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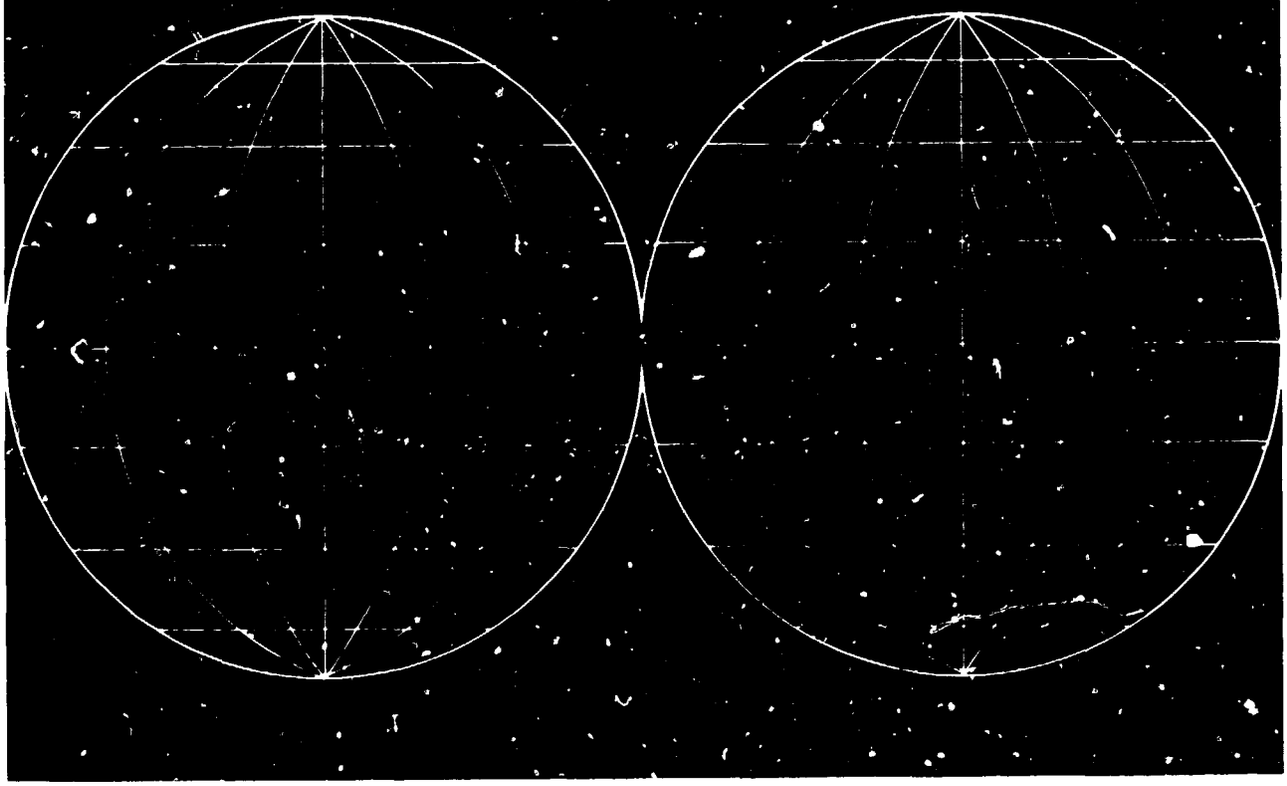
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

WORLD INDUSTRY IN 1980



UNITED NATIONS

WORLD INDUSTRY IN 1980

Regular issue
of the biennial
Industrial Development Survey

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna

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EXPLANATORY NOTES

Regional classifications, industrial classifications, trade classifications and symbols used in the statistical tables of this survey, unless otherwise indicated, follow those adopted in the United Nations *Statistical Yearbook*.

The following classification of economic groupings is used in the text and in most tables, in conformity with the classification adopted by the United Nations Statistical Office: "Developing countries" includes the Caribbean area, Central and South America, Africa (other than South Africa), the Asian Middle East (other than Israel) and East and South-East Asia (other than Japan). "Developed market economies" includes North America (Canada and the United States of America), Europe (other than Eastern Europe), Australia, Israel, Japan, New Zealand and South Africa. "Centrally planned economies" includes Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Poland, Romania and the Union of Soviet Socialist Republics. Unless otherwise specified, "world" excludes Albania, China, the Democratic People's Republic of Korea, Mongolia and Viet Nam. In some tables the classification may differ slightly from that given above, depending on the source cited.

Countries are generally arranged in the order adopted in the *Statistical Yearbook*. Inclusion of a particular country or area in, or its exclusion from, any economic or geographical grouping has been dictated by considerations of the availability of comparable data in statistics of the United Nations and other international agencies.

"Manufacturing" includes the industry groups listed in Major Division 3 of the International Standard Industrial Classification of All Economic Activities (ISIC) (United Nations publication, Sales No. 71.XVII.8) throughout this volume, unless otherwise indicated.

Reference to ISIC codes in the tables are accompanied by a descriptive title (for example, ISIC 323: "Manufacture of leather and products of leather, leather substitutes and fur, except footwear and wearing apparel"). Considerations of space, however, may require a shortening of this description (for example, ISIC 323 may be referred to simply as "Leather and leather products").

Dates divided by a slash (1960/61) indicate a crop year or a financial year.

Dates divided by a hyphen (1960-1965) indicate the full period involved, including the beginning and end years.

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

References to pounds (£) are to pounds sterling, unless otherwise stated.

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

Annual rates of growth or change refer to annual compound rates, unless otherwise specified.

In tables:

Apparent arithmetical discrepancies, such as details and percentages that do not add precisely to totals, are owing to rounding of the basic data or to differences in rounding of numbers known to different degrees of precision;

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

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

A blank indicates that the item is not applicable;

A minus sign before a figure (–2) denotes a deficit or decrease, except as indicated;

The names of countries are those in current official use.

The following abbreviations are used in this volume:

United Nations Secretariat

UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization

United Nations specialized agencies

ILO	International Labour Organisation

* * * * *

GATT	General Agreement on Tariffs and Trade
UNCTC	United Nations Centre on Transnational Corporations

Other organizations

ACP	Africa-Caribbean-Pacific
ASEAN	Association of South-East Asian Nations
CMEA	Council for Mutual Economic Assistance
EEC	European Economic Community
IISI	International Iron and Steel Institute
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries

Economic and technical abbreviations

DR	direct reduction
EP	export performance
GSP	generalized system of preferences
GW	gigawatt
ISIC	International Standard Industrial Classification
LEC	large energy consuming
MVA	manufacturing value added
n.e.c.	not elsewhere classified
NIC	newly industrializing country
NTB	non-tariff barrier
ODA	official development assistance
RCA	revealed comparative advantage
SITC	Standard International Trade Classification
TNC	transnational corporation
VERs	voluntary export restraints

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Introduction

Restructuring world industry, which is the central theme of this issue of the *Industrial Development Survey*, is a primary objective of many of the activities of the United Nations Industrial Development Organization (UNIDO). These activities range from a technical assistance programme expected to reach a level of over $200 million by 1986 to a system of consultations intended to facilitate the global spread of industrial capacity while minimizing many of the associated short-term adjustment problems.

Restructuring is understood here in an international rather than a national context. To define the concept briefly, economies are constantly in a state of flux because of structural changes such as technological advancement, the accumulation of capital, the growth of skilled labour and trends in taste. As a result, a country's ability to carry out efficiently various types of industrial activity is altered over time. These structural changes have an uneven effect on industry, in such a way that a country may become more efficient in producing some manufactured products in place of others. As resources and other economic inputs are redirected to new activities, some industries are destined to contract in terms of their shares in production, employment, investment or exports. A contraction in one branch (e.g. textiles) is usually accompanied by a corresponding expansion elsewhere in manufacturing (e.g. electronics or capital goods) or in another sector of the economy (e.g. services).

The pattern of structural change is similar among countries at comparable levels of development. The contraction of an industrial branch is often common to several countries, and it may be preceded by a corresponding expansion of that branch in other countries. This difference in timing leads to over-capacities or imbalances in the demand and supply of labour and capital, which, in turn, cause problems of national adjustment. Hence, it would be erroneous to regard restructuring as a concept applicable only to individual national economies. It may involve developed countries at varying levels of advancement. It may also link the economies of developed and developing countries or even developing countries at different stages of industrialization.

Clearly the concept embraces much more than a simple geographical transfer of production capacity (i.e. redeployment) from the developed to the developing countries. Nor does it merely entail scaling down existing capacity in the sense that the term is used by many industrialists. It requires adaptability to and acceptance of change by all participants, even though such change may have some unpleasant short-term consequences. In the long term, restructuring is in the interest of all countries; without it and the flexibility that would make it possible, the potential for world industrial growth would be diminished.

Restructuring world industry: new dimensions and prospects

Between 1950 and 1970, the rate of world industrial growth exceeded that of any comparable period in the last century. However, this growth was

confined largely to the developed countries, whose structural adaptability was essential to their growth performance. In chapter I, a comparison of the global distribution of population and net manufacturing output illustrates the imbalances and inequities associated with world industry. In 1960, the developing countries' share of world manufacturing value added (MVA) was 8.2 per cent, while their share of world population was 57.4 per cent. In 1980, the corresponding figures of world MVA and population were 10.9 and 65.0 per cent, respectively.[1] The share of the developing regions in world MVA in 1980 was distributed as follows: Africa, 1.0 per cent; Latin America, 6.1 per cent; and West, South and East Asia, 3.8 per cent.

In recent years, the structural adaptability of the developed countries has declined, jeopardizing the growth prospects of all countries. Several reasons for this phenomenon are examined in chapter I of this *Survey*. Briefly, these reasons are:

(a) The increase of foreign over domestic demand, which has led to the introduction of new types of policy designed to reduce the rate of structural change in developed countries;[2]

(b) A decline in the manufacturing sector's share of total employment in several developed countries;

(c) International shifts in comparative advantage, which have resulted in the contraction of some manufacturing branches in these countries;

(d) Changes in country shares of world production, which have altered the basis for negotiations on international policy issues pertaining to trade, investment, technology and industry.

Despite a mutual interest in industrial restructuring, pragmatic initiatives in one international sphere often lead to new difficulties in another. For example, developing countries that do not produce oil currently have about $100 billion of floating rate debt. Every one-point rise in the London interbank offered rate (Libor) increases their annual interest charges by $1 billion. In 1980, the Libor rose from 10 to 20 per cent largely owing to the efforts of central banks in developed countries to control inflation. Thus, a portion of the resultant burden was shifted to those developing countries that have been most active in international financial markets. At the same time, increasing their debt service requirements restricts these countries' available foreign exchange for purchasing imports from developed countries. Chapter I of this *Survey* explores various instances involving trade, investment and mineral extraction in which international policy in one field has had an unexpected or undesirable spillover in another field.

Industrial restructuring may also be affected by technological development in several ways. Innovation has led to basic changes in production processes, permitting the transnational corporations to disperse different parts of their

[1] Shares of MVA are calculated from data in United States dollars at 1975 prices. For further details see chapter I.

[2] In the case of trade restrictions, the policy goals of developed countries have undergone some profound changes. Originally, most trade restrictions (e.g. tariffs and quotas) were intended to be a macroeconomic control of balance of payments or employment problems. Current forms of trade restriction are designed to be a tool of structural policy and are therefore "sector-specific"; exchange-rate policies have replaced them at the macroeconomic level.

operations geographically in a way that would minimize the cost of each operation, while they retain overall control. Countries whose labour costs are relatively cheap have been the main recipients of such investment, which spans a wide range of industrial activities. For the host country, the ability to break up the production process has complex implications that differ greatly between industries and according to the policies of the recipient and of the investor.[3]

A trend that is particularly relevant for industrial restructuring is the spread of new protectionism. Protectionist policies have become increasingly sophisticated, going beyond simple trade-restricting or trade-expanding devices. Today, virtually all government activity affects international economic relations and embodies some protectionist element. Thus, it is not surprising that the developing countries' share of world exports of manufactures (SITC 5 to 8 less 68) has remained low. In 1979, it amounted to 8.7 per cent of the world total, or less than the corresponding share of these countries in world MVA.

Two types of protectionism have bearing on restructuring: defensive policies that slow the rate of contraction in a specific industrial branch and policies to aid already expanding industries. The former may go beyond the objective of gradual adjustment and attempt to prevent further contraction or even reverse it. In a departure from past practice, many of the present trade restrictions are tailored to meet the needs of given industrial branches or firms. Defensive measures may jeopardize growth and restructuring in several ways, each of which are examined in this *Survey*.

Policies to support already expanding lines of industrial activity are initiated for several reasons. First, attempts to postpone contraction in certain industrial branches (defensive policy) may delay expansion in others. Some compensation is necessary if industries with viable growth prospects are not to be handicapped when resources are diverted to contracting industries. Second, the growth of international trade has forced many countries to place higher priority on their competitive position vis-à-vis their main trading partners. This trend has coincided with declining rates of productivity growth and return on capital in developed countries.[4] Accordingly, many Governments have begun to search for new systems of capital goods—rather than investing to expand existing systems—as a means of stimulating productivity growth in a more competitive world environment. Finally, the outlays necessary for R and D in science-intensive industries have risen exponentially. For example rger proportion of R and D expenditures is financed by the Governme n by industry in France, the United Kingdom of Great Britain and Northern Ireland and the United States of America.[5]

An extensive quantitative investigation of recent trends also suggests mixed prospects for world industry. In the developed countries, several important industrial branches have grown very slowly in recent years. Data show that, over time, the composition of output within the manufacturing sectors of developed countries has become more uniform. No similar trend has been observed in the developing countries, however. In the study carried out here,

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[3]This aspect is analysed in some detail in the case studies appearing in chapter III.

[4]See, for example, Interfutures, *Facing the Future: Mastering the Probable and Managing the Unpredictable* (Paris, OECD, 1979), pp. 158 and 349.

[5]In the Federal Republic of Germany, industry's share of R and D expenditures is only slightly greater than the contribution of the Government.

the share of each economic grouping in world MVA was estimated at the branch level. The results indicate that the developing countries accounted for 13 per cent of the world's net output in food products, 16.9 per cent in the case of textiles and only 7.1 per cent for industrial chemicals. Their share in world output was consistently low with regard to every field of activity. Similar calculations of shares in world industrial employment reveal only modest progress on the part of the developing countries.

Some consequences of a general contraction in the manufacturing sector in developed countries may be seen by comparing the current situation in manufacturing to earlier trends in agriculture. Historically, as the agricultural sector contracted, resources and manpower were moved into manufacturing. These shifts (and the implicit costs that they entailed) took on social and political dimensions that were dealt with by political means. What emerged was a system of policies that isolated agriculture in part from the market dicta that otherwise governed resource allocation. Although agriculture continues to decline, it does so at a reduced rate because of the generous protective measures and subsidies accorded it by Governments in developed countries. It is generally recognized that such policies affect inequitably the exports of agricultural products from developing countries, e.g. exports of cane sugar from the African, Caribbean and Pacific (ACP) countries is adversely affected by the protection of beet sugar in EEC.

More recently, various industrial activities have replaced agriculture as the focus of contraction problems. Few developed market economies did not experience a decline in their share of output or employment in manufacturing during the period 1950-1980. Recent shifts in several centrally planned economies show a stabilization of or slight decline in industry's share of net material product and total employment. Opposite trends were observed for developing countries. A study of changes in the composition of net output in the manufacturing sector bears out the findings regarding shifts between manufacturing, agriculture and services. Among branches within the manufacturing sector, the composition of output in the developed countries is becoming more similar while no such trend is found for the developing countries. The industrial priorities and policies of all countries will eventually change to reflect the new realities. And these new priorities will also affect the formulation of policies regarding production, technological innovation, trade and investment.

Dynamic changes in comparative advantage and export prospects for the 1980s

A growing number of empirical studies have concluded that shifts in comparative advantage are occurring with increasing rapidity. For a number of manufacturing activities, these shifts favour industrialists in the developing countries.

In chapter II, a study is made of 134 specifically defined industries. These are divided into five overlapping product categories representing differing levels of technology, the degree of standardization or sophistication in the production process and the resource-using nature of the industry. Each category is further subdivided according to whether the industry's inputs are labour-intensive or

capital-intensive. The export performance of these industries in the mid-1960s is then compared to performance in the mid-1970s for a number of developing and developed countries.

It was found that among the more advanced developing countries, export performance in the manufacturing sector depended largely on a unique set of industries, different from those in developed countries or in other developing countries. Many of the product processes involved were first introduced in developed countries and later transferred to the more advanced developing countries. These processes are also fairly labour-intensive. By contrast, in other countries (both developing and developed) many of the leading export industries have substantial natural resource inputs or are closely linked to the agricultural sector.

The analysis is carried further by an examination of the extent of intra-industry trade (i.e. international trade between producers in the same industry). Such trade is found to increase with the level of development and to rise over time. For those industries where this trade is important, the likelihood of additional trade restrictions may be lessened. The benefits of intra-industry trade compared with the benefits from an exchange of unrelated products may not be substantial, although evidence on this point is incomplete.

With regard to the outlook for trade in manufactures during the 1980s, interest is focused here on three aspects relevant to the developing countries: *(a)* the prospects for expanding their exports of manufactures to developed countries; *(b)* the prospects for expanding trade in manufactures among themselves; and *(c)* their ability to pay for their imports of capital goods by exporting manufactures. During the period 1960-1977, the developing countries' exports of manufactures grew at an annual average rate of 11.9 per cent. There was a substantial difference, however, in the rates of growth according to destination; exports to the developed market economies grew at a rate of 10.2 per cent, while exports to other developing countries expanded at a rate of 15.5 per cent. In a comparison of the developing countries' exports of all manufactures to their imports of capital goods, the ratio of the former to the latter reached a high in 1972 and 1973 (61 per cent). Since that time it has declined alarmingly, dropping to 51 per cent in 1975.

On the basis of an econometric model and assumptions about growth and trade-related policies in the 1980s, five scenarios are derived to show the range of possibilities with regard to the three aspects of trade described above. Two are reference scenarios that assume a continuation of previous growth experiences and policy references. The first, "a cyclical view", presupposes that the slow-down of the 1970s will not last and that the rate of growth of the 1960s will be resumed. The second scenario assumes a secular growth pattern, and it is based on the hypothesis that the slow rate of growth persisting throughout the 1970s is only part of a longer-term trend.

The hypothetical results for 1990 are not encouraging. The developing countries would supply only about 8 per cent of all the developed market economies' imports of manufactures compared with 7.5 per cent in 1977. Furthermore, developing countries' total exports of manufactures would be equivalent to only 80 per cent of their imports of capital goods (ignoring imports of other essential items such as food and fuels).

Two additional scenarios relate to policy. The first assumes the continued spread of new protectionism in the developed countries, a tightening of international financial markets and, as a result, a policy shift in developing countries favouring import substitution instead of export promotion. On the basis of this scenario, entitled "export pessimism", the developing countries' ability to pay for imports of capital goods by exporting manufactures would be severely restricted, and the participation of these countries in world trade in manufactures would show little change from the present. Any relative gains would be owing to expanded trade among developing countries. The other policy scenario, which takes an opposite view, assumes that there will be no spread of protectionism and that the policies of developing countries will continue to favour export promotion. Yet even with this favourable policy environment, the share of developing countries in world trade in manufactures would be only 13.8 per cent in 1990, although their ability to pay for imports of capital goods and to supply manufactures to developed countries would increase.

The last scenario, entitled "collective self-reliance", assumes that the developing countries' exports of all manufactures will be roughly equivalent to their imports of capital goods by 1990. To achieve this result would require a pronounced export orientation, coupled with a resumption of the rate of growth experienced in the 1960s, progress on the part of the developed countries in addressing their domestic structural problems and a reduction of protectionist measures. Under these favourable conditions the developing countries would account for almost 16 per cent of world trade in manufactures by 1990 and would supply 12.5 per cent of all the developed market economies' imports of manufactures—both comparatively modest figures. The availability of industrial finance, from either domestic or international sources, would be a crucial element in this scenario, however.

In general, the econometric model demonstrates the very close interrelationship between growth in income, growth in trade and the direction of trade policy. If the developing countries are to continue to be an important market for capital goods produced by developed countries, the latter will need to relax or abandon protectionist policies, to revive the growth of income and to improve the international financial mechanisms for facilitating industrialization in developing countries. Finally, any improvement in terms of these criteria will also depend on an increase of trade in manufactures among the developing countries.

Restructuring world industry: trends and prospects in selected industrial branches

Despite recent obverse policy trends, the restructuring of world industry that began during the 1960s and 1970s remains a valid course for the 1980s. In chapter III, the process is examined through case studies of four branches of industry: chemicals and petrochemicals, iron and steel, engineering products and food processing. One conclusion that emerges from this study is that the major decisions facing industrialists, planners and policy-makers are increasingly dependent on factors outside the domestic economy. Another finding is that trends in industrial organization have led to a gradual overlapping of activities

in the public and private sector, diluting the "public" or "private" character of a given industrial enterprise. Yet comparatively little attention has been paid to a study of the nature of the relationship between public and private entities. Most observers have focused instead on problems of "efficient" pricing and investment and on assessments of differences in the operational objective of public and private enterprises. The fusion of functions and responsibilities of public and private enterprises is evident in both contracting and expanding industries. Both groups increasingly rely on state agencies to create the conditions necessary for their survival or expansion. At the same time, Governments are also becoming more dependent on the performance of these enterprises to achieve national objectives written into their political programmes.

A review of the development of the chemical and petrochemical industry reveals that it has passed through several distinct phases. Prior to the advent of petrochemicals, the industry performed a supplier's role, providing inputs to other industries. The development of petrochemicals led to a phase characterized by an entire new set of products intended for final consumers rather than for other industries. Chemicals and petrochemicals are rapidly entering a mature or service phase marked by *(a)* the desire to increase value added to compensate for a declining rate of growth, *(b)* a service orientation designed to satisfy the more specific demands for final users and *(c)* an increasing willingness to sell their know-how to other industries.

Contributing to the new phase of the industry are rising feedstock costs, which have changed operational concepts, making chemicals a feedstock-intensive rather than a capital-intensive industry. As a result, economies of scale that are realized by building larger plants will not necessarily lead to substantial cost advantages. Another consequence is that the tendency to emphasize applied instead of pure research will accelerate as firms search for new ways of reducing the costs of raw materials and feedstocks. Finally, the industry's growing maturity is reflected in its new political orientation evidenced by the spread of state-owned producers. Government action that arose out of environmental concerns now goes far beyond this aspect.

The responses of the developed countries to these new conditions in the industry differ greatly, ranging from a programme of rationalization, coupled with joint ventures with developing countries, to extensive protection (i.e. defensive policies) and regulatory controls to remedy problems of over-capacity. Disputes between developed countries have become frequent as defensive policies have distorted patterns of investment and trade.

At the same time, the competitive position of several developing countries has steadily improved, owing in part to their access to cheaper feedstock supplies. The new willingness of some producers in developed countries to sell their know-how has also facilitated the spread of capacity. Still, producers in developing countries have yet to become full-fledged international participants in the chemical industry (including investment and trade aspects), and the spread of new protectionist measures will further delay this transition and complicate the adjustment process.

A review of the iron and steel industry also reveals several distinct phases. A steady, if not remarkable, rate of growth was maintained from 1960 to the mid-1970s. Since then, world output of steel has fluctuated erratically. In 1980, it dropped 4 per cent below the levels in the previous year. Producers in

developed market economies were hardest hit; output declined 18.2 per cent in the United States and 8.3 per cent in EEC.

Explanations for this slump are essentially structural in character. First, the demand in the major steel-using industries (automobiles, shipbuilding) fell as their own production efforts were cut back. The present growth industries (telecommunications, space and computers) are not intensive users of steel. Second, new materials such as aluminium, plastics and glass have replaced steel in many traditional uses. Technical progress in steelmaking (e.g. continuous casting) has reduced crude steel requirements per unit of finished steel. Finally, consumers have economized on the amount of steel they require by designing lighter machines and engines.

A study of the industry during the last three decades reveals a changing relationship between trade and production. The share of exports in production rose from about 11 per cent in 1950 to over 24 per cent by the mid-1970s. Continuous efforts to realize economies of scale were one reason for the shift. The importance of trade has also been ennanced owing to the variety of product characteristics desired by consumers and the degree of production specialization this has entailed. With the growth of trade, defensive policies and trade restrictions have proliferated. In the United States, a "trigger price mechanism" has become a key policy measure, while EEC has focused on efforts to establish a producers' cartel, to regulate investment and to rationalize the industry.

In the engineering goods industry, differences between firms in the developing and the developed countries are particularly marked. Moreover, there are substantial differences among the various product groups. Engineering is no longer a field of rapid growth as it was in the past, with the exception of specific product lines such as semiconductors, basic components and electronic capital goods. The industry has experienced three stages of industrial expansion and restructuring: the first began with the industrial revolution; the second took place in the early 1950s as the capacity to produce engineering goods spread rapidly from one developed country to another; and the third has occurred more recently in the developing countries, in part as the result of a policy decision to achieve self-reliance in capital goods.

In developed countries, the emphasis on innovation reflects a growing government-industry relationship. A new generation of key industries is emerging, consisting partly of new electronic components and electronic capital goods and embracing fields such as automation, data processing and telecommunications. The nucleus for this electronic complex are firms producing micro-circuits, which are finding widespread application in the production of automobiles, ships, electronic products, in computers and telecommunications, and in consumer electronic products.

In the developing countries, transnational corporations (TNCs) have been an important vehicle for the relocation of engineering products. Their investments are usually identified with activities that have a comparative disadvantage in developed countries (e.g. they require large amounts of unskilled labour). Examples of this investment flow are automobile assembly and parts production and electronics parts and units products.

The food-processing industry differs from the other industries considered in chapter III in terms of its characteristics of production and supply. It has a strong

link with agriculture (processing value added tends to be about one quarter of output value), but not with other industrial branches. International marketing ties and post-colonial connections are important influences on trade, investment and the operations of th ansnational corporations in this area. TNCs predominate in the export of luxury foods produced by large agribusinesses. Significantly, this type of product accounts for about one quarter of the developing countries' production of processed foods. Virtually all these exports are marketed by a few TNCs that are dependent on the host country for raw materials and labour but that import other inputs and services.[6]

In many developing countries the agricultural sector accounts for more than 50 per cent of total employment and almost one quarter of GDP. Because of the close link between agriculture and food processing—and characteristics peculiar to demand and production technology—this industry accounts for a large portion of the developing countries' net manufacturing output. For example, in the mid-1970s food-processing activities contributed to almost 20 per cent of the developing countries' MVA. Among the poorer countries, particularly the least developed ones, this share was substantially higher.

The growth of net output in food processing has lagged behind that of other industries for the following reasons: *(a)* the demand for food products tends to be rather income inelastic at higher income levels; *(b)* input supplies are largely limited by the availability of land; and *(c)* technological changes that would allow cost reductions are difficult to achieve. As a result, food-processing activities have not played a large role in recent world industrial restructuring. The most important trends have been the increase in production and consumption of frozen and fancy foods in developed countries, the emergence of a few developing countries, particularly Brazil, as major exporters, and increased processing of exports by developing countries. The low rate of increase in the world *per capita* availability of several important food products in the period 1970-1977 was also significant. Finally, with regard to production-trade relationships, there has been little variation among countries in the ratio of imports to consumption (typically about 20 per cent so that many countries are close to being self-sufficient), but ratios of exports to production vary widely.

Energy requirements in manufacturing—some implications for restructuring

In the 1980s, the demand of the developing countries for energy is expected to grow at about 6 per cent per annum, or a rate below the corresponding rates during the 1960s but substantially higher than the growth of 2 to 3 per cent forecast in the demand for energy in developed countries.[7] In the longer term, most forecasts predict some redistribution of energy consumption. For example, one recent study indicates that the energy requirements of OECD

[6] *Far Eastern Economic Review*, 11 July 1980.

[7] The recent rise in rates of energy consumption in developing countries is partly owing to a statistical discrepancy resulting from the underestimation of energy consumption in earlier years. Today, developing countries are shifting from "non-commercial" energy forms (e.g. wood, waste crops and dung), which were often underestimated in calculations, to coal and oil, which are more easily measured.

countries could double by the year 2000.[8] Estimates of the developing countries' requirements are more tentative, but some forecasts predict an increase of between twofold and sevenfold by the year 2000.

These prospects mean that investment and conservation in this field will be crucial for all countries. In terms of investment, the developing countries now devote about 1.3 per cent of their GNP to energy production and conversion. By 1990, this share will probably exceed 3 per cent. The total investment of developing countries and developed market economies in new energy equipment during the next 20 years has recently been estimated at $10 thousand billion (at 1979 prices).[9] Much of the developed countries' investment may go into the diversification of energy sources away from oil. Such a shift is important since, in 1979, oil accounted for 45 per cent of total energy consumption, although it represents less than 3.8 per cent of known energy raw material.[10] A related concern, however, is that crude oil and its derivatives are the most effective energy sources for developing countries. Thus, excessive rates of depletion of oil reserves will place a particularly heavy burden on energy-poor developing countries. Hence, there is urgent need for greater conservation.

Available evidence on energy consumption by manufacturing indicates that expenditures on energy have risen at a much faster rate than the rate of growth of MVA. By this measure, Japan's increases were the largest in the 1970s, followed by the United States. The most energy-intensive industrial branches, in the order of declining importance, were: iron and steel, non-ferrous metals, non-metallic mineral products, paper, and miscellaneous products of petroleum and coal. A comparison of this pattern among several countries reveals a wide difference in figures for the same industrial branch. Differences in production technologies, types of specific products being produced and scale of operation account for such variations.

A detailed examination of energy-saving advances in production technology points to several conclusions. First, it is likely that many innovations intended to reduce energy use will favour the location of industry in developed countries. Second, the evidence does not suggest that large-scale and widely disseminated technological changes of a clearly defined and universally applied nature are being undertaken. Instead, in all the industrial branches whose experience was examined, recent or anticipated changes are modest, have a parochial application and a phased introduction. Notwithstanding the piecemeal or parochial nature of these changes, their cumulative effect is significant. Despite the inherent difficulties of interpreting measures such as energy/output ratios, it appears that, in many cases, the use of industrial energy has been reduced.

The chapter on energy concludes with a case study of India. In that country, the growth of energy consumption has exceeded industrial growth as the result of structural changes in the economy and in the industrial sector. Industry consumes nearly 60 per cent of commercial energy and therefore energy itself is one of the most crucial industries and not merely part of the

[8] Interfutures, *op. cit.*, p. 35.

[9] Estimate of the Dresdner Bank of the Federal Republic of Germany at the eleventh World Energy Conference in Munich, as cited in the *Financial Times*, 8 September 1980. The estimate excludes centrally planned economies.

[10] *Ibid.*

country's infrastructure. In India, energy will continue to require nearly 30 per cent of the planned allocations for the next two decades. Owing to the substitution of human, animal and non-commercial energy by commercial energy, and to increases in the quality of outputs, energy consumption norms have increased in some industries.

Changes in energy sources may favour the greater use of coal and, later, solar alternatives for process heat. In the next two decades, the growth in energy requirements, compatible with a 7.2 per cent growth rate in industry, would be 7.5 per cent for electricity, 2.3 per cent for fuel oil and 8.7 per cent for coal.

The transnational corporation as an agent for industrial restructuring

The operations of transnational corporations in developing countries may bring benefits but they also entail costs. If the investment of TNCs reflects changing patterns of comparative advantage, their activities may contribute significantly to industrialization in the developing countries, particularly countries suffering from a shortage of investment funds. TNCs can be an important means of channelling finance from contracting industrial branches in developed countries to expanding ones in the developing countries. Thus, they can be an important agent for restructuring if the negative aspects of their operations can be avoided. Among the major drawbacks of extensive reliance on TNCs are the possibilities that *(a)* their investments are concentrated within industries that are monopolistic and *(b)* that their operations lead to minimal backward and forward linkages with locally owned industries. In such cases, the impact of their investment on the industrial development of host countries is likely to be limited. Several studies have found that the extensive presence of TNCs is sometimes associated with subsequent declining rates of income growth. TNCs sometimes employ technologies that are not suitable to the host country. Moreover, they may not effectively participate in the export expansion strategies of developing countries. These factors adversely affect attempts to increase co-operation between TNCs and the Governments of developing countries.

Governments of developing countries can, however, introduce policy measures to ensure that the investment of TNCs shall contribute to industrial restructuring in accordance with changing comparative advantage. Much can also be gained by dismantling policies that attract TNC investment in relatively inefficient industries. Such measures, if coupled with policies to promote linkages between TNCs and domestic enterprises, can enhance the development impact of TNC investment. In some developing countries—notably India—government policy has successfully increased the level of local subcontracting undertaken by TNC subsidiaries. In others—such as Malaysia and Singapore—TNCs have been induced to invest in a number of labour-intensive industrial branches. Moreover, with effective use of joint ventures, TNCs can help to overcome protectionist barriers in many international markets.

An empirical analysis presented in chapter V reveals that TNC investment behaviour is best explained by models that relate growth in fixed assets to levels of sales and capacity utilization. In other words, the investment of TNCs is likely to be affected by the general economic environment prevailing in the host

economy. The analysis also shows that short-term profitability is less of a constraint on the expansion of investment by TNCs than it is for investment undertaken by locally owned private firms. The result suggests that attempts to attract transnational investment through fiscal concessions that guarantee artificially high profit rates (and that are thus uneconomic) are short-sighted. Such policies are not likely to augment TNC investment significantly and—what is more important—they do not give the correct investment signals to TNC investors. TNC investment can contribute more effectively to development if it leads to the expansion of industrial activities in which the developing countries enjoy international comparative advantages. A developing country that adapts its industrialization strategy to changes in comparative advantage is most likely to attract TNC investment in the appropriate industrial branches. Under these conditions, there may be less incentive for the TNC to transfer profits abroad by such means as overpricing inputs and salary remittances. It is likely that TNCs will develop a longer-term perspective towards economies that steadily improve the degree of their international competitiveness and that display evidence of substantial economic potential and viability.

Such developing countries can also devise a number of policies to counter transfer pricing. They may channel imports through independent national trading agencies and encourage national participation in the equity of TNCs. They can make use of international agencies—particularly those within the United Nations system—to monitor international prices. Above all, regional co-operation schemes may improve the bargaining power of Governments of developing countries vis-à-vis transnational corporations. An attempt should be made to induce TNCs to participate effectively in a process of international industrial restructuring that relocates productive capacity in accordance with changing comparative advantage. Restructuring in this form encourages an international division of labour that allows both developed and developing countries to realize their economic potential.

I. RESTRUCTURING WORLD INDUSTRY: NEW DIMENSIONS AND PROSPECTS

A. THE RESTRUCTURING PROCESS[1]

Industrial restructuring, as it is described in the introduction to this *Survey*, is essential for growth and, in the long term, works to the mutual benefit of both the developing and the developed countries. The concept of industrial restructuring is first examined here from an international perspective. It is then considered from the standpoint of its interrelationship with the growth of world industry.

The data in this chapter indicate that the rate of industrial growth between 1950 and 1970 far exceeded that in any comparable period within the last century, although, by 1980, the pace had slowed. The ability of countries to restructure, thereby permitting a greater degree of international specialization in production, was essential to the success achieved in the earlier years when the structural adaptability of the developed countries has been described as "remarkable".[2]

To date, the international spread of industrial capacity has been largely confined to the developed countries. Since 1950 new industrial capacity has been created at an extraordinary rate in both the centrally planned economies and the developed market economies. Significantly, the process had not impaired the growth performance of countries that were already established industrial leaders. While their shares in world income or manufacturing value added (MVA) have declined, their absolute and *per capita* growth has continued at a brisk pace. Although restructuring has not been free of costs to the established participants (i.e. today's developed countries), the potential gains have far outweighed such costs as retraining labour or scrapping obsolete capacity.

Another aspect of the restructuring process involves shifts in industrial capacity between developing countries. As yet, such structural adjustments are limited in scope and magnitude, reflecting the small share of world MVA of these countries. Textiles, an industry with a comparatively long history in the developing countries, is a good example. In the countries of Asia, modern production of cotton fabrics was well under way by the 1950s. The first restructuring phase was mainly related to the growth of production in Hong

[1]The restructuring process has been the subject of considerable study in UNIDO. For an analysis and a summary of empirical results in the developed market economies, see *Structural Changes in Industry* (United Nations publication, Sales No. E.81.II.B.2).

[2]Interfutures, *Facing the Future: Mastering the Probable and Managing the Unpredictable* (Paris, OECD, 1979), p. 69.

Kong, the Republic of Korea and Singapore and a corresponding slow-down of capacity expansion in Japan.[3] More recently, a second phase has begun. In Hong Kong and in other early entrants into the textile industry, producers are striving to upgrade their quality and move into better fashion lines. At the same time the production of mass-produced textiles using labour-intensive methods is shifting to neighbouring countries.[4]

Instances of restructuring involving only developing countries are too isolated as yet to show an effect on trade, investment or the transfer of technology. However, if such trends should emerge, they would boost trade between these countries, broaden their opportunities for technical co-operation and promote collective self-reliance.

At present, the possibilities for restructuring are almost entirely contingent on structural adjustments linking the manufacturing sectors of the developing and the developed countries. Several developing countries have reached a level of industrial sophistication whereby they could logically become full participants in the restructuring process, and others may soon attain this threshold. At the same time, many developed countries appear to have lost the inclination to continue to participate in the restructuring process. The structural adaptability of these countries has diminished, at least temporarily. It is difficult to put forward precise reasons for this lack of adaptability, although it may be explained in part by the following phenomena. First, world trade expanded rapidly between 1950 and 1970. Consequently, foreign demand grew more rapidly than domestic demand and, in the process, reduced the effect of some national policies designed for macroeconomic regulation. The result was increased uncertainty in the growth process and the emergence of new types of policy initiative.

Second, long-term employment trends reveal a decline in the manufacturing sector's share of total employment in several developed countries.[5] While earlier types of employment shifts, i.e. from agriculture to manufacturing or within the manufacturing sector, were easily accomplished,[6] displaced workers cannot readily transfer from the manufacturing to the tertiary sector where employment has been growing. These and other circumstances may have contributed to a "mismatch" in the demand for and supply of resources, including labour. Thus, when major structural shifts occur, labour and other resources do not flow immediately from unprofitable or contracting activities to new ones with growth potential. During the period of transition, the growth of income may be reduced. The mismatch in resource requirements is reflected in the simultaneous existence of labour shortages in some areas and job shortages in others, together with long delivery delays in some products and surplus capacity in

[3]This was aided by policy incentives introduced by Governments of the developing countries and direct joint investments by Japanese textile manufacturers and trading companies which encouraged the rapid transfer of production technology, management skills and marketing techniques.

[4]National differences in wage rates and the cost of raw materials as well as comparatively extensive trade restrictions have all been contributing factors in this second restructuring phase.

[5]This point is documented in a later section of this chapter.

[6]Jobs in the tertiary sector frequently do not apply to the registered labour force; they typically pay less than jobs in manufacturing and are often only part time. Thus, they are more attractive to new workers than to those previously employed in industry.

others.[7] Although the resultant unemployment pressures may be transitory, Governments are inclined to respond by holding back the rate of structural change, thereby limiting the restructuring process.[8]

Third, policy-makers in developed countries have yet to fully appreciate the long-term consequences of industrial growth and structural change. In the early-to-intermediate stages of development the manufacturing sector tends to grow at a disproportionately rapid rate. Consequently, the prices of manufactured goods fall relative to those for other goods produced by services or agriculture.[9] Between 1965 and 1980 there was a substantial rise in the ratio of commodity prices to the prices of manufactures. The developed countries bore the brunt of this shift since they were heavily specialized in manufacturing. Faced with a deterioration in real prices, investors shifted from manufacturing to other sectors. Thus, contraction in some fields of manufacturing was a sensible response to new world price conditions and market structures that reflected changes in comparative advantage gained in non-industrial activities. Some observers, however, regarded the contraction of manufacturing (which reflected only one side of the shift) as a seriously damaging trend and called for both macroeconomic and industry-specific policies to reverse the trend.

Fourth, the formulation of international policy in the developed countries has become increasingly multipolar. The dispersion of capacity among these countries has altered each country's approach to questions of international policy pertaining to industry. And as their shares in world production have changed, so have their capacities to influence international industrial policies. In the case of MVA, such trends are clearly evident in the data presented in this chapter. The result has been that the basis for negotiations on international policy issues pertaining to trade, investment, technology and industry has undergone a subtle readjustment reflecting the new environment.

Faced with such sweeping changes, the Governments of developed countries are generally more prone to try to reduce uncertainties by isolating in part their national economies from international developments. In doing so, however, they implicitly reject the restructuring process which has spurred the growth of world industry and, at the same time, place restraints on the industrial prospects of those developing countries that are now capable of participating in the restructuring process.

The benefits of long-term, continued industrial restructuring

During the 1970s many observers in the developed countries regarded the economic situation as recessionary, implying that it was temporary in character

[7]The possibility of such mismatches are explored by Michael Beenstock and Patrick Willcocks in "The causes of slower growth in the world economy", Discussion Paper No. 76 (London, London Business School, 1980).

[8]Protectionist forces have originally attributed unemployment partly to import penetration by the developing countries. Various studies by ILO, OECD, UNCTAD, UNIDO and individual economists have shown rising productivity and fluctuations in aggregate demand to be much more important. See *World Industry since 1960: Progress and Prospects* (United Nations publication, Sales No. E.79.II.B.3), p. 18.

[9]For an extensive analysis of this growth characteristic, see *World Industry since 1960* . . . , chap. II and the annex to that chapter.

or part of a short-term business cycle. As late as 1977 a group of experts concluded that it resulted from "an unusual bunching of unfortunate disturbances unlikely to be repeated on the same scale, the impact of which was compounded by some avoidable errors in economic policy".[10] The Governments of most developed countries reasoned that a recession was best resolved by marginal changes in policy and patient statesmanship. There is growing scepticism, however, about the efficacy of this approach. In the developed market economies, discontent with current economic policies in dealing with the problem of stagflation has grown. Demands for new policies reflect an increasing realization that the economic malaise cannot be remedied by marginal adjustments in policy.

For the developing countries, there is an urgent need for major revisions in international policy. To this end various proposals have been put forward since the 1970s within the context of the call for a New International Economic Order. Advocates stress that dissatisfaction with policy arises from an acute need for greater equity in the world distribution of wealth. Many among them tend to take a long-term view of the problem. Mahbub ul Haq, for one, has observed that "restructuring the international order so as to make it more equitable and responsive to the needs of the poor nations is a long-term process, not an event. It will require patient work on both sides if negotiations are to succeed".[11]

The distinction between the two lines of thought reflects a conflict between short-term and long-term perspectives. When current economic problems are described as "recessionary", the importance of resource reallocation and the need for restructuring may well be overlooked. However, although important differences over substance remain, there is a growing consensus that placing emphasis on marginal policy changes may be myopic and self-defeating.

If a consensus is emerging on the appropriate time horizon, it is then urgent that international discussions turn to more constructive matters; specifically, the identification of areas of mutual interest for the developing and developed countries which could provide a guide for prompt action. The benefits that would accrue to the developing countries through a reform of existing international systems have been analysed extensively elsewhere.[12] Emphasis here is on the mutual interests of both the developing and the developed countries.

A number of studies have indicated that the developing countries made a positive and important contribution to world growth during the economic

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[10]*Towards Full Employment and Price Stability*, a report to the OECD by a group of independent experts, Paul McCraken, Chairman (Paris, OECD, 1977), p. 103.

[11]Mahbub ul Haq, "A view from the South: the second phase of the North-South dialogue", *The United States and World Development* (New York, Praeger, 1979), p. 115.

[12]Several major studies of the developing countries' proposals for a New International Economic Order are available. They include Albert Fishlow and others, *Rich and Poor Nations in the World Economy* (New York, McGraw-Hill, 1978); Jagdish N. Bhagwati, ed., *The New International Economic Order: The North-South Debate* (Cambridge, Mass., MIT Press, 1977); and G. K. Helleiner, ed., *A World Divided: The Less Developed Countries in the International Economy* (New York, Cambridge Press, 1975).

downturn beginning in the 1970s.[13] Their purchase of manufactures raised substantially the employment levels and foreign-exchange earnings of the developed countries throughout the period. Observers have noted that the balance-of-payments deficit of the developing countries sustained demand comparable to a vigorous expansion of demand from the Federal Republic of Germany.[14] A good example is provided by trade in textile machinery and textiles. In one year (1977) the developing countries imported $2 billion worth of textile machinery from the developed market economies.[15] In addition, the developing countries were suppliers of low-cost consumer goods to developed countries and thus helped to alleviate inflationary pressures in the latter countries. None the less, the balance of trade in manufactures increasingly favoured the developed countries. Ironically, the ability of the developing countries to export textiles to the developed countries, from which they first purchased the productive capacity, is limited under the terms of the present Multifibre Agreement. The reluctance to grant wider market access to the manufactured exports of developing countries is discussed extensively elsewhere in this *Survey*. It is sufficient to note that such approaches lessen the potential benefits of industrial restructuring for all participants.

