars)	12	11	10	10	10 /e
Growth rate (%) /na.c	-5.09	-5.95	1.25	0.14	-0.13 /e
Manufacturing share (%) /na.current prices	1.6 /e	1.6 /e			

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

GUYANA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	591	494	430	456	491
Growth rate (%) /na.c	1.66	1.02	-6.20	6.06	7.77
Per capita (in 1980-dollars) /na.c	778.2	624.3	540.5	573.2	617.0
MVA: /na.c (in million 1980-dollars)	64	45	29	23	32 /e
Growth rate (%) /na.c	0.76	-3.13	-16.67	-1.34	11.78 /e
Manufacturing share (%) /na.current prices	12.1	13.9	15.9	9.5	9.5 /e

HAITI	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1437	1365	1389	1377	1240
Growth rate (%) /na.c	7.34	0.26	-0.70	-0.81	-10.00
Per capita (in 1980-dollars) /na.c	267.5	231.8	213.3	207.3	182.9
MVA: /na.c (in million 1980-dollars)	274	228	220	215	173 /e
Growth rate (%) /na.c	14.69	-2.87	-0.51	-2.37	-19.32 /e
Manufacturing share (%) /na.current prices	18.3	15.0			

KOREA, DEMOCRATIC PEOPLE'S REPUBLIC	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	12730	20368	26618	25234	23972
Growth rate (%) /na.c	9.89	9.59	5.50	-5.20	-5.00
Per capita (in 1980-dollars) /na.c	697.2	1024.1	1223.5	1139.3	1063.1
MVA: /na.c (in million 1980-dollars)					
Growth rate (%) /na.c					
Manufacturing share (%) /na.current prices					

LAO PEOPLE'S DEMOCRATIC REPUBLIC	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	462	661	903	942	1011 /e
Growth rate (%) /na.c	1.70	9.83	9.10	4.30	7.30 /e
Per capita (in 1980-dollars) /na.c	144.1	183.8	218.5	221.6	231.2 /e
MVA: /na.c (in million 1980-dollars)	23	29	34	38	41 /e
Growth rate (%) /na.c	7.94	1.99	10.10	11.32	8.00 /e
Manufacturing share (%) /na.current prices					

LESOTHO	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	368	395	552	581	601 /e
Growth rate (%) /na.c	8.35	3.49	3.96	5.28	3.40 /e
Per capita (in 1980-dollars) /na.c	274.6	256.6	311.3	318.6	320.3 /e
MVA: /na.c (in million 1980-dollars)	21	37	65		
Growth rate (%) /na.c	16.00	4.36	-3.95		
Manufacturing share (%) /na.current prices	6.3	10.4	13.0	15.5	

LIBERIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	917	843	872	887	876 /e
Growth rate (%) /na.c	-6.29	-2.02	-1.99	1.70	-1.24 /e
Per capita (in 1980-dollars) /na.c	488.3	383.4	338.7	333.8	319.4 /e
MVA: /na.c (in million 1980-dollars)	77	75	80	83	83 /e
Growth rate (%) /na.c	-21.21	-1.61	-2.98	3.40	0.29 /e
Manufacturing share (%) /na.current prices	9.5	6.6	6.9 /e		

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

MALI	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1629	1666	2252	2248	2255 /e
Growth rate (%) /na.c	4.01	-0.11	2.45	-0.15	0.30 /e
Per capita (in 1980-dollars) /na.c	237.3	210.4	244.5	236.9	230.5 /e
MVA: /na.c (in million 1980-dollars)	71	105	121	121	125 /e
Growth rate (%) /na.c	1.58	-0.47	5.15	0.27	3.34 /e
Manufacturing share (%) /na.current prices	4.3	7.3	12.2		

MARTINIQUE	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1444	1797	2403	2525	2678 /e
Growth rate (%) /na.c	2.80	4.50	6.10	5.10	6.06 /e
Per capita (in 1980-dollars) /na.c	4415.4	5413.0	7045.6	7383.3	7785.0 /e
MVA: /na.c (in million 1980-dollars)	72	79	88	90	92 /e
Growth rate (%) /na.c	1.84	3.01	2.34	2.09	1.93 /e
Manufacturing share (%) /na.current prices	5.1				

MAURITANIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	829	874	1023	1018	1032 /e
Growth rate (%) /na.c	3.93	3.11	4.00	-0.50	1.39 /e
Per capita (in 1980-dollars) /na.c	534.6	494.4	505.8	489.7	483.2 /e
MVA: /na.c (in million 1980-dollars)	43	66	89	95	101 /e
Growth rate (%) /na.c	-1.39	7.80	5.30	6.76	6.28 /e
Manufacturing share (%) /na.current prices	5.6	12.8	12.9	12.0	

MONGOLIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1389	1911	2374	2070	1913
Growth rate (%) /na.c	3.43	5.51	4.47	-12.80	-7.60
Per capita (in 1980-dollars) /na.c	835.0	1000.8	1083.9	919.6	826.5
MVA: /na.c (in million 1980-dollars)	347	516	575	500	429 /e
Growth rate (%) /na.c	8.03	3.07	2.19	-13.20	14.20 /e
Manufacturing share (%) /na.current prices	29.3	32.6	35.0		

MONTSERRAT	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	24	27	44	48	48 /e
Growth rate (%) /na.c	10.22	4.73	11.06	8.44	0.30 /e
Per capita (in 1980-dollars) /na.c	2018.5	2241.1	3412.5	3436.3	3446.6 /e
MVA: /na.c (in million 1980-dollars)	1	1	2	2	2 /e
Growth rate (%) /na.c	10.73	0.00	8.12	9.99	6.28 /e
Manufacturing share (%) /na.current prices	5.7	5.5			

MOZAMBIQUE	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	2407	1914	2308	2319	2319 /e
Growth rate (%) /na.c	2.46	-8.82	3.10	0.50	0.00 /e
Per capita (in 1980-dollars) /na.c	199.0	139.6	147.5	144.3	140.6 /e
MVA: /na.c (in million 1980-dollars)	759	334	434	451	450 /e
Growth rate (%) /na.c	3.25	-11.98	4.40	3.90	-0.25 /e
Manufacturing share (%) /na.current prices	33.1 /e	14.9 /e			

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

MYANMAR	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	5851	7473	7238	7335	7423
Growth rate (%) /na.c	7.94	3.20	5.10	1.35	1.20
Per capita (in 1980-dollars) /na.c	173.0	199.1	173.7	172.4	170.9
MVA: /na.c (in million 1980-dollars)	558	722	721	723	731 /e
Growth rate (%) /na.c	7.46	2.14	7.00	0.27	1.11 /e
Manufacturing share (%) /na.current prices	9.5	9.9	8.2		

NAMIBIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	2007	1871	2156	2219	2241 /e
Growth rate (%) /na.c	0.18	0.00	6.00	2.90	1.00 /e
Per capita (in 1980-dollars) /na.c	1535.6	1232.0	1210.0	1205.9	1179.5 /e
MVA: /na.c (in million 1980-dollars)	79	83	92		
Growth rate (%) /na.c	-14.65	-3.54	5.91		
Manufacturing share (%) /na.current prices	4.0	4.3 /e	4.3 /e		

NEPAL	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1946	2471	3097	3269	3371
Growth rate (%) /na.c	-2.32	6.15	3.60	5.55	3.13
Per capita (in 1980-dollars) /na.c	131.0	146.1	161.7	166.4	167.4
MVA: /na.c (in million 1980-dollars)	78	101	105	107	108 /e
Growth rate (%) /na.c	-8.24	-9.86	2.46	1.16	1.52 /e
Manufacturing share (%) /na.current prices	4.3	4.8	5.1	4.7 /e	

NETHERLANDS ANTILLES AND ARUBA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	866	829	1003	1022	1012 /e
Growth rate (%) /na.c	4.06	-2.07	6.99	1.92	-1.00 /e
Per capita (in 1980-dollars) /na.c	4947.6	4555.5	5336.2	5381.1	5299.4 /e
MVA: /na.c (in million 1980-dollars)	75	73	81	83	85 /e
Growth rate (%) /na.c	4.52	2.80	1.94	2.42	2.71 /e
Manufacturing share (%) /na.current prices					