Other opportunities exist for spurring industrial restructuring. For example, there is widespread concern about the decline in the exploration undertaken in the developing countries for minerals and sources of energy. These countries' ability to maintain national sovereignty over their resources depends on the ability of their industrial sectors to participate in the exploration, production and processing phases. For this reason, coupled with the possibility of global shortages in strategic commodities and an acknowledged inefficiency in present arrangements, new agreements should be negotiated that would serve mutual interests.[16]

One possible guide—although certainly not the only one—for determining specific areas of mutual interest is provided by international changes in comparative advantage.[17] Such shifts in the industrial sector point to the need for a redistribution of productive capacity. Changes in international comparative advantage are traced in subsequent chapters of this *Survey*. Trends in a

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[13]See for example, *North-South: A Programme for Survival*, Report of the Independent Commission on International Development under the Chairmanship of Willy Brandt (London, Pan Books, 1980), p. 106 (hereafter referred to as the *Brandt Report*); World Bank, *World Development Report, 1979* (Washington, D.C., 1979), p. 23; OECD, "The impact of the newly industrialized countries" (Paris, 1979); UNIDO, "The impact of trade with developing countries on employment in developed countries: empirical evidence from recent research", Working Papers on Structural Change, No. 3 (UNIDO/ICIS.85), p. 84; and Michael Noelke, *Europe-Third World Interdependence: Fact and Figures* (Brussels, Commission of the European Communities, 1979), p. 54.

[14]John A. Holsen and Jean L. Waelbroeck, "The less developed countries and the international monetary mechanism", *American Economic Review*, vol. 66, No. 2 (May 1976), p. 175.

[15]*The Economist*, 6 December 1980.

[16]Some economists, however, have maintained that the interest of many developed countries in negotiating new arrangements is limited only to strategic commodities and does not extend to commodities which they regard as non-strategic. See Gerald K. Helleiner, *International Economic Disorder* (London, MacMillan, 1980), p. 13.

[17]If economic efficiency is accepted as a guide to the location of industrial capacity, it does not mean that social efficiency will follow. For a thorough discussion of this point, see Gerald K. Helleiner, "World market imperfections and the developing countries", Occasional Paper No. 11, NIEO Series (Washington, D.C., Overseas Development Council, May 1978).

number of industrial branches clearly favour the developing countries. In others, the developed countries may retain lasting competitive advantage.

Deep-seated pressures for adjustment in the manufacturing sector multiplied during the 1970s. Observers in the developed countries often attributed such pressures to dramatic shifts in the location of world industrial capacity. The data and analysis included here indicate, however, that this interpretation is not altogether accurate, in particular if it is applied to the developing countries. In fact, the mounting pressure for adjustment being experienced by many manufacturers in the developed countries stems partly from their reluctance to endorse structural changes and to adapt to them in the same fashion as they did in the 1950s and 1960s.[18]

The *Brandt Report* indicates a number of areas in which policy could be reformulated to great potential advantage, opening the way for the international community to extract itself from what otherwise might be a persistent state of depression. The initiatives specified could serve the mutual interests of the developing and the developed countries. Some of them are noted briefly here:[19]

(a) The purchase by developing countries of goods manufactured in developed countries is a less inflationary process than the demand generated by public-sector borrowing and expenditure, since such purchases are directed to sectors with excess capacity;

(b) Improving the access of developing countries to markets in the developed countries can help to abate world inflation because many of the former countries' exports are cheaper in price than similar goods produced elsewhere;

(c) It may be unrealistic, in the 1980s, to expect that commercial banks can sustain the expansion of credit to the developing countries without assistance from the Governments of the developed countries. Without such assistance the developing countries' demand for imports will be severely constrained with consequent deleterious effects on industrial growth in the developed countries;

(d) An expansion of world trade can increase productivity in the developed countries, raising rates of capacity utilization. The developed countries would then be in a position to capitalize on their comparative advantages in capital and technology-intensive industries and to reallocate resources within their domestic economies to maximize their growth potential.

In conclusion, it is essential that future changes in the world industrial map be guided, at least in part, by the principle of mutual interest, for two principal reasons. First, the economic prospects of the developed and the developing countries are closely linked and world progress will depend on their improved co-operation. The alternative is an uncertain and uncomfortable

[18]Notably, a recent GATT study has pinpointed the late 1960s as a turning point when "a general difficulty of adjustment began to be felt in the advanced industrial countries" for various reasons. See Richard Blackhurst, Nicolas Marian and Jan Tumlir, *Trade Liberalization, Protectionism and Interdependence*, GATT Studies in International Trade, No. 5 (Geneva, 1977), p. 50.

[19]See *Brandt Report*, pp. 67-71.

future for the developed countries and increasingly dismal prospects for the developing countries. Second, the ability of the international community to maintain, or to regain, momentum for growth depends on its willingness to accept structural change as a continuing feature of economic life. The difficulty lies in translating this long-term vision into immediate and practical policy action in the face of the concerted opposition of domestic interest groups in some developed countries to each individual proposal. In the following discussion some of the implications of structural change for industrial finance and technological transfer are examined, and current policy trends arising from the pressures of interest groups in developed countries are identified.

Financing the restructuring process[20]

The conditions governing the availability of international finance to the developing countries are well known. There has been a long-term downward trend in official development assistance (ODA) while non-concessional funds have risen as a proportion of the total. Consequently, while the debt of the developing countries increased threefold during 1970-1977, annual debt service charges rose fourfold.[21] Between 1980 and 1985, the existing debt of the developing countries would have to increase by $300-$500 billion in order to sustain their growth.[22]

Non-concessional debt is spread very unevenly among the developing countries. Today, five developing countries account for over 40 per cent of all commercial loans to non-oil producers in that economic grouping. Developing countries that do not produce oil now have a floating rate debt of about $100 billion. Every one-point rise in the London interbank offered rate (Libor) increases their annual interest charges by $1 billion.[23] In 1980, the Libor rose from 10 to 20 per cent largely because of the efforts of central banks in developed countries to control inflation. The international financial system has shifted a portion of the resultant burden on to the economies of those developing countries that have been most active in international markets.

The gap between the amount of international finance presently available to the developing countries and their future requirements is also widening as the result of an unimpressive rate of increase in foreign private investment. Although net foreign private investment in developing countries in 1978 was more than twice that in 1970,[24] inflation eroded much of the apparent gain. Moreover, the developing countries' share in the stock of direct foreign investment has actually declined. In 1967, these countries absorbed 31 per cent

[20]Many of the financial aspects of the restructuring process are dealt with in other UNIDO studies and publications. For this reason the subject is briefly summarized here.

[21]UNIDO, *Special Report of the Executive Director*, Third General Conference of UNIDO, New Delhi, 21 January-8 February 1980 (ID/242), p. 13. The disproportionate rise in service charges was probably owing to both an increase in the share of non-concessional finance and a rise in the cost of such finance over time.

[22]*Brandt Report*, p. 239.

[23]Figures are from *The Economist*, 20 December 1980.

[24]World Bank, *World Development Report, 1980* (Washington, D.C.), pp. 136-137.

of such investment, but, by 1975, their share had been reduced to 26 per cent.[25] Thus, direct foreign investment in the OECD countries grew at a faster rate than in the developing countries.

The balance-of-payments problems of some developing countries are one reason for the slow growth in foreign private investment. A chief concern of these investors is how the deficit will be financed. On the one hand, increased borrowing will mean higher service charges unless the concessional finance is also increased. On the other hand, if countries try to deal with their deficits by braking the growth of their economy, their attractiveness for foreign investment will also be reduced in addition to the more important and damaging effect on living standards. Sectors other than manufacturing have been affected by the slump in investment and their industrial prospects have suffered as a result. In mining, for example, insufficient investment has limited that sector's ability to supply industrial inputs. The real prices of metals declined in the long term during the 1970s. Mineral producers suffered from a repeated "boom-or-bust" pattern after the late 1960s. With one exception, each cycle has left them worse off than the previous one, since the prices of their manufactured imports have risen more rapidly than mineral export prices.[26] Consequently, investment is thought to be at historically low levels, with the result that financial requirements may be unusually high in the future. If the demand for metals (aluminium, copper, iron-ore, nickel and tin) increases only moderately in comparison with recent experience, world investment in mining (including the replacement of capital) may rise to $12 billion per annum from an average of $2 billion over recent years. Roughly, $5 billion of this investment will be needed in developing countries; four fifths of this amount would have to be financed externally.

The magnitude of these requirements is indeed great. The problem is further complicated by the uneasy relationship between the relevant transnational corporations and the host countries. Opportunities that would benefit both the developing and the developed countries are apparent, but their realization is contingent on the introduction of new international finance mechanisms and appropriate forms of investment and ownership which would be acceptable to the investor and to the host country. Until such steps are taken, commodity market conditions will continue to impinge on world industrial growth and inhibit the restructuring process.

These trends do not augur well for accelerating the pace of structural change in world industry. Efforts of the developing countries to industrialize are largely dependent on the availability of external finance. In order to achieve sustained growth, industry's share of total investment in these countries will have to rise from 18 per cent to about 25 per cent over the next 20 years.[27] This would require an expansion in international industrial finance available on a long-term basis and deployed in a manner that would ensure its effective use.

[25] *Transnational Corporations in World Development: A Re-examination* (United Nations publication, Sales No. 78.II.A.5), p. 237. Figures exclude the centrally planned economies.

[26] Commodity prices have tended to become more volatile for several reasons. One is that buyers' interest or concern about one commodity market is now more liable to spill over to another market. The recent rise in gold and silver prices affected copper and other base metals as well as rubber and even sugar. Another reason is the behaviour of stocks, which fell sharply between 1976 and 1980.

[27] UNIDO, *Special Report of the Executive Director* . . . , p. 13.

The role of technology in the restructuring process

Many of the preceding observations concerning trade, investment and structural change within the manufacturing sector cannot be clearly separated from technological development. Technological innovation and adaptation are even more germane. Perhaps most important is the developing countries' need to develop indigenous technologies—a prerequisite for collective self-reliance. The existing technological capacity of most developing countries is limited. They have often relied on transnational corporations for many of their technological inputs into industrial production. The acquisition of such technology is costly. Moreover, it is not likely to match the resource endowments and labour markets of the developing countries and may thus be inappropriate.

The importance that the developing countries attach to the need for technical co-operation among themselves is therefore encouraging. There is ample scope for such co-operation. As the Brandt Commission notes "[the developing countries] can do much to upgrade their technological capabilities through collective efforts. They can share skills and establish where necessary regional and sub-regional centres to adapt and develop technology".[28]

While technological development is a key element in achieving such long-term objectives as collective self-reliance, its short-term impact on the restructuring process is also substantial. Technological innovation has led to basic changes in the production process enabling the transnational corporations to disperse different phases of their operations while retaining overall control. This phenomenon, known as production fragmentation, permits firms to site related activities in different parts of the world in such a manner that the costs for each activity are minimized.

Fragmentation is usually associated with goods that have standardized production procedures. The search for cheaper locations for specific phases of the production process most often occurs in industries where vigorous price competition prevails and where the market lends itself to mass-production techniques. Today, fragmentation can be found in the production of automobiles, automobile parts, textiles, clothing, aircraft parts, power tools and machine tools, radio sets, television receivers, semiconductors and many other activities.

The possibility of breaking up the production process in this manner has many consequences. The rapid growth of intra-firm and intra-industry trade[29] is an example. To date, the information available on the net effects of production fragmentation on host countries is ambiguous. Both positive and negative aspects have been stressed by different writers. On the one hand, adjustments to changes in the pattern of production and trade within an industrial branch are generally thought to be easier than adjustments to changes between industries. Intra-firm and intra-industry trade is also thought to be one way of overcoming many trade barriers. In addition production fragmentation reduces the influence of relative factor endowments on location. For reasons such as these, the opportunities for a more extensive division of labour in manufacturing have proved to be greater than anticipated. On the other hand, host countries may find that transfer pricing among branches of

[28] *Brandt Report*, p. 138.

[29] For a definition of this term, see chapter II, p. 84.

the transnational corporations are costly. Furthermore, it is generally thought that the per unit benefit of trade in the form described here is much smaller than that arising from trade in complementary products.[30] Thus, the consequences of production fragmentation could be widely different depending on the industrial activity in question and the relevant policies of both the host country and the foreign investor.

In the longer term, technological progress in the developed countries will have a considerable impact on the restructuring process. The search for new systems of capital goods in response to declining rates of return on capital and of productivity growth has been noted. Technological advances are also a prerequisite for the generation of new growth industries. Increasingly, the capital goods sector has become the focal point for these efforts. Rapid developments in the automation of capital goods, in data processing, communications etc. will magnify the impact of technical progress. Simultaneously, the large investments and risks involved in such undertakings suggest that state participation may continue to grow. Likewise, technological innovations that are central to many production processes may pose problems reflecting new relationships of dependence or interdependence of an international scope. Their long-term impact on the restructuring process is bound to be complex and, as yet, can only be a subject of speculation. For the immediate future, efforts to continue the restructuring process can have a positive effect on the long-term patterns of technological development by ensuring that centralization and restrictions to access are minimized.

Of great importance to the restructuring process is national policy initiative. The nature of current policies is in stark contrast to the types of action called for in the *Brandt Report*. In many cases their consequences are inimical to structural change and the restructuring process sketched above.

New protectionism

The spread of new protectionism reflects the emergence of a growing tendency towards structural rigidities in the developed countries. In its present form, new protectionism is not exclusively, or even predominantly, concerned with trade. As one economist has observed, "old protection referred exclusively to trade-restricting and trade-expanding devices, such as the tariff or export subsidy. The new protection is much broader than this; . . . what is new is the realization that virtually all government activity can affect international economic relations".[31]

Isolationist trends associated with new protectionism are not yet pervasive. Some developed countries continue to demonstrate their willingness to participate in the restructuring process. Protectionist policies are still applied pragmatically, because policy concessions of the sort are typically government responses to political pressure from organized groups having specific interests to protect.

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[30]On this point, see Lincoln Gordon, *Growth Policies and the International Order* (New York, McGraw-Hill, 1979), p. 147.

[31]Melvin B. Krauss, *The New Protectionism, the Welfare State and International Trade* (Oxford, Blackwell, 1979), p. 36.

Increasing structural rigidities are likely to result from two distinct policy trends. The first involves what are referred to as "defensive policies". These are intended to slow the rate of contraction that a specific industrial branch experiences because of structural change and shifts in international comparative advantage. The second policy approach concerns the growing involvement of Governments in advanced-technology activities.

The defensive orientation of many industrial policies today is closely related to the changing pattern of trade which accompanied the restructuring process of the 1960s and 1970s. Developed countries justify these policies by the contention that the rapid growth of imports leads to politically unacceptable economic and social costs to the domestic firms and labour forces affected. Supporters emphasize the need to forestall rapid adjustment, implying that such adjustments are more costly and disruptive than gradual adjustments.

At times, defensive policies may go beyond the objective of gradual adjustment by attempting to prevent further contraction or even reverse the process. In a departure from past practice, many current trade restrictions are tailored to meet the needs of given industrial branches or firms.[32] Two policy variants are common. The first, known as voluntary export restraints (VERs), amounts to a bilateral agreement whereby a supplying country limits its exports to another country.[33] The second, known as orderly marketing agreements, restricts exports to predetermined levels which, if exceeded, are enforced by means of an explicit quota. The degree of protection afforded by these methods tends to exceed that provided by comparable tariffs or quotas.[34] Not surprisingly, economists attribute the proliferation of such defensive trade restrictions in the developed countries to the emergence of a "profound skepticism" regarding the ability of market forces to allocate resources.[35]

Such measures jeopardize the restructuring process—including that of prospective participants in the developing countries—in several ways. First, although the main targets of new protectionist measures are usually exporters in developed countries, restrictions are quickly applied to other suppliers. Trade in steel products is a good example. Here, the trigger price mechanism of the United States was originally devised to limit Japanese imports and recently broadened to restrict further both Japanese and European exports. However, VERs have also been negotiated by the United States with Argentina, the Republic of Korea and other developing countries. Similarly, Brazil, Indonesia, Mexico and the Republic of Korea have been involved in negotiations with EEC. Another example is the orderly marketing agreement governing the

[32]In the case of trade restrictions, the policy objectives of developed countries have undergone some profound changes. Originally, most trade restrictions (e.g. tariffs and quotas) were intended to be a macroeconomic control designed to deal with balance-of-payments or employment problems. Current forms of trade restriction are designed to be a tool of structural policy and are, therefore, "sector-specific", while exchange rate policies have replaced them at the macroeconomic level.

[33]Often these agreements are negotiated under the threat of a more restrictive form of protection. See Tracy Murray, Wilson Schmidt and Ingo Walter, "Alternative forms of protection against market disruption", *Kyklos*, vol. 31, Fasc. 4, p. 626.

[34]See Murray, Schmidt and Walter, *loc. cit.*, p. 629.

[35]See, for example, Jan Tumlir, "The new protectionism, cartels and the international order", in *Challenges to Liberal Economic Order*, Ryan Amacher, ed. (Washington, D.C., American Enterprise Institute, 1978).

United States' imports of colour television receivers from Japan. This agreement has led to a rise in the exports of several developing countries to the United States. As a consequence, similar agreements were negotiated subsequently with these exporters, such as the one with the Republic of Korea.

Second, defensive policies, although granted as a form of short-term assistance to contracting industrial branches, tend to become long-term arrangements. A prominent example is the Multifibre Agreement originally negotiated in the 1960s to regulate trade in cotton textiles. Later, the Agreement was broadened to include wool and synthetic textiles, and its time limit was extended to 1983. Such defensive policies also tend to bring about a chain reaction. The adoption of measures to assist one contracting branch legitimizes similar demands of other branches. The net effect is to further reduce the structural adaptability of some developed market economies.

Third, such restrictions can distort the pattern of foreign investment in manufacturing. Firms that were originally exporting to the restricted market find that their prospects for expanding or even for continuing this export trade are seriously constrained by new protectionist measures. Increasingly, they have responded by investing in the home markets of their previous trading partners. These investments are not necessarily the most efficient ones, however, and they might not have occurred if these firms had had a wider range of options in choosing locational sites. The tendency is reinforced by the reliance of many developed market economies on the exchange rate as a macroeconomic policy tool to deal with balance-of-payments and other problems. Undervalued currencies make investment in a country much more attractive although not necessarily more efficient than investment elsewhere.[36]

Fourth, as industrial capacity in the developing countries expands, new producers may find that they are able to compete with developed countries yet have very limited access to major markets where obsolete capacity is protected. The new competitors obviously lack financial and investment capabilities. Thus, they cannot avoid the restrictive effects of substituting foreign investment for exports in the same manner as producers in developed countries.

Finally, there is some evidence that new protectionism is mainly given activities in which the developing countries tend to have a comparative advantage. As one economist has observed, "unskilled-labour-intensity is everywhere the dominant characteristic of the protected sectors".[37] If so, this would mean that the all-important phase of the restructuring process linking the developing and the developed countries suffers most.

Defensive policies are not limited to those with explicit trade-related consequences. Other notable efforts to support contracting industries include state aids and subsidies, government procurement policies, investment incentives, assistance to industry in depressed areas and temporary employment subsidy schemes.

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[36]For example, it is no accident that in the 1970s some of the most active foreign investors were firms producing in countries with traditionally hard currencies and investing in developed countries with soft currencies.

[37]G. K. Helleiner, "Structural aspects of third world trade: some trends and prospects", *Journal of Development Studies*, vol. 15, No. 3 (April 1979), p. 80. A similar conclusion has been reached with regard to the exchange-rate policies of several developed market economies in the 1970s. The competitive position of certain countries in labour-intensive activities would have deteriorated even more without these adjustments. Interfutures, *op. cit.*, pp.154-156.

An assessment of the significance of such measures is difficult, although their consequences may be substantial. For example, in the case of government procurement, policies in France and the United States in the late 1950s and early 1960s were thought to have had a restrictive effect on trade equivalent to a tariff of 42 to 43 per cent.[38] In view of subsequent trends, their present-day effect would be even greater. With regard to government subsidies, direct subsidies to industry rose steeply in many developed market economies in the 1970s. The preferred form of subsidy was the provision of capital by the Government at favourable rates, whether by grant, loan, loan guarantee or equity participation, usually in return for acceptance of some conditions. Accordingly, many subsidies were "firm-specific", i.e. they were provided to individual firms rather than to the entire industrial branch or to the manufacturing sector. This trend was also accompanied by a rapid increase in indirect subsidies (accelerated depreciation, investment incentives etc.).[39]

Schemes designed to provide assistance to depressed areas are widespread and have expanded in scope as the problems of manufacturing sectors have persisted.[40] The international consequences of these programmes, as for many others, have been accentuated by the long-term trend towards greater interdependence. In so far as they concern contracting industries, they can lead to the continued subsidization of inefficient operations which would be more efficiently carried out in developing countries. Neither the long-term interests of workers in the depressed areas of developed countries nor those in developing countries are best served by this approach.

Often, these government policies are described as measures for adjustment assistance, implying that they are used to ease the burden of domestic adjustment to changed economic circumstances. Government assistance may consist of grants and loans given to firms that scrap obsolete capacity, or of financial support to firms willing to invest in new capacity. A typical evaluation is that "adjustment assistance seems in practice often designed to bolster the defences against imports rather than clear the ground for them . . . few attempts have been made to accelerate the contraction of individual sectors".[41]

Ultimately, defensive policies may not even serve the objective for which they were intended. Their ineffectiveness is owing partly to the fact that they are economic measures introduced to appease domestic political pressure groups. Sometimes, the link between the underlying economic adversity and the political objective is obscure. For example, employment in the developed countries' textile and apparel industries has fallen steadily although the share of these industries' imports from developing countries has remained stable as the result of negotiations carried out under the Multifibre Agreement. At the same time, labour-saving technology has been introduced steadily to raise the

[38]Robert Baldwin, *Nontariff Distortion of International Trade* (Washington, D.C., Brookings Institute, 1970), p. 77. Baldwin concludes that "governments are more restrictive in their import policies than private purchasers".

[39]Interfutures, *op. cit.*, p. 178.

[40]The EEC fund to boost investment in depressed areas is typical of trends in other countries. The 1979 regional budget was 53 per cent higher than 1978 which, in turn, exceeded that of the previous year by 56 per cent.

[41]Göran Ohlin, "Adjustment assistance in Sweden", *Adjustment for Trade* (Paris, Development Centre of the OECD, 1975), p. 9. Similar opinions have been expressed by Krauss, *op. cit.*, p. 66, and many others.

developed countries' degree of competitiveness. The resultant productivity gains explained 80 per cent of the job loss in the textile industry in Japan, 74 per cent in the United States and 59 per cent in EEC in the period 1973-1978.[42] Thus, trade restraints have had little or no effect on job losses in this industry since they result from technological advances, not from import penetration.[43]

Thus, to sum up, industrial growth is largely dependent on the accommodation of deep-seated structural changes. Clearly, one by-product of growth will be the appearance of different combinations of expanding and contracting industrial branches in various countries. A basic characteristic of policy formulation in the 1970s was the emergence and involvement of economic pressure groups which, by virtue of their association with various contracting activities, have had little chance to preserve their economic position through traditional market mechanisms. Consequently, these groups have chosen to work through existing domestic political institutions and to negotiate with the Government and with each other to preserve or even increase their net claim on resources and income. Their efforts, when successful, have usually led to the initiation of the types of defensive policies outlined here.

Policies to aid expanding industries

Policies with a protectionist bias are designed not only to help contracting industries. Science-intensive industries such as various types of capital goods, electrical components and automated control equipment, aerospace and energy have also benefited from a widening range of government assistance and encouragement. There are several reasons for the growing significance of interventions in the market designed to support already expanding lines of industrial activity. First, attempts to prevent or to postpone contraction in certain industrial branches (i.e. defensive policy) can delay expansion in others. Some compensatory efforts are necessary if industries with viable growth prospects are not to be handicapped because resources that would otherwise be available to them are diverted instead to contracting industries. Second, the growth of international trade has forced many countries to place a higher priority on their competitive abilities vis-à-vis their main trading partners. This trend has coincided with declining rates of productivity growth and return on capital in most developed countries.[44] Accordingly, many Governments have begun to search for new systems of capital goods, rather than to rely on additional investment to expand existing systems, as a means of stimulating productivity growth in a more competitive world environment. Third, the outlays necessary for R and D in science-intensive industries have risen

[42]Wilhelm Kurth, "Textiles and clothing: a national and international issue", Paper submitted to the International Symposium on Industrial Policies for the '80s, Madrid, 5-9 May 1980, p. 6.

[43]Another example of mis-specification is the orderly marketing arrangements negotiated by the United States with the Republic of Korea and other Asian countries to limit the latter's exports of children's shoes, sporting footwear and miscellaneous non-leather footwear. The small, import-sensitive United States firms continue to produce adult leather footwear in direct competition with imports from Brazil, Italy and Spain.

[44]See, for example, Interfutures, *op. cit.*, p. 158 and p. 349.

exponentially. Governments have responded with vigorous support. Today, a larger proportion of R and D expenditures is financed by the Government than by industry in France, the United Kingdom and the United States.[45] In addition to direct financial aid, often in the form of outright grants, Governments are offering favourable tax treatment for R and D expenditures and the provision of risk capital at preferential terms.

These circumstances have led to market intervention by Governments designed to spur the development of certain science intensive industries called "national champions". These are fostered in intense competition with similar government-industry partnerships in other developed countries.[46] Already, many Governments are reserving a large proportion of public orders for their national industries. With regard to the effect on trade, they are said to be "behaving like a sort of super-enterprise".[47]

Rapid growth in the science-intensive industries of the developed countries can offset in part contractions in other fields of manufacturing. However, the strategy produces certain side-effects which have both national and international consequences that should be recognized. At the national level, the vigorous support by Governments of their science-intensive industries has accelerated the diffusion of technological advances throughout the manufacturing sector.[48] The extent of the advances in science-intensive industries may best be illustrated by briefly surveying likely developments in one of these fields, automated production systems. New systems, based on cheap computers and micro-processors, have improved the capability of manufacturing a variety of parts. The introduction of computer-controlled machine tools promises to increase the speed of production several fold, to raise productivity substantially, to help overcome shortages in skilled labour and to facilitate the rapid introduction of new product lines. Other advances such as computer programs that allow designers to develop products on a video-display terminal may soon make possible computer-aided production scheduling and materials planning. Forecasts indicate that, by 1985, 10 per cent of the manufacturers in the United States will be using computers to design parts and the machines that make them. By 1990, 20 per cent of those in the United Kingdom and in the United States should have integrated their material planning with process planning, thus allowing computers to plan orders for raw materials and production.[49] Clearly, the results will be enormous domestic adjustments, differential rates of structural change, and productivity and employment shifts. Implicit in the decision to encourage the rapid development of these and other science-intensive industries is the need to provide the means of facilitating and accommodating the concomitant shifts in resources—including, in particular, labour—without reducing the economy's structural adaptability.

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[45]In the Federal Republic of Germany, industry's share of R and D expenditures is only slightly greater than the contribution of the Government.

[46]Göran Ohlin, "Subsidies and other industrial aids", in *International Trade and Industrial Policies*, Steven J. Warnecke, ed. (London, MacMillan, 1978), p. 32.

[47]Interfutures, *op. cit.*, p. 179.

[48]For data on R and D expenditures and related investment in such fields as automated equipment, see *World Industry since 1960 . . .*, pp. 14 and 21.

[49]*Current and Future Trends of Manufacturing and Technology in the United Kingdom* (London, Institution of Production Engineers, 1980).

At the international level, the consequences of the emphasis on science-intensive industries are not yet clear, but certain dangers may be foreseen. For example, government policies may further centralize the responsibility for initiative and innovation. Thus, technological advances would increasingly reflect national priorities and be less dependent on the response of individual corporations to industrial needs or even to market conditions. The transfer of new technologies—to other developed countries or to developing countries—is not as likely to be encouraged if such a competitive environment prevails. Increasingly, countries may be prone to single out certain science-intensive activities as their national priorities and then attempt to protect their lead in these fields by jealously guarding against technological transfers.[50] Once again, structural adaptability could suffer.

The following section, which examines recent trends in several large industrial fields, weighs some of the consequences of the policies discussed above.

B. CURRENT TRENDS IN WORLD INDUSTRY

Growth in manufacturing value added

In this section current trends in manufacturing output, trade and employment for the years 1978-1980 are compared with the progress made over the longer term since 1960. To turn first to the growth of manufacturing output, the data in figure I show the shares of each economic grouping in world MVA throughout the period 1960-1980.[51] The period may be divided conveniently into two time spans, 1960-1968 and 1969-1980. The first was one of rapid industrial growth throughout the world. During these years the growth performance of the developing countries roughly matched that of the developed countries. As a consequence, their share in world MVA remained unchanged despite their much larger proportion of the world's population and lower levels of *per capita* income.

Since 1968, the developing countries have recorded steady, although minor, gains. Preliminary estimates for 1980 show that their share of world MVA was about 10.9 per cent compared to 8.3 per cent in 1968. Year-to-year changes in levels of net manufacturing output (as shown in figure II) help to explain the changes in recent years. Net manufacturing output in the developed market economies has consistently evidenced a greater fluctuation than that observed for either of the other two economic groupings. In the developed

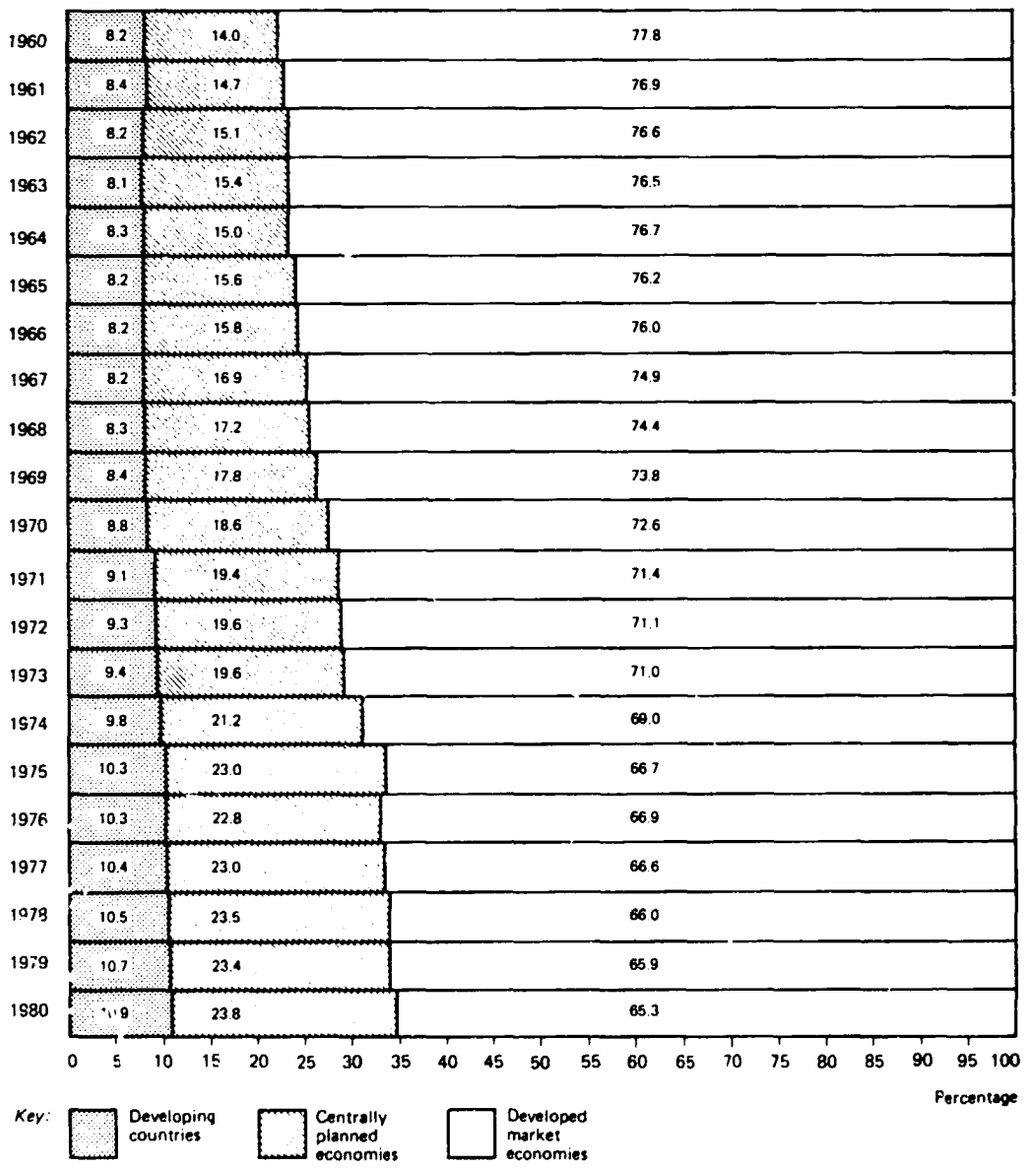
[50]There is, of course, wide scope for international co-operation in this field. However, many of the present proposals for international co-operation focus on important but non-competitive technologies such as waste disposal, mass transportation, data processing or private-sector construction.

[51]The data used in this analysis were derived from national accounts figures for 94 developing countries, 26 developed market economies and 10 centrally planned economies. Among the countries for which comparable data were not available, China has the largest manufacturing sector. Some tentative estimates of manufacturing output in this country were made on the basis of other sources and are shown in the appendix to this chapter. For further discussion of the statistics used in this *Survey*, see the same appendix.

market economies, annual rates of increase in net manufacturing output were lower than in the rest of the world and were even negative in 1974 and 1975. This pattern continued during the period 1976 to 1980. In comparison with previous years, growth in 1980 was modest in all three economic groupings, although the developed market economies again had the lowest net increase.

By comparison with the other two economic groupings, the centrally planned economies have enjoyed a steady growth in their share of world MVA.

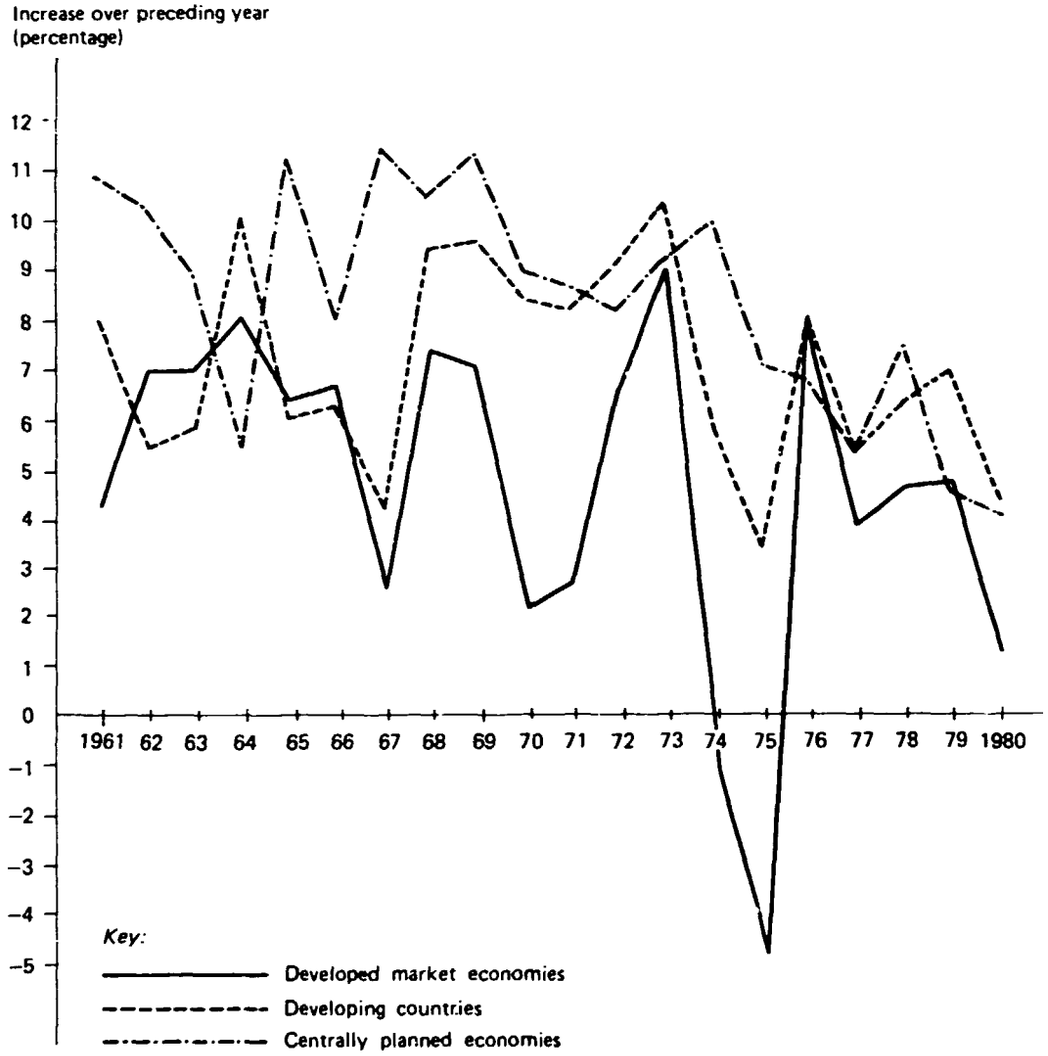
Figure I. Share in world manufacturing value added, by economic grouping, 1960-1980



Source: UNIDO data base; information supplied by the United Nations Office of Development Research and Policy Analysis and the United Nations Statistical Office; United Nations, *Monthly Bulletin of Statistics*, November 1980; and estimates by the UNIDO secretariat.

Note: Data for 1980 are preliminary estimates.

Figure II. Annual increase in manufacturing value added, by economic grouping, 1961-1980



Source: UNIDO data base; information supplied by the United Nations Office of Development Research and Policy Analysis and the United Nations Statistical Office; United Nations, *Monthly Bulletin of Statistics*, November 1980; and estimates by the UNIDO secretariat.

Note: Data for 1980 are preliminary estimates.

Fluctuations in annual rates of increase in net output have not been large by world standards. These countries now account for almost 24 per cent of world MVA, although there has been some slow-down in the year-to-year increase in net output since 1975. Much of the industrial growth in the 1950s and 1960s is attributed to the rapid expansion in industrial employment in these countries; this rate slowed in the 1970s, however. Additional growth impetus through resource reallocation, improved use of investment funds and more efficient use of raw materials and energy characterized development strategies in the 1970s.[52]

[52]Zoltan Román, "Industrial specialization in CMEA countries—selected issues", a consultant paper submitted to UNIDO, December 1980.

Such measures, however, are long-term, and the pace of growth in the first half of the 1980s is expected to be lower than that in the past.

Industrial progress among the developing countries has been by no means uniform. The distribution of MVA in the four developing regions is given in table I.1. The modest rise in the developing countries' share of world MVA in 1978-1980 is mainly attributable to the gains recorded in Latin America. Prior to 1978 the share of that region underwent an erratic although generally upward trend, which then declined between 1975 and 1978. The share of Africa in world MVA has remained almost unchanged in recent years as it had throughout the entire period 1960-1980. Manufacturing in both regions of Asia enjoyed a period of rapid growth before 1978, although the pace apparently slackened by the end of the last decade. Many industries in the region are export-oriented and the spread of new protectionism probably slowed their progress in the late 1970s.

TABLE I.1. SHARE OF DEVELOPING REGIONS IN WORLD MANUFACTURING VALUE ADDED,[a] SELECTED YEARS

(Percentage)

Year	*Africa*	*West Asia*	*South and East Asia*	*Latin America*
1960	0.8	0.4	2.0	5.0
1965	0.8	0.5	2.1	4.8
1970	0.9	0.6	2.2	5.2
1971	0.8	0.6	2.3	5.4
1972	0.8	0.6	2.3	5.6
1973	0.8	0.6	2.4	5.6
1974	0.9	0.6	2.4	5.8
1975	0.9	0.7	2.6	6.0
1976	0.9	0.7	2.8	5.9
1977	0.9	0.7	2.9	5.9
1978[b]	1.0	3.8		5.8
1979[b]	0.9	3.8		5.9
1980[c]	1.0	3.8		6.1

Source: Based on data supplied by the United Nations Office of Development Research and Policy Analysis; United Nations, *Monthly Bulletin of Statistics*, November 1980; and estimates by the UNIDO secretariat.

[a] Percentages derived from absolute figures in 1975 United States dollars.

[b] Figures for 1978 and 1979 were derived by linking United Nations indices for regional production with value added data for preceding years.

[c] Estimate.

The figures in table I.2 summarize the growth performance in each industrial branch according to economic grouping and developing region. The recent slow-down experienced in the developed market economies affected growth across a wide range of industrial activities. In 1976-1978 levels of real net output (i.e. at constant prices) actually declined in several industrial branches (textiles, leather and fur products and footwear) and expanded only modestly in others. Many of the slower-growing branches are either key areas of industrial activity (petroleum refining, iron and steel, non-ferrous metals), or are light industries employing a large labour force. In general, in the industrial

TABLE I.2. GROWTH RATES OF MANUFACTURING VALUE ADDED,

(Percentage)

Branch	*ISIC*	*Developed market economies*		*Centrally planned economies*		*Total*	
		1963-1976	*1976-1978*	*1963-1976*	*1976-1978*	*1963-1976*	*1976-1978*
Food products	311/2	3.4	3.0	5.7	3.5	4.1 (56)	4.5 (52)
Beverages	313	4.5	3.5	5.8	3.2	6.8 (58)	13.2 (51)
Tobacco	314	2.2	1.6	4.4	1.4	3.9 (58)	5.6 (45)
Textiles	321	3.0	−0.4	6.1	3.9	4.2 (50)	1.8 (40)
Wearing apparel	322	2.5	1.7	7.7	3.8	4.7 (41)	1.1 (30)
Leather and fur products	323	1.2	−0.9	5.1	2.7	3.4 (44)	3.1 (27)
Footwear	324	0.0	−0.4	5.3	4.5	3.4 (44)	1.4 (32)
Wood and cork products	331	2.9	2.6	5.1	2.8	3.7 (55)	4.2 (42)
Furniture and fixtures excluding metal	332	4.6	2.8	8.6	6.7	1.8 (44)	2.6 (28)
Paper	341	4.2	3.9	7.4	4.2	6.2 (41)	7.0 (33)
Printing and publishing	342	2.8	4.0	7.9	4.5	5.7 (37)	3.6 (30)
Industrial chemicals	351	8.3	5.5	11.9	6.3	11.5 (38)	8.0 (37)
Other chemicals	352	6.4	7.0	10.6	6.2	8.6 (40)	8.2 (35)
Petroleum refineries	353	5.8	1.9	12.6	6.6	2.8 (44)	4.6 (39)

BY ECONOMIC GROUPING, IN 1975 DOLLARS[a]

Developing countries					
Africa		*Asia*		*Latin America*	
1963-1976	*1976-1978*	*1963-1976*	*1976-1978*	*1963-1976*	*1976-1978*
4.3 (18)	3.9 (16)	5.0 (17)	8.0 (17)	3.7 (21)	2.7 (19)
8.5 (22)	13.2 (19)	9.9 (15)	22.7 (13)	5.5 (21)	9.0 (19)
5.8 (22)	6.5 (15)	4.1 (16)	6.0 (14)	3.2 (20)	4.6 (16)
4.6 (15)	3.1 (9)	4.3 (17)	2.8 (15)	4.0 (18)	0.6 (16)
-1.9 (10)	8.2 (8)	6.5 (14)	0.4 (10)	4.1 (17)	1.3 (12)
5.4 (13)	-1.4 (7)	2.0 (14)	7.5 (9)	3.8 (17)	0.2 (11)
3.1 (13)	5.0 (8)	3.4 (14)	-0.1 (10)	3.5 (17)	1.6 (14)
2.8 (21)	1.3 (14)	3.4 (16)	5.2 (13)	4.4 (18)	2.9 (15)
2.8 (14)	4.9 (7)	0.1 (16)	9.4 (10)	2.9 (14)	. . .
5.4 (12)	4.2 (7)	5.5 (13)	9.1 (12)	6.5 (16)	6.4 (14)
1.6 (9)	. . .	10.8 (13)	6.1 (11)	5.0 (15)	2.5 (14)
6.3 (6)	2.4 (9)	15.4 (16)	15.8 (14)	10.2 (16)	4.5 (14)
7.1 (9)	5.9 (7)	7.1 (13)	15.9 (13)	9.4 (18)	5.6 (15)
9.1 (10)	4.1 (10)	2.0 (18)	6.5 (14)	3.9 (16)	1.9 (15)

Miscellaneous products of petroleum and coal	354	1.2	0.6	3.9	2.4	11.3 (48)	7.1 (45)	6.2 (18)	9.9 (17)	13.1 (14)	9.7 (14)	11.4 (16)	4.3 (14)
Rubber products	355	4.5	4.8	8.6	5.1	7.5 (38)	5.6 (31)	1.3 (9)	0.2 (6)	7.0 (13)	12.0 (12)	8.2 (16)	2.4 (13)
Plastic products	356	12.4	9.6	15.8	7.2	9.8 (23)	7.2 (20)	13.2 (5)	13.9 (6)	22.2 (7)	. . .	9.1 (11)	2.9 (8)
Pottery, china and earthenware	361	4.4	2.6	9.2	6.8	5.6 (52)	6.1 (46)	3.9 (19)	6.2 (17)	1.1 (14)	9.9 (13)	7.4 (19)	5.3 (16)
Glass	362	5.0	5.3	10.7	7.3	9.3 (49)	6.5 (41)	5.0 (15)	4.7 (13)	11.9 (15)	8.5 (12)	8.4 (19)	5.3 (16)
Other non-metallic mineral products	369	3.2	4.9	7.8	3.9	8.7 (57)	7.6 (53)	6.7 (18)	4.9 (15)	10.0 (18)	11.5 (20)	8.3 (21)	5.1 (18)
Iron and steel	371	3.2	1.8	5.4	3.7	7.5 (41)	7.8 (33)	6.4 (14)	5.2 (11)	6.1 (12)	6.8 (10)	8.2 (15)	8.4 (12)
Non-ferrous metals	372	4.0	3.1	9.3	3.6	4.8 (40)	9.0 (32)	2.0 (16)	3.7 (13)	7.7 (11)	12.4 (10)	4.6 (13)	8.7 (9)
Metal products, excluding machinery	381	4.0	5.0	11.0	8.7	7.3 (40)	7.0 (29)	10.4 (12)	2.8 (6)	6.7 (13)	12.0 (9)	7.2 (15)	6.0 (14)
Non-electrical machinery	382	5.1	4.7	10.4	8.8	11.7 (37)	2.6 (22)	8.2 (10)	. . .	7.9 (13)	12.8 (8)	13.2 (14)	0.1 (9)
Electrical machinery	383	7.0	6.4	11.4	9.4	11.1 (37)	9.7 (27)	9.5 (9)	. . .	14.7 (13)	17.6 (8)	9.7 (15)	5.2 (14)
Transport equipment	384	4.1	5.4	11.2	9.0	9.9 (36)	5.5 (25)	5.9 (9)	. . .	6.4 (13)	8.0 (8)	11.2 (14)	4.2 (12)
Professional and scientific equipment, photographic and optical goods	385	5.7	7.3	11.3	9.4	6.5 (19)	9.9 (15)	. . .	. . .	5.9 (6)	18.1 (7)	6.8 (10)	0.0 (7)

Source: UNIDO data base and information supplied by the United Nations Statistical Office.

[a] The number of developing countries for which data were available is shown in parentheses. The coverage of the developed market economies and centrally planned economies was complete.

branches that grew most slowly in earlier years growth rates continued to decelerate during the late 1970s. In fast-growing branches, the pace either accelerated (e.g. scientific equipment, diverse chemicals) or declined moderately (electrical machinery, plastic products).

The pattern in the centrally planned economies was somewhat different. All industrial branches had lower rates of growth in 1976-1978 than in the earlier years, although the variation among branches was not so wide as in the developed market economies. Capital-goods-producing industries (e.g. machinery, metal products and transport equipment) continued to lead the manufacturing sector, while growth in chemicals and petroleum refining slowed after a period of very rapid expansion in the earlier years. The structural changes noted in the centrally planned economies were largely attributable to a different set of conditions from those pertaining in the developed market economies. These included distinct differences in patterns of consumption, in rates of technological progress and, most important, in types of production specialization. It has been observed that specialization occurs mainly among countries that are members of the same economic grouping rather than among countries in different groupings.[53] It follows that in the restructuring process the relationship between the centrally planned economies and the developed market economies would differ from that between either grouping and the developing countries.

The pattern of growth in the developing countries is more diversified than that described above. Growth in 11 industrial branches (out of 27) accelerated after 1976. Most of the expanding activities were closely related to the processing of raw materials or natural resources, e.g. food, beverages, tobacco, wood products, paper, petroleum refining, iron and steel and non-ferrous metals. Two disturbing trends should be noted, however. First, several branches that were important sources of exports and employment recorded decidedly lower rates of growth in 1976-1978. These include textiles, clothing and footwear. Second, the rate of growth in the capital goods industries (ISIC 38) also declined in 1976-1978 relative to that in earlier years. Although these branches account for only a small share of the manufacturing sector's total output in the developing countries, a slow-down in their growth would have serious implications for national development objectives such as self-reliance.

Among the developing regions, recent figures for Africa show a mixed performance relative to that in earlier years. The production of capital goods was limited to comparatively few African countries and lagged behind corresponding rates of expansion recorded for all developing countries. In the period 1976-1978 only a limited number of industrial branches improved their earlier rates of growth. The opposite trend may be observed in Asian countries where output of most branches accelerated in 1976-1978 compared with earlier years. However, textiles, clothing and footwear were obvious and important exceptions. The trade restraints referred to earlier in this chapter were directed primarily at these industrial branches. Finally, the figures for Latin America show that, in 1976-1978, very few branches improved on their long-term rates of growth. In this region both labour-intensive branches (e.g. textiles and wearing apparel) and capital-goods industries have experienced a definite slump

[53] Román, *op. cit.*, p. 34.

in recent years. The pattern is consistent with the region's declining share of world MVA during the same period (see table I.1), although preliminary estimates for 1979 and 1980 suggest that the rate of growth may have picked up in these latter years.

Changes in the composition of industrial output and rates of growth have altered the world industrial map. Some consequences are summarized in table I.3. During the 1970s the share of the developed market economies in world MVA declined in each industrial branch.[54] Despite the downward trend, however, there were only two branches in which these countries accounted for less than one half of world MVA in 1978. Over the period the centrally planned economies and the developing countries gained at the expense of the developed market economies.

TABLE I.3. SHARE IN WORLD MANUFACTURING VALUE ADDED, BY BRANCH OF INDUSTRY AND ECONOMIC GROUPING[a]

(Percentage)

		Developed market economies			*Centrally planned economies*			*Developing countries*		
Branch	*ISIC*	*1970*	*1975*	*1978*	*1970*	*1975*	*1978*	*1970*	*1975*	*1978*
Food products	311/2	65.2	62.8	62.7	22.8	25.0	24.3	12.0	12.2	13.0
Beverages	313	69.2	66.1	64.2	19.2	20.7	20.5	11.6	13.2	15.3
Tobacco	314	61.0	57.7	56.4	13.3	14.7	14.6	25.7	27.6	29.0
Textiles	321	61.4	55.4	54.3	23.8	27.8	28.8	14.8	16.8	16.9
Wood and cork products	331	74.2	70.3	70.9	16.7	20.2	19.3	9.1	9.5	9.8
Industrial chemicals	351	76.4	68.8	69.8	18.6	24.1	23.1	5.0	7.1	7.1
Other chemicals	352	83.9	79.5	79.8	5.2	6.8	6.4	10.9	13.7	13.8
Petroleum refineries	353	54.7	53.5	50.2	9.2	14.2	14.8	36.1	32.3	35.0
Miscellaneous products of petroleum and coal	354	52.7	48.1	46.4	35.7	38.1	38.1	11.6	13.8	15.5
Pottery, china and earthenware	361	58.7	50.1	48.3	29.8	37.2	38.8	11.5	12.7	12.9
Glass	362	75.9	68.1	67.4	17.1	22.8	23.7	7.0	9.1	8.9
Other non-metallic mineral products	369	64.6	57.7	58.1	27.8	32.8	31.6	7.6	9.5	10.3

Source: UNIDO data base; data supplied by the United Nations Statistical Office; and estimates by the UNIDO secretariat.

[a]Based on data in 1975 United States dollars.

A comparison between the figures for the developing and the developed countries shows a wide variation in the relative contribution of different branches. In the developing countries, the shares of only two industrial branches[55] surpassed the Lima target—at least 25 per cent of world MVA. More important, the slow progress made towards achieving the Lima target characterized a great many activities; it was a general phenomenon and could not be attributed to slow growth in some industrial branches only.

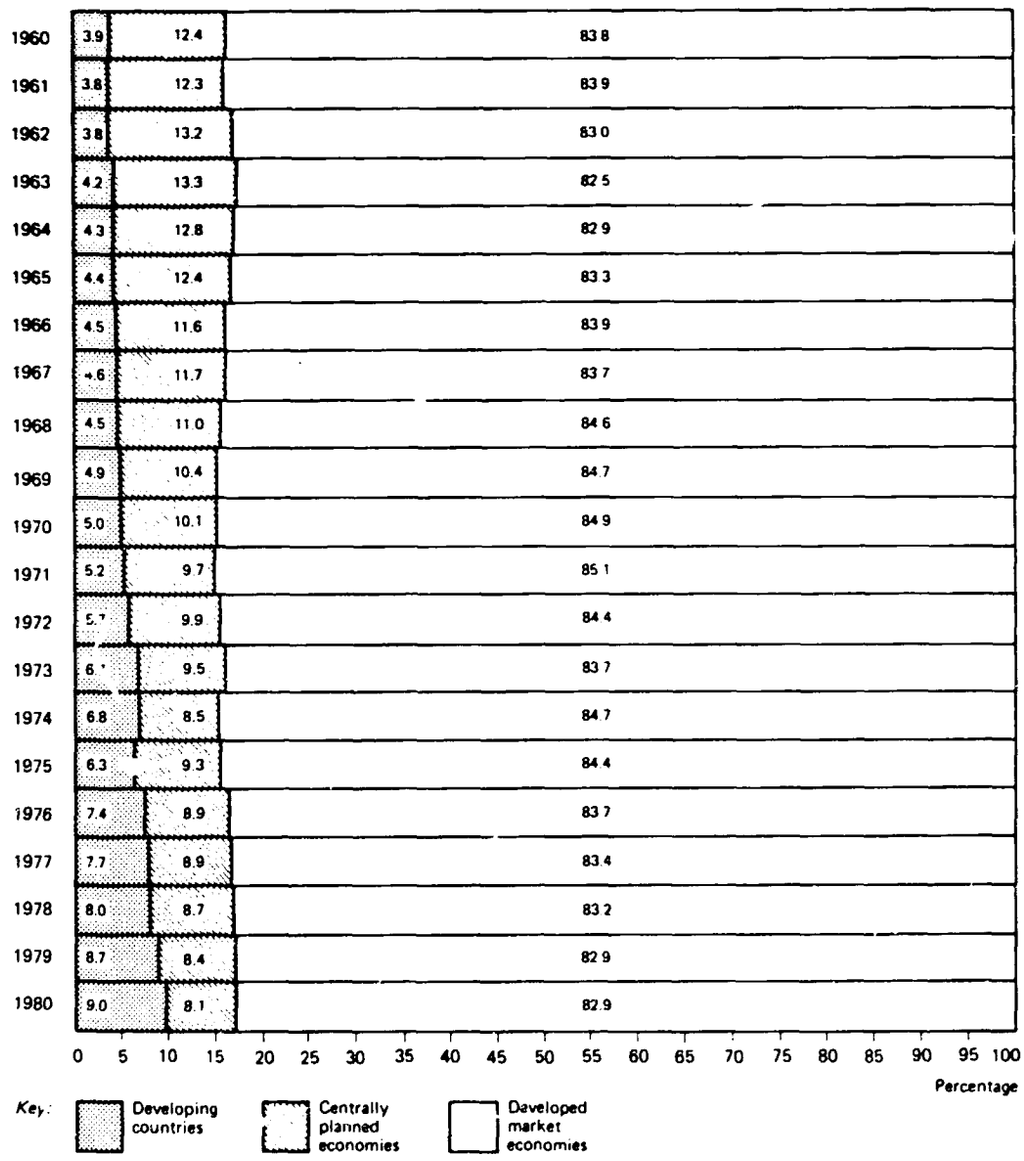
[54]Country coverage was not sufficient to estimate the shares of all 28 industrial branches.

[55]In the case of petroleum refining, the developing countries' relatively high share is mainly a result of the international pattern of resource endowment. No upward trend was found during the last decade, however. The share in 1970 exceeded the corresponding figure in 1978.

Growth of trade in manufacturing

The most remarkable feature of the share of the economic groupings in world exports of manufactures (figure III) is the continued predominance of the developed market economies throughout the last two decades. These countries persistently accounted for an overwhelming portion of world trade despite a

Figure III. Share in world exports of manufactures (SITC 5-8 less 68), by economic grouping, 1960-1980



Source: UNCTAD, *Handbook of International Trade Statistics*, various issues; United Nations, *Monthly Bulletin of Statistics*, various issues; and estimates by the UNIDO secretariat.

Note: Trade between the centrally planned economies of Asia is not included in the data. Data for 1979 and 1980 are estimates.

long-term decline in their share of world MVA (see figure I).[56] As noted earlier, the growing importance of foreign demand relative to domestic demand had important consequences in the approach to policy of the developed market economies. In the developing countries, participation in world exports of manufactures increased from a negligible level (3.9 per cent in 1960) to 8.7 per cent by 1970 although their share remained below the corresponding figures for value added. In 1979 the exports of manufactures from the developing countries (non-oil producers only) exceeded their exports of raw materials for the first time.[57] The shift was largely attributable to the export successes of Latin American countries such as Brazil, Peru and Venezuela. The gains were the result of a deliberate policy shift towards a more open economy and away from a strategy of import substitution. By contrast, the share of the centrally planned economies in world trade in manufactures declined throughout the period considered, even though their share of world MVA rose.[58] In general, countries with large domestic markets devote a smaller portion of their production to exports than do smaller countries. The importance of the Union of Soviet Socialist Republics in the composition of the output and trade of the centrally planned economies would partly explain this feature.[59]

Figure IV shows annual percentage increases in the exports of each economic grouping. Unlike the figures for net manufacturing output there was no instance in which the level of trade actually declined. There was an upward trend in the annual gains throughout the 1960s and the first half of the 1970s. This pattern was most pronounced among the developed market economies and, to a lesser extent, in the developing countries. During this period the exports of the centrally planned economies evidenced a more stable, albeit slower, rate of growth. A pronounced world-wide slump occurred in 1975 which brought a drastic drop in the exports of the developing countries. Since that year, trade in manufactures has resumed an upward trend although annual rates of increase have not attained the average recorded for the early 1970s. A comparison of past trends with recent performance (1977-1980) is provided in table I.4.

Export performance is, of course, closely related to the direction of trade and the market conditions prevailing among a country's major trading partners. The data in table I.5 show these trade links in three different years. For the developed countries, trade between members of the same economic grouping chiefly characterized the pattern of world trade throughout the 1960s and 1970s. The picture differed for the developing countries, which absorbed over one quarter of the manufactures exported by the developed market economies. This percentage increased steadily throughout the 1970s. Conversely, almost two thirds of the exports of manufactures from the

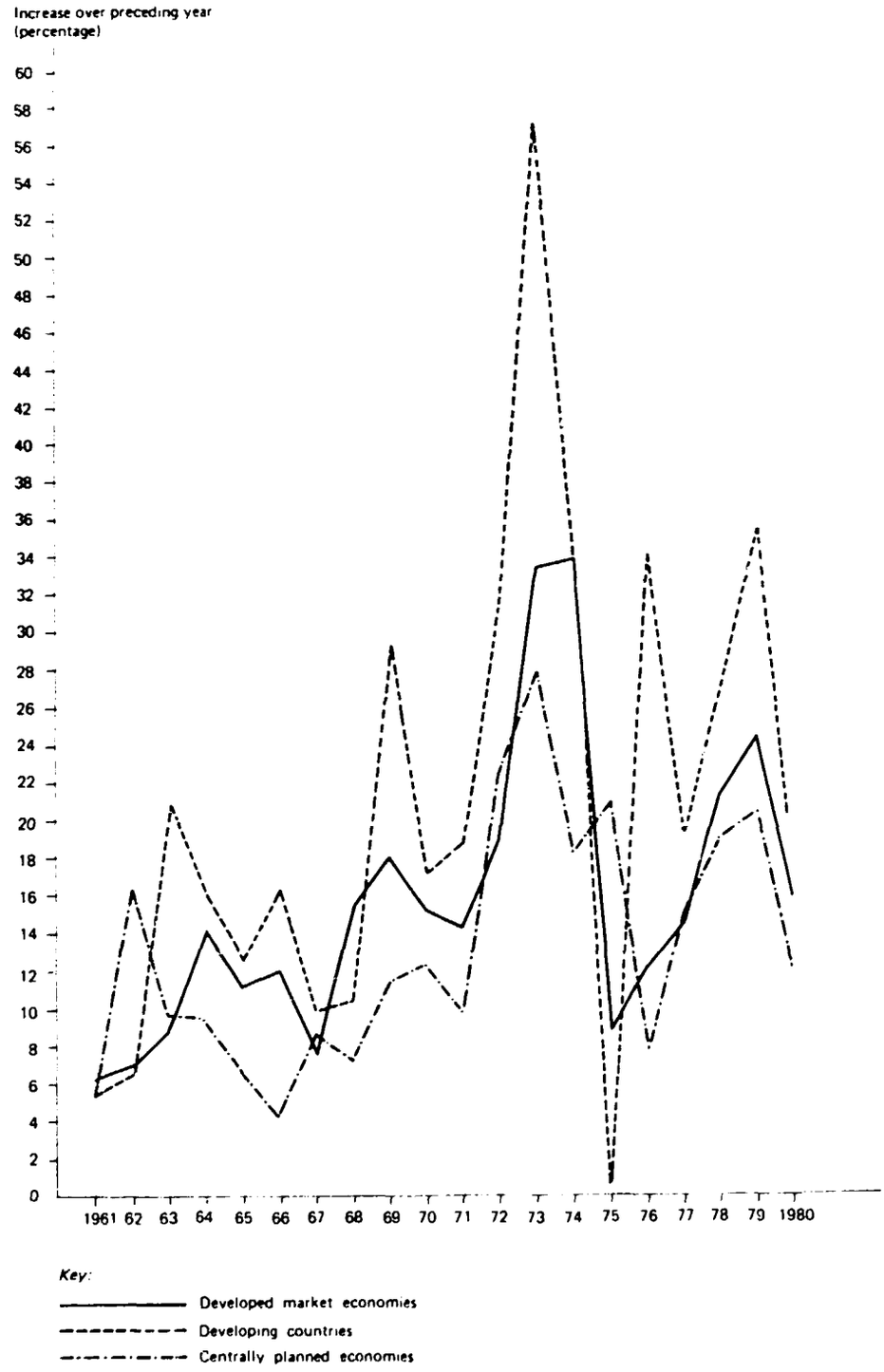
[56]Comparisons between exports and value added pose two problems. First, exports are reported in terms of gross output while MVA refers to net output. Second, the definition of trade in manufactures does not include the same set of industrial activities as those covered by the definition of manufacturing production. For an approximate comparison, see chapter II of this *Survey*. These qualifications do not mean that the two sets of data have no relationship; long-term trends in MVA do have some bearing on long-term trends in the export of manufactures.

[57]General Agreement on Tariffs and Trade, *International Trade 1979-1980* (Geneva, 1980).

[58]This share is underestimated somewhat because the available United Nations statistics omit trade between the centrally planned economies of Asia.

[59]Román, *op. cit.*, p. 45.

Figure IV. Annual increase in exports of manufactures (SITC 5-8 less 68), by economic grouping, 1960-1980



Source: UNCTAD, *Handbook of International Trade Statistics*, various issues; United Nations, *Monthly Bulletin of Statistics*, various issues; and estimates by the UNIDO secretariat.

Note: Trade between the centrally planned economies of Asia is not included in the data. Data for 1979 and 1980 are estimates.

TABLE I.4. GROWTH OF EXPORTS OF MANUFACTURES (SITC 5-8 LESS 68), BY ECONOMIC GROUPING

(Percentage)

Year	*Developed market economies*	*Developing countries*	*Centrally planned economies*[a]	*World*
1960-1977	15.2	20.1	12.2	15.2
1977-1980[b]	20.6	27.7	17.2	20.9

Source: UNCTAD, *Handbook of International Trade Statistics*, various issues, and United Nations, *Monthly Bulletin of Statistics*, various issues.

[a] Trade between the centrally planned economies of Asia is not included in the data.

[b] Figures for 1979 and 1980 are estimates.

TABLE I.5. SHARE OF EXPORTS OF MANUFACTURES (SITC 5-8 LESS 68), BY DESTINATION AND ECONOMIC GROUPING, SELECTED YEARS

(Percentage)

Exports from \ *Exports to*	*Year*	*Developed market economies*	*Developing countries*	*Centrally planned economies*
Developed market economies	1963	71.0	25.7	3.3
	1970	75.6	20.5	3.9
	1978	69.0	26.0	5.0
Developing countries	1963	55.8	41.2	3.0
	1970	59.7	35.4	4.9
	1978	63.4	34.6	2.1
Centrally planned economies[a]	1963	10.6	15.1	74.3
	1970	14.6	15.2	70.2
	1978	18.2	16.1	65.8

Source: UNCTAD, *Handbook of International Trade Statistics*, various issues; United Nations, *Monthly Bulletin of Statistics*, various issues; and estimates by the UNIDO secretariat.

[a] Trade between the centrally planned economies of Asia is not included in the data.

developing countries went to the developed market economies. Thus, unlike the trade patterns of the more advanced countries, the exchange of manufactured goods between developing countries was of minor importance and actually declined as a share of their total trade in manufactures.

The existing patterns of trade have two important implications. First, the spread of new protectionism in the developed market economies may not only hinder trade among countries within that economic grouping but, equally important, it may seriously jeopardize the export prospects of the developing countries. Second, the developing countries' emphasis on collective self-reliance and increased co-operation should eventually lead to a rise in the share of trade among themselves. Such a basic shift would make their trade pattern roughly correspond with that of the other two economic groupings. For the present, however, the opposite trend appears to be occurring since the share of trade among developing countries has actually declined in recent years.

Employment in the manufacturing sector

A third important aspect of industrialization is employment in the manufacturing sector. The expansion of manufacturing employment has long been a major concern of policy-makers. During the first United Nations Development Decade manufacturing output in developing countries grew at an annual average rate of 7.2 per cent, but employment in the sector rose at a rate of only 3.2 per cent.[60] Given the relatively high rates of population increase in most developing countries, a growth rate of 3 per cent would do little more than absorb the annual increase in the existing industrial labour force; it could not contribute substantially to absorbing the urban migrants and to reducing the level of unemployment.

In some developing countries industrial employment has expanded at much higher rates, however. Estimates for countries with *per capita* income levels of over $400 (in 1978 prices) show that the manufacturing sector's share in total employment rose from 17 per cent in 1960 to 23 per cent in 1978. Over the same period the sector's share of GDP increased from 31 per cent to 34 per cent. For developing countries with *per capita* income levels below $400, the share of total employment in manufacturing increased from 9 per cent in 1960 to only 11 per cent in 1978. These proportions are far below the corresponding figures for output in these countries—17 per cent of GDP in 1960 and 24 per cent in 1978. Clearly, in many of these countries the growth of industrial employment lagged significantly behind the growth of industrial output.

These trends may also be compared with those in developed countries. In the centrally planned economies, the share of manufacturing in total employment increased considerably—from 20 per cent in 1960 to 31 per cent in 1978[61]—although gains were slow in the later years. The share of manufacturing in total employment in the developed market economies actually declined in several instances (see table I.9) during this period. Today there are many developing countries and areas—including Hong Kong, Jordan, the Republic of Korea and Singapore—in which the share of the manufacturing sector in total employment surpasses that in many developed market economies (e.g. Australia, Canada, Finland, Ireland and the United States).

Table I.6 shows employment in the manufacturing sector in each of the three economic groupings in 1963 and 1975. In the developing countries, food processing and textiles were particularly important, accounting for almost 39 per cent of employment in the manufacturing sector in 1975. The share of the labour force in textile production has declined since the early 1960s as producers have moved into the production of clothing. To some extent this shift can be attributed to the effects of the Multifibre Agreement which has limited the developing countries' exports of textiles to the developed market economies. Food processing and textiles, although still important, are of declining significance for employment in the developing countries where industries producing mainly capital goods (e.g. metal products, non-electrical

[60] United Nations Centre for Development Planning, *Employment Strategies and Poverty Reduction Policies of Developing Countries* (E/AC.54/L.47).

[61] All figures cited are from *World Development Report, 1980, op. cit.*, pp. 110, 114-115, 146-147.

TABLE I.6. STRUCTURE[a] OF MANUFACTURING EMPLOYMENT, 1963 AND 1975

(Percentage)

Branch	ISIC	Developed market economies[b]		Developing countries[c]		Centrally planned economies[d]	
		1963	1975	1963	1975	1963	1975
Food products	311/2	8.7	8.4	15.6	16.2	8.9	8.5
Beverages	313	1.7	1.5	1.4	1.5	1.4	1.3
Tobacco	314	0.9	0.7	3.2	2.7	0.5	0.4
Textiles	321	9.5	7.0	28.0	22.6	9.9	8.2
Wearing apparel	322	5.4	5.2	2.9	5.3	5.9	6.5
Leather and fur products	323	0.7	0.6	0.6	0.7	1.0	0.8
Footwear	324	1.4	0.9	0.7	0.7	2.0	1.8
Wood and cork products	331	3.6	3.2	2.2	2.2	3.6	2.6
Furniture and fixtures excluding metal	332	2.0	2.2	1.2	0.9	2.0	2.0
Paper	341	3.4	3.3	1.6	1.9	1.1	1.1
Printing and publishing	342	4.8	5.1	3.5	2.7	[e]	[e]
Industrial chemicals	351	2.7	2.7	4.3	2.2	2.8	3.3
Other chemicals	352	2.6	2.5	0.1	3.4	1.0	0.9
Petroleum refineries	353	0.6	0.5	0.6	0.4	0.6	0.7
Miscellaneous products of petroleum and coal	354	0.2	0.2	0.0	0.3	0.7	0.7
Rubber products	355	1.6	1.5	1.8	1.9	1.0	1.1
Plastic products	356	1.2	2.1	0.7	1.7	0.5	0.6
Pottery, china and earthenware	361	0.8	0.8	5.1	0.5	1.2	0.8
Glass	362	1.0	0.9	0.1	0.9	1.0	0.8
Other non-metallic mineral products	369	2.6	2.6	0.1	3.6	5.7	5.8
Iron and steel	371	5.0	4.5	5.0	5.3	4.1	3.6
Non-ferrous metals	372	1.6	1.6	0.7	0.9	[e]	[e]
Metal products, excluding machinery	381	7.3	8.2	4.5	4.2	8.8	8.5
Non-electrical machinery	382	9.2	10.0	3.9	4.6	10.3	10.0
Electrical machinery	383	8.3	9.4	2.8	5.3	3.8	8.7
Transport equipment	384	8.9	10.0	7.7	5.4	9.5	9.0
Professional and scientific equipment, photographic and optical goods	385	2.5	2.5	1.8	0.7	7.9	7.7
Other manufactures	390	2.0	1.9	0.2	1.3	4.8	4.7

Source: Data supplied by the United Nations Statistical Office.

[a] Percentages were calculated by adding numbers employed in each industrial branch for all countries in the economic grouping before calculating the percentages for the grouping.

[b] Australia, Belgium, Canada, Denmark, Finland, France, Greece, Ireland, Israel, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom and United States.

[c] Chile, Colombia, Costa Rica, Cyprus, Dominican Republic, Ecuador, El Salvador, Honduras, Hong Kong, India, Jordan, Kenya, Nigeria, Philippines, Republic of Korea, Singapore, Syrian Arab Republic, Tunisia, Turkey, Venezuela.

[d] Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Union of Soviet Socialist Republics.

[e] Included in ISIC 390.

machinery, electrical machinery and transport equipment) are more prominent and have increased their share of the industrial labour force.

The distribution of employment in manufacturing shown in table I.6 can be related to the distribution of manufacturing output among the various

industrial branches. A comparison of the results, at different points in time, provides some insight into the effect of the growth of output on the growth of employment.[62] For the developed market economies, the correlation between the two structures was 0.93 in 1975. Five industrial branches in these countries—food manufacturing, transport equipment, non-electrical machinery, electrical machinery and metal products—accounted for 46 per cent of employment and an equal share of net manufacturing output (see table I.12).

For the developing countries, the correlation coefficient between industries ranked by share in net output and share in aggregate employment was significantly lower, 0.8. The five leading contributors to net output in these countries were food manufacturing, textiles, transport equipment, other chemicals and non-electrical machinery, which produced about 43 per cent of the net manufacturing output and employed more than one half of the manufacturing labour force. Textiles and food manufacturing alone accounted for over 38 per cent of manufacturing employment. In general, employment remains heavily concentrated in the traditional manufacturing lines, which have, however, been growing less rapidly than the comparatively newly established industrial branches.

Table I.7 provides more detailed information on the distribution of MVA and employment in the manufacturing sectors of the developing countries between the period 1963-1965 and 1973-1975. Over time, the relationship between these two structural measures weakened. Spearman's correlation coefficient for industries ranked by share in MVA and employment for the period 1963-1965 was 0.89, but it declined to 0.72 in the later period. The traditional industries—textiles, beverages, tobacco and food manufacturing—increased their share in manufacturing employment marginally from 43 per cent in 1963-1965 to 46 per cent in 1973-1975, although their share in MVA was stationary. The pattern in other industrial branches was markedly different. For example, the share of petroleum refineries (ISIC 353) in MVA rose from 1.9 per cent in 1963-1965 to 6.8 per cent in 1973-1975, while its share in manufacturing employment remained stationary at 0.4 per cent. In other branches, such as electrical machinery, growth in value added was matched by a corresponding growth in employment.

Table I.8 shows rates of growth of manufacturing employment in each economic grouping in the period 1970-1977. In the developing countries, employment expanded throughout the manufacturing sector. The highest growth rates were achieved in professional and scientific equipment, electrical machinery, pottery, china and earthenware, leather and fur products, and non-electrical machinery, while the growth of employment in both the textiles and the food manufacturing branches were well below the sectoral average. These results show a tendency for the employment pattern to shift gradually away from the traditional branches to the more recently established industrial branches.

The industrial branches that have been growing rapidly have presumably been attracting a larger share of the industrial labour force. The pace at which restructuring is taking place, however, is not sufficient to displace the traditional industries as the major source of industrial employment in the

[62] Calculations for manufacturing output corresponding to the employment figures shown in table I.6 are given in table I.11.

TABLE I.7. STRUCTURAL CHANGE IN MANUFACTURING VALUE ADDED AND EMPLOYMENT IN DEVELOPING COUNTRIES, 1963-1965 AND 1973-1975[a]

(Percentage)

		1963-1965		1973-1975	
Branch	*ISIC*	*Value added*	*Employment*	*Value added*	*Employment*
Food products	311/2	14.6	14.0	12.3	16.5
Beverages	313	4.0	1.6	5.7	1.6
Tobacco	314	4.3	2.5	4.7	3.7
Textiles	321	14.3	25.4	14.6	24.6
Wearing apparel	322	2.4	3.2	1.7	2.9
Leather and fur products	323	0.6	0.7	0.6	0.7
Footwear	324	0.4	0.5	0.4	0.7
Wood and cork products	331	1.9	2.8	1.5	2.1
Furniture and fixtures excluding metal	332	1.0	1.4	0.4	0.8
Paper	341	2.7	1.9	3.1	2.0
Printing and publishing	342	2.6	3.2	1.8	2.6
Industrial chemicals	351	9.8	4.9	5.2	2.5
Other chemicals	352	2.2	0.2	5.3	3.5
Petroleum refineries	353	1.9	0.4	6.8	0.4
Miscellaneous products of petroleum and coal	354	0.1	0.1	0.7	0.3
Rubber products	355	2.3	1.6	2.0	1.8
Plastic products	356	0.4	0.2	1.0	1.0
Pottery, china and earthenware	361	4.0	4.4	0.4	0.7
Glass	362	0.4	0.3	1.1	1.1
Other non-metallic mineral products	369	1.1	1.1	3.7	3.8
Iron and steel	371	8.4	6.5	7.1	5.2
Non-ferrous metals	372	1.2	0.6	1.4	0.9
Metal products, excluding machinery	381	2.7	3.6	3.4	3.8
Non-electrical machinery	382	3.7	4.6	3.2	4.3
Electrical machinery	383	4.2	3.6	5.0	4.8
Transport equipment	384	6.5	7.6	6.1	6.0
Professional and scientific equipment, photographic and optical goods	385	1.8	1.9	0.4	0.6
Other manufactures	390	0.3	0.6	0.7	1.1

Source: Data supplied by the United Nations Statistical Office.

Note: Countries in the 1963-1965 sample are: Brazil, Chile, Colombia, Ecuador, Honduras, India, Iran, Jordan, Kenya, Libyan Arab Jamahiriya, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Peru, Republic of Korea, Singapore, Somalia, Syrian Arab Republic, Trinidad and Tobago, Turkey, Uganda and Zambia.

Countries in the 1973-1975 sample are: Bangladesh, Colombia, Costa Rica, Dominican Republic, Ecuador, Ethiopia, Fiji, Guatemala, Honduras, India, Indonesia, Iraq, Jordan, Kenya, Libyan Arab Jamahiriya, Madagascar, Malawi, Mexico, Nigeria, Pakistan, Panama, Papua New Guinea, Republic of Korea, Singapore, Somalia, Syrian Arab Republic, Tunisia, Turkey, Uruguay and Venezuela.

[a] Value added in United States dollars at 1975 prices. The method of calculating percentages is a weighted method as described in table I.6, footnote *a*.

developing countries. It can be expected, however, that as industrial growth continues, further changes in the pattern of output will lead to more significant changes in the pattern of industrial employment. National and international policy could go a long way towards accelerating the rate of structural change in

TABLE I.8. RATES OF GROWTH[a] IN EMPLOYMENT IN MANUFACTURING INDUSTRIES, BY ECONOMIC GROUPING, 1970-1977

(Percentage and, in parentheses, number of countries)

Branch	*ISIC*	*Developed market economies*	*Developing countries*	*Centrally planned economies*
Total manufacturing	300	—0.4 (19)	8.5 (25)	1.7 (5)
Food products	311/2	0.1 (19)	4.8 (26)	1.3 (7)
Beverages	313	—1.0 (19)	7.0 (27)	1.8 (7)
Tobacco	314	—0.7 (19)	1.3 (25)	1.7 (7)
Textiles	321	—3.0 (20)	6.4 (26)	0.9 (7)
Wearing apparel	322	—0.7 (19)	13.8 (23)	1.0 (7)
Leather and fur products	323	—1.0 (19)	13.5 (25)	0.9 (7)
Footwear	324	—2.7 (18)	10.1 (25)	0.7 (7)
Wood and cork products	331	—0.6 (19)	3.8 (23)	—0.6 (7)
Furniture and fixtures excluding metal	332	0.8 (18)	6.5 (23)	1.8 (7)
Paper	341	—1.0 (19)	7.6 (25)	1.2 (7)
Printing and publishing	342	—0.1 (18)	4.1 (23)	1.3 (6)
Industrial chemicals	351	—0.2 (19)	3.9 (24)	2.1 (7)
Other chemicals	352	—0.8 (19)	14.4 (26)	1.8 (7)
Petroleum refineries	353	—0.1 (20)	4.8 (23)	1.5 (6)
Miscellaneous products of petroleum and coal	354	0.3 (18)	2.9 (24)	1.2 (6)
Rubber products	355	—0.9 (19)	10.5 (25)	2.9 (7)
Plastic products	356	3.0 (19)	7.2 (24)	4.5 (6)
Pottery, china and earthenware	361	—1.1 (19)	14.1 (23)	3.0 (7)
Glass	362	—1.1 (19)	4.1 (24)	2.2 (7)
Other non-metallic mineral products	369	—0.6 (19)	4.2 (25)	1.1 (7)
Iron and steel	371	—1.2 (20)	10.4 (25)	0.7 (7)
Non-ferrous metals	372	—1.3 (19)	6.1 (24)	6.4 (6)
Metal products, excluding machinery	381	0.1 (19)	7.8 (26)	2.8 (7)
Non-electrical machinery	382	—0.1 (19)	13.6 (25)	2.5 (7)
Electrical machinery	383	—0.2 (19)	15.3 (25)	3.1 (7)
Transport equipment	384	1.1 (20)	7.7 (24)	2.7 (7)
Professional and scientific equipment, photographic and optical goods	385	—0.0 (18)	19.7 (23)	2.5 (7)
Other manufactures	390	—1.0 (19)	3.7 (25)	0.8 (7)

Source: Estimates by the UNIDO secretariat based on data supplied by the United Nations Statistical Office.

[a]Growth rates are calculated using a semilog regression on time for all years in the period 1970 to 1977.

manufacturing employment. Thus, a lowering of protectionist barriers could play an important part in stimulating industrial employment, although export-oriented industries in some cases might be less labour-intensive than domestic market-oriented ones. The electrical machinery industry in most developing countries is unlikely to use as much of the labour force per unit of production as the food manufacturing branch. Food manufacturing, however, has a relatively low growth elasticity, particularly in the middle-income developing countries. Some export-oriented industries, on the other hand, have significantly higher growth elasticities; their growth is not constrained by a limited

domestic market. Despite their relative capital intensity,[63] their expansion could have a large positive impact on the level of manufacturing employment. Hence, an export-oriented industrialization strategy, supported by international measures to lower protectionist barriers, could make a substantial contribution to increasing industrial employment in some developing countries.

At the country level, industrial employment could be fostered by policies designed to utilize existing production capacity more fully. There is considerable scope for experimenting with shift working, and attempts should also be made to choose labour-intensive techniques of production where such a choice is practicable. Industrial employment could also be stimulated by a wage policy that would seek to correct existing price distortions in the labour market. Many such policies have been adopted by some of the countries and areas that are developing most rapidly—Hong Kong, the Republic of Korea, and Singapore—in which the rate of expansion of manufacturing employment has been consistently high over the last two decades.

C. AN OVERVIEW OF THE RESTRUCTURING PROCESS

In this section several characteristics of the growth process are examined together with their implications for industrial policy. These characteristics are thought to be the result of deep-seated structural forces that are the natural consequences of development. A coherent set of national and international industrial policies would reflect such forces which are part of the given state of the world. Regrettably, many policies are attempts to obviate the natural pattern of change. From this standpoint the growth of manufacturing is compared with growth in other sectors and growth within the manufacturing sector. The section concludes with an analysis of some consequences of present trends for the world distribution of MVA.

The share of manufacturing in GDP

Previous issues of the *Survey* have stressed the fact that, to a certain degree, changes in the composition of GDP follow a roughly predictable pattern.[64] In the developed countries a useful parallel may be found by comparing the current situation in manufacturing to earlier trends in agriculture. Historically, the agricultural sector contracted as resources and manpower were moved into manufacturing.

These shifts (and the implicit costs that they entailed) acquired social and political dimensions which were dealt with by political means. What emerged was a network of policies which isolated agriculture in part from the market dicta that otherwise governed resource allocation. Although agriculture

[63] Relative, that is, to some domestic market-oriented industries such as food manufacturing.

[64] See, in particular, *World Industry since 1960* . . . , chapter II and the annex to that chapter.

continues to decline, it does so at a reduced rate owing to the generous protective measures and subsidies accorded it by Governments in the developed countries.

More recently, various industrial activities have replaced agriculture as the focus of contraction problems, for various reasons. First, a fall in rates of population growth and a reduction in working hours has meant that in periods of rapid growth (e.g. 1950-1970) expanding industrial branches have attracted additional labour by offering higher wages than those offered by contracting branches. Agriculture, which had supplied the reserve army for manufacturing during the period of rapid growth, was no longer important enough to make an additional contribution. Wage rates did not necessarily drop in later years when the rate of growth slowed and unemployment rose. Thus, expanding industrial branches, for the most part, had to compete within the industrial sector for their labour needs.[65] Second, a combination of structural forces, such as rates of growth in productivity and income, elasticities of demand, environmental constraints and changing social values, has meant that the services sector has expanded at much higher rates than has the manufacturing sector.[66] Third, automation in manufacturing has proceeded at a rapid pace. As indicated earlier, the Governments of some developed countries strongly supported this trend in an effort to maintain their competitive position relative to that of their trading partners. Although labour productivity increased, employment in manufacturing rose only slowly or stagnated. Finally, the modernization of some industrial branches has become increasingly expensive, raising firms' indebtedness and reducing profits. Abrupt rises in the costs of certain industrial inputs have complicated the situation, with long-term investments often proving to be ill-timed in that producers have been committed to processes that have not been efficient within the new cost structure.[67]

Obviously, a distinctly different set of circumstances prevails in the developing countries. Industrialization, although it has also followed a roughly predictable pattern, bears little resemblance to that of the developed countries. At low levels of *per capita* income the manufacturing sector has accounted for a relatively small share of GDP. The pace of structural change has accelerated as *per capita* income has risen, bringing about a disproportionate increase in the sector's share of GDP at intermediate income levels.[68] At higher income levels, the manufacturing sector's share has continued to grow, albeit at a slower rate. The reasons for such a growth pattern relate to the abundance of labour, the

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[65] At least one economist has held that the major factor contributing to the remarkable economic growth in most European countries during 1950-1965 was the ready availability of a large supply of labour. Where labour supplies were tight, growth was slower. See Charles P. Kindleberger, *Europe's Postwar Growth* (Cambridge, Harvard University Press, 1967).

[66] The services sector is defined to include transport and public utilities, finance and real estate, education and health services and government. The rise of the services sector was first documented by Victor R. Fuchs, *The Service Sector* (Washington, D.C., National Bureau of Economic Research, 1968).

[67] An example is the petrochemicals industry in which operations have become "feedstock-intensive" rather than capital-intensive. One consequence is that economies of scale, realized by building larger plants, do not necessarily lead to substantial cost advantages. For a discussion, see chapter III.

[68] When measured in 1970 United States dollars, the most dynamic income range was $265-$1,075. See *World Industry since 1960* . . . , pp. 44 ff.

slower growth of wage rates and the more rapid rise of productivity in manufacturing compared with the developed countries.

The growth patterns described here for the developing and the developed countries suggest the type of temporary mismatch mentioned earlier.[69] Often the rate of capacity expansion in one set of countries will exceed the corresponding rate of contraction elsewhere. Although the resultant imbalances are not permanent, they are often treated as such in the policies formulated as an immediate response.

The pattern of structural change in industry since the Second World War reveals the effects of different sets of conditions operating in the developing and the developed countries. At the sectoral level, structural changes are usually expressed in terms of each sector's share in GDP or in total employment. Among the developed market economies, the average ratio of industrial to total employment is said to have fallen from almost 36 per cent in the late 1960s to around 32 per cent by the late 1970s.[70] The figures in table 1.9 provide some idea of the extent and rate of change in the manufacturing sectors of individual countries. With few exceptions, the share of MVA in GDP declined between

TABLE 1.9. STRUCTURAL CHANGES IN MANUFACTURING IN SELECTED DEVELOPED MARKET ECONOMIES, 1955-1977

(Percentage)

Country	*Share of MVA in GDP (producers' values at current prices)*				*Share of manufacturing employment in civilian employment*			
	1955	*1965*	*1975*	*1977*	*1955*	*1965*	*1975*	*1977*
Belgium	29	30	27	27	34	35	30	28
Canada	28	23	19	18	26	24	20	20
France	36[a]	35	27	27	27	28	28	27
Germany, Federal Republic of	41[a]	40	37	38	34[b]	38	36	36
Italy	26	29	30	32	23	29	33	28[c]
Japan	22[d]	32	29	28	18	24	26	25
Netherlands	31	32	27	26	30[e]	28	24	22
Norway	27	25	22	20	25	26	24	22
Sweden	32	26	28	24	34[f]	32	28	26
United Kingdom	37	30	25	25	40	35	31	30
United States	30[a]	29	23	24	26	25	22	22

Source: United Nations, *Yearbook of National Accounts Statistics*, various issues; OECD, *Labour Force Statistics*, various issues; ILO, *ILO Yearbook*, various issues; and estimates by the UNIDO secretariat.

[a] GDP at market prices.

[b] 1957.

[c] Figures for 1977 are not directly comparable with earlier years owing to a revised definition of employment and a new industrial classification.

[d] Net domestic product at factor cost.

[e] 1956.

[f] 1961; including mining, quarrying and manufacturing.

[69] See page 14.

[70] *Financial Times*, 24 April 1980, p. 19.

1955 and 1975.[31] The drop was most pronounced in the United Kingdom, and clearly evident in Canada, France, Norway and the United States. In the more recently industrialized countries (e.g. Italy and Japan) the share rose owing to the restructuring process in the post-war period. Employment figures also show a downward trend, although their movement has been more erratic, largely reflecting government employment policies and trade-union resistance to job losses. Nevertheless, in selected developed market economies the share of manufacturing employment in the work force is now as low as 22 per cent. The relative decline in the manufacturing sector is a fairly widespread phenomenon which emerged during a period of rather high growth and which has continued for several decades.

TABLE I.10. STRUCTURAL CHANGES IN INDUSTRIAL ACTIVITY IN CENTRALLY PLANNED ECONOMIES, 1960-1978

(Percentage)

Country	*Share of industrial activity in net material product*				*Share of industrial employment in civilian labour force*			
	1960	*1965*	*1975*	*1978*	*1960*	*1965*	*1975*	*1978*
Bulgaria	46	45	51	55	43	43	35	34
Czechoslovakia	63	65	65	60	37	38	38	38
German Democratic Republic[a]	54	57	60	62	. . .	47	46	43
Hungary	59	60	47	47	28	34	35	34
Poland	47	51	60	52	. . .	. . .	29	29
Romania[b]	44	49	60	58	. . .	19	31	33
USSR	52	52	53	51	28	30	29	29[c]

Source: United Nations, *Yearbook of National Accounts Statistics*, various issues; OECD, *Labour Force Statistics*, various issues; ILO, *ILO Yearbook*, various issues; and estimates by the UNIDO secretariat.

[a] At 1967 constant prices.

[b] GDP.

[c] Including Byelorussian Soviet Socialist Republic and Ukrainian Soviet Socialist Republic.

Since 1950 all the CMEA countries shown in table I.10 followed a policy of rapid industrialization, and, by the mid-1970s, the manufacturing sector accounted for a comparatively large share of both total production and employment.[32] However, the recent structural changes in several countries (Czechoslovakia, Poland and the Union of Soviet Socialist Republics) suggest a pattern similar to that observed in the developed market economies—a stabilization or slight decline in industry's share of net material product and total employment.

[31] Output shares are expressed in current prices. The downward trend is not so pronounced when shares are calculated at constant prices. This divergence has been attributed to the fact that relative prices have tended to move against manufacturing. See C. J. F. Brown and T. S. Sheriff, "De-industrialization: a background paper", in *De-industrialization*, Frank Blackaby, ed. (London, National Institute of Economic and Social Research, 1978), pp. 239-240.

[32] The production figures for the two economic groupings are not directly comparable. Data for centrally planned economies refer to net material product while developed market economies use gross domestic product. The latter concept is defined according to the system of national accounts and is broader in scope.

The figures in table I.11 gave a distinctly different picture for the developing countries. Although the share of manufacturing in GDP depends on many factors—resource endowment, country size, level of development etc.—the general trend has been upward. Data on employment are less complete, but they show a rise over time. The clear impression emerges that the role of the manufacturing sector, in the developing countries, is taking on new significance.