NEW CALEDONIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1183	1407	1686	1846	2012
Growth rate (%) /na.c	3.23	4.87	3.94	9.50	9.00
Per capita (in 1980-dollars) /na.c	8446.4	9192.8	10035.7	10796.3	11499.0
MVA: /na.c (in million 1980-dollars)	68	70	85	89	95 /e
Growth rate (%) /na.c	2.07	2.30	4.16	5.51	6.74 /e
Manufacturing share (%) /na.current prices	5.8	4.7			

NIGER	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	2538	2473	2639	2675	2718 /e
Growth rate (%) /na.c	4.90	5.70	2.80	1.35	1.60 /e
Per capita (in 1980-dollars) /na.c	454.3	374.1	341.5	335.4	330.3 /e
MVA: /na.c (in million 1980-dollars)	94	100	98	99	101 /e
Growth rate (%) /na.c	4.68	8.25	1.70	1.73	1.27 /e
Manufacturing share (%) /na.current prices	3.8	7.4	8.9 /e		

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex.

OMAN	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	5896	11850	14054	14757	15790 /e
Growth rate (%) /na.c	6.03	13.76	9.08	5.00	7.00 /e
Per capita (in 1980-dollars) /na.c	5991.6	9533.6	9344.5	9447.4	9728.7 /e
MVA: /na.c (in million 1980-dollars)	45	240	339		
Growth rate (%) /na.c	19.05	20.39	8.34		
Manufacturing share (%) /na,current prices	0.8	2.4	3.7	4.2	

PAPUA NEW GUINEA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	2549	2739	2841	3112	3391
Growth rate (%) /na.c	-1.91	4.31	-3.71	9.55	8.96
Per capita (in 1980-dollars) /na.c	825.9	791.2	733.3	785.3	836.7
MVA: /na.c (in million 1980-dollars)	242	268	239	243	279 /e
Growth rate (%) /na.c	-3.02	2.80	-14.54	1.50	15.06 /e
Manufacturing share (%) /na,current prices	10.5	11.0	12.2	9.7	9.7 /e

PUERTO RICO	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	15956	18412	22793	22793	23021
Growth rate (%) /na.c	1.07	8.16	2.00	0.00	1.00
Per capita (in 1980-dollars) /na.c	4975.3	5608.4	6549.7	6473.4	6462.9
MVA: /na.c (in million 1980-dollars)	5793	6552	7851	7899	8032 /e
Growth rate (%) /na.c	1.04	2.69	-0.23	0.61	1.68 /e
Manufacturing share (%) /na,current prices	37.2	39.2	40.0		

QATAR	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	7838	6342	7609	7876	8191 /e
Growth rate (%) /na.c	7.10	-3.91	10.50	3.50	4.00 /e
Per capita (in 1980-dollars) /na.c	34077.6	21211.1	20621.3	20456.0	20374.6 /e
MVA: /na.c (in million 1980-dollars)	258	389	598	651	714 /e
Growth rate (%) /na.c	11.20	3.64	14.61	8.96	9.66 /e
Manufacturing share (%) /na,current prices	3.3	7.8			

REUNION	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1999	2455	3008	3120	3267 /e
Growth rate (%) /na.c	4.20	3.49	4.00	3.74	4.71 /e
Per capita (in 1980-dollars) /na.c	3927.7	4488.9	5013.2	5107.0	5244.3 /e
MVA: /na.c (in million 1980-dollars)	190	217	266	278	289 /e
Growth rate (%) /na.c	0.86	3.36	8.90	4.43	4.09 /e
Manufacturing share (%) /na,current prices	10.2	8.7			

RWANDA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	1163	1347	1365	1324	1073
Growth rate (%) /na.c	6.01	4.41	-1.65	-2.96	-19.00
Per capita (in 1980-dollars) /na.c	225.2	220.7	188.6	176.9	138.5
MVA: /na.c (in million 1980-dollars)	178	202	233	215	
Growth rate (%) /na.c	12.30	6.96	-4.00	-8.00	
Manufacturing share (%) /na,current prices	15.8	14.2	15.2	14.8 /e	