TABLE I.11. STRUCTURAL CHANGES IN MANUFACTURING IN SELECTED DEVELOPING COUNTRIES, 1960-1977

(Percentage)

	Share of MVA in GDP (producers' values at current prices)				*Share of manufacturing employment in civilian employment*		
Developing country	*1960*	*1965*	*1975*	*1977*	*1965*	*1975*	*1977*
Bolivia	13	14	13	13	...	9	9
Egypt	19	20	18	20	11[a]	14[a]	15
Gabon	7	6	5	7	9	11	12
India	14	15	16	17	...	26	26
Jamaica	15	17	16	18	...	11	11
Kenya	8	10	12	13	11	12	13
Mauritius	14	17	21	20	15[b]	14	18
Panama	13	15	15	14	9	10	10
Philippines	22	21	25	25	...	...	...
Republic of Korea	14	18	27	28	9	19	22
Sierra Leone	6	6	8	8	...	9	10
Singapore	12	15	24	25	14[c]	26	27
Syrian Arab Republic[d]	15	15	10	8	11	12	14
Thailand	13	14	18	19	...	14	...
Trinidad and Tobago	14	17	14	13	19[a]	20[a]	20[a]
Tunisia	9	9	10	11	...	17	20

Source: Based on data supplied by the United Nations Office of Development Research and Policy Analysis, Department of International Economic and Social Affairs, ILO, *Labour Force Projections, 1965-1985; ILO Yearbook*, 1974, 1979; and estimates by the UNIDO secretariat.

[a] Including mining.

[b] 1962; percentage in economically active population.

[c] 1957; percentage in economically active population.

[d] The fact that the share of manufacturing output in the Syrian Arab Republic declined during the 1970s was not owing to a contraction of that sector but to the rapid growth of minerals and mining (largely petroleum).

A safe assumption is that the growth pattern described here will continue into the 1980s and, most likely, beyond. Both national and international policy approaches are likely to change substantially as the priorities of countries in all three economic groupings are altered. For example, developed countries that to date have been major exporters of manufactures have usually taken the initiative in making further efforts to liberalize trade. Their priorities may change depending on whether the manufacturing sector and its potential for exports is contracting or expanding. Other countries where manufacturing and its exports are gaining importance would be more likely then to assume the lead in pursuing trade liberalization. Conversely, in countries where the manufactur-

ing sector continues to contract, interest in trade liberalization is already shifting from manufactures to services. Exports of services are currently estimated to be $300 billion per year[73] and involve insurance, shipping and film companies, airlines, brokerage, accounting, computer and civil engineering firms. Recent proposals to include the services sector in future negotiations on international trade restrictions are receiving growing support.

Structural changes may also have consequences for international investment in manufacturing. Industrial investors may become more inclined to look abroad in response to changes in international comparative advantage. In many instances, changes in comparative advantage favour investment in the developing countries. In other instances, comparative advantages among the developed countries have recently undergone substantial shifts with a significant effect on international investment.[74] The rise of new protectionism, which is a result of structural change, has also led firms to invest abroad rather than export. This tactic is not a new one. For decades many firms have set up operations in developing countries in order to avoid the tariff barriers that prevailed during the era of import substitution. At present, however, both the investor and the recipient are in developed market economies. The effect is to increase the "coverage" of the tariff—i.e. the proportion of world output benefiting from the implicit subsidy—and, thus, to enlarge the extent of resource misallocation.[75] Examples are numerous, but automobiles, certain types of basic chemicals and household appliances are well publicized.[76]

The tendency to replace exports by foreign investment could lead to a greater degree of international interdependence. In the past, firms may have exported 5 to 10 per cent of their output without being too concerned about conditions in the importing markets. In the future, an increasing number of firms will find themselves operating subsidiaries abroad or, conversely, becoming part of a foreign-based operation. Thus, they will have a direct interest in labour conditions, supply and distribution matters, financial conditions and industrial policy in the host country. In these circumstances, issues touching on foreign investment and the treatment of foreign earnings could take on a high priority among developed countries as they already have in developing countries.

Structural changes in the developing countries are not likely to bring about significant long-term changes in their own policy approaches. Industry now assumes a relatively high priority and international issues such as industrial finance and foreign investment, technology transfer or market access will probably continue to be central ones. National strategies for industrialization are likely to remain comparatively diverse as various Governments choose to

[73] *International Herald Tribune*, 15 December 1980. The article notes the support for this trend among government officials and semi-public research bodies in developed countries.

[74] For a detailed study of changes in comparative advantage, see chapter II. Chapter III includes an analysis of investment patterns and related shifts in the competitive abilities of selected industrial branches in both the developing and the developed countries. See, in particular, the discussion of chemicals and petrochemicals.

[75] Thus, as firms become more mobile internationally, resource distortions are magnified. See Krauss, *op. cit.*, chapter I.

[76] It is significant that the branches in which competition and growth in the developed market economies is most vigorous—e.g. sophisticated electronics and aerospace—are not major participants in this process.

emphasize light or heavy manufacturing, an outward (export) or a home market orientation, employment generation etc. Whatever the alternative adopted, the choice of an industrial strategy will take on added significance for the national economy in accordance with the growing importance of the manufacturing sector.

Structural changes within the manufacturing sector

As structural changes within the manufacturing sector have consequences for patterns of trade, investment, employment and policy formulation, it is important to gain an impression of the nature of such changes in the different economic groupings. Observers are then in a better position to gauge the extent of adjustment pressures linking industrialization to other economic and policy questions. Although a thorough analysis is beyond the scope of this *Survey*, changes in the composition of manufacturing output are recorded and an attempt is made to assess the broad trends towards increased homogeneity or heterogeneity.

The data in table I.12 show the composition of net manufacturing output in the developing countries in two years, 1963 and 1975.[77] Two measures are used. The first, a relative measure, is best adapted to represent the structure of output in a group of countries.[78] The second, an equal-weights measure,[79] serves better to represent the output mix of a developing country chosen at random. A comparison of the two sets of estimates for 1963 reveals that the importance of several industrial branches of light manufacturing[80] is accentuated by the use of the equal-weights measure. These branches dominate the manufacturing sectors of many of the smaller or less developed countries, but they show little effect if their importance is calculated by the relative-weights measure.

With the exception of plastic products (ISIC 356), all branches of light manufacturing declined in importance between the two years. These shifts were more pronounced as indicated by the relative measure, suggesting that it was mainly in the more advanced developing countries that light manufacturing grew more slowly than heavy manufacturing.[81] Declines were balanced by gains

[77] The year 1975 was chosen as the terminal year because country coverage was superior to that in later years. Structural changes of this type are generally long-term, and figures for more recent years are not expected to differ greatly from those shown in table I.12.

[78] The relative measure is a weighted average. The observations (value added in a given branch) are summed over all countries and expressed as a percentage of total value added by manufacturing in those countries. All calculations are in United States dollars at current prices.

[79] This measure is simply an unweighted average of a given industrial branch's share taken over all countries in the group.

[80] Light manufacturing is defined in terms of the following ISIC divisions and major groups of industry: food, beverages and tobacco (31); textiles, wearing apparel and leather (32); wood and wood products including furniture (33); printing, publishing and allied industries (342); rubber products (355); plastic products (356); and other manufactures (39). Heavy industry consists of the following: paper and paper products (341); industrial chemicals (351); other chemical products (352); petroleum refineries (353); miscellaneous products of petroleum and coal (354); non-metallic mineral products except products of petroleum and coal (36); basic metals (37); and fabricated metal products, machinery and equipment (38).

[81] The appropriate comparison would be between the output composition of the same country sample in both years. These figures are shown in parentheses for 1975 (table I.12).

TABLE I.12. STRUCTURE OF NET MANUFACTURING OUTPUT IN DEVELOPING COUNTRIES, 1963 AND 1975

(Percentage)

Branch	ISIC	1963[a]		1975[b]	
		Relative measure	Equal-weights measure	Relative measure	Equal-weights measure
Food products	311/2	18.3	23.3	13.5 (12.7)	19.5 (18.8)
Beverages	313	4.4	7.1	3.4 (4.2)	5.4 (5.6)
Tobacco	314	3.2	4.1	2.9 (3.1)	4.7 (3.8)
Textiles	321	14.4	13.5	10.8 (10.5)	13.7 (11.6)
Wearing apparel	322	4.0	2.8	3.2 (3.0)	4.1 (2.5)
Leather and fur products	323	0.7	0.8	0.6 (0.6)	0.9 (0.7)
Footwear	324	1.4	1.3	1.0 (0.9)	1.6 (0.9)
Wood and cork products	331	2.4	2.4	2.2 (1.9)	2.9 (2.2)
Furniture and fixtures excluding metal	332	0.9	1.2	1.2 (0.8)	1.4 (0.9)
Paper	341	2.4	2.4	2.3 (2.7)	2.0 (2.5)
Printing and publishing	342	2.6	3.2	2.4 (2.3)	2.4 (2.5)
Industrial chemicals	351	2.7	2.4	4.1 (5.3)	3.0 (3.9)
Other chemicals	352	5.5	5.0	5.8 (5.8)	4.9 (5.6)
Petroleum refineries	353	3.7	4.1	5.2 (6.1)	5.4 (6.8)
Miscellaneous products of petroleum and coal	354	0.2	0.2	0.7 (0.5)	0.5 (0.3)
Rubber products	355	2.9	2.6	1.9 (1.9)	1.8 (2.0)
Plastic products	356	0.6	0.7	1.6 (1.4)	1.4 (1.6)
Pottery, china and earthenware	361	0.7	0.3	0.7 (0.5)	0.4 (0.3)
Glass	362	0.8	0.8	0.9 (1.0)	0.7 (0.9)
Other non-metallic mineral products	369	3.5	4.0	3.5 (3.4)	4.0 (4.2)
Iron and steel	371	4.3	2.2	5.3 (5.7)	2.8 (3.5)
Non-ferrous metals	372	1.9	1.8	1.8 (2.2)	1.7 (1.9)
Metal products, excluding machinery	381	5.4	4.4	4.8 (5.2)	4.1 (4.5)
Non-electrical machinery	382	2.8	2.0	5.5 (4.6)	2.1 (2.6)
Electrical machinery	383	2.6	2.1	5.1 (4.8)	3.1 (3.7)
Transport equipment	384	5.2	4.0	7.6 (7.1)	3.6 (4.8)
Professional and scientific equipment, photographic and optical goods	385	0.3	0.2	0.5 (0.5)	0.4 (0.3)
Other manufactures	390	2.2	1.1	1.5 (1.4)	1.4 (1.0)

Source: Based on data supplied by the United Nations Statistical Office.

[a] Only 18 developing countries provided sufficient data on net manufacturing output at ISIC 3-digit levels. The sample for 1963 included: Angola, Argentina, Chile, Colombia, Costa Rica, Ecuador, India, Indonesia, Kenya, Mexico, Morocco, Mozambique, Peru, Philippines, Republic of Korea, Turkey, Uruguay and Venezuela.

[b] The sample consisted of 43 countries with complete coverage at the ISIC 3-digit level. Figures in parentheses are calculations for the identical country sample for which 1963 calculations were made.

in heavy manufacturing, notably in industrial chemicals, petroleum refining, non-electrical and electrical machinery and transport equipment. In a comparison of the two measures for 1975, substantial differences at times appear in the corresponding percentages for a given industrial branch. This is an artefact of the heterogeneous composition of output among individual countries.

Table I.13 indicates the composition of net manufacturing output in the developed market economies and the centrally planned economies in 1963 and

1975 and illustrates several phenomena. First, the more important industrial branches were in heavy manufacturing while the shares of branches of light manufacturing were smaller than those observed for the developing countries. Second, there were only moderate shifts in the shares by comparison with the shifts observed for the developing countries.

TABLE 1.13. STRUCTURE OF NET MANUFACTURING OUTPUT IN DEVELOPED MARKET AND CENTRALLY PLANNED ECONOMIES,[a] 1963 AND 1975

(Percentage)

		Developed market economies				*Centrally planned economies*			
		1963		*1975*		*1963*		*1975*	
Branch	*ISIC*	*Relative measure*	*Equal-weights measure*	*Relative measure*	*Equal-weights measure*	*Relative measure*	*Equal-weights measure*	*Relative measure*	*Equal-weights measure*
Food products	311/2	9.5	12.0	9.6	10.9	13.2	10.8	11.1	8.9
Beverages	313	1.5	2.3	2.2	2.8	2.0	2.1	2.0	2.3
Tobacco	314	1.0	1.6	0.9	1.1	0.6	1.5	0.6	1.4
Textiles	321	4.7	7.4	4.3	6.0	5.5	7.7	6.6	7.0
Wearing apparel	322	3.4	4.3	2.8	4.4	3.5	3.8	4.5	3.3
Leather and fur products	323	0.4	0.6	0.4	0.6	0.6	1.0	0.6	0.7
Footwear	324	0.7	1.3	0.6	0.9	1.1	1.6	1.4	1.2
Wood and cork products	331	2.5	4.0	2.2	3.0	3.0	2.1	1.8	1.9
Furniture and fixtures excluding metal	332	1.3	2.0	1.5	2.5	1.5	2.0	1.4	1.5
Paper	341	4.4	5.0	3.9	4.2	1.1	1.1	0.1	1.2
Printing and publishing	342	4.8	4.9	5.0	4.6	1.4	1.0	1.0	0.7
Industrial chemicals	351	5.2	3.6	5.1	4.2	4.7	3.6	5.7	5.7
Other chemicals	352	4.4	3.7	4.2	3.5	1.2	1.6	1.1	1.6
Petroleum refineries	353	1.5	1.7	2.1	1.6	0.8	1.0	1.5	2.3
Miscellaneous products of petroleum and coal	354	0.3	0.4	0.3	0.4	0.9	0.5	0.8	0.4
Rubber products	355	1.6	1.4	1.4	1.4	0.8	0.9	1.1	1.3
Plastic products	356	1.0	1.0	1.8	1.7	0.4	0.5	0.7	0.7
Pottery, china and earthenware	361	0.3	0.5	0.3	0.4	0.6	0.7	0.8	0.5
Glass	362	1.0	0.8	0.9	0.9	0.7	1.1	0.9	0.9
Other non-metallic mineral products	369	2.9	3.8	2.8	3.6	5.6	3.4	4.8	3.0
Iron and steel	371	6.6	5.0	5.4	4.8	4.9	4.4	5.4	6.0
Non-ferrous metals	372	2.1	1.7	1.8	1.9	3.8	2.0	2.8	2.0
Metal products, excluding machinery	381	6.9	6.9	7.0	7.9	7.3	5.0	7.0	4.1
Non-electrical machinery	382	9.7	8.1	11.2	8.0	9.6	10.0	9.6	9.7
Electrical machinery	383	8.1	5.8	8.1	7.2	7.8	5.9	7.9	6.2
Transport equipment	384	10.7	8.2	10.5	8.8	8.5	7.9	8.5	7.2
Professional and scientific equipment, photographic and optical goods	385	2.1	0.9	2.2	1.0	6.0	1.9	6.5	3.2
Other manufactures	390	1.5	1.1	1.5	1.8	2.9	3.0	2.7	2.7

Source: Based on data supplied by the United Nations Statistical Office and on estimates by the UNIDO secretariat.

[a] Adequate data were available for 11 developed market economies in 1963 and 20 in 1975. Seven centrally planned economies were included for both years. Calculations were in current United States dollars.

In the centrally planned economies, the share of food products, wood products, non-metallic minerals and non-ferrous metals declined. Expanding industrial branches included textiles, clothing, industrial chemicals, petroleum refining and iron and steel. Contracting branches in the developed market economies included textiles, clothing and iron and steel, while petroleum refining, plastic products and non-electrical machinery expanded.

A final noteworthy point exemplified by the composition of net manufacturing output concerns the overall pattern of change in the developed countries. The relatively small share of net output accounted for by light manufacturing was noted above. However, the shares of several of these branches either remained stable or rose during the period.[82] In the past, the declining shares of these branches were attributed to *(a)* income elasticities of domestic demand which were less than unity and *(b)* the fact that the production technologies used were often fairly simple. There are limits to the extent of contraction in any branch, however. For example, since Governments are not likely to permit the continued contraction of agriculture, they may support indirectly agro-processing branches such as food, beverages, tobacco and textiles. Furthermore, there are economic reasons to expect that, in the long term, contraction will not go beyond a fixed minimum. The demand for necessities, although not a stimulus to long-term growth when manufacturing is expanding rapidly, will continue to be a significant component of aggregate demand, particularly if the growth of income is slow.

Trends in certain branches of heavy manufacturing may reinforce these shifts. The traditional view that rapid technological advances are associated with heavy industry (e.g. basic metals, printing and metal products, sometimes referred to as "late industries"[83]) may no longer hold true in some countries. Certainly, the rate of technological advance is rapid in electronics, specific types of machinery and capital goods. However, it has also led to substitutions (e.g. aluminium, plastics and glass have replaced steel in several uses), which have slowed the pace of growth in heavy manufacturing. Technological advances have brought about reductions in inputs of steel, chemicals and metals per unit of final output which, in turn, have reduced the demand in these industries.[84] Finally, in several fields of heavy manufacturing—iron and steel, non-ferrous metals, chemicals, petroleum refining and products of petroleum—interdependence has grown because of supply bottle-necks and because the effects of flagging demand have been transferred from one economy to another.

These observations suggest that some activities in heavy industry may eventually experience a relative decline or contraction, although the causes

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[82]By the use of the relative measure—the appropriate expression when considering a group of countries—the shares of the following branches of light manufacturing showed no contraction in the developed market economies: food products, beverages, furniture, printing and publishing, plastic products and other manufactures. In the centrally planned economies a similar observation applied to beverages, tobacco, textiles, wearing apparel, leather, footwear, rubber and plastic products.

[83]H. Chenery and L. Taylor used this term to describe these industries, which tended to expand most rapidly at later stages of development. See H. Chenery and L. Taylor, "Development patterns: among countries and over time", *Review of Economics and Statistics*, vol. L, No 4 (November 1968), p. 391.

[84]See, for example, chapter III, pp. 133-134.

would be largely distinct from those associated with the contraction of other activities such as textiles, clothing or footwear. For one, some industrial branches—e.g. petrochemicals and plastics—may have reached a mature state of development and will no longer provide the growth impetus for which they were known in the 1970s. A decidedly slower rate of expansion would be one characteristic of such industrial branches.[85] For another, change in technology and its impact on interindustry linkages may alter the list of high-growth activities. For example, in the 1970s the manufacturing inputs into a computer system fell below one half of the products' value much sooner than was expected.[86]

With regard to the international consequences of structural changes within the manufacturing sector, the foregoing type of analysis provides little basis for a comparison between the two economic groupings. Some studies have suggested that patterns of structural change may differ markedly between the developing and the developed countries.[87] One such interpretation is tested here. Each of the 28 branches of manufacturing was ranked by its share in net output in three separate years for each developed market economy and developing country for which data were available.[88] These rankings were then tested to determine the degree of structural similarity within each cell. The results are given in table I.14.

Defined in the above manner, the output composition in developed market economies showed a considerable degree of similarity. Equally important, the similarity in rankings became greater over time. An increase in the number of countries included in the sample (from 11 to 18) reduced Kendall's coefficient of concordance by only a marginal amount.[89]

A comparison of the coefficients between the developed market economies and the developing countries revealed a distinct difference in output mix. Furthermore, there was no observable trend (upward or downward) in the similarity of the developing countries' pattern. The inclusion of additional developing countries reduced the coefficients considerably. Most likely, if data for additional developing countries were available, the differences in the coefficients of the two economic groupings would become even more marked.

The foregoing analysis and results appear to support the conclusion that the structure of net manufacturing output in the developed market economies has gradually become more homogeneous. No similar trend is found with

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[85]The chemicals industry already exhibits several characteristics of a mature industry. These characteristics are documented in chapter III. A statistical truism is also relevant here: as an industrial branch like petrochemicals continues to grow, it accounts for a greater portion of MVA and its growth rate converges with that of the manufacturing sector.

[86]*The Economist*, 27 December 1979. Similar trends are noted in chapter III in the case of steel.

[87]See, for example, *World Industry since 1960* . . . , chapters I and III.

[88]Comparable figures were available for seven centrally planned economies. Similar tests were not carried out for these countries since the number is too small to allow for tests of statistical significance.

[89]The coefficient indicates the association between k sets of rankings and takes values between 0 and +1, the latter value indicating identical rank orders in all k sets ($k > 2$). Kendall's coefficient, unlike the Spearman rank correlation coefficient, can never be negative for the simple reason that there can never be complete disagreement among more than two rankings. See A. E. Maxwell, *Analysing Qualitative Data* (London, Methuen, 1961), pp. 114-120.

TABLE I.14. KENDALL'S COEFFICIENT OF CONCORDANCE[a] BETWEEN THE RANKINGS OF INDUSTRIAL BRANCHES (VALUE ADDED)[b] ACROSS COUNTRIES

Sample group	*Number of countries*	*1963*	*1970*	*1975*
Developed market economies	11	0.787	0.812	0.830
		(35.948)	(43.191)	(48.824)
Developing countries	13	0.697	0.684	0.706
		(23.005)	(21.641)	(24.003)
Developed market economies	18	. . .	0.748	0.772
			(29.683)	(33.861)
Developing countries	37	. . .	0.530	0.525
			(11.273)	(11.053)

Note: The definition of adjusted coefficient of concordance W' is given by the equation:

$$W' = \frac{12(S - 1)}{k^2(n^3 - n) + 24}$$

where S is the sum of the squares of the deviations of the total of the ranks obtained by each object from the average of these totals. The number of rankings is k, and n is the number of objects in each ranking. See A. E. Maxwell, *Analysing Qualitative Data* (London, Methuen, 1967), pp. 117-121.

[a] F values are given in parentheses. All coefficients are significant at 99 per cent.

[b] Calculations were in current United States dollars.

regard to the developing countries; if anything, the output mixes of these countries is becoming more dissimilar over time.

Such structural changes could have important consequences for several aspects of development, including productivity trends, industrial investment, trade in manufactures and industrial policy. Although a clear picture of these consequences would require greater study, a few broad and tentative interpretations may be made. Greater homogeneity in the pattern of manufacturing production in the developed market economies may contribute to increased competition among these countries. Other things being equal, greater homogeneity would lead to comparable trends in productivity, investment and rates of return, and patterns of industrial demand. Among the developing countries the degree of homogeneity is certainly less. Not only do they face a different set of industrial problems from those confronting the developed countries, but the industrial problems and circumstances differ widely among countries within this economic grouping. The importance of technical co-operation and trade or investment among developing countries takes on added significance in this light. Fruitful opportunities for pursuing such lines of collaboration should multiply as development proceeds.

The world distribution of *per capita* MVA

Rapid growth has been a characteristic of the manufacturing sector for several decades. By 1977, world MVA had reached \$586[90] *per capita* compared with \$312 in 1960. As manufacturing provides a substantial share of world income, the simple fact that *per capita* value added almost doubled during these years represents a significant achievement. However, when evaluating these

[90] All figures in this section are based on data in United States dollars at 1975 prices.

gains, it is also important to know how they were distributed among countries. This information is useful in determining the extent to which the restructuring process has contributed to a more equitable distribution of the income associated with industrial growth since 1960.

Obviously, countries have embarked on an industrial course at different periods in their history, depending on when they achieved independence, when they deemed industrialization appropriate etc. Thus, one method of examining growth patterns is to distinguish between countries according to how long they have been engaged in the industrialization process. Such an arrangement of countries is shown in table I.15. The developed market economies are divided into two subgroups: countries where the manufacturing sector has a long history and countries where the sector has become comparatively important only in the last three decades. The developing countries are separated into three subgroups: newly industrializing developing countries (NICs), countries that have yet to start industrializing (i.e. the least developed countries), and a residual of other developing countries. The centrally planned economies are treated as a separate group.

TABLE I.15. INDICES OF *PER CAPITA* MVA IN SELECTED ECONOMIC SUBGROUPS, 1960 AND 1977

(Base 100 = world average MVA per capita)

Subgroups (number of countries)	*1960*	1977
Industrially mature market economies[a] (13)	342.6	314.0
Recently industrialized market economies (13)	126.2	192.9
Newly industrializing developing countries[b] (9)	50.6	60.2
Least developed countries[c] (24)	2.4	2.2
Other developing countries (63)	8.7	9.4
Centrally planned economies of Europe and the Union of Soviet Socialist Republics (8)	101.3	196.3
World (130)	100.0	100.0

Source: Based on data supplied by the United Nations Office of Development Research and Policy Analysis and the United Nations Statistical Office, and on estimates by the UNIDO secretariat.

[a]Industrially mature market economies include: Austria, Belgium, Denmark, France, Germany, Federal Republic of, Italy, Luxembourg, Netherlands, Norway, Sweden, Switzerland, United Kingdom and United States. The remaining developed market economies were treated as recently industrialized economies.

[b]The criteria for selection of the newly industrializing developing countries were: (i) a minimum level of $1,100 *per capita* GDP in 1978 at current prices and (ii) a share of net manufacturing output equivalent to at least 20 per cent of GDP in 1978. For further discussion regarding the identification and growth process in this subgroup, see Bela Balassa, "A stages approach to comparative advantage", paper presented to the Fifth World Congress of the International Economic Association, 29 August 1977, Tokyo, and chapter II of this *Survey*.

[c]Data were not available for all of the least developed countries.

A comparison between the six subgroups shows only one positional shift: rapid industrial growth in the centrally planned economies coupled with low rates of population growth meant that, by 1977, their *per capita* MVA exceeded the level attained in recently industrialized market economies. Changes in each index over time are also of interest. In the centrally planned economies, *per capita* MVA rose from a level roughly equivalent to the world average in 1960

to a value almost twice the world average in 1977. The gains of the recently industrialized market economies were almost as dramatic.

A contrary trend occurred in the least developed countries where *per capita* MVA actually declined from 2.4 per cent of the world average to 2.2 per cent in 1977. Although this change is not great, it is perhaps the most significant feature of the results. No "catching-up" phase took place since these countries were largely excluded from the restructuring process. In the last 20 years *per capita* MVA in the least developed countries has risen by only $5 (i.e. roughly equivalent to a growth of only $1 per person every four years). Thus, the gap between this subgroup and the rest of the world, although already substantial, increased during a period when industrial growth was comparatively high by historical standards. This widening gap appears to present the most pressing problem of industrialization for the years ahead.

The remaining subgroups of developing countries shown in table I.15 have reduced the gap in *per capita* MVA by comparison with the world average. In the case of the newly industrializing developing countries, the gap was reduced to 60 per cent of the world average by 1977. The residual group of other developing countries also recorded modest gains; by 1977 their *per capita* MVA was 9.4 per cent of the world figure.

From this discussion it is not immediately clear whether the world distribution of *per capita* MVA became more equitable during the period 1960-1977. Certain groups of countries improved their position while others, in particular the least developed countries, experienced a further deterioration. Thus, for some countries new income differentials appeared while others improved their relative position. The net effect of all these shifts can best be gauged with the help of an index[91] measuring the equitableness of the world distribution of *per capita* MVA. The index chosen is intended to reflect international shifts in the level of manufacturing activity on a *per capita* basis.[92] Issues of "equal" or "unequal" distribution are, therefore, addressed in terms of production rather than consumption.

The index was first calculated using each country (a total of 130) as a unit of observation.[93] The results in table I.16 show a slight decline in the index over time, indicating that world *per capita* MVA had become more evenly distributed among countries by 1977.

When the developed market economies are considered separately, the results show a more even distribution of *per capita* MVA. The fact that *per capita* MVA in the developed market economies approaches similar levels over

[91] The measure used here is Theil's index of dispersion normalized by its maximum possible value in the year of observation. The index is defined as follows:

$$T = \frac{\sum y_i \ln (y_i/n_i)}{\ln (1/n_j)}$$

where y_i and n_i are the shares of the MVA and population of a given country grouping in the total MVA and population of the world, and n_j is the population share of the smallest country grouping. Theil's index takes the value zero in the case where maximum equality is reached; thus, in that case the index used here is not determined.

[92] In the present context, a completely equal or even distribution would be found if, in each group of countries, the share of MVA were equal to the share of population. Conversely, a totally inequitable distribution would be obtained if all the world MVA were concentrated in the country grouping with the smallest population.

[93] Data on *per capita* MVA for China were not available for inclusion in this exercise.

TABLE I.16. INDEX OF THE DISPERSION OF *PER CAPITA* MVA IN SELECTED ECONOMIC GROUPINGS,[a] SELECTED YEARS

Economic grouping	*1960*	*1965*	*1970*	*1975*	*1980*
World	8.7	8.6	8.4	8.1	8.3
Developed market economies	1.9	1.6	1.1	1.0	1.0
Developing countries	8.4	8.1	8.1	8.3	8.3

Source: Based on data supplied by the United Nations Office of Development Research and Policy Analysis and the United Nations Statistical Office, and on estimates by the UNIDO secretariat.

[a]Calculated by country from national accounts data in United States dollars at 1975 prices.

time may be one aspect of a more general trend towards greater homogeneity.[94] Patterns of trade and similarity in output composition reported elsewhere in this *Survey* point to the same conclusion.[95] Taken together, they suggest that competitive pressures among the developed market economies are increasing. One possibility is that the slow-down in industrial growth during the 1970s may, at least in part, have been owing to profound structural changes that occurred as a number of advanced countries reached a stage of industrial maturity. When the developing countries are considered separately, the indices changed little. Although certain countries made great headway in raising their levels of *per capita* MVA, others experienced a decline.

The approach described above provides a means of determining the world distribution of *per capita* MVA among a large number of individual countries. While it is of value to summarize the results of all such changes in the form of a single index, the extensive level of disaggregation may rule out useful generalizations. For example, subgroups of countries experience rates of industrial growth that are roughly similar to the individual growth rates of members of that group but that differ widely in comparison with those of other groups. This is the case when the least developed countries are compared with some of the more advanced developing countries.[96]

Table I.17 shows the results of a comparison of the distribution of *per capita* MVA that distinguishes not between individual countries (as done in table I.16) but between different groups of countries arranged according to their level of development and timing of the industrialization effort. Thus, three subgroups of developed countries were considered along with the same number of subgroups of developing countries (see table I.15). Although there has been a significant dispersion of industrial capacity among these subgroups in the last 20 years, the results show no noticeable change in the distribution of *per capita*

[94]Other evidence suggesting a long-term tendency towards greater similarity in the industrial structures of the developed market economies has been reported elsewhere. For example, two recent studies have found that the composition of net manufacturing output in various developed market economies is becoming more homogeneous. See *Structure and Change in European Industry* (United Nations publication, Sales No. E.77.II.E.3), pp. 17-18 and *World Industry since 1960 . . .*, pp. 70-72.

[95]For a discussion of the growing importance of the exchange of very similar manufactured products, see chapter II. For an examination of the growing similarity of output composition, see pp. 55-56 of this chapter.

[96]See *World Industry since 1960 . . .*, pp. 43-44.

TABLE I.17. INDEX OF THE DISPERSION OF *PER CAPITA* MVA IN SELECTED ECONOMIC SUBGROUPS, SELECTED YEARS

Economic subgroups	*1960*	*1965*	*1970*	*1975*	*1977*
Thiel's index for six subgroups of countries[a]	26.6	26.9	26.6	26.2	26.9

Source: Based on data supplied by the United Nations Office of Development Research and Policy Analysis, the United Nations Statistical Office and estimates by the UNIDO secretariat.

[a]The subgroups included are as follows:
Industrially mature market economies
Recently industrialized market economies
Newly industrializing developing countries
Least developed countries
Other developing countries
Centrally planned economies
For a definition of the composition, see table I.15.

MVA when measured in this way. The value of the index remained roughly constant throughout the period. In 1960, the main factor determining the global pattern was that 68 per cent of world MVA was concentrated among 20 per cent of the world's population (in the industrially mature market economies).

It is apparent from the foregoing discussion that, to date, most shifts in industrial capacity have been confined to the developed countries and that only a limited number of developing countries have participated in the restructuring process. Therefore, when the global distribution of MVA *per capita* is examined relative to world population, movement towards greater equality under the present conditions seems unlikely. When *per capita* MVA is examined in terms of distinct subgroups of countries, no change in the global pattern was observed. Difference in international policy formulation and approaches to world problems are likely to persist while these gaps in *per capita* income remain.

Subsequent chapters examine these shifts in industrial capacity from other viewpoints, including that of efficiency, and explore the ability of manufacturers in the developing countries to compete more effectively on an international scale. The investigations indicate that the developing countries' potential to participate in the restructuring process exceeds the limited and marginal gains documented here.

Finally, a more equitable distribution of world MVA *per capita* should contribute to the greater efficiency of world industry, and to a more harmonious environment for the formulation of international policies designed to address some of the manufacturing sector's more pressing problems.

Appendix

SHARE OF CHINA IN WORLD MANUFACTURING VALUE ADDED

In the preparation of estimates of China's share in world manufacturing value added, information published by the State Statistical Bureau of China has been given priority, where possible. The reliance on indicators such as gross output in

industry (which is defined to include mining, electricity and gas, as well as manufacturing) or the percentage change in national income, however, entailed certain assumptions that could not be tested.

As a first step, an estimate for value added in manufacturing for 1976, in 1970 United States dollars,[a] was re-based to 1975 prices. Extrapolations for the three latest years were derived exclusively from official data, but are based on the assumption that the ratio of value added to gross output remained constant throughout the period.

To extrapolate China's manufacturing value added from 1976 to 1977, use was made of available information on the percentage change in national income[b] between 1976 and 1977. Acceptance of this approach required the additional assumptions that, for China, net factor income from abroad was negligible and that the percentage change in the manufacturing component of net material product was close to the average change for all economic sectors (including agriculture) during the year (a questionable assumption).

The extrapolation after 1977 was based on data from official sources[c] on the value of gross output for industry (i.e. including mining, manufacturing, electricity and gas), at constant prices. Although it was not possible to derive a separate series covering net manufacturing output only, quantity series for three commodities (coal, crude oil and electricity) that are important indicators of non-manufacturing activity were examined for their possible confounding effect. Table A.1 indicates that changes in the gross output series for industry fall in a range that is consistent with changes in the commodity series.

TABLE A.1. PERCENTAGE CHANGE IN GROSS OUTPUT OF "INDUSTRY" (MINING, MANUFACTURING, ELECTRICITY AND GAS) COMPARED WITH CORRESPONDING DATA FOR SELECTED COMMODITIES

	Year	
	1978	*1979*
Output	*1977*	*1978*
Gross output of "industry" (ISIC 2, 3, 4) at constant prices	13.5	8.5
Output (quantity data)		
Coal	12.3	2.8
Crude oil	11.1	2.0
Electricity	14.9	9.9

Source: State Statistical Bureau of China, *Main Indicators, Development of the National Economy of the People's Republic of China* (Beijing, 1979).

This would suggest that the inclusion of industries other than manufacturing does not significantly distort the use of the gross output of industry series as an indicator of change in manufacturing output. The resultant world distribution of manufacturing value added in the period 1976 through 1979 is provided in table A.2.

[a] See *World Industry since 1960: Progress and Prospects* (United Nations publication, Sales No. E.79.II.B.3), pp. 364-365.

[b] *Communiqué on Fulfilment of China's 1978 National Economic Plan* (State Statistical Bureau of China, 27 June 1979), p. 2.

[c] State Statistical Bureau of China, *op. cit.*, and *Main Indicators, Development of the National Economy of the People's Republic of China* (Beijing, 1979).

TABLE A.2. ESTIMATED SHARES OF ECONOMIC GROUPINGS AND OF CHINA IN WORLD MANUFACTURING VALUE ADDED

(Percentage)

Economic grouping and China	*1976*	*1977*	*1978*	*1979*
Developing countries	9.6	9.7	9.8	9.9
Developed market economies	62.8	62.4	61.6	61.4
Centrally planned economies (excluding China)	21.4	21.6	21.9	21.8
China (new estimate)	6.1	6.3	6.8	7.0

II. THE EXPORT PERFORMANCE OF THE DEVELOPING COUNTRIES— DYNAMIC CHANGES IN COMPARATIVE ADVANTAGE

For years economists have explained which goods a country imports and which it exports by the concept of comparative advantage. In the past three decades, the rapidity and extent of changes in production processes, in types of products, in the location of production facilities and in the types of required inputs have altered their thinking about the impact of trade on industrial restructuring. In particular, they now recognize that the interaction between determinants of comparative advantage is a more complex process than originally thought. Comparative advantage, itself, has come to be regarded as a constantly changing, or dynamic, concept.

Substantial shifts in comparative advantage suggest many significant consequences. One of the most important of these is forecast by a question raised in a recent study: "In terms of technologies and factors, are the comparative advantages of the various economies, developed and developing, in the process of changing radically so as to generate considerable and differential pressure on the economic structures of the OECD countries?"[1] The study answers the question essentially in the affirmative.

The present chapter addresses a more narrow aspect of this question. Briefly, it attempts to provide a rough impression of the actual comparative advantages in different industries in the developing countries, in order to determine whether these advantages have changed in recent years and, if so, the directions of such change. The investigation is one means of gauging the impact of comparative advantage on the geographical dispersion of industry and on the distribution of industrial investment. Some implications for export diversification and intra-industry trade are then discussed. The chapter concludes by considering some consequences for the composition and directions of trade in manufactures during the 1980s.

Initially, most economic theory to do with trade determinants dwelt simply on a country's relative endowments of labour and capital. By definition, the developing countries had relatively little accumulated capital. Apart from certain resource-based industries, their comparative advantages were thought to be in activities requiring relatively large amounts of unskilled labour but sparing in their use of capital. An additional proviso was soon added as both

[1] Interfutures, *Facing the Future. Mastering the Probable and Managing the Unpredictable* (Paris, OECD, June 1979), p. 151.

economists and industrialists began to appreciate the importance of differences in the quality of labour.[2] A country's endowment of human capital, i.e. the capital invested in education and labour training, was seen to influence trade patterns. Another refinement was introduced as it became clear that there was a fairly strong association between a country's share of world exports of certain products and the R and D intensity of those products. This led to the idea of a product cycle which proceeded from the premise that production of some goods in their life cycles passed through three product phases, described as "new", "growth" and "mature". The production of new products was characterized by their large skill requirements (i.e. the use of scientists, engineers and skilled craftsmen). After these products had passed through a phase of rapid growth, they were thought to have reached maturity when their production required relatively low skill intensities.[3]

Traditionally, the theory of international trade rested on the assumption that factors of production (such as labour and capital) were not mobile between countries or that their movements were so insignificant that a clear understanding of the trade process could be gained by referring only to a country's existing domestic supply of productive resources. The restructuring process has proved the need to modify this opinion. The conclusion of one economist is typical of this change in view, that "the long-run effects of factor movements on development of industry in different countries and on trade between them can be very considerable".[4]

Thus, the economists' interpretation of comparative advantage and of the forces that determine it has been modified in two ways. First, explanations now take into account the role of human capital, R and D, technology transfer etc. Second, the significance of the international movement of these inputs and of unskilled labour and capital are now better appreciated. For the purpose of the present discussion, what is important about these modifications is the implication that comparative advantage is itself a dynamic concept, that it changes in response to a new set of underlying forces or to changes in a country's relative endowments and access to skilled and unskilled labour, capital, technology etc.

The growth and restructuring of world industry has a cause-and-effect relationship with shifts in comparative advantage. Differential rates of structural change in the developed and the developing countries have accentuated these shifts. For example, in the case of labour, the developing countries have steadily enlarged their available supplies of skilled and semi-skilled labour. Gains in labour productivity have been fairly rapid as new

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[2]The Leontief paradox was instrumental in prompting this revision. Leontief found that the United States, though obviously using more capital per worker than other countries, exported labour-intensive goods and imported capital-intensive goods. W. Leontief, "Domestic production and foreign trade: the American capital position re-examined", *Proceedings of the American Philosophical Society*, September 1953, p. 343.

[3]For a further discussion, see, for example, Seev Hirch, "The product cycle model of international trade—a multi-country cross-section analysis", *Oxford Bulletin of Economics and Statistics*, vol. 37, No. 4 (1975), pp. 305-317.

[4]Bertil Ohlin, "Some aspects of the relations between international movements of commodities, factors of production, and technology", in *The International Allocation of Economic Activity*, Bertil Ohlin and others, eds. (London, MacMillan Press, 1977), p. 37.

production processes have been mastered. In the developed market economies, where ample supplies of skilled labour have long been available, gains in productivity have often lagged behind increases in real labour costs in recent years. Thus, for industrial activities with a high labour content, the competitive position of these economies has probably deteriorated by comparison with that of the developing countries.[5]

With regard to productive and financial capital, in the 1970s, there was a general decline in returns on capital in most developed countries. This decline led to a fall in investment which, coupled with an increase in international liquidity, helped to finance industrial projects in some developing countries. Such funds were not without costs, however, since they were lent through commercial banks. Moreover, it was essentially the transnational corporations that promoted this movement by dint of their privileged access to the international capital market.[6] Nevertheless, this flow of investment funds did serve to enlarge productive capacity in the developing countries. And in the process the potential comparative advantages of some industrial branches were actually realized.

The process of technological transfer proceeded in a fashion similar to the flow of capital. Like capital flows, technology was sometimes acquired at a high price, but, once it was installed, the developing countries usually proved capable of competing on equal terms with producers elsewhere.

Other factors have also altered the comparative costs of producers in developing and developed countries. Among certain chemicals, the rising costs of raw materials and feedstocks have made production "feedstock-intensive" rather than capital-intensive.[7] Future technological advances may again alter these relationships to favour new locations in developed countries, although at present this possibility is speculative. Continual competitive pressure in major consuming markets have forced most producers of standardized (or mature) electronic products to continue their search for ways to transfer parts of their operations to developing countries where costs are cheaper.[8]

Such trends are tentative and do not suggest that the bulk of industrial activity will be transferred to developing countries. The developed countries should continue to account for an overwhelming share of world manufacturing value added (MVA) for some time to come. The significance of these trends is that they demonstrate the dynamic nature of the industrialization process. By comparison with conditions in 1950, the present rapid growth of international flows—trade, investment, technology—has accentuated the importance of international demand. Consequently, each country's competitive position relative to its trading partners has taken on added importance, becoming a major policy issue. Thus, the question of shifts in comparative advantages and comparative costs is central to the course of future industrial relations between the developing and the developed countries.

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[5]Interfutures, *op. cit.*, pp. 152-153.

[6]*Ibid.*, pp. 158-159.

[7]See chapter III.

[8]See chapter III.

A. THE DEVELOPING COUNTRIES' PERFORMANCE IN THE EXPORT OF MANUFACTURES

Export performance has varied widely among developing countries and within the various branches of the manufacturing sector. There are reasons to believe, however, that certain subgroups of developing countries experience roughly similar trends in the composition of their major exports and in underlying changes in comparative advantage.

To simplify this study, three representative country samples were selected for examination. Two of these were drawn from the developing countries. The first sample is made up of what are often described as newly industrializing countries (NICs). They are important exporters of manufactures and have already reached a relatively advanced phase of industrialization. The criteria for selection of the NICs were: *(a)* a minimum *per capita* income of $1,100 in 1978 and *(b)* a share of net manufacturing output equal to at least 20 per cent of GDP in that year.[9] A second sample was composed of 10 additional developing countries for which detailed export data were available for the periods 1966-1967 and 1975-1976. In so far as dynamic changes in comparative advantage are systematically related to the level of development and the extent of industrialization, differences between the two samples and changes in the composition of their exports of manufactures over time are both relevant. A third sample was composed of developed countries at a somewhat higher stage of industrialization than that of the two other country samples; it was included for the purpose of comparison.

The composition of these three samples, along with the value and growth of exports, are shown in table II.1.

In most of these countries, exports of both total merchandise and of manufactures have expanded rapidly since 1970. Typically, growth rates for exports of manufactures tended to exceed those for total exports of merchandise. The main distinction between the three samples was found in comparing differences in the value of exports in 1977. First, exports of manufactures by the NICs and the developed countries were substantially greater than the levels recorded for the sample of other developing countries. Second, manufactures accounted for the bulk of total merchandise exports in each of the developed countries. Among the NICs, only Hong Kong and the Republic of Korea relied to such an extent on manufactures. The share of manufactures in total exports was small for the comparative sample of developing countries.[10]

The subsequent trade analysis is based on a detailed investigation of the exports of manufactures by the three country samples. The developed countries are regarded as a sample whose exports reflect patterns of comparative advantage that are at the upper end of a range.[11] It is assumed that the NICs

[9] See, for example, Bela Balassa, "A stages approach to comparative advantage", Paper presented to the Fifth World Congress of the International Economic Association, 29 August 1977, Tokyo.

[10] By virtue of its large size and comparatively large manufacturing sector, India was an exception to these generalizations.

[11] More advanced developed countries such as the Federal Republic of Germany, the USSR or the United States were excluded, since their patterns of comparative advantage would presumably represent a more advanced phase of development.

TABLE II.1. COMPOSITION OF COUNTRY SAMPLES, LEVELS OF *PER CAPITA* GNP AND VALUE AND GROWTH OF EXPORTS

Country group	*Country or area*	Per capita *GNP, 1978 (dollars)*	*Total merchandise exports, 1977[a] (SITC 0-9)*		*Exports of manufactures, 1977[a] (SITC 5-8)*	
Newly	Argentina	1 910	5 642	(18.0)	1 351	(27.4)
industria-	Brazil	1 570	12 120	(23.7)	3 072	(35.4)
lizing	Hong Kong	3 040	7 514	(20.5)	7 270	(20.6)
countries	Mexico	1 290	3 353[b]	(18.6)[c]	1 156[b]	(15.7)[c]
(NICs)	Republic of Korea	1 160	10 016	(42.7)	8 501	(44.7)
	Singapore	3 290	8 241	(26.9)	3 543	(35.1)
	Turkey	1 200	1 753	(16.9)	450	(33.0)
Developing	Colombia	850	2 443	(18.9)	459	(32.8)
countries,	Egypt	390	1 708	(12.2)	460	(12.1)
comparative	India	180	5 990	(16.9)	3 449	(18.4)
sample	Ivory Coast	840	2 155	(24.3)	154	(26.3)
	Nicaragua	840	633	(20.2)	106	(20.9)
	Philippines	510	3 138	(16.8)	577	(32.4)
	Sri Lanka	190	760	(12.6)	43	(36.0)
	Thailand	490	3 490	(26.2)	838	(33.7)
	Tunisia	950	929	(26.2)	322	(34.2)
	United Republic of Cameroon	460	663	(16.6)	58	(5.1)
Developed	Greece	3 250	2 757	(23.1)	1 505	(28.3)
countries,	Israel	3 500	3 083	(21.8)	2 450	(23.5)
comparative	Portugal	1 990	2 013	(11.3)	1 389	(12.8)
sample	Spain	3 470	10 218	(23.1)	7 356	(27.8)
	Yugoslavia	2 380	4 896	(16.5)	3 692	(17.6)

Source: World Bank, *World Development Report, 1980* (Washington, D.C., 1980); United Nations, *Yearbook of International Trade Statistics*, various issues; and data supplied by the United Nations Statistical Office.

[a]Export values in million dollars. Average annual rates of growth of exports over the period 1970-1977 (percentage) are given in parentheses.

[b]1976.

[c]Average annual growth in the period 1970-1976.

are at an intermediate stage and that, in time, their comparative advantages may approximate those in the sample of developed countries. The developing countries in the remaining sample are expected to have comparative advantages in a slightly different type of goods but, in the longer term, it is presumed that their pattern will resemble that of the NICs today.

In addition to the need to limit the country coverage of the study to a manageable number, some decision regarding the precise definition of manufactures was also required.[12] Traditionally, the scope of manufacturing activities is described in terms of production (ISIC) statistics. Thus trade in manufactures was defined in such a way as to ensure that it should roughly

[12]The choice of a definition is a more important decision than it might first appear. Estimates of the value, volume and composition of exports of manufactures are sensitive to such a definition and are not necessarily related in a systematic fashion. See V. Prakash, "Measuring industrial exports: a comparative statistical study of variations arising from differences in definition", World Bank Staff Working Paper No. 225 (Washington, D.C., February 1976).

match the range of activities commonly identified with the manufacturing sector.[13] The main difference between the present definition and others is that exports of resource-based industries with relatively little value added content are included here while they are often excluded from other studies.[14] Since the present study is concerned with the developing countries' exports of manufactures, it seemed desirable to include processed raw materials, which play an important part in these countries' trade.

Finally, it seemed appropriate to define precisely what was meant by an "industry". In order to account for diversity in market conditions and production processes, a specific definition was adopted.[15] Thus, 134 industries were treated as the constituent parts of trade in manufactures (see the appendix to this chapter), and estimates of comparative advantage were made on the basis of two-year averages for the periods 1966-1967 and 1975-1976.

Table II.2 lists all the developing countries whose exports of manufactures exceeded a value of $100 million in 1975. A comparison is also made between a traditional definition of trade in manufactures (SITC 5-8) and the broader definition used in the present discussion. Where differences between the two measures were large, the discrepancy was owing to the high proportion of exports, e.g. lightly processed products, which fall outside the traditional definition. Argentina, Brazil and the Philippines are examples where the traditional definition accounted for substantially less than one half of the country's total exports of manufactures (according to the broad definition used here). Conversely, where the two definitions led to similar estimates, the country's exports either included little in the way of lightly processed goods or food (e.g. Hong Kong, Mexico and the Republic of Korea) or consisted almost entirely of processed metals, which are traditionally defined as manufactures (e.g. Zaire and Zambia).

According to these measures, an extreme concentration of exports is revealed among a few countries. For example, 15 suppliers accounted for more than 80 per cent of the developing countries' exports of manufactures in 1975. The seven NICs supplied 52 per cent of the total exports reported in table II.2, while the comparative sample of other developing countries provided an

[13] A precise statistical definition of trade in manufactures is, of course, a subjective matter. At least six definitions of trade in manufactures are used. These include *(a)* SITC 5 to 8, *(b)* SITC 5 to 8 less 68, *(c)* SITC 5 to 8 less 67 and 68, *(d)* a list of 76 specifically identified SITC codes, *(e)* a list of 45 specifically identified SITC codes and *(f)* a nomenclature arranging products into manufactures and semi-manufactures. Definitions *(a)* and *(b)* are frequently found in a variety of studies. Examples of definitions *(c)* and *(d)* are to be found in UNCTAD, *Handbook of International Trade and Development Statistics*, various issues, and UNCTAD, *Trade in Manufactures of Developing Countries*, various issues. Definition *(e)* is taken from *Standard International Trade Classification, Revision 2* (United Nations publication, Sales No. 75.XVII.6). For definition *(f)* see UNCTAD, "The definition of primary commodities, semi-manufactures and manufactures" (TD/B/C.2/3, July 1965).

[14] Other studies sometimes exclude resource-based manufactures because comparative advantage in these goods is largely determined by a country's natural resource endowment instead of factor proportions or other country characteristics that are crucial for one of the models of international trade

[15] In trade studies the most common definition of an industry is a three-digit SITC category. See, for example, Bela Balassa, "Trade liberalization and revealed comparative advantage", *The Manchester School of Economics and Social Studies*, vol. 33, No. 1 (1965), p. 104. This definition, with the addition of several four-digit categories, was adopted here.

TABLE II.2. EXPORTS OF MANUFACTURES FROM THE DEVELOPING COUNTRIES,[a] 1975

Country or area	*Exports of industrially processed goods and intermediates*[b]		*Exports of manufactures (SITC 5-8) as a percentage of industrially processed goods and intermediates*[b]
	Value (million dollars)	*Cumulative percentage in developing countries' total*	
Brazil*	4 945.8	11.6	44.9
Republic of Korea*	4 517.3	22.2	91.5
Hong Kong*	4 494.3	32.7	99.5
Singapore*	4 416.8	43.1	50.9
India†	3 069.7	50.3	70.1
Malaysia	2 155.4	55.4	54.2
Argentina*	1 577.5	59.1	45.8
Kuwait	1 575.5	62.8	46.5
Mexico*	1 570.7	66.5	68.9
Philippines†	1 377.9	69.7	27.0
Egypt†	1 219.6	72.6	39.3
Thailand†	1 111.8	75.2	38.9
Pakistan	937.2	77.4	59.8
Indonesia	876.0	79.5	19.3
Turkey*	785.7	81.3	43.0
Zambia	777.1	83.1	100.0
Colombia†	640.8	84.6	48.1
Zaire	614.8	86.0	99.1
Senegal	489.6	87.1	30.0
Ivory Coast†	436.4	88.1	30.7
Guatemala	397 2	89.0	38.9
Morocco	366.3	89.9	53.8
Tunisia†	332.3	90.7	53.4
El Salvador	328.1	91.5	43.5
Sri Lanka†	326.9	92.3	6.5
Nicaragua†	273.2	92.9	23.1
Uruguay	259.6	93.5	44.0
Kenya	258.1	94.1	23.3
Syrian Arab Republic	227.4	94.6	31.8
Costa Rica	219.6	95.1	54.1
Panama	201.9	95.6	7.0
Nigeria	165.8	96.0	27.2
Ghana	163.9	96.4	23.9
United Republic of Cameroon†	152.8	96.8	52.0
Paraguay	121.5	97.1	14.9
Honduras	119.7	97.4	26.8
Burma	106.5	97.6	8.8
United Republic of Tanzania	101.6	97.8	40.8
Total developing countries[c]	42 666.2		58.5

Source: Data supplied by the United Nations Statistical Office.

Note: An asterisk (*) indicates that the country is a newly industrializing country; a dagger (†) indicates a developing country included in the comparative sample.

[a] Bahrain, Iran, Libyan Arab Jamahiriya, Netherlands Antilles, Saudi Arabia, Trinidad and Tobago, and Venezuela were excluded because petroleum products account for the bulk of their exported manufactures.

[b] For the definition of trade in industrially processed goods and intermediates, see the appendix to this chapter.

[c] In addition to the countries shown, 27 others for which comparable data were available are included in the total.

additional 21 per cent. Together, the two groups were responsible for almost three quarters of all developing countries' exports of manufactures.

With regard to the distribution among industries of exports of manufactures for the three country samples, table II.3 shows the major exporting industries (47 of 134) divided into resource-based industries[16] and other industries and ranked by the value of the developing countries' exports in 1975. The corresponding values and shares are given for each of the three country samples. In 1975, almost 62 per cent of exports of manufactures from 74 developing countries were resource-based products. Although the corresponding share still exceeded 60 per cent in the case of the comparative sample of 10 developing countries, it amounted to only 37 per cent of the NICs' exports of manufactures and 30 per cent of the exports of the comparative sample of five developed countries. Thus, the importance of lightly processed exports, which are closely related to the primary sector, is obvious. With higher levels of development, countries become less dependent on the availability of natural resources, as indicated by the figures for the NICs and developed countries.

Petroleum products amounted to 41 per cent of the 74 developing countries' exports of resource-based manufactures. This industry's exports, though substantial, were considerably less important for the three country samples studied here. Other resource-based products, whose aggregate export values for all developing countries reached relatively high levels in 1975, were processed raw materials (both agricultural and non-agricultural).

Among industries that do not belong to the resource-based category, the familiar pattern of export concentration in goods whose production is labour-intensive is repeated.[17] Examples are clothing, textiles, footwear and leather. For the NICs, a somewhat different set of products was fairly important. While petroleum products and processed agricultural goods figured prominently among the exports of resource-based industries, clothing, electrical machinery, telecommunications equipment and motor vehicles were prominent among the exports of non-resource-based industries. Finally, the exports of the sample of developed countries were more diversified; lightly processed raw materials did not figure prominently. Although labour-intensive industries—clothing and footwear—were important earners of foreign exchange, exports of motor vehicles, non-electrical machines and ships and boats were also significant.

In a more detailed comparison of the figures of the developing countries, two distinct features emerge. First, among traditional exports, the NICs (primarily Hong Kong and the Republic of Korea) are major suppliers of clothing, travel goods and footwear, accounting for over 70 per cent of all the developing countries' exports in 1975. The exports of other textile and leather products (e.g. cotton fabrics, textile yarn, textile goods and leather) are more evenly dispersed between suppliers in the NICs and other developing countries. Second, the NICs are also major suppliers, among the developing countries, of several "non-traditional" exports, such as electrical machinery (90 per cent), road motor vehicles (64 per cent), telecommunications equipment (90 per cent), non-electrical machines (70 per cent), toys and sporting goods (89 per cent),

[16] For a definition of resource-based industries (products), see the commodity typology presented in the appendix to this chapter and the corresponding explanation.

[17] A list of labour-intensive products is found in the appendix to this chapter.

TABLE II.3. MANUFACTURED EXPORTS BY TYPE OF INDUSTRY AND COUNTRY SAMPLE, 1975

(Million dollars and percentage[a])

Industry	*SITC*	*Exports of 74 developing countries (including oil countries)*		*NICs*		*Comparative sample of developing countries*		*Comparative sample of developed countries*	
A. Resource-based industries									
Petroleum products	332	13 545.1	(41.0)	2 032.5	(24.9)	330.7	(6.1)	542.8	(12.1)
Sugar and honey	061	4 040 7	(12.2)	1 604.1	(19.7)	1 677.9	(12.6)	50.5	(1.1)
Other fixed vegetable oils	422	1 420.1	(4.3)	215.7	(2.6)	347.9	(6.5)	23.0	(0.5)
Copper	682	1 246.8	(3.8)	39.6	(0.5)	1.9	(0.0)	182.3	(4.1)
Animal feeding stuff	081	1 099.4	(3.3)	718.9	(8.8)	192.4	(3.6)	46.8	(1.0)
Tea and mate	074	783.1	(2.4)	34.2	(0.4)	567.2	(10.5)	— [b]	—
Tin	687	753.3	(2.3)	28.2	(0.3)	112.2	(2.1)	10.8	(0.2)
Rice, glazed or polished	0422	693.2	(2.1)	6.8	(0.1)	31.8	(0.6)	20.5	(0.5)
Wood, shaped	243	620.5	(1.9)	169.1	(2.1)	113.0	(2.1)	143.7	(3.2)
Fixed vegetable oils, soft	421	516.7	(1.6)	240.1	(2.9)	87.9	(1.6)	156.5	(3.5)
Veneer, plywood	631	497.6	(1.5)	331.2	(4.1)	63.0	(1.2)	62.6	(1.4)
Fruit, preserved, prepared	053	373.9	(1.1)	182.2	(2.2)	106.6	(2.0)	241.1	(5.4)
Fertilizers	561	351.6	(1.1)	30.9	(0.4)	54.3	(1.0)	183.0	(4.1)
Mineral tar etc	521	335.2	(1.0)	21.6	(0.3)	16.1	(0.3)	2.2	(0.0)
Cocoa powder (unsweetened), butter and paste	0722/3	317.0	(1.0)	13.5	(0.2)	107.5	(2.0)	20.8	(0.5)
Inorganic chemicals	513	287.5	(0.9)	103.1	(1.3)	58.7	(1.1)	178.6	(4.0)
Silver, platinum etc.	681	285.0	(0.9)	6.0	(0.1)	273.0	(5.1)	40.8	(0.9)
Organic chemicals	512	256.4	(0.8)	176.8	(2.2)	30.6	(0.6)	213.9	(4.8)
Meat, tinned, n.e.s.	013	255.6	(0.8)	198.3	(2.4)	0.6	(0.0)	58.6	(1.3)
Aluminium	684	200.7	(0.6)	18.2	(0.2)	45.2	(0.8)	225.3	(5.0)
Total resource-based industries		33 055.9	(100.0)	8 147.1	(100.0)	5 389.9	(100.0)	4 468.7	(100.0)

TABLE 11.3 *(continued)*

Industry	*SITC*	*Exports of 74 developing countries (including oil countries)*	
B. Non-resource-based industries			
Clothing	841	4 255.4	(20.6)
Electrical machinery	729	1 003.0	(4.9)
Cotton fabrics	652	943.9	(4.6)
Textile yarn	651	899.9	(4.4)
Road motor vehicles	732	855.9	(4.1)
Woven textiles, non-cotton	653	763.8	(3.7)
Telecommunications equipment	724	761.2	(3.7)
Footwear	851	610.1	(3.0)
Machines, n.e.s., non-electrical	719	505.6	(2.4)
Toys, sporting goods	894	481.3	(2.3)
Textile goods, n.e.s.	656	436.9	(2.1)
Office machines	714	429.0	(2.1)
Leather	611	389.2	(1.9)
Other manufactured goods	899	358.7	(1.7)
Floor covering, tapestry	657	344.2	(1.7)
Instruments, apparatus	861	334.2	(1.6)
Cement etc.	661	330.2	(1.6)
Ships, boats	735	327.2	(1.6)
Medicinal products	541	318.6	(1.5)
Power-generating machines, non-electric	711	305.9	(1.5)
Printed matter	892	302.6	(1.5)
Electric power machines	722	298.3	(1.4)
Articles of plastic, n.e.s.	893	273.0	(1.3)
Iron and steel tubes and pipes	678	272.5	(1.3)
Travel goods	831	256.7	(1.2)
Machines for special industries	718	251.4	(1.2)
Watches, clocks	864	238.4	(1.2)
Total non-resource-based industries[c]		20 677.9	(100.0)

Source: Data supplied by the United Nations Statistical Office.

[a]Value of exports in million dollars and the industry's share in the group's total exports of resource

[b]Value less than $1,000,000.

[c]Totals include other industries.

NICs		Comparative sample of developing countries		Comparative sample of developed countries	
3 428.8	(24.2)	435.2	(12.3)	784.5	(7.7)
900.9	(6.4)	40.4	(1.1)	199.0	(1.9)
437.0	(3.1)	289.7	(8.2)	99.2	(1.0)
507.9	(3.6)	232.7	(6.6)	352.9	(3.4)
545.6	(3.9)	85.1	(2.4)	618.4	(6.0)
433.3	(3.1)	223.1	(6.3)	201.2	(2.0)
688.5	(4.9)	16.1	(0.5)	217.8	(2.1)
440.5	(3.1)	76.1	(2.1)	698.7	(6.8)
356.4	(2.5)	60.4	(1.7)	449.9	(4.4)
426.7	(3.0)	18.6	(0.5)	94.0	(0.9)
137.3	(1.0)	192.5	(5.4)	152.0	(1.5)
382.9	(2.7)	8.7	(0.2)	90.6	(0.9)
110.4	(0.8)	198.8	(5.6)	80.0	(0.8)
263.7	(1.9)	57.8	(1.6)	47.9	(0.5)
37.6	(0.3)	79.2	(2.2)	63.1	(0.6)
160.3	(1.1)	10.7	(0.3)	54.0	(0.5)
126.5	(0.9)	103.0	(2.9)	260.8	(2.5)
296.0	(2.1)	11.6	(0.3)	758.1	(7.4)
179.4	(1.3)	50 5	(1.4)	145.2	(1.4)
237.5	(1.7)	40.5	(1.1)	125.1	(1.2)
155.7	(1.1)	30.8	(0.9)	205.0	(2.0)
157.4	(1.1)	29.9	(0.8)	220.7	(2.2)
219.6	(1.6)	17.7	(0.5)	45.0	(0.4)
184.2	(1.3)	45.6	(1.3)	216.2	(2.1)
201.1	(1.4)	34.7	(1.0)	36.2	(0.4)
172.0	(1.2)	19.4	(0.5)	83.8	(0.8)
228.2	(1.6)	3.8	(0.1)	24.9	(0.2)
14 161.0	(100.0)	3 551.5	(100.0)	10 254.8	(100.0)

e-based industries (A) or non resource-based industries (B).

office machines (89 per cent), power-generating machines (78 per cent), steel tubing and pipes (68 per cent), and watches and clocks (96 per cent).

The foregoing results clearly show that different types of export are important to different countries included in the three samples. Little may be concluded, however, about the performance of the main exporting industries without some quantitative measure of comparative advantage. A straightforward attempt to measure the importance of each determinant of comparative advantage would not be possible, for lack of data if for no other reason. Instead, economists have adopted a proxy measure that summarizes the net effect of the various determinants. They argue that "'revealed' comparative advantage (RCA) can be indicated by the trade performance of individual countries".[18] The approach assumes that the pattern of trade reflects intercountry differences in relative cost as well as in non-price factors such as quality differences, goodwill and servicing. Previous studies have measured trade performance (and, hence, revealed comparative advantage) in two ways. One alternative is to view RCA as a ratio of an industry's exports to its imports. Another approach is to treat an industry's relative export performance as an indicator of comparative advantage. Most economists maintain that the latter approach yields a more accurate measure, since intercountry differences in the export-import ratio are greatly influenced by the system of protection used in the country. This interpretation was accepted for the analysis here. The following examination of comparative advantage is in terms of export performance.

The export performance ratio[19] represents an industry's share in a given country's exports of manufactures relative to world exports of that industry as a share of world trade in manufactures. For example, a value of 2.0 indicates that the industry's share in the given country's exports of manufactures is twice the corresponding world total. The measure is taken as an indication of revealed comparative advantage or disadvantage in the export of certain products.[20] Export performance ratios were computed for each of the 134 industries and the countries of the three samples identified earlier. The results are shown in the appendix to this chapter.[21]

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[18]Balassa, "Trade liberalization . . .", *loc. cit.*, p. 103. For further elaboration see, also, B. Balassa, "The changing pattern of comparative advantage in manufactured goods", *The Review of Economics and Statistics*, vol. LXI, No. 2 (May 1979), pp. 259-266.

[19]The export performance ratio EP is defined as follows:

(1) $EP_{ij} = [(X_i^j/X_i^m)/(X_.^j/X_.^m)]$

where: i = country, j = commodity, m = total manufacturing, . = world total, X = value of the respective export flow. See Balassa, "Trade liberalization . . .", *loc. cit.*, p. 106.

[20]For a discussion of the concept of revealed comparative advantage, see A. L. Hillman, "Observations on the relation between revealed comparative advantage and comparative advantage as indicated by pre-trade relative prices", *Weltwirtschaftliches Archiv*, Band 116/2, 1980, pp. 315-321.

[21]The export performance ratio for country sample g (g = 1, 2, 3) is obtained as a weighted average of the individual countries' values, where the values of total trade (exports plus imports) are taken as weights:

(2) $EP_{gj} = \sum_{i=1}^{G} (X + M)_{ij} EP_{ij} / \sum_{i=1}^{G} (X + M)_{ij}$

where X is exports, M is imports, G stands for the number of countries forming the sample, i represents an individual country, and j refers to a specific industry.

The ratio shows a wide range of variation around 1.0, the "normal" value indicating conformity with the world pattern. In the case of some resource-based industries, the results reflect an individual country's trading position rather than that of the country sample.[22] Thus, the absolute values of some export performance ratios must be regarded with caution, although a discussion focusing on the relative changes could yield valuable information.

A comparison of the export performance of various industries in the three country samples is limited to those activities that are not primarily dependent on resource endowments. The export performance of individual resource-based industries is largely dependent on the endowments of countries with natural resources and, therefore, cannot be regarded as part of a general development process.[23] The industries that are not resource-based were then ranked within the three country samples according to their export performance ratios. These three sets of industry rankings then served as one means of comparison. When the rankings differ between the three sets of countries, corresponding differences in export performance and revealed comparative advantages are expected. The results of such a comparison are shown in table II.4. They indicate that there was only a rough similarity between export performance ratios although the rankings became more comparable over time. Surprisingly, the closest match between the rankings of industry by export performance occurred when relating the comparative sample of developed countries to the comparative sample of developing countries. Apparently, the export performance of the NICs was based, at least partly, on industries that were somewhat unique to the countries considered here.

TABLE II.4. SPEARMAN RANK CORRELATION COEFFICIENTS BETWEEN COUNTRY SAMPLES, 1966-1967 AND 1975-1976

Country groups compared	*1966-1967*	*1975-1976*
NICs with developing countries (comparative sample)	0.596	0.597
NICs with developed countries (comparative sample)	0.431	0.517
Developed countries (comparative sample) with developing countries (comparative sample)	0.512	0.717

Source. Data collected by the UNIDO secretariat from primary sources.

Note: All coefficients are significant at the 1 per cent level. The number of industries (SITC three-digit) included in each calculation was 79.

The results suggest that the pattern of RCA does differ between different groups of countries. The modified interpretation of trade determinants, as

[22]Examples are Mexico, with an EP ratio for lead of almost 30, and Thailand, with a ratio for tin of over 100.

[23]The aggregate export share obtained by resource-based products is of interest and is discussed later in this chapter.

distinct from traditional thinking, stresses the differences in the exporting industries' production requirements, particularly in their skill requirements and in the degree to which the production process is standardized. Two alternative interpretations of industry were considered here. According to one, an industry's RCA depends on its requirements for and the availability of skilled labour. Products requiring fairly large amounts of skilled labour are thought to be "new products" still in the early phase of their life cycle. Products requiring little in the way of skilled labour are described as "mature products" whose production utilizes a large number of unskilled workers.[24] The alternative is to depict product development as a continuing process with "the rate of development determined by the condition that an acceleration of this rate would add more to costs than to revenue".[25] In this case, standardized products are indicated by a low rate of product development while unstandardized products are associated with a high rate of product development. Unstandardized industries are not necessarily the same as new industries. For example, producers of office machines and scientific instruments incur large R and D expenditures, require large numbers of skilled workers and have high rates of product development. However, producers of plastic and rubber articles, soaps and cleansers have high rates of product development but require little skilled labour. Both types of products would be described as "unstandardized", although only the former would be "new products". The second alternative interpretation associates export performance with producers' abilities (and inclinations) to alter their products' characteristics in response to demand or to achieve some degree of product differentiation. Both interpretations are used as a basis for the discussion that follows where industries are arranged into groups according to their skill intensities and rates of product development.

Since the country samples chosen for the analysis may be regarded as representing different (presumably subsequent) stages of economic development, dynamic changes in comparative advantage may be reflected in two different ways. First, differences in trade patterns and underlying comparative advantages between the three country samples should be qualitatively predictable according to factor endowment and product characteristics. Second, export performance should change over time according to expectations regarding changes in factor endowment and the nature of the product cycle.[26]

In order to identify specific fields of comparative advantage or disadvantage, a measure of "revealed comparative advantage" (RCA index) was

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[24]For a discussion, see S. Hirsch, "Hypothesis regarding trade between developing and industrial countries", in *The International Division of Labour: Problems and Perspectives*, H. Giersch, ed. (Tübingen, J. C. G. Mohr, 1974), pp. 65-82. An often-cited example of the product cycle is the development of the transistor radio. Initially, a large proportion of costs were in R and D, implying that the labour force was highly skilled. As the production process "matured", the operations became standardized and required much smaller numbers of skilled labour.

[25]J. M. Finger, "A new view of the product cycle theory", *Weltwirtschaftliches Archiv*, Band CXI, 1975, p. 86. Finger regards product development as a form of competition intended to retain old, and gain new, markets by offering for sale at established prices products that buyers regard as different from the existing list of available products.

[26]See, for example, Balassa, "The changing pattern . . .", *loc. cit.*, and R. Banerji, "Major determinants of the share of manufactures in exports: a cross-section analysis and case study on India", *Weltwirtschaftliches Archiv*, Band 108, 1972, pp. 345-377.

derived from the export performance ratios given in the appendix.[2] The measure is a simple projection of export performance intended to reflect both the static and the dynamic aspects of revealed comparative advantage. On this basis a product (industry) was described as having a "marked" revealed comparative advantage if its RCA index exceeded a "normal" level of 100 by at least 50 per cent and if the ratio of net exports (exports minus imports) to total trade (exports plus imports) was not smaller than the corresponding ratio for all manufactures. The second condition—the relationship between exports and imports—was introduced in order to exclude products with a large excess of imports over exports for the country or country group in question.

The distribution of marked RCA in each NIC in the period 1975-1976 is given in table II.5, with corresponding figures for the two other country samples. As expected, the countries that are relatively well endowed with natural resources also enjoy substantial comparative advantages in resource-based industries. Roughly 40 per cent of all the manufactured exports from the comparative sample of developing countries in these years involve resource-based industries with a marked RCA. The corresponding aggregate values for the other two country samples were lower (25 per cent for the NICs as a whole and 21 per cent for the five developed countries). The wide spectrum of trade patterns in the NICs is reflected by extreme values of the share, ranging from 0 per cent for Hong Kong to more than 40 per cent for Brazil and Singapore. Differences between the three country samples indicate that at early stages of development, comparative advantages are mainly found in industries for which the domestic availability of certain natural resources is crucially important and in products that are closely related to the primary stage. Examples, drawn from the comparative sample of developing countries, are: food products (such as preserved or prepared vegetables, tea and maté and fixed vegetable oils), mineral tar and tin. At higher levels of development the dominant position of resource-based industries wanes and other exports become competitive.

For an understanding of the export performance of industries that are not resource-intensive, the concept of the product cycle is useful. According to one version of this concept, mature industries (i.e. those with comparatively low degrees of skill requirements) are expected to show a much higher frequency of marked RCA in developing countries than do "new industries" (i.e. those with a high degree of skill intensity). Empirical evidence to bear out this hypothesis appears in table II.5, which shows that over one third of the NICs' exports of manufactures were from mature industries with a marked RCA. The share of these products in the exports of all manufactures was highest for Hong Kong and the Republic of Korea; the absence of such RCA industries in Singapore was the exception to the rule. Argentina, Brazil and Mexico had comparatively modest but significant shares, which were less than the average of the comparative sample of developing countries (25 per cent). On the other hand,

[2] In order to obtain a simple indicator for both the most recent competitive position of an industry and for its trend in comparative advantage over the sampled period, the following RCA index was used (see Balassa, "Trade liberalization . . .", *loc. cit.*, p. 106):

$$RCA_{ij} = \tfrac{1}{2} EP_{ij}^{1} [1 + (EP_{ij}^{1}/EP_{ij}^{0}] \times 100$$

where EP stands for the export performance ratio, *i* for a country or country group, *j* for an industry and the superscripts 0 and 1 indicate averages for the periods 1966-1967 and 1975-1976, respectively.

TABLE II.5. EXPORTS WITH A MARKED RCA AS A SHARE OF EXPORTS OF MANUFACTURES, BY TYPE OF INDUSTRY AND COUNTRY SAMPLE, 1975-1976

(Percentage and, in parentheses, number of industries)

Type of industry	*Developed countries, comparative sample*	*NICs*							*Developing countries, comparative sample*
		Argentina	*Brazil*	*Hong Kong*	*Mexico*	*Republic of Korea*	*Singapore*	*Turkey*	
Resource-based	20.9 (19)	36.9 (18)	42.5 (13)	0.0 (0)	30.7 (20)	9.4 (7)	44.5 (8)	17.0 (10)	40.7 (17)
Mature industries									
Labour-intensive	21.0 (19)	7.4 (10)	12.8 (14)	67.7 (10)	13.9 (14)	53.1 (17)	0.0 (0)	27.9 (9)	22.6 (17)
Capital-intensive	7.7 (5)	0.0 (0)	2.8 (1)	0.0 (0)	1.4 (2)	6.1 (5)	0.0 (0)	2.9 (2)	1.7 (2)
Total[a]	28.7 (24)	14.4 (12)	21.5 (16)	67.7 (10)	16.6 (17)	59.2 (22)	0.0 (0)	30.8 (11)	24.6 (20)
New industries									
Labour-intensive	4.3 (5)	6.1 (4)	0.6 (2)	10.6 (5)	3.6 (4)	4.6 (3)	19.1 (4)	0.8 (2)	0.6 (2)
Capital-intensive	0.6 (2)	1.5 (2)	0.2 (2)	0.0 (0)	2.6 (1)	0.4 (1)	1.6 (1)	0.1 (1)	0.4 (1)
Total[a]	6.8 (9)	8.5 (8)	0.8 (4)	10.6 (5)	8.0 (7)	5.0 (4)	20.7 (5)	1.3 (4)	1.0 (3)
Standardized industries (low rates of product development)									
Labour-intensive	22.3 (20)	9.4 (11)	12.3 (14)	74.4 (13)	15.2 (16)	53.5 (16)	17.4 (3)	25.2 (8)	20.3 (16)
Capital-intensive	3.1 (4)	1.5 (2)	0.2 (2)	0.0 (0)	3.9 (3)	2.2 (3)	1.6 (1)	3.0 (3)	1.5 (2)
Total[a]	25.8 (25)	11.2 (14)	12.5 (16)	74.4 (13)	19.5 (20)	55.7 (19)	19.0 (4)	28.7 (13)	21.8 (18)
Unstandardized industries (high rates of product development)									
Labour-intensive	2.9 (4)	4.0 (3)	1.0 (2)	3.9 (2)	2.3 (2)	4.1 (4)	1.7 (1)	3.5 (3)	2.9 (3)
Capital-intensive	5.2 (3)	0.0 (0)	2.8 (1)	0.0 (0)	0.0 (0)	4.3 (3)	0.0 (0)	0.0 (0)	0.6 (1)
Total[a]	8.1 (7)	11.8 (6)	9.7 (4)	3.9 (2)	3.6 (3)	8.4 (7)	1.7 (1)	3.5 (3)	3.8 (5)

Source: Based on data supplied by the United Nations Statistical Office.

[a]The "total" share may also include industries for which the classification "labour-intensive" or "capital-intensive" was not applicable.

Turkey's share of marked RCA exports of mature industries in total exports of manufactures was close to the corresponding average for the comparative sample of developed countries (29 per cent). Furthermore, among marked RCA exports of mature industries, all country samples indicated a characteristic dominance of labour-intensive over capital-intensive products.[28] Among the new industries, only a few exporters apparently enjoyed any significant comparative advantages. These exports were a small share of the total for the developed countries and for almost all NICs[29] and were negligible for the comparative sample of other developing countries.

A similar pattern was found when industries were arranged according to their rates of product development—representing an alternative interpretation of the product cycle in international trade. Marked RCAs were concentrated among industries producing standardized goods, which are relatively labour-intensive. This was particularly true for the NICs as a whole, with a 35 per cent share of marked RCA exports of this type in total exports of manufactures. Examples included articles of plastic, floor coverings and made-up textiles. Differences between countries within the NIC sample were largely the same as those identified in the mature industry-new industry categorization; in the present framework Singapore conformed to the general pattern, too.

At the other extreme, industries with a competitive disadvantage can also be identified. Applying a comparable criterion to that used above, industries whose RCAs were less than one half the normal value may be described as having a competitive disadvantage. This "reverse" picture of the three samples' aggregate RCA structures confirmed the patterns described above. In the two samples composed of developing countries, only two mature labour-intensive industries showed an index less than 50. The corresponding number of industries, described as mature and capital-intensive, were six among the NICs and four among the other developing countries. The number of industries having a competitive disadvantage (excluding resource-based industries) was highest among the new (skill-intensive) industries in developing countries. There were 10 in the NICs and 17 in the comparative sample of other developing countries. They consisted mostly of engineering industries (SITC 7), together with some branches of metal manufacturing (SITC 69), several chemical industries such as paints (SITC 533) and pharmaceutical products (SITC 541).

In general, the results show that the revealed comparative advantage of developing countries is concentrated in resource-based industries and in mature (standardized) products. Also according to the notion of factor proportions, the overwhelming proportion of these industries' exports is accounted for by labour-intensive goods.

The second hypothesis that was advanced earlier in this chapter concerns systematic changes in revealed comparative advantage over time. Table II.6 gives weighted averages of the changes in the export performance ratios between

[28]The production of travel goods, clothing, leather and sporting goods is important in the NICs; sporting goods, leather and cotton fabrics are important among the other developing countries, while fur skins, made-up articles of textile material and footwear show high RCA indices in the developed country sample.

[29]Singapore's exceptional 21 per cent share of new marked-RCA products in total exports of manufactures is accounted for by exports of electrical machinery, telecommunications apparatus, ships and boats, office machines and pharmaceutical products.

TABLE II.6. AVERAGE PERCENTAGE CHANGES IN EXPORT PERFORMANCE RATIOS,[a] BY TYPE OF INDUSTRY AND COUNTRY SAMPLE, BETWEEN 1966-1967 AND 1975-1976

Type of industry	Developed countries, comparative sample	NICs							Developing countries, comparative sample
		Argentina	Brazil	Hong Kong	Mexico	Republic of Korea	Singapore	Turkey	
All manufactures	53.6	334.6	289.5	32.4	221.4	133.3	146.5	1 424.6	135.1
Resource-based	11.7	81.9	261.6	5.8	91.9	10.6	—16.5	186.4	74.1
Mature industries									
Labour-intensive	24.3	408.0	296.7	11.1	119.9	104.4	17.2	3 336.9	276.5
Capital-intensive	183.9	44.0	42.8	542.2	103.7	215.7	39.9	—20.1	11.0
Total	73.5	306.4	193.8	34.9	116.8	118.7	25.1	3 169.5	239.0
New industries									
Labour-intensive	58.5	732.7	73.8	25.6	172.2	275.6	527.9	—19.0	218.0
Capital-intensive	63.1	33.5	—36.6	27.8	—21.4	225.0	175.8	—	8.0
Total	58.9	603.0	70.3	25.8	129.4	273.8	489.5	—19.0	179.6
Standardized industries (low rates of product (development)									
Labour-intensive	39.7	776.5	126.5	11.1	152.6	100.8	421.2	3 852.9	308.0
Capital-intensive	129.0	33.5	—22.0	27.8	85.7	309.6	152.1	—	8.1
Total	50.3	655.8	115.1	11.4	142.9	108.6	392.5	3 852.9	286.6
Unstandardized industries (high rates of product development)									
Labour-intensive	44.8	58.4	387.7	63.0	45.7	746.4	265.7	248.6	20.5
Capital-intensive	186.9	44.0	54.2	542.2	—11.4	178.2	45.1	—20.1	12.2
Total	136.8	52.7	194.3	279.4	16.6	412.0	146.1	181.2	16.8

Source: Appendix to this chapter and data supplied by the United Nations Statistical Office.

[a]Increases in EP ratios are weighted by 1975-1976 average values of exports. For each country or country group only industries with a share in total exports of manufactures of more than 0.1 per cent in both 1966-1967 and 1975-1976 were included in the computation of average changes.

1966-1967 and 1975-1976 by product category and country sample. The average percentage increases in the export performance ratio for all manufactured goods indicated an improvement in the export position of each of the three country samples.

In this regard, resource-based industries recorded significant gains for developing countries in the comparative sample, for the Latin American NICs and for Turkey. Among the mature industries (those with low skill intensities) the result showed a consistent pattern of transition. For labour-intensive products the most significant gains were recorded by countries at lower stages of development. By and large, increases in the export performance ratios of those products declined as the level of development rose. Accordingly, developed countries and the high income NICs (e.g. Hong Kong and Singapore) showed only slight improvements in the export performance of this product category between 1966-1967 and 1975-1976, while the corresponding percentage increases ranged roughly between 100 and 400 per cent for the comparative sample of developing countries and the three Latin American NICs.[30] The opposite relationship between the level of development and gains in export performance can be found among mature industries that are relatively capital-intensive. The complementary group of "new" industries showed a similar pattern with regard to the distinction between labour-intensive and capital-intensive exports. While the gains for new products were fairly evenly distributed between the two factor-intensity categories in the developed countries, Hong Kong and the Republic of Korea, the increases in the export performance ratios of labour-intensive new products exceeded those of capital-intensive new products by far for the NICs Argentina, Brazil and Mexico and for the other developing countries.

The alternative interpretation of the product cycle—depicted in terms of rates of product development—sheds further light on the differences between the three country samples. The results for standardized industries were similar to those found above for mature industries. However, in industries characterized by high rates of product development, the gains in export performance of the NICs were significantly greater than those of other developing countries. Quite likely, the alternative versions of the product cycle would show many similar features if a detailed examination were carried out on an industry-by-industry basis. The results do suggest that the changing pattern of RCAs does not always conform to the expectations of economists that the developing countries' main areas of comparative advantage are confined labour-intensive industries.

Finally, to put the preceding discussion of export performance in some perspective, table II.7 shows the contribution to export growth by type of industry. Exports of manufactures by the sample of developing countries rose by a factor of 3.4 between the periods 1966-1967 and 1975-1976. Over one half of these gains were attributable to resource-based industries, a figure significantly greater than the corresponding shares for the other country samples. Both the developed countries and the NICs owed much of their progress mainly to the export of mature products requiring little in the way of skills. The exports of

[30]Turkey's extremely high export performance increase in labour-intensive mature industries is owing to the extraordinarily fast growth of clothing and cotton fabrics exports.

TABLE II.7. CONTRIBUTIONS TO THE GROWTH OF EXPORTS OF MANUFACTURES, BY TYPE OF INDUSTRY AND COUNTRY SAMPLE, BETWEEN 1966-1967 AND 1975-1976

($\Delta X_i^j / \Delta X_i^m$ as a percentage)[a]

Type of industry	*Developed countries, comparative sample*	*NICs*	*Developing countries, comparative sample*
Resource-based	26.5	28.6	55.7
Mature industries			
Labour intensive	24.4	38.5	25.4
Capital-intensive	13.3	6.5	6.6
Total[b]	43.1	47.8	33.7
New industries			
Labour-intensive	21.6	18.9	5.9
Capital-intensive	2.5	1.9	2.1
Total[b]	29.1	23.1	9.8
Standardized industries (low rates of product development)			
Labour-intensive	41.8	52.4	28.3
Capital-intensive	6.0	3.4	4.8
Total[b]	50.3	57.4	34.1
Unstandardized industries (high rates of product development)			
Labour-intensive	4.2	5.0	3.1
Capital-intensive	9.8	5.1	3.9
Total[b]	20.1	13.1	9.1

Source: Appendix to this chapter and data supplied by the United Nations Statistical Office.

[a] ΔX designates the difference between the 1966-1967 and 1975-1976 levels of exports, i stands for a country group, j is one of the listed product categories, and m is total manufactures.

[b] "Total" also includes industries for which the classification "labour-intensive" or "capital-intensive" was not applicable.

products with relatively high skill intensities accounted for a significant portion of these countries' export gains.

When industries were arranged according to rates of product development, a somewhat different picture emerged. The export gains of each group were more concentrated, mainly among industries producing standardized products with low rates of product development. For both the developed countries and the NICs, exports of standardized products (mainly labour-intensive ones) made an important contribution to foreign-exchange needs. In contrast, the exports of unstandardized products were not as important in terms of export growth, despite the fact that producers' competitive abilities improved.

Perhaps the most important impression emerging from the analysis is that, in at least a number of industries, comparative advantage appears to be shifting in favour of the developing countries. Moreover, these shifts are not exclusively restricted to labour-intensive industries. Constraints in the form of shortage of industrial finance or lack of access to industrial technologies also limit the positive benefits of the restructuring process for the developed as well as the developing countries.

Some consequences of changing comparative advantage—export diversification and intra-industry trade

A changing pattern of comparative advantage may offer countries the opportunity of diversifying their exports of manufactures over time. While traditional exports (e.g. labour-intensive or resource-based products) may retain an important position, their dominance would gradually be reduced if the restructuring process were to continue. The composition of exports of manufactures by different industries provides a rough idea of export concentration, whereas the export performance ratios indicate the dispersion of RCAs among product groups.

An impression of the extent of export diversification may be gained from some figures that were derived from table II.3. These figures suggest that the exports of the developed country sample were rather widely dispersed among industries in the period covered. For example, the highest portion of total exports recorded by one industry was 5.3 per cent. The corresponding maximum shares for the NICs and the comparative sample of other developing countries were 15.4 per cent and 18.8 per cent, respectively. This initial impression is confirmed by the alternative measures of export concentration shown in table II.8, which indicate systematic differences between countries and changes over time in the degree of export concentration in certain products.

The concentration index ranges between 0.086 and 1. The former value indicates complete diversification whereas the latter is associated with the concentration of exports in only one industry (product group).[31] The variation of the concentration index was considerable. Several leading exporters—Hong Kong, Singapore and, to a lesser extent, the Republic of Korea—had relatively high degrees of export concentration. Nevertheless, unweighted averages for each country sample showed the expected ranking—the extent of export concentration declined at higher levels of development. Furthermore, the developed country sample proved to be the most homogeneous group. Indices ranged from 0.161 (Yugoslavia) to 0.215 (Israel) in the period 1975-1976 with a standard deviation of 0.026. Indices for the other countries considered here had a considerably wider range of fluctuation.

With regard to changes in the pattern of concentration over time, only three of the 22 countries and areas considered (Hong Kong, Nicaragua and Singapore) experienced a rising concentration in their exports of manufactures. The general trend was towards reduced concentration (i.e. increased diversification) during the period considered.[32]

The concentration index may be regarded as somewhat abstract, since it ranges between two unlikely extremes representing "complete diversification" (equal export shares of all industries where $C = 1/\sqrt{n}$) and complete

[31] C reaches its minimum value $(1/n)^{1/2}$ if all n industries (products) retain the same share in exports of manufactures. The value 0.086 corresponds to $n = 134$ (see the appendix to this chapter). The maximum value 1 obviously characterizes complete concentration in one industry (product).

[32] Because of the almost uniform trend towards greater diversification, the cross-country pattern remained largely the same between the periods 1966-1967 and 1975-1976. For example, the Spearman rank correlation coefficient between the indices for the two periods was highly significant: 0.829.

TABLE II.8. TRADE DIVERSIFICATION MEASURES, BY COUNTRY SAMPLE, 1966-1967 TO 1975-1976

Country sample	*Concentration index*[a]		*Coefficient of variation for export performance ratio (percentage)*	
	1966-1967	*1975-1976*	*1966-1967*	*1975-1976*
Greece	0.305	0.211	608.8	352.8
Israel	0.220	0.215	243.4	227.7
Portugal	0.210	0.205	508.5	666.1
Spain	0.181	0.164	224.6	148.9
Yugoslavia	0.167	0.161	142.6	138.0
Total, comparative sample of developed countries[b]	0.217	0.191	345.6	306.7
Argentina	0.338	0.217	390.4	338.2
Brazil	0.294	0.251	314.1	270.3
Hong Kong	0.406	0.457	284.4	264.7
Mexico	0.254	0.171	307.2	224.5
Republic of Korea	0.340	0.295	368.5	186.8
Singapore	0.400	0.406	183.3	191.6
Turkey	0.432	0.293	757.0	567.5
Total, sample of newly industrializing countries[b]	0.352	0.299	372.1	291.9
Colombia	0.279	0.245	314.3	196.9
Egypt	0.440	0.338	501.7	306.0
India	0.356	0.231	426.9	357.3
Ivory Coast	0.368	0.297	449.8	549.4
Nicaragua	0.278	0.341	378.5	283.5
Philippines	0.520	0.427	620.2	497.0
Sri Lanka	0.908	0.824	970.5	959.4
Thailand	0.593	0.367	747.0	564.1
Tunisia	0.386	0.346	501.7	306.0
United Republic of Cameroon	0.744	0.340	672.1	657.0
Total, comparative sample of developing countries[b]	0.487	0.376	558.3	467.7

Source: Based on data supplied by the United Nations Statistical Office. Including the 134 products listed in the appendix to this chapter.

[a]The concentration index C_i is defined by

$$C_i = \left[\sum_{j=1}^{n} (X_{ij}/X_{i\cdot})^2 \right]^{1/2}$$

where X designates exports, i stands for the exporting country, j is the exported product, and a dot represents a summation over the respective subscript.