For sources, footnotes and comments see 'Technical notes' at the beginning of this Annex

SAMOA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	112	109	106	117	111
Growth rate (%) /na.c	3.00	6.04	-4.52	2.83	-5.00
Per capita (in 1980-dollars) /na.c	718.4	568.2	525.5	565.2	548.1
MVA: /na.c (in million 1980-dollars)	19	13	13	19	19 /e
Growth rate (%) /na.c	-5.08	10.22	-2.77	4.09	-0.64 /e
Manufacturing share (%) /na,current prices	4.6	13.8			

SAO TOME AND PRINCIPE	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	47	33	39	40	40 /e
Growth rate (%) /na.c	2.59	-5.01	3.81	1.51	0.80 /e
Per capita (in 1980-dollars) /na.c	497.2	311.0	324.5	321.4	316.3 /e
MVA: /na.c (in million 1980-dollars)	3	3	3	3	3 /e
Growth rate (%) /na.c	0.00	-8.74	3.28	1.91	1.33 /e
Manufacturing share (%) /na,current prices	7.3	7.2 /e			

SEYCHELLES	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	147	158	197	201	205 /e
Growth rate (%) /na.c	-2.55	10.25	6.62	2.50	1.91 /e
Per capita (in 1980-dollars) /na.c	2302.4	2393.9	2807.1	2877.3	2891.0 /e
MVA: /na.c (in million 1980-dollars)	11	11	17	19	20 /e
Growth rate (%) /na.c	18.21	8.44	11.04	6.21	7.89 /e
Manufacturing share (%) /na,current prices	8.0	10.6	9.8		

SIERRA LEONE	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	758	828	888	913	946 /e
Growth rate (%) /na.c	3.00	8.53	3.01	2.82	3.54 /e
Per capita (in 1980-dollars) /na.c	232.1	226.0	214.2	214.9	217.1 /e
MVA: /na.c (in million 1980-dollars)	55	54	44	44	44 /e
Growth rate (%) /na.c	-5.57	-13.93	-3.96	0.00	0.31 /e
Manufacturing share (%) /na,current prices	7.5	4.8	9.7		

SOMALIA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	2755	3658	4075	3260	3032 /e
Growth rate (%) /na.c	-2.25	7.93	-1.60	-20.00	-7.00 /e
Per capita (in 1980-dollars) /na.c	515.3	574.2	540.8	418.3	376.2 /e
MVA: /na.c (in million 1980-dollars)	123	103	137		
Growth rate (%) /na.c	9.17	7.55	0.00		
Manufacturing share (%) /na,current prices	4.7	4.9	4.3 /e		

SUDAN	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	7807	7688	7355	7403	7551 /e
Growth rate (%) /na.c	-3.41	-2.90	-8.04	0.65	2.00 /e
Per capita (in 1980-dollars) /na.c	417.9	352.3	291.8	285.3	282.7 /e
MVA: /na.c (in million 1980-dollars)	673	744	816	869	878 /e
Growth rate (%) /na.c	-7.69	-0.26	4.99	6.45	1.05 /e
Manufacturing share (%) /na,current prices	8.9	8.8	9.0	9.5	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

SURINAME	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	891	879	921	895	908 /e
Growth rate (%) /na.c	-6.57	2.02	-1.66	-2.81	1.43 /e
Per capita (in 1980-dollars) /na.c	2522.9	2294.3	2182.6	2081.8	2068.2 /e
MVA: /na.c (in million 1980-dollars)	140	112	95	88	89 /e
Growth rate (%) /na.c	-10.52	6.45	-9.58	-6.95	1.00 /e
Manufacturing share (%) /na.current prices	17.6	12.5	10.2	9.9 /e	

SWAZILAND	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	543	637	836	856	891 /e
Growth rate (%) /na.c	3.28	2.35	4.60	2.50	4.05 /e
Per capita (in 1980-dollars) /na.c	963.7	959.4	1059.1	1049.6	1054.6 /e
MVA: /na.c (in million 1980-dollars)	102	119	171	179	189 /e
Growth rate (%) /na.c	11.17	-1.28	7.70	4.42	5.98 /e
Manufacturing share (%) /na.current prices	21.3	15.3	30.9 /e		

TONGA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	60	90	100	105	107
Growth rate (%) /na.c	15.81	5.37	0.80	5.30	1.90
Per capita (in 1980-dollars) /na.c	614.8	938.4	1052.5	1120.1	1141.4
MVA: /na.c (in million 1980-dollars)	3	3	4	4	5 /e
Growth rate (%) /na.c	21.44	6.26	2.98	9.10	6.31 /e
Manufacturing share (%) /na.current prices	6.1	8.2	...	...	...