[b]Totals are unweighted averages of the respective country values.

concentration in one industry (unity). The second indicator, a measure of dispersion for export performance (in this case the coefficient of variation for the export performance ratio), is also used to indicate export diversification.[33] Here, diversification is considered relative to the pattern of world demand for

[33]For a similar interpretation of the dispersion of export performance indices, see Balassa, "Trade liberalization . . .", *loc. cit.*

exports of manufactures.[34] The conceptual differences between the two measures do not greatly alter the picture that emerges, however. For example, in the period 1975-1976, the coefficient of variation of this measure was largest for the comparative sample of developing countries (467.7), indicating wide differences in export performance. The corresponding measures for the other two samples indicated that the extent of dispersion was less. Thus, both measures point to a similar pattern of diversification which is related to the level of development.

In general, economists and policy-makers regard any trend towards a greater degree of diversification as desirable for several reasons. First, the failure to diversify could prompt additional protectionist pressures if a growing volume of exports were to remain concentrated in a very few product lines. Second, an unchanging pattern of exports based on only a few product lines would mean that the country's potential foreign-exchange earnings may be quite volatile, varying with demand conditions for these few products. Finally, if countries could diversify in accordance with shifts in comparative advantage, consumers in the importing country would benefit by acquiring goods at cheaper prices. For these reasons, a continuing pattern of changing comparative advantage would be desirable and beneficial to both importers and exporters.

Export diversification and the concomitant broadening of the export base is not the only salient consequence of a changing pattern of comparative advantage. The emergence of intra-industry trade (IIT), defined as the simultaneous export and import of products belonging to the same industry,[35] is increasingly dominating international trade. As with the concept of comparative advantage, experience has disproved the expectations of economists. Previously, it was thought that the rising levels of international investment would be a substitute for trade and would eventually replace it. Instead, investment has led to increased trade and has accentuated the degree of specialization in production.[36] At the same time, it has served to accelerate international shifts in comparative advantage. The growth of intra-industry trade demonstrates in itself that the opportunities for a more extensive international division of labour in manufacturing are greater than many observers originally expected. Correspondingly, the adjustment problems of trade liberalization may be less.

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[34] World demand for exports of the various industries is brought into the analysis by taking the industries' shares in world exports of manufactures as a norm for measuring a country's export performance. Consequently, the ratios' dispersion around the "normal value" of 1 would strictly refer to a country's diversification in line with (or concentration against) the prevailing structure of world exports of manufactures. For obvious statistical reasons, however, the standard deviation (and finally its normalized version: the coefficient of variation) was chosen; its values in most cases differed only slightly from the corresponding values of the "deviation from the norm" described above.

[35] Herbert Grubel and P. J. Lloyd, *Intra-industry Trade. The Theory and Measurement of International Trade in Differentiated Products* (London, MacMillan, 1975), p. 1. The statistical definition of an "industry" used by Grubel and Lloyd is identical with the definition used in this chapter.

[36] Lincoln Gordon, *Growth Policies and the International Order* (New York, McGraw-Hill, 1979), p. 147. Gordon goes on to make the point that the benefits to trading partners per unit of trade in closely similar products may be smaller than those arising from complementary products or complementary differences in factor endowment.

Thus, like the concept of comparative advantage, intra-industry trade is inextricably linked to the restructuring process.

An empirical analysis of intra-industry trade is not a simple task.[37] On the basis of the country samples analysed above, the share of intra-industry trade in total exports and imports was taken as a measure of its extent.[38] For the purpose of comparison, a fourth country sample comprised of several developed market economies was included, since intra-industry trade is of particular importance to countries in this economic grouping.[39] With this information, some broad comparisons between the country samples and the product groups could be made.

Table II.9 indicates that a clear relationship exists between intra-industry trade and the level of development, that the extent of intra-industry trade increases as industrialization proceeds.[40] With very few exceptions, the proportion of such trade was greatest in the period shown among the advanced developed market economies, followed by other developed countries, the NICs and the comparative sample of developing countries. This result is entirely plausible since product differentiation and specialization in narrow product lines are important reasons for intra-industry trade and are closely identified with the industrialization process. Furthermore, the data show that, without exception, the level of intra-industry trade rose over the period considered.

A detailed analysis by individual industries would be too extensive to include here. However, some more specific aspects should be noted. First, the extent of intra-industry trade was significantly less for semi-manufactures than for finished products, probably because there is less scope for product differentiation in the former type of goods. Second, intra-industry trade was highest among industries specializing in unstandardized or new products. Both the product-cycle and the technology-gap interpretations of international trade imply that this circumstance would prevail.[41]

Finally, a review of those industries with the highest shares of intra-industry trade reveals some interesting details of the trade patterns of each country sample. A comparison of the 20 top-ranking industries in terms of intra-industry trade among three samples—developed market economies, recently developed countries and the NICs—revealed some common features. The most striking common characteristic was the great amount of intra-

[37]Some empirical evidence on the sources of intra-industry trade can be found in R. Loertscher and F. Wolter, "Determinants of intra-industry trade: among countries and across industries", *Weltwirtschaftliches Archiv*, Band 116/2, 1980, pp. 280-293.

[38]The measure of intra-industry trade used in the present study was taken from Grubel and Lloyd, *op. cit.*, p. 21, and is defined as follows:

$$IIT_{ij} = \frac{(X_{ij} + M_{ij}) - |X_{ij} - M_{ij}|}{X_{ij} + M_{ij}} \times 100$$

where i stands for a country, j is a product group (industry), X is exports and M is imports. Average IIT values for both country groups and industry groups were obtained as weighted averages with the values of total trade (exports plus imports) providing the weights.

[39]The countries included were France, Germany, Federal Republic of, Japan, the United Kingdom and the United States.

[40]The same result was obtained in D. McAleese, "Intra-industry trade, level of development and market size", in *On the Economics of Intra-Industry Trade, Symposium 1978*, H. Giersch, ed. (Tübingen, J. C. G. Mohr, 1979).

[41]See Grubel and Lloyd, *op. cit.*, p. 102.

TABLE II.9. AVERAGE INTRA-INDUSTRY TRADE[a] IN MANUFACTURES, BY TYPE OF INDUSTRY AND COUNTRY SAMPLE, 1966-1967 AND 1975-1976

(Percentage)

Type of industry[b]	*Period*	*Selected developed market economies*	*Developed countries, comparative sample*	*NICs*	*Developing countries, comparative sample*
All manufactures	1966-1967	53.1	31.7	27.8	7.8
	1975-1976	57.6	40.9	33.4	14.9
Resource-based industries	1966-1967	48.1	31.8	25.7	8.5
	1975-1976	55.1	36.5	23.8	11.0
Standardized industries (low rates of product development)	1966-1967	53.2	32.2	27.7	6.4
	1975-1976	56.7	40.4	36.1	17.5
Unstandardized industries (high rates of product development)	1966-1967	58.4	27.4	30.7	9.6
	1975-1976	60.4	44.0	39.5	16.8

Source: Based on data supplied by the United Nations Statistical Office.

[a] For a definition of the measure of intra-industry trade, see footnote 38 of the present chapter.

[b] For definition and coverage of the respective types of industries, see the appendix to this chapter.

industry trade in the textile industry. That industry is representative of a group of products with similar input requirements and with opportunities for product differentiation (e.g. by quality) according to the consumer's preference. Economies of scale associated with specialization in differentiated products are a plausible explanation of the exchange of goods within this industry. The following industries of the same type show similarly high shares of intra-industry trade in both the developed countries and the NICs: tools (SITC 695), telecommunications equipment (SITC 724) and furniture (SITC 821).

The results demonstrate that a positive relationship exists between export diversification and intra-industry trade, on the one hand, and industrialization, on the other. A continuation of the restructuring process, in so far as it conforms to changing patterns of comparative advantage, should strengthen both trends. Benefits would accrue to both developing and developed countries as a consequence, in purely economic terms and in terms of alleviating the adjustment pressures that are currently giving rise to new protectionism in developed countries.

B. THE DEVELOPING COUNTRIES' EXPORTS OF MANUFACTURES—SOME PROSPECTS FOR THE 1980s

The changes in comparative advantage described in section A will clearly have important implications for the global pattern of industrial production and trade in manufactures. The discussion that follows points out some probable

consequences for international trade in the 1980s. As this subject is too broad to be considered in its entirety, the focus is on three aspects that are relevant to the situation in developing countries: *(a)* the prospects for these countries to expand their exports of manufactures to developed countries; *(b)* their possibilities for increasing trade in manufactures among themselves: and *(c)* their outlook for earning foreign exchange (by exporting) to pay for imports of necessary capital goods.

The environment created by policy will affect all aspects of trade in the 1980s and hence should be considered here. In the past, trade-related policies have been marked by rather abrupt and drastic shifts in approach. Pessimism about the outlook for exports was almost universal in the 1950s, leading policy-makers to put heavy emphasis on import substitution. Various factors—disenchantment with import substitution, international efforts to reduce impediments to trade, the rapid growth in world demand and the success of a few developing countries that opted for an industrial strategy of export expansion[42]—brought about drastic changes in the thinking of policy-makers. As Arthur Lewis recently observed, the rapid growth of world trade "was not universally recognized until the second half of the 1960s. Then, nearly every country discovered the virtues of exporting".[43]

Recent studies have lent strong support to the hypothesis that the rapid growth of exports accelerates the growth of an economy. This result has also been found when the investigation has been limited to the manufacturing sector.[44] The growth of exports spurs production when exporters demand additional primary or industrial inputs and when their domestic suppliers purchase manufactured inputs and machinery locally. Export successes can boost a country' income, encourage the rapid diffusion of technological advances and increase the availability of foreign exchange. To sum up in broad terms, a fairly open market may enable a developing country to find its areas of comparative advantage and to avoid high-cost, inefficient activities. Moreover, there are additional benefits more closely identified with the individual exporting firm. For example, exporting enables firms to realize economies of scale or to improve rates of capacity utilization which they might not otherwise have done. Learning-by-doing effects, which may favourably influence managerial, marketing and related functions, as well as labour productivity and other "catch-up" processes, are also examples of this type of advantage. Hence,

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[42]A summary of economic policy options and a schedule of changes in policy orientation for a sample of developing countries can be found in J. B. Donges and J. Riedel, "The expansion of manufactured exports in developing countries: an empirical assessment of supply and demand issues", *Weltwirtschaftliches Archiv*, Band 113, 1977, pp. 58-87.

[43]W. Arthur Lewis, "The slowing down of the engine of growth", *American Economic Review*, vol. 70, No. 4 (September 1980), p. 556.

[44]Examples are R. Emery, "The relation of exports and economic growth", *Kyklos*, vol. 20, 1967, pp. 470-486; I. B. Kravis, "Trade as a handmaiden of growth: similarities between the nineteenth and twentieth centuries", *Economic Journal*, December 1970, pp. 850-872; M. Michaely, "Exports and growth, an empirical investigation", *Journal of Development Economics*, vol. 4, 1977, pp. 49-53; B. Balassa, "Exports and growth, further evidence", *Journal of Development Economics*, vol. 5, 1978, pp. 181-189, and "Export incentives and export performance in developing countries: a comparative analysis", *Weltwirtschaftliches Archiv*, Band 114, 1978, pp. 24-61; and Peter S. Heller and Richard C. Porter, "Exports and growth—an empirical re-investigation", *Journal of Development Economics*, vol. 5, 1978, pp. 191-193.

export orientation is likely to be supported by many economists and policy-makers in the developing countries in the medium term.

In the developed countries, policies in this area are more diverse and are likely to remain so. The new protectionist trends described in chapter I are expected to persist if not widen. Although highly important, new protectionism represents only part of the complex attitude towards trade-related policies in developed countries. As stressed elsewhere in this *Survey*, the growth in international investment flows between developed countries has increased dramatically, creating a new pattern.[45] New protectionism and differential costs in inputs (e.g. labour and energy) are two reasons for this pattern. Countries losing capital are working to stem its outflow in various ways. A unique feature of this modern-day mercantilism is the willingness of Governments to manipulate monetary and fiscal policies in order to obtain a trade advantage.[46] Achieving a balance-of-payments surplus has become a major policy objective of developed countries that are export-oriented. Thus, the trade policies of developed countries are likely to continue to be complex, often stressing protectionist measures for contracting industries while according a high priority to the growth of exports. These policies, together with those followed by developing countries, are some of the major considerations to be taken into account in an evaluation of the latter's export prospects in the 1980s. In view of recent trends, other studies have placed much emphasis on international trade as a key factor in future economic development.[47]

In an environment characterized by fairly liberal trade policies and some structural flexibility, shifts in comparative advantage should lead to vigorous growth in the exports of a wide range of manufactures from the developing countries. From the viewpoint of the developing countries, the potential for the expansion of their exports of manufactures will strongly influence their growth expectations for the coming decade. Because developed countries are the main market for exports of manufactures from developing countries,[48] their trade and industrial policies are of crucial importance.

With regard to the prospects for an expansion of trade in manufactures between developing countries, such trade has grown rapidly although it continues to be only a small proportion of the developing countries' total trade. Trade among developing countries in manufactures may, however, be a viable supplement or even an alternative to these countries' current dependence on buyers in developed countries.[49] A number of experts have stressed "the enormous potential market for industrial products represented by the un-

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[45]See chapter I, pp. 23-25.

[46]The former United States Under-Secretary of the Treasury, C. Fred Bergsten, observed the "growing trend to manipulate the flow of investment by offering various incentives and then imposing performance requirements". He expressed concern that "this may increase the overall level of investment, but it may also produce a protectionist backlash", cited in *International Money Management*, 9 July 1979.

[47]See, for example, Interfutures, *op. cit.*, pp. 180-186 and World Bank, *World Development Report, 1980* (Washington, D.C., 1980), pp. 18-25.

[48]In 1977, 65 per cent of developing countries' exports of manufactures went to developed market economies.

[49]The important role that trade among developing countries is supposed to play in these countries' growth process is pointed out in Lewis, *loc. cit.*, pp. 555-564.

satisfied requirements of developing countries"[50]—a potential that could raise the expectations for intra-developing-country trade in manufactures. In this context, special consideration should also be given to the policies governing trade among these countries.[51]

In support of the potential for such trade, observers frequently cite the case of Japan after the Second World War.[52] There, comparative advantages began to shift away from labour-intensive goods towards industries that utilized considerably more capital per man (e.g. steel and metal products). Later, the Japanese moved into other industries requiring substantial amounts of human capital.

A similar form of internal adjustment is now thought to be occurring in several of the more advanced developing countries which are also successful exporters. The mark of this success is a rising real wage, capital accumulation, the development of a more skilled labour force and, consequently, a shift in comparative advantage away from industries whose exports were initially most profitable into others whose production requirements are more compatible with the new internal circumstances.

As comparative advantages shift, the countries originally exporting labour-intensive products such as textiles find such domestic industries less and less economic, thus providing another market for newcomers. To the extent that comparative advantages in Japan and, later, Brazil, Mexico, the Republic of Korea or Singapore shifted, they increased the size of the world market for newcomers, both by adding their own demand for, and reducing their exports of, labour-intensive products. This phenomenon would suggest that trade between developing countries should continue to grow rapidly since several of the new markets for labour-intensive exports will be these countries.[53]

Finally, with regard to the need for developing countries to import capital goods during the industrialization process, clearly production of a substantial part of these goods will continue to be the exclusive domain of developed countries; such goods are those requiring sophisticated technologies and substantial outlays for R and D. During the 1980s, capital equipment will account for a major portion of the essential imports of developing countries. Their capability of satisfying technological needs through imports will depend largely on their success in exporting other types of manufactures.[54] There is, then, an import interrelationship between the developing countries' need for

[50]Interfutures, *op. cit.*, p. 257.

[51]Some characteristics of the barriers to intra-developing-country trade are discussed along with proposals for creating trade preferences among these countries in A. J. Yeats, "Tariff valuation, transport costs and the establishment of trade preferences among developing countries", *World Development*, vol. 8, 1980, pp. 129-136.

[52]On this point, see Balassa, "The changing pattern . . .", *loc. cit.*, and Anne O. Krueger, "LDC manufacturing production and implications for OECD comparative advantage", in *Western Economies in Transition*, Irving Leveson and Jimmy W. Wheeler, eds. (London, Croom Helm, 1980), pp. 219-249.

[53]The argument implies that internal adjustments in the economies of today's successful exporters will mean a steady growth of labour-intensive exports from developing country entrants without any additional pressure for structural adjustment in developed countries than has existed to date.

[54]The degree of success will vary widely, although the number of countries with sizeable earnings from exports of manufactures should increase in the next decade if the current pattern of change in comparative advantage is maintained.

high technology imports and their ability to pay for these imports. Most likely, the demand for capital goods will grow in the next decade, particularly if the developing countries commit themselves to medium- and long-term industrial development programmes. An increase in their ability to pay for capital requirements through the exports of manufactures could be an important step towards the realization of objectives such as collective self-reliance and the Lima target.

To summarize, the first important determinant of trade for the developing countries in the 1980s is the trade-related policies of both the developing countries and of their major trading partners among the developed countries. Naturally, basic changes in the policies of either group would alter trade prospects. The second main determinant is the direction of trade flows (and any likely shifts), which are closely related to trade prospects. While the developed countries are the major consumers of exports from the developing countries, some shifts may occur if the latter countries expand trade among themselves. Finally, the developing countries' requirements for high-technology goods will set some "floor", or minimum, level for their exports if they are to pay for these imports.

The section that follows describes the results of an econometric exercise illustrating some possible changes in trade during the 1980s. The results are presented in the form of scenarios. These results are not regarded as projections or forecasts but rather as indications of possible interactions between trade policy and changing directions of trade, on the one hand, and the developing countries' likely trade requirements (in terms of the imports and exports of manufactures), on the other.

The centrally planned economies could not be included in the analysis owing to the lack of sufficiently detailed data on their trade with developing countries.[55] Thus, the "world" or statistical "universe" for the purpose of the exercise is confined to the developing countries and the developed market economies. In line with the nomenclature used in other studies of this type, a "North-South" orientation was adopted; the developed market economies are referred to as the North and developing countries as the South.

The historical background

The period of reference for the present study is 1960-1977. These were years of rapid growth prior to the recession in the early 1970s and include the initial period of adjustment to payments imbalances and higher energy costs.[56] Figures I and II show the values for various components of particular interest in the present study.[57] During the 1960s, GDP grew at an average annual rate of 5.1 per cent in the North and 5.7 per cent in the South.[58] Differences in rates

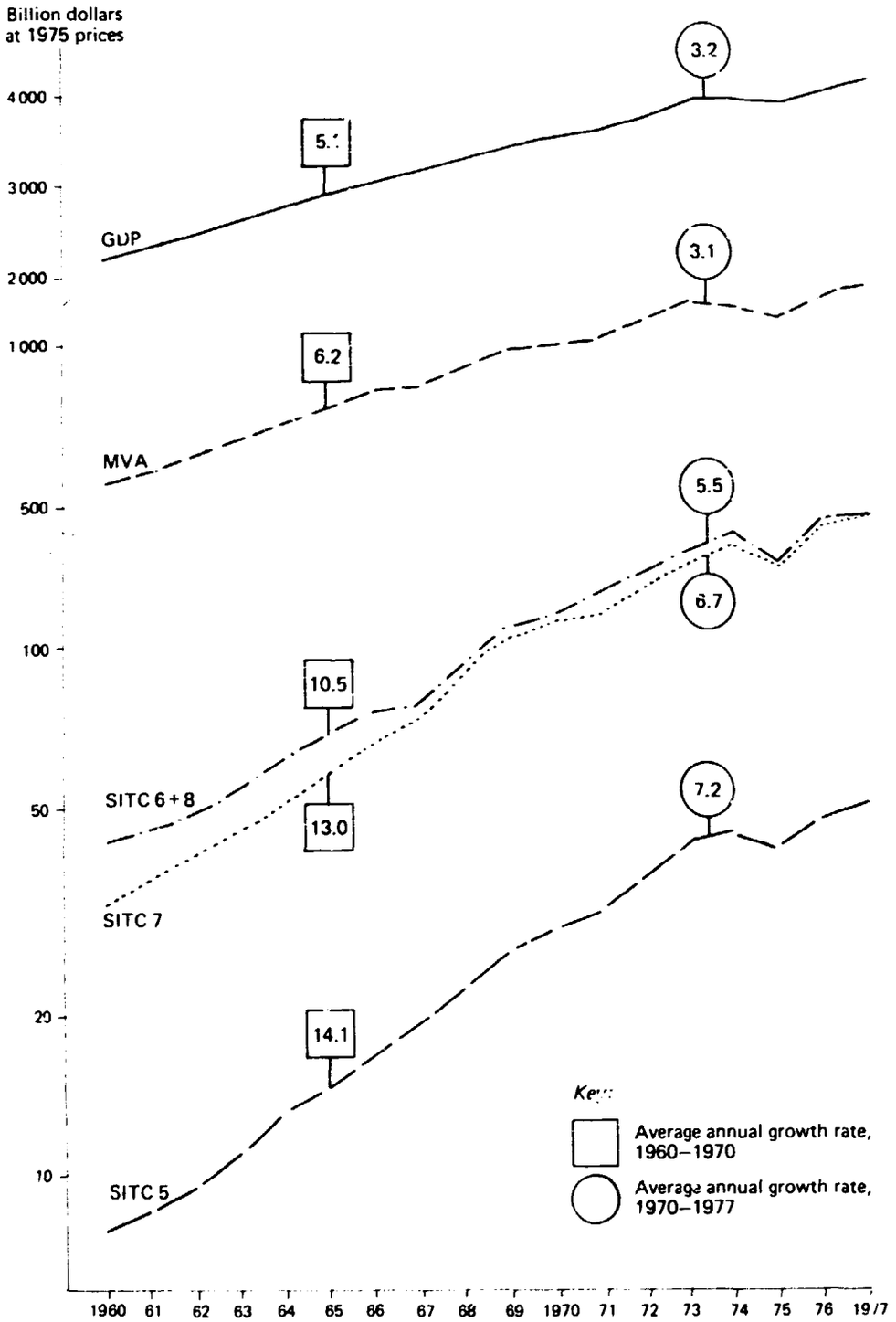
[55] Since exports of manufactures from developing countries are the main issue, this restriction may not be serious. The developing countries' exports of manufactures to centrally planned economies amounted to 3.4 per cent of the value of their total exports of manufactures in 1978.

[56] *World Development Report, 1980, op. cit.*, p. 3.

[57] Because the data are plotted on a semi-logarithmic scale, a comparison of annual growth rates is obtained directly by comparing the slopes of the respective graphs.

[58] The data presented in connection with the reference period are at constant prices of 1975. All growth rates shown are trend growth rates calculated by semi-logarithmic regressions over time.

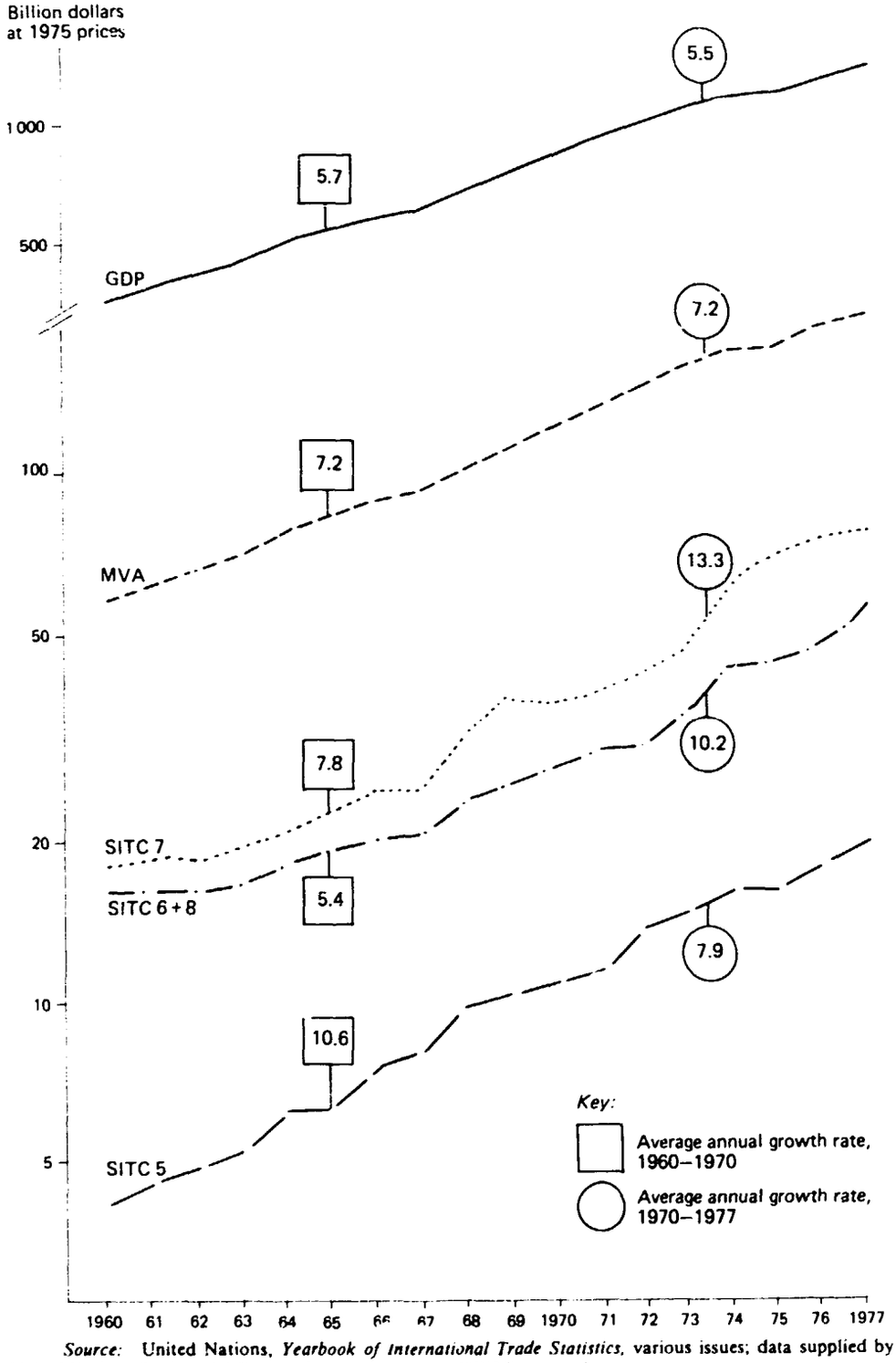
Figure I. Growth rates and value of MVA, GDP and imports[a] of manufactures by the North, 1960-1977



Source: United Nations, *Yearbook of International Trade Statistics*, various issues; data supplied by the United Nations Statistical Office; and estimates by the UNIDO secretariat.

[a]Imports, expressed in current dollars, f.o.b., were deflated using unit value indices for each individual import category. These indices, originally at a 1970 base, were rebased to 1975 = 100 in order to arrive at a base comparable to that for GDP and MVA.

Figure II. Growth rates and value of MVA, GDP and imports[a] of manufactures by the South, 1960-1977



Source: United Nations, *Yearbook of International Trade Statistics*, various issues; data supplied by the United Nations Statistical Office; and estimates by the UNIDO secretariat.

[a]Imports, expressed in current dollars, f.o.b., were deflated using unit value indices for each individual import category. These indices, originally at a 1970 base, were rebased to 1975 = 100 in order to arrive at a base comparable to that for GDP and MVA.

of growth widened in the 1970s owing to the slow-down in the North. In the period 1970-1977, the growth of GDP in the North fell to 3.2 per cent, while that of the South dropped slightly to 5.5 per cent.[59] Differences between the 1960s and 1970s are accentuated further when growth rates are compared for net manufacturing output at constant prices. In the 1960s, annual growth rates of MVA were similar in the North and South (6.2 per cent and 7.2 per cent, respectively). However, in 1970-1977, MVA expanded at a much slower rate in the North than in the South (3.1 per cent compared with 7.2 per cent).

The composition and level of trade also changed considerably during the reference period. In the 1960s, the North's imports of manufactures grew at an average annual rate of 11.9 per cent. Imports of chemicals expanded most rapidly (14.1 per cent), followed by machinery and transport equipment (13.0 per cent). The South's imports of manufactures grew at a significantly slower rate, 7.2 per cent. Here, too, chemicals led the way, expanding at a rate of 10.6 per cent.

Between 1970 and 1977, some North-South relationships were reversed. The North's imports of manufactures slowed dramatically, down to the equivalent of 6.2 per cent per annum while the South's imports accelerated to 11.5 per cent per annum. Chemicals (7.2 per cent) continued to be the fastest growing import category in the North, while in the South, imports of machinery and transport equipment (13.3 per cent) became the most dynamic imports. This last characteristic reflects the need to import capital goods during the process of industrialization.

With regard to the export performance of the South, figure III shows exports of manufactures by destination. South-South trade proved to be the most dynamic, growing at an annual average rate of 10.2 per cent in the period 1960-1970 and 15.5 per cent in the period 1970-1977. The average annual growth rate of exports to the North was roughly the same for the two subperiods (10.3 per cent and 10.2 per cent, respectively).

Despite vigorous growth, the South's share in world exports of all manufactures expanded only moderately, from 6.5 per cent in 1960 to 8.4 per cent in 1977. Northern consumers continued to be the most important market for Southern exports of manufactures. In 1977, 65 per cent of these exports went to the North (compared with 74 per cent in 1960). The South's comparatively small share of Northern markets (ranging from a minimum of 5.8 per cent in 1967 and 1968 to less than 8 per cent in 1976) suggests that there is considerable scope for the further expansion of this trade flow.

The extent to which the South has paid for its imports of capital goods by exporting manufactures is indicated in the upper half of figure III by the changing ratio of the two trade flows.[60] The ratio increased during the first decade, from 0.44 to 0.58. It continued to move upward during the first three years of the 1970s, but after 1973 it was erratic, moving from a high of 0.68 in 1972 and 1973 to a low of 0.51 in 1975.

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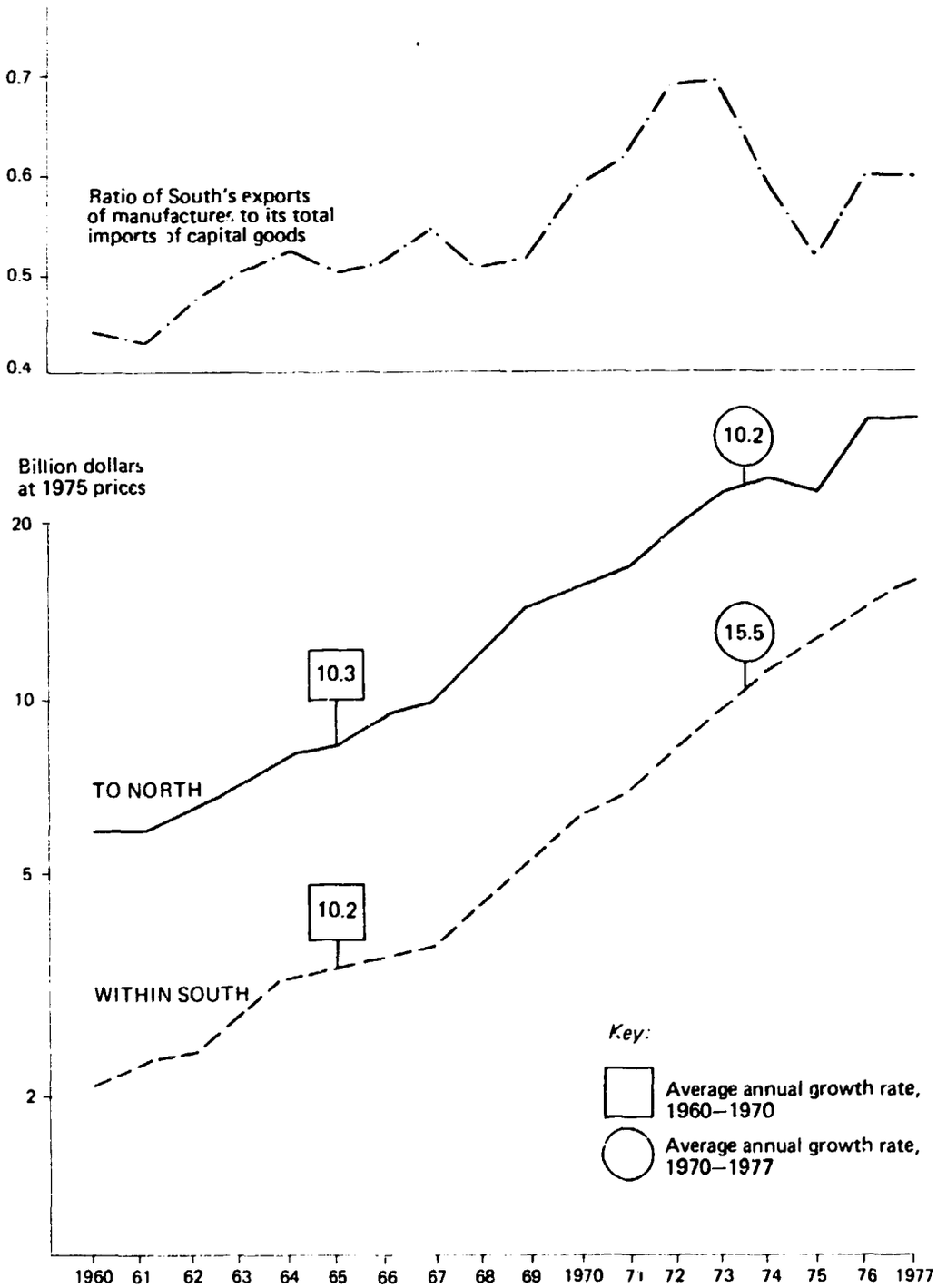
[59] In terms of *per capita* income, however, the gap between North and South remained largely unchanged over the whole period, ranging from a North-South ratio of 11.1 in 1960 to 11.9 in 1970 and 11.5 in 1977.

[60] Both numerator and denominator in the ratio include intra-South trade. This view takes into account the benefits that are expected to accrue to the developing countries as a whole from an expansion of their intra-trade in manufactures.

Figure III. Exports of manufactures[a] from the South, by destination and by comparison with its imports of capital goods, 1960-1977



Source: United Nations, *Yearbook of International Trade Statistics*, various issues; data supplied by the United Nations Statistical Office; and estimates by the UNIDO secretariat.

[a]For conversion to 1975 prices, see footnote *a* to figure I of this chapter.

Based on data for the reference period, a first step in the exercise was to estimate the relationships between key trade variables and levels of domestic activity. The estimated elasticities link the growth of trade to the growth of domestic activity, indicating the percentage increase in the trade component (imports or exports) associated with a 1 per cent increase in the relevant domestic activity variable.[61] For example, a value of 2.0 implies that the growth of the trade component is twice that of the related domestic activity.

Table II.10 estimates the various trade elasticities in the period 1960-1977. It may be noted that the growth rate of each trade category is associated with the growth rate of either MVA or GDP. Chemicals (SITC 5) are regarded as intermediate products while machinery and transport equipment (SITC 7) are treated as industrial supplies and capital goods. Accordingly, a close relationship between these imports and MVA was assumed and corresponding

TABLE II.10. ELASTICITIES OF SELECTED TRADE FLOWS WITH RESPECT TO RELATED DOMESTIC ECONOMIC VARIABLES, 1960-1977

Trade flow	*Related domestic economic variable*	*Elasticity estimate*[a]	*Equation*
North			
Imports of chemicals (SITC 5)	MVA	2.2-2.4	I
Imports of machinery and transport equipment (SITC 7)	MVA	1.9-2.2	II
Imports of other manufactures (SITC 6 + 8)	GDP	1.9-2.1	III
South			
Imports of chemicals (SITC 5)	MVA	1.1-1.4	I
Imports of machinery and transport equipment (SITC 7)	MVA	1.0-1.4	II
Imports of other manufactures (SITC 6 + 8)	GDP	1.1-1.4	III
Exports of manufactures (SITC 5-8)	MVA	1.4-1.6	IV

Source: The original data were compiled from United Nations, *Yearbook of International Trade Statistics*, various issues, and information supplied by the United Nations Statistical Office.

Note: Based on the assumption of constant elasticities, the following log-linear equations were estimated:

$$\text{(I)}\ \ln M^{i} = a_1 + b_1 \ln \text{MVA} + u_1$$

$$\text{(II)}\ \ln M^{i} = a_2 + b_2 \ln \text{MVA} + u_2$$

$$\text{(III)}\ \ln M^{6+8} = a_3 + b_3 \ln \text{GDP} + u_3$$

$$\text{(IV)}\ \ln X^{5-8} = a_4 + b_4 \ln \text{MVA} + u_4$$

where M stands for imports, X is exports, the superscripts refer to the respective SITC sections, and u denotes an error term. Estimates of the b-coefficients provide estimates of the corresponding constant elasticities. Further technical details are described in UNIDO, *The Developing Countries' Prospects for Trade in Manufactures in the 1980s: Export Performance and Import Requirements; Methodological Considerations*, Working Paper (forthcoming).

[a] The range for each elasticity estimate represents an approximate 5 per cent confidence interval.

[61] Estimates of elasticities were obtained by fitting log-linear equations to annual observations for each trade component and the relevant domestic activity variable. For further details, see table II.10.

elasticities were estimated. For other manufactures (SITC 6 and 8), which includes the bulk of consumer goods, total income or GDP is taken to be the appropriate domestic variable. The association between import demand and domestic activity is common in the literature.[62]

Import elasticities in the North were approximately twice as high as those in the South in the period indicated. As the North is expected to continue to be the main market for the South's exports of manufactures, this finding points to the crucial role it can play for the further expansion of exports from the South. Conversely, sustained growth (of GDP and MVA) at a fairly rapid pace is important if demand in the South is to continue to provide enough stimulus to make growth worthwhile.[63] A similar elasticity was calculated for exports of manufactures by the South. For the period 1960-1977, this elasticity was estimated to be 1.4 to 1.6, indicating that exports rose about 50 per cent faster than MVA. If export-oriented policies were adopted by a greater number of developing countries, the elasticity could be expected to rise even more in the future.

The relationship between industrial growth, on the one hand, and the level, composition and direction of trade in manufactures, on the other, is a complex one. Sellers and buyers of internationally traded manufactures may be indifferent to the destinations and origins of their imports and exports. However, their decisions are strongly influenced by national policies which channel national trade towards particular areas. Thus, while the rate of economic growth or manufacturing activity may be the main determinant of past and future national export potentials and import requirements, changes in the composition and direction of trade reflect government policies as they are applied and then altered.

With these points in mind, a simple econometric model was employed to illustrate the interrelationships between the following trade flows:

(a) The South's exports of manufactures to the North;

(b) The South's exports of manufactures to the South;

(c) The South's imports of capital goods;

(d) The share of the South's exports of manufactures in markets of both the North and the South.

The model provides alternative pictures or scenarios of the relevant trade component based on assumptions regarding the following aspects:

(a) The growth of GDP in both North and South;

(b) The policy options of the North with regard to its imports of manufactures;

(c) The choice of industrial strategies in the South between an inward-looking orientation (import substitution) and an outward-looking strategy of export promotion;

[62]A typical example is the work of the Senior Economic Advisers to ECE Governments, Committee on the Development of Trade, *Ad Hoc* Meeting on Long-Term Economic Growth and Trade Prospects, Geneva, 28-30 April 1980.

[63]As stressed elsewhere in this *Survey*, the South's demand for foreign goods made an important contribution to sustaining world demand during the slow-down of the 1970s. See chap. I, pp. 16-17.

(d) Future developments regarding the price relationship between the North's exports of manufactures and the South's exports of manufactures.

Given the high degree of interdependence of these aspects, each set of assumptions had to be considered carefully. Five scenarios were developed, representing a fairly wide range of alternatives for growth in the coming decade. The scenarios are intended to illustrate some of the implications for trade in manufactures indicated by more wide-ranging investigations carried out elsewhere.[64] It should be emphasized that assumptions about the key economic aggregates are highly tentative and subject to large and unforeseeable margins of error. Thus, the model does not indicate the likelihood of a particular scenario or of the trade pattern it implies. Rather, it represents the possible consequences of different patterns of growth and policies for the trade prospects of the developing countries.

Each of the scenarios is briefly described in table II.11. Two (A and B) are reference scenarios based on trade-production relationships in the 1960s and the 1970s; they assume that there will be no changes in the relevant policies. The first scenario assumes (optimistically) that the rate of growth in the 1960s will resume, i.e. that conditions in the 1970s merely represented a cyclical downswing. The second scenario views growth in the 1970s as part of a long-term secular phenomenon and foresees that the rate of growth in the 1980s will be similar to that experienced in the 1970s.

The three remaining scenarios (C, D and E) involve assumptions about policy as well as growth. Scenario C, "export pessimism", postulates that continued slow growth in the North will give rise to a spread of new protectionism. As the result of further restrictions placed on the South's access to markets in the North, the present trend favouring a strategy of outward-orientation will be reversed. Countries in the South will revert to industrial strategies emphasizing import substitution.

Scenario D is a high-growth alternative called "export orientation". Compared with the 1970s, the North's rate of growth is expected to rise, coupled with policy adjustments favourable to restructuring and trade liberalization after 1985. In the South, rates of growth in domestic activity and in exports will also rise as the present trend towards export promotion spreads.

The final scenario stresses greater collective self-reliance. Here, the key assumptions are that the South's exports of manufactures will satisfy the foreign-exchange requirements to meet their needs for capital goods imports by 1990. Supporting assumptions concern an increase in the transfer of resources (e.g. official development assistance (ODA) to the developing countries), an expansion in South-South trade and further liberalization of world trade in manufactures.

The results of each scenario are summarized in table II.12, which shows the corresponding rates of growth and trade shares.[65] Each scenario is discussed in some detail below, with further indications of the underlying assumptions and their consequences.

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[64]The main guides for specifying the different sets of assumptions were two global prospective studies: Interfutures, *op. cit.*, and *World Development Report, 1980, op. cit.*

[65]All figures are in constant prices with 1975 as the base year.

TABLE II.11. TRADE PROSPECTS IN THE 1980s: ALTERNATIVE SCENARIOS, MAJOR ASSUMPTIONS AND RELATED SOURCES

Scenario	*Main growth and policy assumptions*	*Related source*[a]
A. The 1960s resumed—a cyclical view	Slow-down of the 1970s is merely cyclical; rapid growth will be resumed Structural relationships between the North and the South in the 1980s will reflect those of the reference period 1960–1977	Historical performance
B. The 1970s continued—a secular view	Growth will continue at a pace similar to that in the 1970s Existing structural relationships between the North and the South will remain unchanged in the 1980s	Historical performance
C. Export pessimism	Continued slow growth in the North More restricted access to Northern markets (e.g. the spread of new protectionism) A re-emergence of export pessimism in the South	Interfutures, "Scenario B" World Bank, "low case"
D. Export orientation	A rise in the North's rate of growth compared with the 1970s Policy initiatives favourable to restructuring and export liberalization become effective after 1985 An acceleration of growth of production and exports in the South	Interfutures, "Scenario A" World Bank, "high case"
E. Collective self-reliance	The same acceleration of the North's growth as in scenario D Restructuring and trade liberalization policies become effective from the beginning of the 1980s Even faster growth of production and exports in the South compared with scenario D	World Bank, "faster growth case"

[a]The related sources include: World Bank, *World Development Report, 1980* (Washington, D.C., 1980), and Interfutures, *Facing the Future: Mastering the Probable and Managing the Unpredictable* (OECD, 1979). The approaches and arguments developed in these studies were taken as an approximate guide in formulating the assumptions for the present exercise.

The sixties resumed—a cyclical review

In addition to the assumption that the rate of growth in the 1960s will be resumed in the 1980s, the scenario assumes no change in trade policies. Thus, imports of manufactures into the North will continue to enter subject to roughly the same degree of restriction as has prevailed to date, while the export orientation of the South will remain the same but will not become more widespread. In these circumstances, the income elasticities of the South's imports of manufactures, and the price elasticity of the North's demand for the South's exports of manufactures,

TABLE II.12. PROJECTED GROWTH RATES[a] AND SHARES OF THE SOUTH'S EXPORTS AND INTRA-TRADE IN MANUFACTURES, 1977-1990

(Percentage)

Variable	*Historical rates* 1960-1970	1970-1977	*The 1960s resumed, a cyclical view*	*The 1970s continued, a secular view*	*Export pessimism*	*Export orientation*	*Collective self-reliance*
			Projected growth rates 1977-1990				
North							
GDP	5.1	3.2	5.1	3.2	3.0	4.2	4.2
Imports of manufactures	11.9	6.2	11.1	6.8	6.4	9.0	9.7
South							
GDP	5.7	5.5	5.7	5.5	4.8	6.7	7.3
Imports of manufactures	7.2	11.5	8.0	7.7	6.6	9.6	10.6
Imports of machinery (SITC 7)	7.8	13.3	8.4	8.1	6.9	10.1	11.3
Exports of manufactures:							
(a) to North	10.3	10.2	12.5	7.6	6.3	12.2	14.6
(b) to South	10.2	15.5	8.4	14.0	11.9	14.6	16.8
(c) total	10.3	11.9	11.1	10.7	8.9	13.2	15.5
Trade shares	*Share in 1977*	*Projected share in*	*Projected shares*				
(a) The South's exports to the North as a percentage of the North's imports of		1985	7.7	7.4	7.0	8.2	9.9
all manufactures	7.5	1990	8.3	7.7	7.1	10.3	12.5
(b) The South's exports to the South as a percentage of the South's imports of		1985	13.7	20.8	18.9	19.5	17.6
all manufactures	10.5	1990	12.9	25.9	23.1	22.1	23.4
(c) The South's exports to the world as a percentage of the world's imports of		1985	9.1	11.2	10.2	11.4	12.0
manufactures	8.4	1990	9.3	13.1	11.6	13.7	15.6
(d) Ratio of South's exports of manufactures to its imports of machinery and		1985	0.74	0.74	0.71	0.75	0.81
transport equipment	0.59	1990	0.82	0.82	0.77	0.86	0.98

[a]Growth rates are calculated by a semilog regression over time. All data are expressed in 1975 prices.

will conform to those prevailing in the period 1960-1977. Similarly, the South's supply elasticity, i.e. the relationship between the growth of that region's exports of manufactures and the expansion of its industrial capacity, will be comparable in the 1980s to the estimates for the reference period. It is assumed that only the

North's income elasticity of demand for imports of manufactures will be slightly below that for the reference period. The shift, it is thought, will be a likely consequence of a deterioration in the North's terms of trade because of a rise in the cost of various raw materials and supplies (e.g. energy), on the one hand, and the continuing problems of structural adjustment, on the other. Finally, it is assumed that export prices in both regions will grow at roughly equal rates over the 1980s, meaning that the relative price of the South's exports of manufactures will remain unchanged in the near future.

To turn to the trade implications of the scenario, the rapid growth of the South's exports to the North (12.5 per cent) deserves mention. Export gains would be owing to the assumed recovery in the North, coupled with a continuation of the shifts in comparative advantage indicated in section A of this chapter. In contrast, the growth of South-South trade would be rather modest (8.4 per cent) compared with experience in the period 1960-1977. This result leads to the conjecture that without a reorientation of most developing countries' export policies, supply constraints may come into play in a high-growth environment. The corresponding estimates of market shares show a similar picture. By 1990, the South would supply over 8.3 per cent of the North's imports of manufactures, although the share of South-South trade would actually decline throughout the 1980s. This decline in projected intra-South trade reflects the need to dismantle protectionist barriers in the South.[66] The results point to an increase in the ratio of the South's exports of manufactures to its imports of capital goods. By 1990, over 80 per cent of these imports could be matched by exports of manufactures—despite the fact that export opportunities would not be fully exploited in such an environment.

The seventies continued—a secular view

The significant difference between this scenario and the foregoing one lies in the assumptions about future growth of GDP. In the present scenario, the North's GDP is assumed to grow at 3.2 per cent compared with a rate of 5.5 per cent in the South. Related assumptions regarding trade policies, elasticities and export price relationships are the same for the two reference scenarios.

Differences in the rates of growth of GDP in the North and South would have an important effect on the pattern of trade. The South's exports of manufactures to the North would grow at only a moderate rate (7.6 per cent). To some extent this would be offset by a rapid increase in South-South trade (a rate of 14 per cent per annum).[67] Although the South would succeed in increasing the share of manufactures that it supplies to the North (7.7 per cent in 1990 compared with 7.5 per cent in 1977), the slow pace of world growth would impose a serious constraint. Only a dramatic rise in the share of South-South trade (25.9 per cent in 1990) would be sufficient to sustain the South's rate of development. Contingent on a rapid expansion of intra-trade, the export/capital goods ratio would rise despite a depressed economic environment. Clearly, attaining a greater measure of collective self-reliance would be crucial in a period of world depression and stagnation.

[66] See Yeats, *loc. cit.*

[67] Further discussion regarding the possible realization of this variant can be found in Lewis, *loc. cit.*

Export pessimism

Other recent studies have noted "some disturbing signs" indicating that the effects of slow growth are spreading. Among the consequences are that the current aid to low-income countries is unlikely to meet even the most modest requirements, while some middle-income countries may experience various difficulties (including financial ones) associated with slow growth.[68] The assumptions of the present scenario conform approximately to this pessimistic view. The North's GDP is assumed to grow slowly (an annual rate of 3 per cent) from 1977 to 1990, while the growth of GDP in the South would be equivalent to an annual rate of 4.7 per cent between 1977 and 1985 and 5 per cent from 1985 to 1990. The distinction between the first and second halves of the decade is a feature retained in the following scenarios and reflects the expectation that in the second half of the 1980s the world economy could recover significantly from the difficulties associated with "payments imbalances and expensive energy costs".[69]

In the present scenario, it is assumed that the slow growth and resultant adjustment problems in the North will lead to a proliferation of protectionist measures.[70] No specific assumptions are made about the type or form of these measures. Rather, the South's restricted access to Northern markets is represented by a reduction in the respective income and price elasticities. Market restrictions and the sluggish growth of import demand in the North would lead to a revival of export pessimism in the South reminiscent of the emphasis on import substitution during the 1950s. This reversal in policy choice is represented by a significant decrease in the MVA elasticity of the South's exports of manufactures. Furthermore, the small number of developing countries that provide the bulk of these exports would stress price competitiveness by exploiting the advantages of low labour costs. Thus, the price level of the South's exports of manufactures relative to the corresponding price level of the North's exports is projected to decline gradually until, by 1990, the relationship reaches the minimum noted for the period 1960-1977.

The dramatic drop in the growth rate of the South's exports of manufactures to the North (6.3 per cent per annum) would be only partly compensated for by South-South trade, which would grow at 11.9 per cent per annum. The net result would be that the South's exports of manufactures to the world would grow at the low rate of 8.9 per cent per annum, or a rate equivalent to the doubling of the South's *per capita* exports of manufactures between 1977 and 1990. The corresponding level of *per capita* imports would rise by slightly more than 50 per cent between the same two years. The spread of new protectionist measures would lead to a decline in the South's share of Northern markets from 7.5 per cent in 1977 to 7.1 per cent in 1990. Under these conditions, trade within the South would increase as a share of the total

[68] *World Development Report, 1980, op. cit.*, p. 6.

[69] *Ibid.*, p. 3.

[70] For example, one observer argues "that there is a 'hardening' of protectionist measures with an increasing reliance on price controls, quantity controls and domestic subsidies". He concludes "that the sources and nature of contemporary protection are such that the developing countries have reason for considerable concern about the state of commercial policy". See G. P. Sampson, "Contemporary protectionism and exports of developing countries", *World Development*, vol. 8, 1980, p. 113.

although the region would make only a modest stride in meeting the objective of paying for its imports of capital goods by exporting manufactures. The ratio of exports of manufactures to imports of capital goods would rise to 0.77 by 1990, only slightly exceeding the maximum of 0.68 recorded in 1973. Thus, the achievement of collective self-reliance would be made increasingly difficult.

Export orientation

Despite the generally pessimistic outlook for the coming decade, relatively high growth may be attainable with certain policy conditions to do with: "the growth and structure of international trade; the changing pattern of energy production and consumption; investment and productivity in the developing countries; and the inflow of capital".[71] Given favourable policies in various countries, the assumptions on which this scenario is based could be realized in the 1980s. GDP in the North is assumed to grow at an average annual rate of 4 per cent until 1985 and at 4.5 per cent thereafter, and the corresponding growth rates for the South would be 6.5 and 7 per cent, respectively.

High growth in the industrialized world is expected to ease the process of structural adjustment, thereby reducing internal political pressure on the choice of trade policies. A move towards further trade liberalization in the North would emerge subsequent to the adjustment period and would lead to the gradual reduction of trade barriers in the North. These policy shifts should eventually encourage a more widespread adoption of outward-looking industrialization policies in the South, while the availability of cheap labour would be expected to strengthen those countries' price competitiveness.

One of the most obvious features of the export-orientation scenario is the assumption that the South's exports of manufactures would grow vigorously at rates substantially higher than those previously experienced. An acceleration in the growth of trade coupled with a relaxation of trade restrictions would lead to a tripling of the South's *per capita* levels of manufactured exports between 1977 and 1990. Facilitated by freer trade and some progress in dealing with the problems of structural adjustment, the South's share in the North's imports would rise from 7.5 per cent in 1977 to 10.3 per cent in 1990. Together with similar gains in South-South trade, the South's share in world trade in manufactures would reach 13.7 per cent by 1990. The ratio of exports to imports of capital goods would rise accordingly and would well exceed values derived for any of the preceding scenarios.

Collective self-reliance

Collective self-reliance has been taken to mean an approximate balance between the South's exports of manufactures and its imports of capital goods. Equality between these two trade flows was used as a starting point for the scenario. Obviously, there are many possible combinations of assumptions that would lead to this result, although most were discarded as not plausible. The assumptions about growth rates and elasticities described here are similar to those used in deriving the "export-orientation" scenario, although they tend to be more

[71] *World Development Report, 1980, op. cit.*, p. 7.

optimistic. The resultant growth of GDP in the South would be 7 per cent per annum for the first half of this decade, rising to 8 per cent thereafter. In the North, efforts to liberalize trade and to resolve structural problems would begin early in the 1980s, bringing about corresponding shifts in income and price elasticities at an earlier time compared with that for other scenarios. Likewise, in the South export promotion would continue to gain favour as a policy throughout the decade.

The prominent features of this scenario are the high rates of growth required to achieve it. The South's share in world exports of manufactures would rise to 15.6 per cent by the year 1990. The directions of these changes in world trade seem quite plausible although the achievement of self-reliance in this respect would require a massive increase in investment funds. The 15 developing countries that achieved an annual growth rate in GDP of 7 per cent or more between 1970 and 1977[72] increased their share of investment in GDP from 23.1 per cent in 1970 to 28 per cent in 1977.[73] The shares of gross domestic savings in GDP in the same two years for this group of countries were 20.6 per cent and 25.3 per cent, respectively. In comparison, for all developing countries (excluding OPEC countries) the average shares of investment in GDP for the two years were 20 and 23.5 per cent, while the corresponding shares of gross domestic savings amounted to 18 and 21.1 per cent. These figures point to the importance of external capital as a means of financing growth.

In general, the results demonstrate the very close interrelationship between growth in income, growth in trade and trade policy. If the developing countries are to continue to be an important market for capital goods produced by developed countries, the latter countries will need to relax constraints on imports (e.g. to reduce protectionism and to improve the international financial mechanisms for facilitating industrialization in developing countries). Finally, from the developing countries' standpoint any improvement in terms of these criteria will also depend on increased growth of trade in manufactures among these countries.

Appendix

EXPORT PERFORMANCE RATIOS FOR MANUFACTURING INDUSTRIES, BY COUNTRY SAMPLE

SITC	Commodity (industry)	Type codes[a]				Export performance ratio (1966-1967/1975-1976)		
		RES	SK	FD	FI	Developed countries, comparative sample	NICs	Developing countries, comparative sample
012	Meat, dried, salted or smoked	R				—[b]	—[b]	—[b]
013	Meat and meat preparations	R				5.1/4.0	24.3/18.4	—
022	Milk and cream	R				—	—	0.0/0.4

[72] OPEC members are excluded from this sample of fast-growing countries.

[73] These shares and the following savings shares are calculated from current price figures.

Appendix (continued)

SITC	Commodity (industry)	Type codes[a]				Export performance ratio (1966-1967/1975-1976)		
		RES	SK	PD	FI	Developed countries, comparative sample	NICs	Developing countries, comparative sample
023	Butter	R				—	—	—
024	Cheese and curd	R				—	—	—
032	Fish and fish preparations	R				18.6/8.2	2.3/2.5	0.4/3.6
0422	Rice, glazed or polished	R				—	—	12.4/3.4
046	Meal and flour of wheat or of meslin	R				—	0.9/3.0	—
047	Meal and flour of cereals	R				—	—	—
048	Cereal preparations	R				0.1/0.7	0.8/0.9	0.7/0.9
052	Dried fruit	R				131.9/61.2	73.4/87.7	2.0/6.0
053	Fruit, preserved and fruit preparations	R				13.1/12.3	6.6/5.4	16.4/13.8
055	Vegetables, preserved or prepared	R				19.1/11.7	1.4/2.1	14.2/30.9
061	Sugar and honey	R				0.2/0.5	19.8/10.1	49.2/24.0
062	Sugar confectionery	R				2.9/1.7	—	—
0713	Coffee extracts, essences etc.	R				—	18.4/38.3	63.8/27.6
0722/3	Cocoa powder (unsweetened), butter and paste	R				0.2/2.1	—	73.7/161.4
073	Chocolate etc.	R				—	0.2/4.5	2.1/26.9
074	Tea and maté	R				—	2.1/3.2	131.3/297.2
081	Feeding stuff for animals	R				0.6/0.5	9.7/14.0	6.3/4.4
091	Margarine and shortening	R				—	—	—
099	Food preparations not elsewhere specified	R				1.0/0.8	1.5/1.3	0.4/0.7
111	Non-alcoholic beverages, not elsewhere specified	R				—	—	—
112	Alcoholic beverages	R				6.7/5.6	0.5/0.8	3.5/1.9
122	Tobacco manufactures	R				—	—	0.8/1.2
2219	Flour and meal of oil seeds etc.	R				—	—	—
2312	Synthetic rubber etc.	R				—	—	—
243	Wood, shaped or simply worked	R				1.5/2.1	4.7/1.7	5.4/3.9
251	Pulp and waste paper	R				0.6/2.0	0.1/0.2	—
2626-8	Wool shoddy, wool or other animal hair, wool tops	R				—	—	—
266	Synthetic and regenerated fibres	R				0.6/0.8	—	—
332	Petroleum products	R				1.2/1.6	9.7/7.0	0.9/1.4

SITC	Commodity (industry)	Type codes[a]				Export performance ratio (1966-1967, 1975-1976)		
		RES	SK	PD	FI	Developed countries, comparative sample	MCs	Developing countries, comparative sample
411	Animal oils and fats	R				—	—	—
421	Fixed vegetable oils, soft	R				14.1/4.7	9.2/11.0	35.9/27.1
422	Other fixed vegetable oils	R				—	19.1/9.9	76.7/74.9
431	Animal and vegetable oils, processed etc.	R				—	9.2/2.0	—
512	Organic chemicals	R				0.6/0.7	0.6/0.5	0.1/0.2
513	Inorganic chemicals: elements etc.	R				3.6/1.7	2.4/2.1	1.1/4.0
514	Other inorganic chemicals	R				0.8/1.7	0.4/1.0	0.1/0.6
515	Radioactive materials etc.	R				—	—	—
521	Mineral tar etc.	R				—	—	1.9/20.1
531	Synthetic organic dyestuffs etc.		H	L	K	—	—	0.0/0.3
532	Dyeing and tanning extracts etc.		H	L	K	—	38.7/36.1	—
533	Pigments, paints etc.		H	L		1.0/1.5	0.5/0.3	0.2/0.4
541	Medicinal and pharmaceutical products		H	L	K	0.6/0.8	1.3/0.9	0.4/0.5
551	Essential oils etc.		H	L	L	1.7/0.9	3.5/2.0	1.3/7.1
553	Perfumery and cosmetics		H	L	K	1.0/0.8	—	1.5/6.6
554	Soaps, cleansing and polishing preparations		H	H	K	0.7/0.7	—	0.3/0.5
561	Fertilizers, manufactured	R				2.0/2.9	0.2/0.2	2.1/1.3
571	Explosives etc.		H	L	K	2.1/8.7	—	—
581	Plastic materials etc.		L	H	K	0.3/0.4	0.1/0.1	0.1/0.2
599	Chemical materials and products not elsewhere specified					2.0/1.6	0.7/0.6	0.2/0.6
611	Leather		L	L	L	2.0/2.1	2.3/6.3	16.8/21.2
612	Manufactures of leather not elsewhere specified		L	H	L	5.0/3.4	0.8/2.2	0.3/2.6
613	Fur skins, tanned or dressed		L	L	L	20.9/17.6	—	—
621	Materials of rubber		L	L	L	0.3/0.8	—	—
629	Articles of rubber not elsewhere specified		L	H	K	1.6/2.7	0.3/1.1	0.8/0.3
631	Veneers, plywood etc.	R				2.9/1.5	22.1/8.1	17.4/5.4
632	Wood manufactures not elsewhere specified	R				7.6/2.5	0.9/1.6	1.2/6.2
633	Cork manufactures	R				100.7/160.5	—	—
641	Paper and paperboard	R				0.3/0.5	0.0/0.1	—
642	Articles made of paper etc.	R				0.8/1.0	0.6/0.6	5.9/1.4
651	Textile yarn and thread		L	L	L	2.5/3.0	1.1/3.0	4.2/5.6
652	Cotton fabrics		L	L	L	4.2/2.8	8.2/6.5	4.9/8.3

Appendix (continued)

SITC	Commodity (industry)	Type codes[a]				Export performance ratio (1966-1967/1975-1976)		
		RES	SK	PD	FI	Developed countries, comparative sample	NICs	Developing countries, comparative sample
653	Textile fabrics, other than cotton		L	L	L	0.8/1.1	1.0/2.1	7.9/2.4
654	Tulle, lace, embroidery etc.		L	L	L	1.0/1.5	1.6/5.2	—
655	Special textile fabrics etc.		L	L	L	3.7/1.6	1.1/1.2	0.5/1.3
656	Made-up articles of textile materials not elsewhere specified		L	H	L	4.1/7.7	5.1/3.0	22.6/12.7
657	Floor coverings, tapestries etc.		L	H	L	0.9/2.6	0.6/2.2	4.6/5.9
661	Lime, cement etc.		L	L	K	2.6/10.3	0.7/3.1	4.1/4.4
662	Clay construction materials etc.		L	L	L	1.1/2.3	0.8/0.6	0.3/0.5
663	Mineral manufactures not elsewhere specified		H	L	L	1.0/0.9	0.2/0.6	0.2/0.3
664	Glass		L	L	K	0.5/0.7	0.3/0.9	—
665	Glassware		L	L	L	1.5/1.6	1.3/2.3	0.2/0.6
666	Pottery		L	L	L	0.6/1.4	—	—
671	Pig iron etc.		L	H	K	1.8/4.0	2.0/4.4	3.2/3.2
672	Primary forms of iron and steel		L	L	K	0.4/0.4	0.2/0.3	0.0/0.3
673	Iron and steel bars etc.		L	H	K	0.3/2.0	0.4/0.3	0.7/0.9
674	Universals etc. of iron and steel		L	H	K	0.0/0.5	0.6/0.3	0.0/0.1
675	Hoop and strips of iron and steel		L	H	K	—	—	—
676	Rails etc.		L	H	K	3.7/1.8	—	0.7/2.1
677	Iron and steel wire		L	L	K	—	—	—
678	Tubes, pipes of iron and steel		L	H	K	0.6/0.8	0.6/0.5	0.3/0.5
679	Iron and steel castings etc. not elsewhere specified		L	L	K	2.6/1.5	—	—
681	Silver, platinum etc.	R				0.5/0.6	—	1.7/18.0
682	Copper	R				2.3/2.8	1.0/0.2	—
683	Nickel	R				—	—	0.0/8.3
684	Aluminium	R				3.4/3.8	0.1/0.2	17.1/6.0
685	Lead	R				6.4/4.5	24.8/17.8	—
686	Zinc	R				1.6/4.1	2.2/10.5	—
687	Tin	R				—	0.5/2.6	100.6/114.0
689	Miscellaneous non-ferrous base metals	R				—	—	—
691	Finished structural parts not elsewhere specified		H	H		1.1/1.2	0.2/0.3	0.1/0.3
692	Metal containers		H	L		1.4/2.0	2.5/0.9	—

SITC	Commodity (industry)	Type codes[a] RES	SK	PD	FI	Export performance ratio (1966-1967/1975-1976) Developed countries, comparative sample	NICs	Developing countries, comparative sample
693	Wire products (excluding electric)		H	L	L	2.1/1.9	0.4/1.1	0.4/0.8
694	Nails, screws etc.		H	L	K	1.0/1.7	0.2/0.6	0.2/0.5
695	Tools		L	L	K	1.1/1.4	0.3/0.5	0.2/0.6
696	Cutlery		L	L	L	1.2/1.9	1.1/3.6	—
697	Household equipment		H	L	L	1.7/3.8	3.6/2.8	0.4/1.4
698	Manufactures of metal not elsewhere specified		H			1.6/5.2	1.1/0.8	0.2/0.3
711	Power generating machines, non-electric		H	L		0.3/0.4	0.1/0.7	0.0/0.1
712	Agricultural machinery		H	L	L	0.4/0.5	0.0/0.4	—
714	Office machines		H	H	L	0.2/0.4	0.6/1.0	—
715	Metalworking machinery		H	L	L	0.8/1.0	0.1/0.2	0.0/0.1
717	Textile and leather machinery		H	L	L	1.4/0.6	0.2/0.2	0.1/0.1
718	Machines for special industries		H	L	L	0.2/0.3	0.2/0.4	0.1/0.1
719	Machinery and appliances not elsewhere specified		H	L	L	0.2/0.5	0.1/0.3	0.1/0.1
722	Electric power machinery etc.		H	L	L	0.7/0.9	0.1/0.4	0.0/0.2
723	Equipment for distributing electricity		H	L	L	5.3/3.1	0.3/0.4	0.1/0.4
724	Telecommunications apparatus		H	L	L	0.2/0.8	1.2/1.5	0.0/0.1
725	Domestic electrical equipment		H	L	L	0.2/1.1	0.4/1.1	0.1/0.1
726	Electric apparatus, medical etc.		H	L	L	—	—	—
729	Other electrical machinery		H	L	L	0.2/0.5	0.7/1.9	0.1/0.3
731	Railway vehicles		L	L	L	5.0/2.7	0.0/0.9	0.1/0.7
732	Road motor vehicles		L	H		0.2/0.4	0.1/0.3	0.0/0.1
733	Road vehicles other than motor vehicles		L	H		1.9/1.5	0.3/0.6	0.3/1.1
734	Aircraft		H	L		0.2/0.6	0.2/0.2	—
735	Ships and boats		H	L	L	2.8/1.3	0.2/1.0	0.0/0.1
812	Sanitary, plumbing, heating fixtures		L	L	L	2.2/1.5	4.6/2.4	0.1/0.6
821	Furniture		L	L	L	4.3/2.9	1.4/0.7	0.3/0.6
831	Travel goods		L	L	L	1.6/1.9	6.4/10.6	0.5/5.5
841	Clothing		L	L	L	2.5/2.9	14.1/13.2	0.3/2.9
842	Fur clothing		L	L	L	4.1/6.8	0.8/8.6	—
851	Footwear		L	L	L	5.4/7.5	4.6/4.9	1.6/1.5
861	Scientific etc. instruments		H	L	K	0.2/0.3	0.1/0.4	0.0/0.1
862	Photographic, cinematographic supplies		H	H		—	0.1/1.0	—

Appendix (continued)

SITC	Commodity (industry)	Type codes[a] RES	SK	PD	FI	Export performance ratio (1966-1967/1975-1976) Developed countries, comparative sample	NICs	Developing countries, comparative sample
864	Watches and clocks		L	H	K	0.0/0.3	0.8/4.3	—
891	Musical instruments etc.		H	H	L	0.2/0.3	0.2/1.6	—
892	Printed matter		H	H	L	4.1/2.7	1.4/1.6	0.3/1.3
893	Articles of artificial plastic materials		L	H	L	1.0/1.1	1.5/3.3	0.1/0.5
894	Perambulators, toys, sporting goods		L	L	L	1.0/1.6	11.9/10.3	0.0/0.4
895	Office and stationery supplies not elsewhere specified			L		—	—	—
897	Jewellery etc.		L	L	L	1.0/1.8	3.0/6.0	0.6/0.9
899	Manufactured articles not elsewhere specified		L	L	L	1.4/0.9	17.7/5.1	0.5/4.3

Note: The SITC items listed are understood to be "trade in manufactures" as defined in the first section of chapter II, with the addition of the following seven SITC groups or subgroups: fresh, chilled or frozen meat (011), eggs (025), reclaimed rubber (2313), waste and scrap of unhardened rubber (2314), waste of wool and other animal hair, not elsewhere specified (2629), cotton (263) and waste materials from textile fabrics (267). Because of the high proportion of primary items included in SITC 011, 025, and 263 and the waste character of the other trade categories, they were excluded from the detailed presentation. For a description of each product category, see *Standard International Trade Classification, Revision 2* (United Nations publication, Sales No. 75.XVII.6).

[a] In the columns headed "Type codes", industries are classified by four different criteria:

(a) Resource dependence (RES): The identification of resource-based industries (R) relied heavily on the work of S. Hirsch, "Capital or technology? Confronting the neo-factor proportions and neo-technology accounts of international trade", *Weltwirtschaftliches Archiv*, Band CX, Heft 4, p. 343. All products included in SITC classifications 0, 1 and 4 and part of SITC 2 were considered to be resource-based.

(b) Skill intensity (SK): The designation of a high (H) or low (L) level of skill intensity for industries that were not resource-based drew upon the work of H. B. Lary regarding the percentage of the skilled labour force in the United States. See *Imports of Manufactures from Less Developed Countries* (New York, National Bureau of Economic Research, 1968). Use was also made of the work by S. Hirsch, "The product cycle model of international trade—a multi-country cross-section analysis", *Oxford Bulletin of Economics and Statistics*, vol. 37, No. 4 (November 1975), and G. C. Hufbauer, "The impact of national characteristics and technology on the commodity composition of trade in manufactured goods", in *The Technology Factor in International Trade*, R. Vernon, ed. (New York, National Bureau of Economic Research, 1970). The dividing line between the two designations was taken to be the arithmetic mean of the sampled skill ratios.

(c) Product development (PD): Following J. M. Finger, "A new view of the product cycle theory", *Weltwirtschaftliches Archiv*, Band CXI, 1975, p. 79, industries were classified according to high (H) or low (L) rates of "product development". Rates of product turnover (defined as the number of items that appeared or disappeared over a given period as a percentage of the total number of items in the SITC group or subgroup), derived from United States data for the period 1965-1971 and presented in Finger's article, were used for this classification. Again the simple above-mean (H) or below-mean (L) criterion was applied.

(d) Factor intensity (FI): The sources used for classifying industries into a labour-intensive (L) and a capital-intensive (K) subgroup were the following (listed in a priority order of use):

(i) A. H. M. Mahfuzur Rahman, *Exports of Manufactures from Developing Countries, A Study in Comparative Advantage* (Rotterdam University Press, 1973), p. 131 (based on 1965 data from India on capital per man);
(ii) Lary, *op. cit.*, p. 191 (based on 1965 United States data on value added per employee);
(iii) Hirsch, *loc. cit.*, pp. 311, 317;
(iv) G. C. Hufbauer, *loc. cit.*, table A-2.

[b] A dash (—) in one of the last three columns of the table indicates that the 1975-1976 value of exports of that industry accounted for less than 0.1 per cent of total manufacturing exports of the respective country group.

III. RESTRUCTURING WORLD INDUSTRY: TRENDS AND PROSPECTS IN SELECTED INDUSTRIAL BRANCHES

In the preceding chapters, the world-wide dispersion of industrial capacity was viewed from the perspective of the manufacturing sector as a whole. Within that sector, however, the process of structural change differs widely from one industrial branch to another. Each branch is subject to unique restraints and forces for change arising from diverse considerations of industrial policy, technology, trade and capital and labour requirements. It follows that restructuring poses separate problems for individual producers, depending on the industry.

The restructuring process is examined here in four industrial branches: chemicals, iron and steel, engineering products and food processing. The purpose is to illustrate how recent structural changes and related policies are altering the development of each industry.

Two types of decision-makers have become increasingly important in each of the industrial branches surveyed: *(a)* the transnational corporations (TNCs), which are capable of achieving high levels of vertical and horizontal integration across a wide range of production and marketing activities; and *(b)* national Governments, which are being persuaded to adopt interventionist policies. Today, price and output levels in most industrial markets are determined not by the operation of Adam Smith's "invisible hand" but by the interaction of corporate strategists and government planners. Elaborate networks for institutionalizing this relationship have been constructed, and protracted negotiation and bargaining have become a regular feature of policy formulation and modification in both the developed and the developing countries.

In developed countries, employment issues are often the main focus of policy-making. The structural changes that took place during the 1950s and the 1960s were comparatively painless—the labour force that was released in declining industrial branches was gradually absorbed in the dynamic sectors. Even then, however, successful adjustment assistance programmes were exceptional. The problem of absorbing labour intensified in the 1970s with the rapid expansion of branches that had a highly capital- and R and D-intensive production structure and little potential to expand employment, particularly among unskilled and semi-skilled workers. Accelerated structural change entails a shift away from labour-intensive activities, and such shifts threaten to create large-scale unemployment. Furthermore, Governments committed to the defence of a "welfare state" have a political obligation to counter stagflation and maintain high levels of employment. Thus, changes in the structure of

industrial production are mediated through a rapidly evolving institutional framework that is far more complex than is normally assumed.

In the developing countries, too, new relationships are being forged between the TNCs and Governments. For example, in the chemical and petrochemical branch, an intricate web of formal and semi-formal associations has been created facilitating the flow of information and bringing about a convergence of strategies and policies. Hence, industrial progress in the developing countries is creating new property forms that are not fully comprehended by specialists in existing social disciplines. There is thus a need to develop analytical categories that permit an appreciation of the impact of technological development on organizational evolution in industrialized and rapidly industrializing societies.

For international policy, a major task is to facilitate the restructuring process in a manner that would reflect changes in comparative advantage. It should be clear from the subsequent analysis that such an allocation of resources will not occur at the behest of "market forces" guided by an "invisible hand". It is essential to identify the "balance of forces" in individual industrial sectors in order to comprehend the process of policy formulation and to stimulate adjustments that are not designed to retard structural change.

During the period of most rapid industrial growth (1950-1970), many industries were well served by the spread of industrial technology. The development of new production technologies that permitted firms to disperse different phases of the production process to different countries while maintaining overall control hastened the spread of internationalism.[1] Patterns of specialization emerged in industrial production and intra-industry trade, making a positive contribution to the world-wide growth of industry and income.

More recently, in contrast, policy-makers have been slow or more reluctant to give weight to international considerations in accordance with their impact on the domestic economy. To some extent their predilection is understandable: for example, external demand and supply conditions (along with related considerations of price, quality etc.) have often been seen as uncertain or uncontrollable factors. Similarly, the underestimation of existing industrial capacity and the displacement of labour have been primary concerns. Finally, the policy-maker's horizon has tended to be short-term, while the gains to be derived from domestic adjustments to international circumstances have generally been long-term.

The slow-down in industrial growth since 1975 has led manufacturers to view international developments in a somewhat different light. Although most firms continue to be acutely aware of the consequences of international adjustments for their own prospects, those that are largely in contracting industries are increasingly prone to lobby for the types of defensive policies described in chapter I.

[1]This phenomenon, sometimes known as production fragmentation, first appeared in the field of electronics. The production of conductors, tubes, cabinets for television sets, radios etc. was widely dispersed to take advantage of lower production costs. Automobile assembly and the production of related components is another recent example. For further discussion, see G. Helleiner, "Manufactured exports from less-developed countries and multinational firms", *Economic Journal*, March 1973, pp. 21-47, and D. Keesing, "World trade and output of manufactures: structural trends and developing countries' exports" (Washington, D.C., World Bank, February 1978).

Changes in the attitudes of Government, industry and organized labour in the developed countries have been gradual and subtle. As the following case studies will show, few generalizations can be made because of national differences in government policy, institutions, industrial conditions and social values. At least two broad trends may be noted, however; both apply to the more recent defensive approach to restructuring. First, the extent of government intervention has increased as industrial contraction has become widespread. Because of the large size and importance of many of the corporations involved—in terms of their integration into the national economy and the employment that they generate—Governments have been inclined to come to their rescue. The long-term trend towards greater firm size has meant that their failure would disrupt the national economy[2]—a possibility that a Government could not ignore. Second, the response of Governments to trade-related disruptions of the economy has been to restrict the rate of structural change.[3] As a result, industry-specific trade barriers, industrial aids and export subsidies have become prevalent, reflecting a new emphasis on structural rather than macroeconomic policy issues (e.g. employment and balance of payments).[4]

Nevertheless, despite recent obverse policy trends, the successful "internationalization" of industry during the 1960s and 1970s remains a valid course for the 1980s. As the following case studies indicate, a lack of international policy co-ordination together with a short time horizon in the present era of slow growth have put in jeopardy the earlier gains made by both the developed and the developing countries.

A. THE CHEMICAL INDUSTRY

An overview

The chemical industry produces two general groups of products. One group includes a diverse number of final items: paints, varnishes and lacquers, drugs, soaps, cleaning preparations, perfumes, cosmetics and miscellaneous products ranging from polishes and glues to film and explosives.[5] The second group consists of four product types: basic organics and inorganics (e.g. ethylene), fertilizers and pesticides, polymers (plastics, synthetic rubber, man-made fibres etc.) and industrial intermediates (acids and solvents).

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[2]Examples are the recent United States Government's rescue of Chrysler and the United Kingdom's earlier efforts on behalf of Rolls Royce. For further discussion of this trend, see Göran Ohlin, "Subsidies and other industrial aids", in *International Trade and Industrial Policies*, Steven J. Warnecke, ed. (London, MacMillan, 1978), pp. 21-34.

[3]This point is stressed by T. Murray, W. Schmidt and I. Walter, "Alternative forms of protection against market disruptions", *Kyklos*, vol. 31, 1978, pp. 624-625 and G. K. Helleiner, "Structural aspects of third world trade: some trends and prospects", *Journal of Development Studies*, vol. 15, No. 3 (April 1979), p. 80.

[4]Exchange-rate policies have now become a major macroeconomic policy tool of the developed countries.

[5]Nearly one half of the chemicals produced are items purchased by households.

The diversity of the industry's products and markets is mirrored by its pattern of ownership and its integration with firms in other industrial branches, at least in the developed countries. In fact, it is often difficult to specify precisely where the chemical industry ends and another industry begins. For example, chemical firms have moved from the production of basic chemicals into intermediates and a score of end-products traditionally produced by other industrial branches. At the same time, firms in other industrial branches that were heavy users of chemicals quickly began to produce their own chemicals. Examples abound among firms that are in textiles, steel, drugs, food and, above all, oil.[6]

From these characteristics a rough idea can be gained of the role that chemical industries could play in restructuring. First, relocation of production is likely to continue in the 1980s. A number of producers (particularly of petrochemicals) in developing countries will come onstream. This trend has important implications for the current trade pattern among importing markets in both the developed and the developing countries and for policy-makers. Second, in developed countries the industry's future is closely tied to structural changes in other industrial branches. Therefore, restructuring in other industrial fields can have important consequences for chemicals; for example, textiles which is a major user of polymer fibres. The restructuring process has stimulated a rapid expansion in the production of textiles and clothing in developing countries. Established chemical suppliers in developed countries have lost markets as textile firms have reduced their own production and as new producers have emerged in developing countries.

An examination of the industry from a long-term perspective is a useful background for viewing future trends. Prior to the advent of petrochemicals (around the 1920s in the United States), producers were essentially suppliers of intermediates to other industries. This function persists; over one fifth of the output of the chemical industry is consumed by the industry, while another 40 per cent is subsumed by other industries but is not embodied in the final products.[7] However, the emergence of petrochemicals has led to all sorts of new product lines based on synthetics—tyres, textiles, paint, clothing etc. The present, second phase of the chemical industry, is characterized by the introduction of an entire new set of products intended mainly for the final consumers rather than for other industries.

Changes in the structure of demand and costs, technological advances etc. forecast a new phase in the 1980s. Such changes are discussed in some detail below; it is sufficient to note here that market saturation, rising energy costs, environmental considerations, technology and policy trends all confirm that the industry is now appropriately described as "mature". As a result, the pattern of development will undergo some changes. The desire to increase value added to compensate for a declining growth rate in the volume of sales is one example. Another will be the need to satisfy the more specific demands of final

[6] In 1977, about 25 of the leading chemical producers in the United States were not predominantly chemical firms; their main lines of activity were in other fields that required, or were related to, inputs or outputs of the chemical industry.

[7] These percentages vary depending on the measurement used—tonnage, sales value or value added—but a maximum estimate for the share of petrochemicals in the chemicals branch would be about 50 per cent.

users in the future.[8] A third possibility is that chemical firms will be increasingly inclined to sell their know-how to other industries, a trend often encountered among mature industries.

Such a reorientation will entail a much closer relationship between chemical producers and their final consumers, including those in the developing countries. The intention of specializing in products of higher value added will require that firms be aware of significant market developments. Similarly, the desire to provide specific products for specific users will require a greater emphasis on marketing aspects than in the past. Such trends would mean that chemical producers will become even more intimately concerned with conditions in foreign markets and more cognizant of the development of production capacity in these markets.

World production and structural change

In the developed countries, chemicals were consistently the fastest growing industrial branch from the late 1950s until the late 1960s; net output grew at rates almost double those for total manufacturing.[9] Simultaneously, the industry's development had a substantial impact on the consumption pattterns of both industry and households, on investment, on R and D and on trade. A positive, although much smaller, impact was made on employment in manufacturing. While the industry expanded rapidly, its growth did not substantially alter conditions in labour markets.

Growth at such an impressive rate required a substantial reallocation of resources, particularly of investment capital and R and D, during the industry's development phase. Figures for the Federal Republic of Germany and the United Kingdom show that, for the period 1959-1970, cumulated investment in chemicals was 19 to 20 per cent of the total for manufacturing.[10] The United States recorded an even larger share in the 1960s. Data on R and D for the OECD countries show that over 20 per cent of the scientists and engineers working in the manufacturing sector were employed by the chemical industry. In this respect, chemicals were surpassed only by electronics.[11] Many results of the research appeared in the form of new products (both industrial supplies and consumer products).

Much of the R and D, as well as the capital investment by the developed countries, was channelled into petrochemicals. The consequences led to basic changes that distinguished the chemical industry of the 1960s from that of the

[8]An example of this "service orientation" is the intention to provide specific pesticides and herbicides for specific crops in specific geographical areas. In the past, mass production led to indiscriminate use of these products with high economic and ecological costs.

[9]Calculations were in constant prices and refer to ISIC 351 and 352. *Structure and Change in European Industry* (United Nations publication, Sales No. E.77.II.E.3), especially table I.2.

[10]The original data were at constant prices and included petroleum and coal products in chemicals. *Structure and Change* . . ., p. 44.

[11]The distribution is similar if based on expenditures rather than on the number of researchers. See OECD, *A Study of Resources Devoted to R and D in OECD Member Countries in 1963/1964*, Statistical Tables and Notes (Paris, 1968) and *International Survey of the Resources Devoted to R and D in 1967 by OECD Member Countries*, Statistical Tables and Notes, vol. I (Paris, 1970).

1970s. World production of the main end petrochemicals rose from 3 million tons in 1950 to 71 million tons by 1974.[12] In reality, the influence of petrochemicals on the industry's performance is more pervasive than figures on output might suggest. Not only do these products contribute directly to a wide range of synthetic products, but they are also crucial inputs used in combination with inorganic chemicals.[13]

Other structural factors also help to explain why petrochemicals have evidenced the most dynamic growth in the industry. Inorganics, mainly contributing to products such as ammonia, sulphuric acid and chlorine, are the more established and mature part of the industry. Growth in demand for inorganics (perhaps with the exception of plastics) is generally equal to, or even below, an economy's overall economic growth. No one factor or combination of factors—whether growth in demand, development of new technologies or the emergence of new products—has provided a stimulus to expansion equivalent to that observed for petrochemicals.

These trends—the massive expansion encouraged by most developed countries and supplemented by natural structural forces—have transformed the industry. Chemicals have outgrown their initial role as supplier and have entered the second, "product" phase largely dominated by petrochemicals.

Structural trends in the 1970s

During the 1970s, the nature and composition of resource flows (investment and R and D) began to change as the industry's product phase took shape. Data for the period 1970-1975 indicate that nominal investment in the developed market economies remained stable at about 11 to 12 per cent of total investment in manufacturing. Consequently, real investment (at constant prices) fell in many countries for most of this period. In centrally planned economies, levels of investment were generally higher than those recorded in developed market economies, although a downward trend was also noted.[14] In any case, the proportion of investment in manufacturing devoted to the chemical industry in developed countries was definitely below that achieved in the 1960s.

The pattern of R and D expenditures also changed in the 1970s. Increased competition for available funds, including government support and industrial aids, probably explains why chemicals lagged behind both electronics and aerospace in expenditures on R and D. The directions of research changed with the greater emphasis on improving existing production processes and on applied research rather than basic research. Also, product-oriented research increased, particularly in pharmaceuticals. For example, in the United Kingdom, pharmaceuticals, along with synthetic rubber, resins, plastics, paints

[12]Production dropped somewhat in later years. The main end petrochemicals referred to here are plastics, synthetic fibres, synthetic rubbers and detergents. See UNIDO, "First world-wide study on the petrochemical industry: 1975-2000" (UNIDO/ICIS.83, December 1978), p. 20.

[13]For example, polyvinyl chloride is derived from inorganic chloride (60 per cent) and ethylene (40 per cent), a petrochemical building block.

[14]*Market Trends for Chemical Products 1970-1975 and Prospects for 1980*, vol. I (United Nations publication, Sales No. E.78.II.E.14), p. 8.

and varnishes, absorbed almost one half of the chemical industry's R and D expenditures in 1975.[15] Finally, advances in pure research seemed to slow down. The development of new molecular combinations for plastics and fibres became problematic. Only the more difficult molecular chains were left to develop, and the prospect of high returns on R and D expenditure faded.

This brief summary suggests that, in the developed countries, chemicals were going through a transition in the 1960s and 1970s not altogether unlike that experienced by other industrial branches in other periods. The emergence and dramatic growth of petrochemicals altered the industry's growth pattern. By the early 1970s, however, even this subsector was beginning to show some signs of maturity.

Several phenomena that occurred during the 1970s set the conditions for a third phase foreseen in the 1980s. They included *(a)* the rising cost of energy feedstock as petroleum prices were adjusted upward, *(b)* rising environmental and toxicological concerns, *(c)* slower growth with the saturation of many markets for bulk products, *(d)* the entry of state-owned enterprises and the growing tendency to resolve structural issues by policy intervention, and *(e)* the spread of industrial capacity, which foreshadows the appearance of entrants from developing countries in the 1980s.

Of these five conditions, the consequences of energy price adjustments have received the most attention. Some analysts have argued that price trends for feedstocks and oil were singularly important in forcing the slow-down in world growth of chemicals during the 1970s. Certainly, there are sound reasons for relating the two factors, since over 90 per cent of organic chemicals are derived from oil and gas feedstocks.[16]

Growth rates for various periods spanning the years 1960-1979 are shown in figure I. The years 1960-1967 were years of rapid growth in chemicals for the developed countries. With the exception of the developing countries, the growth in output dropped somewhat in the period 1967-1973 for reasons unrelated to the energy question. Growth in later years, 1973-1979, declined significantly, and rising energy costs were certainly a contributing factor. The drop in growth rates was most substantial among chemical industries in energy-poor Western Europe. The fall in the growth rate in the centrally planned economies was noticeable but moderate.

The slow-down was typical of most industrial branches, and chemicals fared better than several others. For example, in the United Kingdom, annual profit rates (at constant prices) in the period 1974-1977 were higher for chemicals than for metal manufacturing, textiles, clothing, leather and footwear.[17] Moreover, since 1976, the production of chemicals has shown an upturn, suggesting that the industry may be adjusting to the new set of input prices.

In the developed countries, one impression of the petrochemical field should, perhaps, be revised because of the adjustment in energy prices. At least

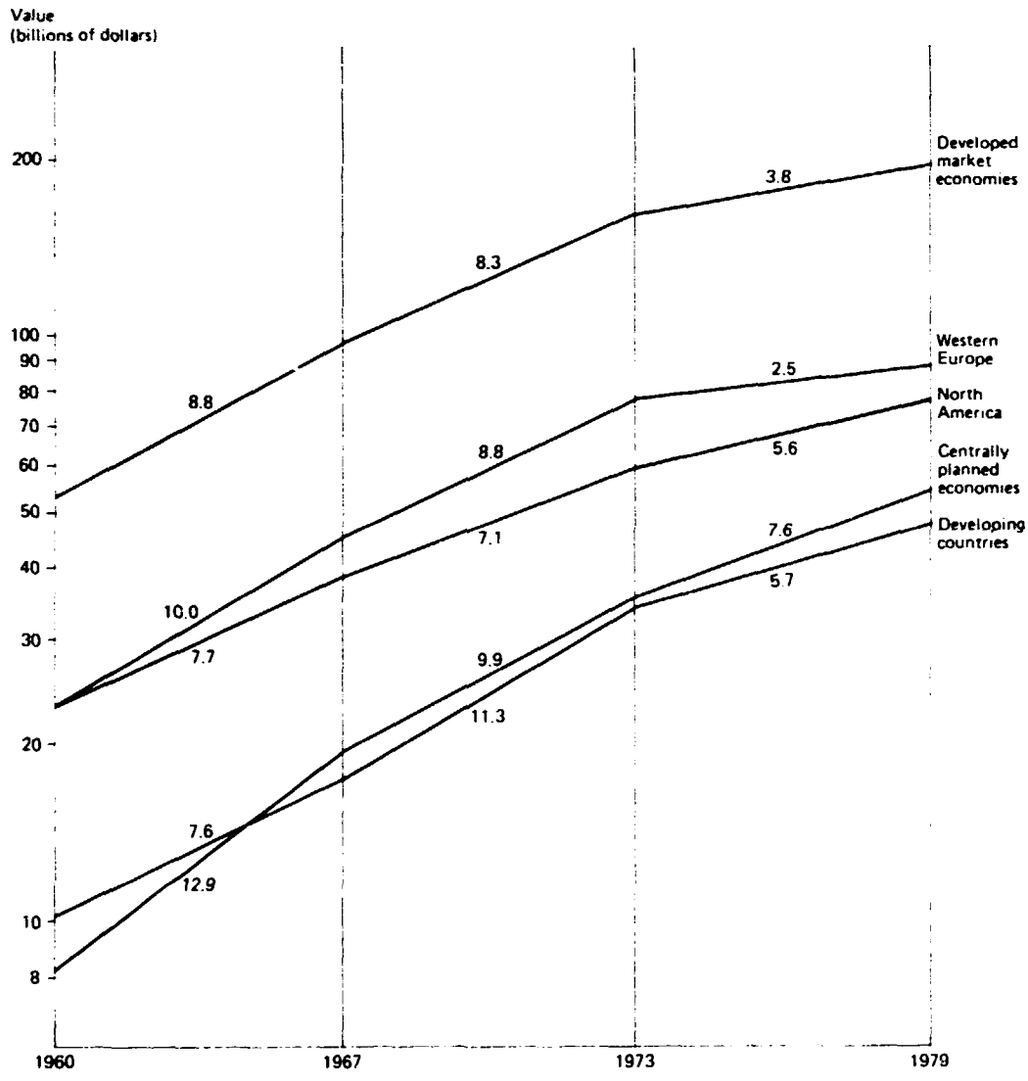
[15] *Ibid.*, p. 10.