TUVALU	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	4	...	...	...	...
Growth rate (%) /na.c	...	...	...	...	...
Per capita (in 1980-dollars) /na.c	525.0	...	...	...	...
MVA: /na.c (in million 1980-dollars)	...	...	...	...	...
Growth rate (%) /na.c	...	...	...	...	...
Manufacturing share (%) /na.current prices	...	...	...	...	...

UGANDA	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	4644	5284	6846	7130	7379
Growth rate (%) /na.c	-3.40	2.00	4.30	4.14	3.50
Per capita (in 1980-dollars) /na.c	354.0	337.7	364.6	366.1	365.3
MVA: /na.c (in million 1980-dollars)	192	194	333	354	374 /e
Growth rate (%) /na.c	6.10	-9.80	7.50	6.32	5.74 /e
Manufacturing share (%) /na.current prices	4.2	2.2	4.1		

UNITED ARAB EMIRATES	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	29629	27036	30375	32654	33796
Growth rate (%) /na.c	26.42	-2.39	17.75	7.50	3.50
Per capita (in 1980-dollars) /na.c	29162.0	20026.8	18984.6	19718.3	19729.4
MVA: /na.c (in million 1980-dollars)	1131	2547	2400	2636	2910 /e
Growth rate (%) /na.c	64.87	-2.20	5.38	9.83	10.40 /e
Manufacturing share (%) /na.current prices	3.7	9.0	7.2	7.5 /e	

For sources, footnotes and comments see "Technical notes" at the beginning of this Annex

VANUATU	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	113	171	185	191	191
Growth rate (%) /na.c	-11.46	1.11	4.70	3.40	0.00
Per capita (in 1980-dollars) /na.c	961.3	1250.6	1163.5	1173.6	1138.6
MVA: /na.c (in million 1980-dollars)	3	7	12	13	15 /e
Growth rate (%) /na.c	13.98	11.23	1.94	13.40	13.59 /e
Manufacturing share (%) /na.current prices	4.2	3.8	5.9		

VIET NAM	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	5630	7791	9338	9899	10700
Growth rate (%) /na.c	-4.81	6.20	2.40	6.00	8.10
Per capita (in 1980-dollars) /na.c	104.8	130.1	140.1	145.3	153.8
MVA: /na.c (in million 1980-dollars)					
Growth rate (%) /na.c	..				
Manufacturing share (%) /na.current prices					

YEMEN, NORTHERN PART	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	2779	3692	5433	5868	6090 /e
Growth rate (%) /na.c	6.04	10.31	6.80	8.00	3.79 /e
Per capita (in 1980-dollars) /na.c	437.1	484.4	590.8	614.5	614.3 /e
MVA: /na.c (in million 1980-dollars)	160	295	363	398	436 /e
Growth rate (%) /na.c	7.70	1.46	2.99	9.51	9.67 /e
Manufacturing share (%) /na.current prices	8.5	12.1	5.2 /e		

YEMEN, SOUTHERN PART	1980	1985	1990	1991	1992
GDP: /na.c (in million 1980-dollars)	668	892	918	944	960 /e
Growth rate (%) /na.c	3.68	-2.97	6.79	2.93	1.66 /e
Per capita (in 1980-dollars) /na.c	359.0	417.2	368.6	368.0	363.0 /e
MVA: /na.c (in million 1980-dollars)	48	88	87	90	93 /e
Growth rate (%) /na.c	-41.12	22.41	0.97	3.60	3.43 /e
Manufacturing share (%) /na.current prices	6.7	9.7			