[16] Over 95 per cent of ammonia, one of the most important inorganic chemicals, is also derived from these feedstocks.

[17] Most recent (1980) rises in feedstock prices and a weakening of demand seem to have hit chemical producers harder than those in other branches, however, in both the United Kingdom and elsewhere.

Figure I. Value of net output of chemicals (ISIC 35) in selected economic groupings and regions, 1960-1979

(Figures on the curves are the average annual growth rates (percentage))



Source: United Nations, *Monthly Bulletin of Statistics*, various issues, and data supplied by the United Nations Statistical Office.

for the next decade, it would probably be more accurate to describe these operations as "feedstock-intensive" rather than "capital-intensive". The initial impact of energy costs was twofold: direct, via higher energy prices and, indirect, through more expensive materials and intermediates.[18] The extent to which production costs actually changed varied widely among producers in the

[18]Between mid-1973 and mid-1974, the prices of raw materials (e.g. naphtha) rose 300 to 400 per cent; intermediates such as ethylene and propylene increased 100 to 200 per cent, plastics such as polypropylene and polyethylene rose 50 to 100 per cent, while finished products (bags, film, mouldings etc.) rose 35 to 50 per cent. See Economic Commission for Europe, *Annual Review of the Chemical Industry*, December 1974, p. 2 (CHEM/8).

developed countries, however. Most Governments exercised some control over energy prices (and still do). Until very recently gas price controls in the United States were relaxed more slowly than those on oil. Since that country's chemical industry relies mainly on gas, its feedstocks cost over 30 per cent less than those of Western European producers. The price of landed American products in Western Europe was assessed to be 10 to 20 per cent lower as a result.[19]

One effect of the new feedstock relationship is that economies of scale, realized by building larger plants, do not necessarily lead to substantial cost advantages.[20] A second is that the emphasis placed on applied rather than on pure research will continue to grow as firms search for ways of reducing raw-material and feedstock costs. Viewed in this way, adjustments in energy markets are reinforcing and accelerating changes in R and D.

The comparatively large share of chemicals in the consumption of energy in the manufacturing sector has led to some reconsideration of policy in the industry. The figures in table III.1 illustrate this feature. In developed countries with a relatively well-established chemical industry, the production of chemicals

TABLE III.1. COST OF PURCHASED FUELS AND ELECTRICITY CONSUMED BY CHEMICALS (ISIC 35) AS A PERCENTAGE OF TOTAL MANUFACTURING, 1963-1964 AND 1975-1976

Country	*1963-1964*	*1975-1976*
Australia	14.5	12.7
Austria	...	12.7
Canada	12.7	16.0
Czechoslovakia	12.6	16.6
Denmark	10.7	15.0
Finland	7.1	13.7
Greece	7.6	13.2[a]
Ireland[b]	2.8	6.7[c]
Israel	15.1	23.0
Japan	19.5	25.9
New Zealand	3.6	4.0
Norway	17.3	13.8
Portugal	12.1	17.7
Spain	17.2	16.9
Sweden	8.2	8.7
United Kingdom	...	17.4
United States	22.1	26.7

Source: Based on data supplied by the United Nations Statistical Office.

Note: Unless otherwise indicated, percentages are two-year averages.

[a] 1975.

[b] Only industrial chemicals (ISIC 351) and other chemicals (ISIC 352).

[c] 1973.

[19] *The Economist*, 10 May 1980, p. 13. These cost relationships are constantly changing. The recent (1978) rise in the price of naphtha penalized European producers more than the United States producers who rely on natural gas for fuel and raw materials. By 1980, the cost of feedstock for the latter producers was 40 per cent cheaper than naphtha.

[20] An extreme example is one Japanese firm which estimated that in 1980 raw materials accounted for 90 per cent of its costs for production of methanol.

often required over one sixth of the total commercial energy purchased by the manufacturing sector. The share of the industry generally rose between the periods 1963-1964 and 1975-1976. The highest share was recorded by Japan where chemicals consumed over one quarter of the manufacturing sector's energy requirements in the mid-1970s.[21] That country represents an extreme case, however, since output of chemicals rose dramatically during the period reviewed. Under such conditions, national policies pertaining to the chemicals branch naturally tend to become closely interrelated with overall energy policy.[22]

The energy question is also directly related to another of the factors mentioned above—the spread of production capacity to the developing countries. The traditional view has been that market proximity was the major determinant of the location of chemical production. However, the rising importance of feedstocks has led some observers to conclude that supply considerations will eventually determine the location of new production centres (specifically for petrochemicals). With variable costs (mainly for feedstocks and fuel) determining up to three fourths of production costs, low-cost inputs become crucial.[23]

New petrochemical production capacity in the developing countries should increase considerably by 1985 with over 20 plants in operation in Iraq, Kuwait, Qatar, Saudi Arabia and other countries. By the mid-1980s, Mexico, too, should become an important producer of a wide variety of petrochemicals. Obviously, growth prospects are best in countries with ample supplies of feedstock. Chemical producers in other developing countries will have to make substantial adjustments. In India, for example, the basic price of naphtha was said to have risen by 145 per cent in the year ending in August 1980. Accordingly, the prices of resins and compounds rose 30 to 40 per cent.

Originally, observers expected cheap gas feedstock to be of most importance in the production of ammonia, nitrogenous fertilizers and ethylene, but they thought the developing countries would encounter difficulties in producing more sophisticated products (e.g. plastics, polymers and fibres) because of high transport and operating costs. Comparative cost estimates for two first-line derivatives are shown in figure II, demonstrating how three key factors altered significantly the relationship between producers in Europe and West Asia between 1974 and 1979. First, the price of European feedstock (naphtha) rose substantially.[24] Second, much cheaper financial terms—including export finance and other soft loans—became available. Both factors worked to the benefit of those potential producers in developing countries with

[21]Significantly, the Japanese Government is reported to have singled out the production of petrochemicals for rationalization. Firms in that country are concentrating on diversification away from energy-intensive processes and on joint ventures with developing countries. See *The Economist*, 3 May 1980, p. 83.

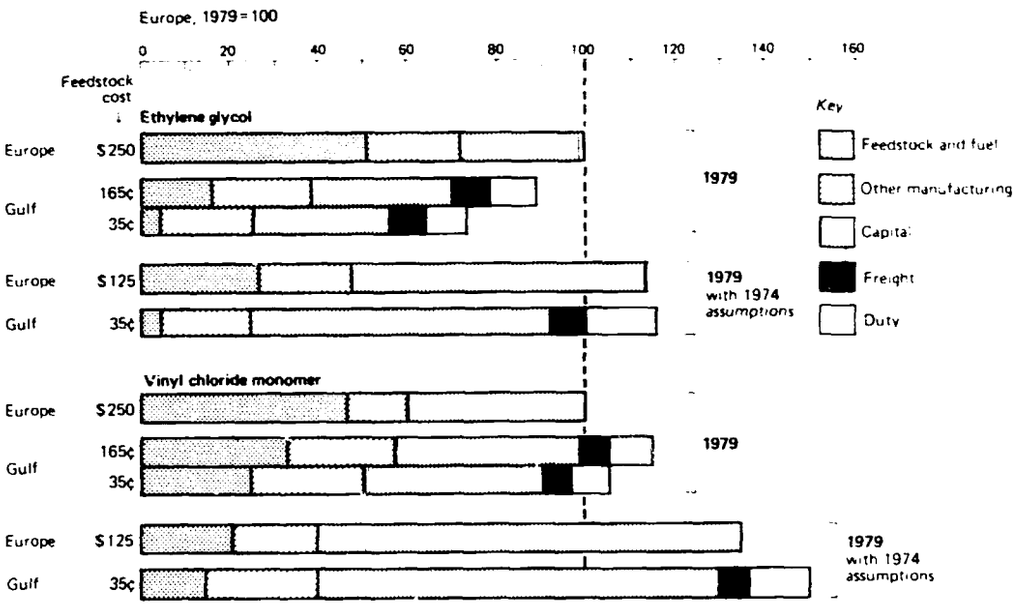
[22]In other instances where the shares in table III.1 are relatively low, this often reflects the country's reliance on other large energy-using activities. An example would be Sweden (8.7 per cent in 1975-1976) where the pulp and paper industry predominates.

[23]Figures are for 1977 and refer to ethylene, a basic building block. The comparable share of variable costs in production costs was 44 per cent in 1974. See *The Economist*, Chemicals Survey, 7 April 1979, p. 18.

[24]The estimates assumed a price of $250 per ton. By August 1980, the European contract price was $325 per ton, down slightly from an early summer price of $350.

Figure II. Comparative costs of chemical production in the Gulf countries and Europe

(Feedstock cost is given in dollars per ton of naphtha (Europe) or cents per million British thermal units (1.05 billion joules) of gas (Gulf))



Source: *The Economist*, 27 October 1979, p. 78.

access to feedstock and finance. Finally, relative construction costs changed in favour of Europe: a chemical plant built in West Asia in 1979 cost two thirds more than one built in Europe instead of one fifth more as in 1974.

Another trend observed in the developed countries may, perhaps, suggest a course for the development of the chemical industry in developing countries with abundant energy supplies. One possibility relates to the growing involvement of several major oil firms in the production of petrochemicals. In 1976, about 13 per cent of the investment of the world's leading oil companies went into chemicals excluding oil refining.[25] The movement of oil firms into the production of basic petrochemicals and plastics is explained by the simple fact that it is a profitable way of selling oil, particularly as these firms become increasingly processors of oil rather than actual producers. These firms are able to make inroads into chemicals largely because they already control the basic facilities for producing the base petrochemicals needed for polyethylene and styrene. Their easy access to a variety of feedstock also helps. Thus, when prices rise for one feedstock (e.g. naphtha), these firms can easily shift to gas oil. In the longer term, chemical firms in energy-abundant developing countries may be able to make similar shifts, provided that the necessary technology is available.

Concern for the environment, together with stricter legislation governing pollution controls, is another salient aspect of the chemical industry in the 1970s, with consequences for restructuring. This concern relates to the toxic pollution of air and water, health risks to the industry's workers and

[25] *The Economist*, Chemicals Survey, 7 April 1979, p. 24.

consumers, and the growing danger of explosions in ever-larger plants or of accidents involving dangerous chemicals while in transport. The expenses incurred in cleaning up dirty processes or in controlling emissions, though substantial, do not warrant such drastic changes in the production process as those being experienced in the automobile industry where plants and product ranges are undergoing complete change.

In the United States, chemical producers accounted for about 19 per cent of total investment in air and water pollution control, or $3.6 billion, in the period 1977-1979. In 1979, this share was 15 per cent, suggesting that the peak period for such investments may have passed. In general, more stringent environmental safeguards will retard the introduction of new products and increase the cost of new plants and processes by requiring more careful verification of health and safety standards, more investment in pollution controls and a higher share of R and D expenditures to support these standards. However, these trends will by no means signal the demise of the industry in the developed countries but, rather, its improvement in several aspects.

Another factor with important consequences for the chemical industry is the increasing influence exerted by Governments of developed countries. Initially, government action was largely pursued for environmental reasons, but its scope is now becoming much broader. The entry of new government producers into the field is the most obvious sign of a new "political" orientation and reflects the industry's growing maturity. Today, the impetus for the closer relationship between the Government and the chemical industry is an outgrowth of the restructuring process and other factors described above.[26] The new approach of various developed countries cannot be described as predominantly "defensive" or "positive", as these terms have been defined earlier in this *Survey*, for two reasons. First, the industry is too diverse and heterogeneous to be characterized as a contracting or an expanding industry; circumstances vary widely among the different types of producers and product groups. Second, the policy of developing countries and the approach of their leading chemical producers differ from country to country.

The evidence from Japan suggests the broad outlines of one strategy, which, if realized, would have important implications for several developing countries. Present trends in that country point to some reduction in the number of petrochemical firms. At the same time, there is a shift from bulk chemicals to products of higher quality and with greater value added content. This "rationalization" may be attributed to *(a)* the shortage and rising cost of feedstock and *(b)* competition from other chemical exporters for Asian markets (mainly firms in the United States and Europe, but also in the Republic of Korea). Rationalization of the domestic chemical industry represents only one side of this apparent strategy. Equally important is Japan's active participation in joint ventures with developing countries. The high costs of pollution control and the desire for access to capacity located in countries where feedstock costs

[26]To date, the need for government initiatives in restructuring the chemical industry can be attributed to the exogenous factors mentioned above (energy and environment), to investments that later proved to be ill-timed because of shifts in demand, and to the rapid development of chemicals in the centrally planned economies, mainly through buy-back deals with western contractors. Substantial production and export of chemicals by producers in developing countries has yet to be a factor; it may well affect the developed countries' approach to restructuring in the 1980s.

are less than costs of Japan's imports of oil and naphtha are considerations spurring the industry's internationalization.

Japan was perhaps harder hit by the rise in feedstock costs than any other developed country. In 1970, the proportion of raw material costs in total production costs of its petrochemical firms averaged 64 per cent; by 1975, the figure had risen to 84 per cent.[27] Not only did this hamper the ability of Japanese firms to compete for Asian export markets, but it prompted a move towards self-sufficiency in developing countries that had experienced shortages and rising prices of their imports of intermediates, resins and synthetic fibres.

Some observers also argued that pricing policy decisions in other areas artificially boosted feedstock costs. The production of naphtha, kerosene, fuel oil, petrol and other products is based on cracking the same barrel of crude oil. The desire to maintain low costs for rural household heating (mainly by kerosene) and power generation (fuel oil) meant that the price of some other product would have to be raised. Consequently, the cost of feedstock rose by proportionately higher amounts than the prices of adjustment in energy.

The new emphasis on joint ventures results from the decision to relocate production close to the sources of supply of the raw materials. Joint ventures with the Republic of Korea, Saudi Arabia and Singapore are only a few examples. Much of the production (ethylene, polyethylene and other derivatives) is earmarked for export to Asia, particularly to Japan.

The approaches of Governments and firms in other developed countries are not so clear cut. The evidence suggests that there is no particular priority attached to siting new production facilities near supply sources. There is some trend towards rationalizing the industry's structure. For example, in the United States the number of new entrants fell from 60 in the period 1967-1969 to 20 in 197[illegible]-1975.[28] Companies have also reduced their product range, concentrating on the most profitable lines.[29]

The European and North American chemical industries face somewhat different problems and operate in a regulatory environment different from that governing the Japanese firms. In Europe, analysts see over-capacity as a major problem that will influence the industry's development through the early 1980s. They attribute the problem to over-investment in the mid-1970s, sparked by an "artificial boom" in demand in 1973-1974 following supply shortages. Production of polypropylene provides a good example of the consequences. In 1973, there were 12 EEC producers with a capacity of 600,000 tons per annum. Only five years later, there were 16 producers with a total capacity three times the level of 1973.[30] The general problem of over-capacity has prompted occasional charges of dumping as firms have attempted to maintain rates of capacity utilization by exporting marginal production to

[27] Rising feedstock prices were not the only factor, however. The rising value of the yen made imported naphtha much more expensive. By the late 1970s, the domestic price of naphtha was as much as 9,300 yen per kilolitre above the European price. See *Far Eastern Economic Review*, 18 April 1980, p. 46.

[28] In the period 1976-1978 the number rose to 30, although this was mainly a result of takeovers and the entry of European firms into the United States market.

[29] One United States-based firm reported that, in the period 1974-1979, it stopped production of 51 products with annual sales of $400 million.

[30] *The Economist*, Chemicals Survey, 7 April 1979, p. 13.

neighbouring countries at cut-rate prices. This has led to calls for a European cartel, although a more effective solution would be to restrain investment.[31]

There does appear to be a general trend (by both European and North American firms) to invest in the United States market. The trend may reflect the opinion of the United States firms that the rapid growth of European chemical markets in the 1960s and 1970s will slow down in the 1980s. It may also have stemmed from the assumption that exports of chemicals from the United States would continue to improve in competitiveness—an assumption that was partially obviated by the United States Government's decision to discontinue the preservation of artificially low prices for feedstock.

A similar line of reasoning may explain the European move into the United States. However, other factors are also relevant. First, traditional export markets will decline as countries such as Austria, Greece, Norway, Portugal, Spain and Turkey extend their own industries and move into consumer-oriented products. Second, European producers in countries with hard currencies (e.g. the Federal Republic of Germany and Switzerland) have an added incentive to locate new capacity abroad. Third, as chemicals become more service-oriented, the need to maintain close contact with customers increases and leads firms to invest in their major foreign markets.

Figure III indicates production trends in the period 1958-1975. The developing countries made substantial gains during this period; their share in world production of industrial chemicals, refining and petroleum products tripled. Most of this growth may be attributed to additional refining capacity, however, rather than to the production of chemicals and petrochemicals. The developing countries' share in related products (rubber and plastic) also increased significantly. Production in the centrally planned economies fluctuated during these two decades without exhibiting a definitive trend. The major shifts occurred in the developed market economies, whose shares of both chemicals and related products declined. These changes were clearly unfavourable to countries of North America; in Europe, the shares of world production in both product categories rose between 1958 and 1979.

Even at such an aggregate level of discussion, the long-term consequences of restructuring are evident. The spread of new industrial capacity away from North America to Europe was the main feature of this process. It is also evident from the discussion, however, that this shift has now largely run its course. In fact, the share of North America in world chemical production may rise slightly in the 1980s. There seems to be little question that, in the 1980s, the shares of the developing countries in world production in chemicals and related products will rise and that these gains will be mainly attributable to increased production of petrochemicals (rather than petroleum refining).

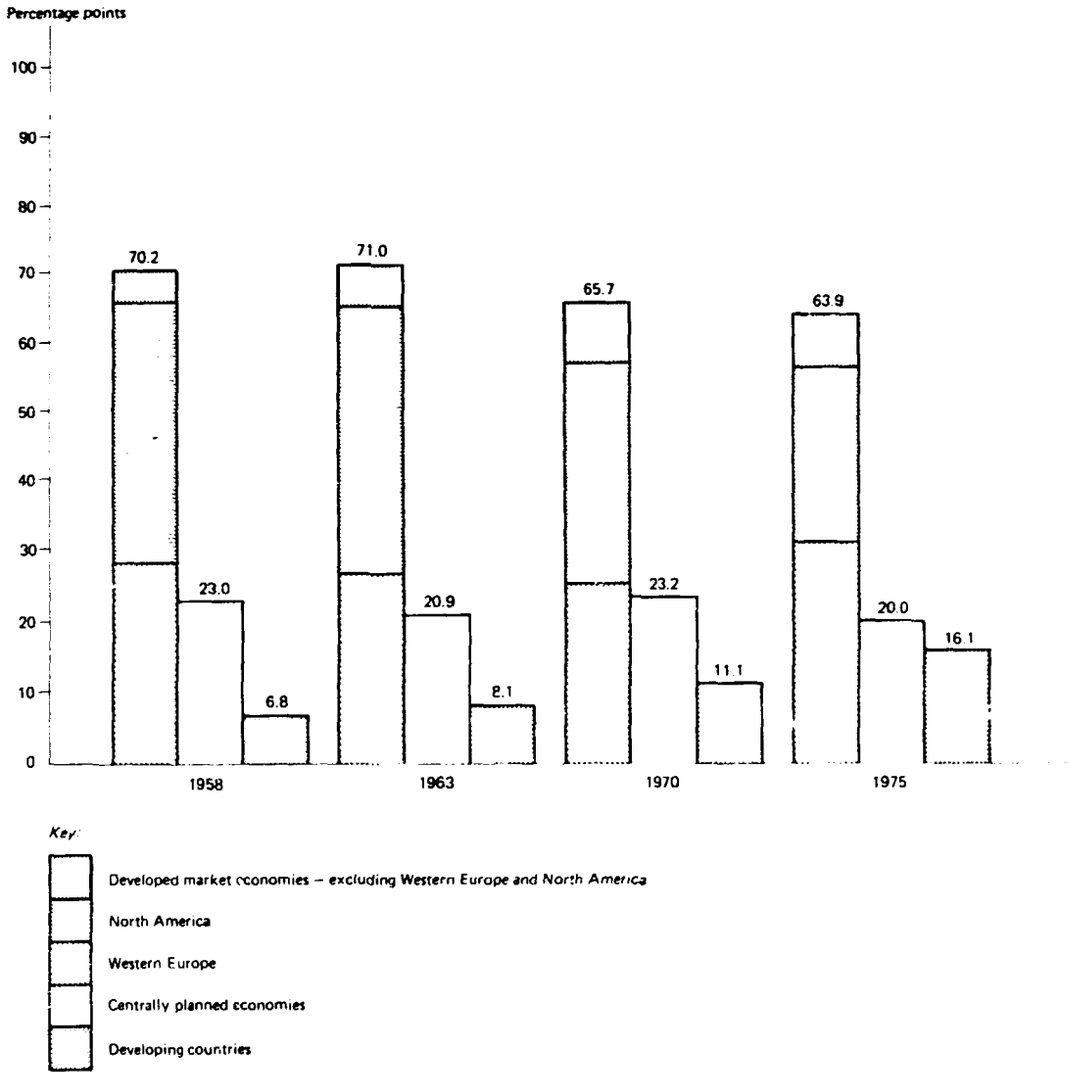
Trade performance and trade policy

Historical and anticipated shifts in production capacity significantly alter patterns of trade and trade policies. In the period 1929-1959 the volume of world trade in chemicals increased more rapidly than that of any other main

[31] Rising feedstock costs will make dumping a less attractive outlet as variable instead of fixed costs become more significant.

Figure III. Share of ISIC division 35 in world manufacturing value added, by economic grouping, selected years

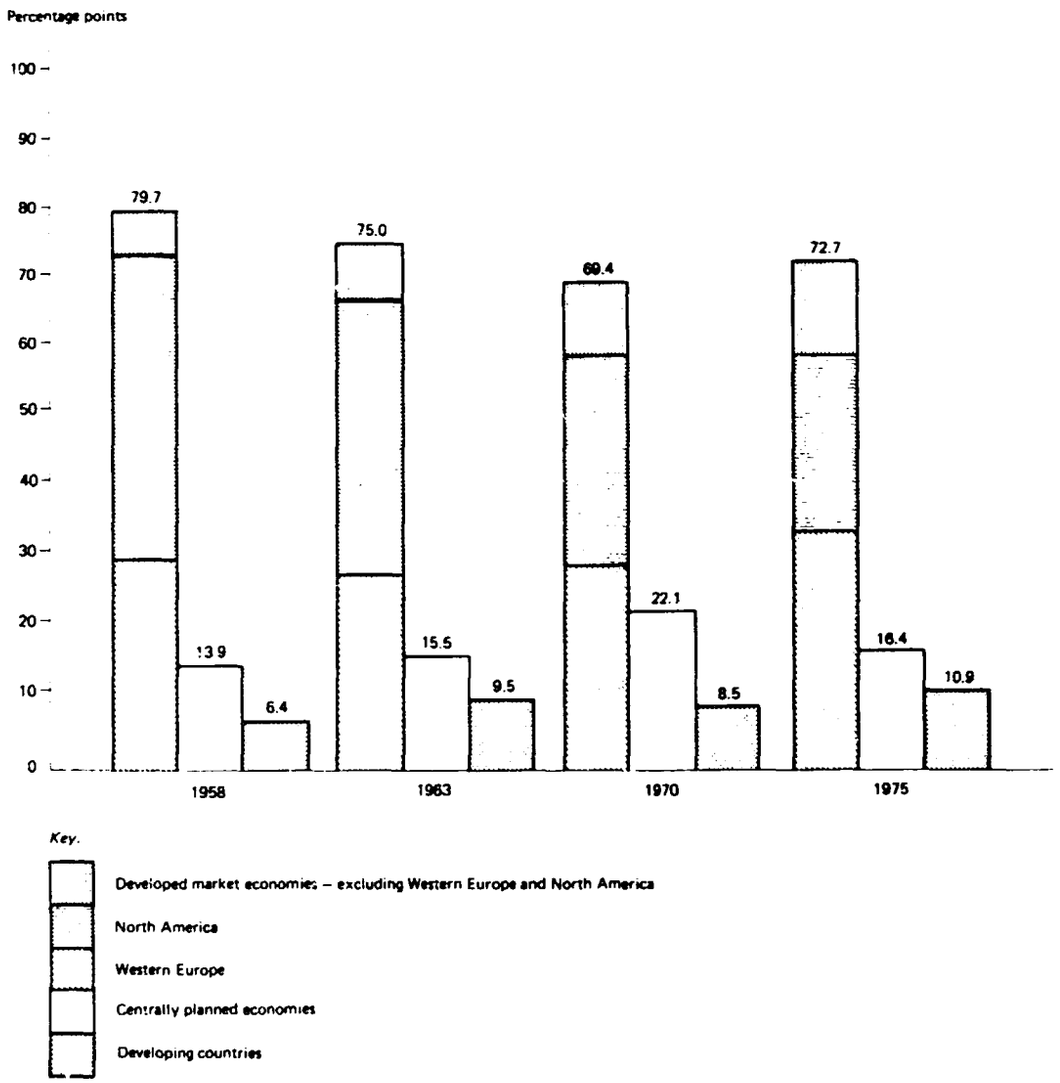
A. Chemicals and chemical, petroleum and coal products (ISIC 351 to 354)



Source: Based on data supplied by the United Nations Statistical Office and UNIDO estimates.

Figure III (continued)

B. Rubber and plastic products (ISIC 355 and 356)



Source: Based on data supplied by the United Nations Statistical Office and UNIDO estimates.

product group.[32] Obviously, changes in the composition of production, production processes and industrial policies have important consequences for trade.

The extent to which the developing countries have participated in trade in world chemicals has been marginal (see table III.2). Their share of world exports in 1978 was roughly the same as in 1955, and it has declined since 1974. Economic explanations for disappointing trade performance are traditionally based on two interpretations. One is a demand-deficiency hypothesis, which attributes slow growth in exports mainly to factors relating to international demand.[33] The other interpretation may explain performance in terms of supply constraints. A method of evaluating the importance of these two interpretations in explaining the developing countries' performance in the export of chemicals is the constant market-share analysis. Such an analysis distinguishes between four different factors, each of which may alter export performance. External or demand-related effects include *(a)* the growth of world demand (i.e. growth that may be attributed to a general increase in world trade in chemicals) and *(b)* a "market-composition effect", which takes into account that each region's export performance depends partly on the demand for chemicals among its major importing markets. Two internal or supply-related effects are considered. One is a "commodity effect", which occurs when some countries specialize in exporting products for which demand is buoyant; these countries benefit compared with others exporting mainly products for which demand has grown slowly. The second internal effect measures "competitiveness" as a residual representing the impact of price and non-price factors on export performance.[34]

TABLE III.2. SHARE OF DEVELOPING COUNTRIES IN WORLD EXPORTS OF CHEMICALS, SELECTED YEARS

(Percentage)

Year	*Share of developing countries*
1955	5.08
1960	3.99
1964	4.22
1968	4.24
1971	3.88
1974	6.23
1975	5.37
1976	5.26
1977	5.90
1978	5.05

Source: R. Banerji, "The export performance of less developed countries: a constant market share analysis", *Weltwirtschaftliches Archiv*, Band 110, 1974, p. 451 and United Nations, *Monthly Bulletin of Statistics*, July 1980.

[32] A. Maizels, *Growth and Trade* (London, Cambridge Press, 1970), p. 166.

[33] Examples of such factors are a low income elasticity of demand, shifts in the composition of industrial output towards goods with a lower import content, restrictive import policies etc.

[34] For further discussion, see E. Learner and R. Stern, *Quantitative International Economics* (Boston, Allyn and Bacon, 1970), pp. 171-183, and *World Industry since 1960: Progress and Prospects* (United Nations publication, Sales No. E.79.II.B.3), pp. 160-165 and annex III.

The figures in table III.3, based on two-year averages for the periods 1970-1971 and 1977-1978, indicate the relative importance of the external and internal effects described above and the actual increases in exports of chemicals during the period. It is apparent that world demand largely accounts for the expansion of the developing countries' exports. Internal, or supply related, effects explain a lesser proportion of export growth. The estimates of the market-composition effect suggest that the developing countries have made little or no headway in penetrating those markets where growth in the demand for chemicals has been most rapid.[35] They have improved their position somewhat by switching to types of chemicals for which foreign demand was relatively buoyant (a commodity effect). With the exception of Africa, most export gains of developing country producers can be attributed to improvements relating to price and other competitive factors (the competitive effect). An overall impression is that producers in OPEC countries, in South and East Asia and, to a lesser extent, in West Asia, have improved their export performance through supply-related adjustments. Growth in foreign demand, however, has tended to be a more important stimulus, not so much because of the magnitude of foreign demand but because supply effects have been comparatively small.[36]

For the developed countries, trade in chemicals is closely related to several of the aspects raised in the preceding section. Over-capacity in a number of developed countries has probably enabled producers to respond readily to foreign demand for chemicals. In fact, some producers probably placed a high

TABLE III.3. ANALYSIS OF THE DEVELOPING COUNTRIES' EXPORTS OF CHEMICALS (SITC 5) TO THE WORLD, 1970-1971 to 1977-1978

Developing region or group	External factors		Internal factors		Actual increase in exports
	World market effect	Market-composition effect	Commodity effect	Competitiveness effect	
	Percentage				Millions of dollars, f.o.b.
Africa	115.5	1.2	13.3	—30.0	328
Latin America	75.8	—0.7	8.7	16.2	1,563
South and East Asia	55.7	6.5	6.4	31.3	1,319
West Asia	52.5	10.7	6.0	30.8	475
OPEC	41.1	1.0	4.7	53.1	496

Source: Calculated from United Nations, *Monthly Bulletin of Statistics.*

Note: For an explanation of the method of calculation, see UNIDO, *World Industry since 1960: Progress and Prospects* (United Nations publication, Sales No. E.79.II.B.3), chapter V and annex III.

[35]This has been a long-term tendency in developing countries. As early as 1955 almost 70 per cent of their chemical exports were destined for markets that were declining relative to world demand. The comparable figure in 1970 was 79 per cent. See R. Banerji, "The export performance of less developed countries: a constant market share analysis", *Weltwirtschaftliches Archiv*, Band 110, 1974, pp. 462-463.

[36]The actual increase in the developing countries' exports of chemicals was obviously limited as suggested by the calculations in table III.2. For example, Japan's actual increase in chemical exports in figures comparable to those shown in table III.3 was $3,322 million, roughly equal to the total for all developing countries.

priority on expanding exports as a means of alleviating their capacity problems.[37] In any case, trade between the developed countries, particularly trade between the United States and EEC, has caught the attention of observers in recent years.

Several national and regional policy initiatives are motivated by defensive or competitive considerations, which are often the result of the rapid changes in material costs and market conditions described previously. Similarly, policy decisions with important trade consequences cannot be easily separated from trends in product development and long-term, investment strategy.

At the centre of the debate is the question of imports of low-cost chemicals into EEC, particularly from the United States. As indicated earlier, some observers contend that United States producers enjoy significant cost advantages derived from their access to cheap feedstock and energy used in chemical plants.[38] This is seen as a hidden subsidy because of the gradual relaxation of price controls on internal gas and oil prices in the United States. The response, to date, has been selected appeals to the EEC Commission to provide additional protection and prevent possible "dumping".[39]

The immediate threat is the prospect of special import duties on products such as man-made fibres and petrochemicals similar to the 17 per cent duty recently applied to imports of acrylic fibres.[40] One complication is that there may well be structural reasons—fewer big producers operating in a large, homogeneous market in a field where economies of scale are significant—that contribute to the lower costs of imports. Another is that the question goes beyond the immediate subject of chemicals and raises the prospect of potential trade reprisals in other areas such as steel and textiles. In view of these complications, one compromise proposed recently was to seek an "industry restraint deal" that would limit further cheap imports whether they involve dumping or not.

Extensive information on barriers to trade in chemicals is not available. This is particularly true for various non-tariff barriers (NTBs) and voluntary export restraints (VERs) whose significance is stressed in this chapter.[41] A recent effort has been made by UNCTAD to improve the information available. Table III.4 gives some of the results of its inventory of trade barriers. The percentages

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[37]Such highly capital-intensive firms as are found in chemicals are heavily dependent on volume. A drop in demand may make a big dent in profits if it leads to lower (and thus more costly) rates of utilization. Hence, firms experiencing a fall in domestic demand try to compensate by raising their exports even if this means that they must drastically drop the prices of these exports.

[38]For example, in the fourth quarter of 1980, the United States price of naphtha was said to be $50-$70 per ton less than the European price. In the case of ethane, the gap was $160 per ton. The United States commitment to do away with all price controls on oil and natural gas could eliminate, or substantially narrow, any cost advantages.

[39]At present, as many as 18 dumping complaints are reportedly being prepared by European chemical producers. This would amount to almost one half of the number of cases normally dealt with by the Commission in a year on behalf of all manufacturing. See *Financial Times*, 24 June 1980.

[40]These anti-dumping duties were not directly linked to the question of feedstock price controls. Instead, the Commission held that United States companies were selling acrylic fibre in EEC at lower prices than at home.

[41]In the case of NTBs, a comprehensive inventory is particularly difficult to compile since many arrangements—voluntary export restraints (VERs), for example—may be negotiated by non-governmental bodies and are not officially recorded.

TABLE III.4. TARIFF AND NON-TARIFF BARRIERS ON SELECTED IMPORTS[a] OF CHEMICALS BY EEC AND THE UNITED STATES IN THE MID-1970s

Importer and origin of imports	Tariff range (percentage)/non-tariff barrier					Value of imports considered (thousands of dollars)	Imports in the sample as a percentage of total chemical imports (SITC 5) from each economic grouping, 1976
	Free	0-5.0	5.0-10.0	10.0-20.0	>20.0		
	As a percentage of imports in the sample						
EEC							
From developed countries	6.3/4.6	7.5/2.8	35.7/5.8	50.6/26.9	—	1 052 267	4.2
From developing countries	33.2/17.9	32.2/9.2	21.3/12.8	13.3/4.3	—	326 687	53.3
United States							
From developed countries	61.0/0.0	4.6/0.0	12.1/0.6	20.3/16.7	2.0/1.1	935 281	21.6
From developing countries	69.3/0.0	18.2/0.0	8.1/0.0	4.1/3.0	0.3/0.3	150 734	34.1

Source: Data on tariff and non-tariff barriers were supplied by UNCTAD, Manufactures Division; data for total imports of chemicals were taken from United Nations, *Commodity Trade Statistics*, Series D, various issues.

[a] Trade data refer to imports in 1976. Many of the trade barriers included in these calculations were applicable for that year but some refer to an earlier year in the 1970s. Thus, the size of the trade flows involved should be interpreted as indicative of the imports that are "sensitive" to trade restrictions.

refer to a sample of chemical products subject to a tariff. For each tariff range, the value of trade subject to some non-tariff barrier is also given. For example, 20.3 per cent of the United States' imports from developed countries were subject to tariffs ranging between 10 and 20 per cent. Of this same trade flow, 16.7 per cent of United States' imports were subject to some NTB.[42]

In the case of the United States, most chemicals included in the sample enter duty-free and unhampered by NTBs. Imports "sensitive to restrictions" amount to roughly 20 per cent of the sample, i.e. those products for which tariffs exceed 10 per cent and which also enter subject to an NTB.

The data for EEC are somewhat more complicated and therefore difficult to interpret. First, the coverage of the sample is small (4 per cent) in the case of imports from developed countries. Second, the percentages referring to NTBs sometimes overestimate the relevant proportion of imports. Information on NTBs applied by individual member countries is available, although the trade totals refer to all EEC imports and not to those of the country in question. Interpretations of these results are therefore very tentative. The data do indicate that a fairly large portion of chemical imports (at least those from developing countries) are subject to tariffs of up to 20 per cent. Also, NTBs seem to be frequently employed. In general, when NTBs are introduced, they are often extended to the trade of developing countries, although the magnitude

[42] The percentages referring to NTBs do not imply a level of protection but concern imports entering under a specific tariff heading which are also subject to other barriers whose restrictive effects may be substantially greater or less than the tariff in question.

of these chemical imports is probably not sufficient to prompt an initial "defensive appeal".

The effects of defensive trade policies may also spill over into other fields. Investment patterns—important in such a capital-intensive industry—have been influenced as firms have sought to get around the wall of import restrictions by investing in the markets of their major trading partners. Firms in countries with hard currencies have also lost some of their competitive edge compared with producers in countries with soft currencies. This circumstance, which is a result of exchange-rate policies, has led the former group of chemical producers to invest in countries with soft currencies.[43] Consequently, foreign investment, particularly in the United States, has risen at a greater rate than total investment,[44] thus also tempering the attitude of some countries towards new protectionist measures. European countries with the largest foreign investments in the United States market are not inclined to take steps that might start a trade war.

The spread of industrial capacity through more vigorous investment programmes in Austria, Greece, Norway, Portugal, Spain, Turkey and a like number of centrally planned economies will further alter trade patterns. Not only may established exporters lose part of their foreign markets as a result, but they may also face additional competition from these newer producers in their own home markets. The emergence of new potential export bases (including, in the future, some developing countries) provides a further reason for the prospective move of established producers into finer chemicals with higher value added content, fields in which their technological lead would provide them with a tangible competitive edge.[45]

One last policy with trade implications is that pursued by the Japanese in response to recent structural changes. The Japanese share of Asian exports has fallen in recent years, mainly because the country's chemical industry has proved particularly sensitive to energy price adjustments. At the same time, other exporters in North America and in the developing countries have forged ahead in Asian markets. The Japanese have responded in part by expanding overseas ties through joint ventures in the Republic of Korea, Saudi Arabia, Singapore and elsewhere. This step, which was also motivated by the rising cost of land and the scarcity of raw materials, will change the composition of trade in chemicals. Japan's imports of feedstock supplies will be replaced by imports of more refined products, while its exports will have a greater share of speciality chemicals.

The overriding impression gained from the foregoing discussion of production and trade is that the 1970s was a period of dramatic change in relative production costs, product development, patterns of trade and policies. Clearly, this period of flux will continue into the 1980s and, as it does, the

[43]For example, chemical groups in the Federal Republic of Germany have argued that their labour costs in 1979 were roughly 28 per cent higher than those in the United States. Hourly costs were $13.20 compared with $10.32 in the United States. This gap was partially owing to the behaviour of the two currencies' rates of exchange. (Calculations here were based on an average exchange of DM 1.83 per dollar in 1979.)

[44]Other reasons for the rise in foreign investment pertain to structural characteristics and are referred to on p. 122.

[45]Examples of these speciality chemicals are agrochemicals, pharmaceuticals, and specialized plastics.

comparative advantages of individual countries in the production of various chemicals will continue to change accordingly.

In order to determine the directions of change in comparative advantage, a more detailed analysis of export performance was carried out. For this exercise, a country's relative export performance in specifically defined product categories was taken to indicate its "revealed" comparative advantage (RCA). To gain some insight into the directions in RCAs, estimates were made for 1966-1967 and 1975.[46]

Table III.5 summarizes the results of an investigation of trade in 37 chemical products identified at the most specific level of disaggregation available.[47] The RCAs are expressed as an index comparing the share of a country with the norm of world exports of each chemical. For example, an index of 110 would mean that a country's share in world exports of that product is 10 per cent higher than that country's share in world exports of all manufactures. The standard deviations indicate the extent to which each country's RCAs are dispersed in comparison with the world norm (equal to 100).

There was a clear upward trend in the number of chemical products exported by the developing countries during the 10-year period.[48] Argentina, Brazil, Mexico and Singapore exported nearly as many different chemicals as did France or the Federal Republic of Germany. However, among such specifically defined products, a high degree of diversification is not necessarily a prerequisite for a successful export programme. The United States, for example, was an extremely successful exporter of chemicals with only an intermediate number of product lines.

With very few exceptions, the mean value of the RCAs estimated for the developing countries was below 100, indicating that by comparison with world trade in the product, these countries had not yet achieved parity.[49] Estimates for some of these countries (i.e. the mean values for Iran, Ivory Coast and Tunisia) proved to be highly volatile, in some instances as a consequence of the development process. For example, when firms move downstream into the

[46]Measurement of actual or theoretical comparative advantage is an empirical impossibility given the difficulties of accounting for all the factors influencing an industrial branch's comparative advantage and of actually estimating and comparing these factors between countries and branches. Instead, economists have suggested that the apparent or revealed trade performance of an industrial branch's trade pattern would serve as an adequate indicator of RCA in international trade. For examples and further discussion, see Bela Balassa, "Trade liberalisation and 'revealed' comparative advantage", *Manchester School*, vol. XXXIII, No. 2 (May 1965), pp. 99-120; "The changing pattern of comparative advantage in manufactured goods", *Review of Economics and Statistics*, vol. LXI, No. 2 (May 1979), pp. 259-266; Thomas G. Parry, "Trade and non-trade performance of U.S. manufacturing industry: revealed comparative advantage", *Manchester School*, No. 2, June 1975, pp. 158-172 and chapter II of this publication.

[47]SITC four- and five-digit definitions were used.

[48]The chemicals most frequently exported by developing countries included in the investigation were as follows: synthetic organic dyestuffs, natural indigo and colour lakes, varnishes, lacquers, water pigments, glycosides, glands and their extracts, medicaments, essential oils and resinoids, synthetic perfume, flavour materials and concentrates, perfumery and cosmetics, soaps, surface-acting agents, polishes, pastes and similar preparations, products of condensation (e.g. phenoplasts), modified natural resins, ester gums and insecticides, fungicides and disinfectants.

[49]Mexico, already an emerging force in the petrochemical field, was an exception. The country's mean values exceeded world shares in both periods.

TABLE III.5. DISTRIBUTION OF REVEALED COMPARATIVE ADVANTAGE IN EXPORTS OF CHEMICALS, IN SELECTED COUNTRIES AND AREAS, 1966-1967 AND 1975

Countries and areas	*1966-1967*			*1975*		
	Number of exported products	*Mean RCA index*	*Deviation from the norm*[a]	*Number of exported products*	*Mean RCA index*	*Standard deviation from the norm*[a]
Developing						
Argentina	31	64.3	132.1	32	86.9	247.8
Brazil	22	76.0	208.7	35	76.8	240.4
Colombia	15	82.2	114.1	30	62.5	126.0
Hong Kong	16	61.0	93.1	17	61.7	98.8
India	22	83.8	164.4	24	79.8	94.6
Iran	13	257.2	95.5	20	55.0	192.9
Ivory Coast	18	172.8	231.5	29	82.8	179.3
Mexico	19	143.2	209.3	35	158.4	371.3
Philippines	6	4.8	100.0	24	52.1	90.8
Republic of Korea	8	7.2	97.9	28	23.6	89.7
Singapore	35	74.6	143.3	35	53.3	103.7
Thailand	7	45.7	98.1	24	29.2	95.0
Tunisia	6	195.8	206.1	14	36.1	109.9
Turkey	4	78.3	107.0	18	122.4	373.0
Venezuela	8	1.9	101.5	26	3.3	99.0
Developed						
France	36	162.7	124.2	36	120.3	104.9
Germany, Federal Republic of	35	165.5	116.4	36	148.4	104.7
Greece	15	28.8	94.5	23	30.5	84.1
Japan	36	66.8	76.9	37	60.4	79.6
United States	25	112.2	58.2	25	111.0	104.4
Yugoslavia	31	93.4	89.1	30	83.5	101.7

Source: Based on data supplied by the United Nations Statistical Office.

[a]The standard deviation from the norm (DN) measures the dispersion of a country's RCA indices around the world norm 100, and is defined by the equation

$$DN = \left[\frac{1}{n-1} \sum_{j=1}^{n} (RCA_j - 100)^2 \right]^{\frac{1}{2}}$$

To allow for intercountry comparisons, the same 23 SITC subgroups were chosen for the calculation of each country's DN.

production of refined-oil products, the exports of basic chemicals, for which comparative advantages are greatest, are the first to be replaced by exports of products based on those chemicals but with a higher value added content. Thus, no clear trends emerge when figures are compared for the developing countries in the two time periods; the mean value of RCAs in some developing countries increased while others fell. The distinction between the two economic groupings is clear, however. Figures for most of the developed countries included in the table exceeded 100 per cent in both periods, while those for the developing countries were typically less than the world norm.

With regard to the standard deviations, high values indicate that the country's RCAs differ widely from those of world trade in chemicals. Typical values for the developed market economies are around 100 per cent or less. Thus, considering the two periods together, Japan's pattern compares most

closely with the world pattern (a standard deviation of 80 in 1975). That country also exported the largest number of chemicals (37) although its RCAs were typically low. These conditions may well be interrelated: substantial diversification in the production and export of chemicals may limit the "competitive ability" of the branch.

To conclude, long-term development in the chemicals field illustrates many interesting facets of the restructuring process. To date, many of these facets have pertained solely to policy, investment or trade issues involving only the developed countries. This characteristic is slowly changing, however, as developing countries become major producers or upgrade their existing operations and begin production of more sophisticated products. Given the "maturing nature" of this industrial branch, along with existing cost trends, the continued global spread of production facilities is desirable for reasons of increased specialization and efficiency. Closer contact between producers (and potential producers) in developed and developing countries is desirable if product development, investment plans and policies are to be realistically formulated for the 1980s and 1990s.

B. IRON AND STEEL

Recent trends

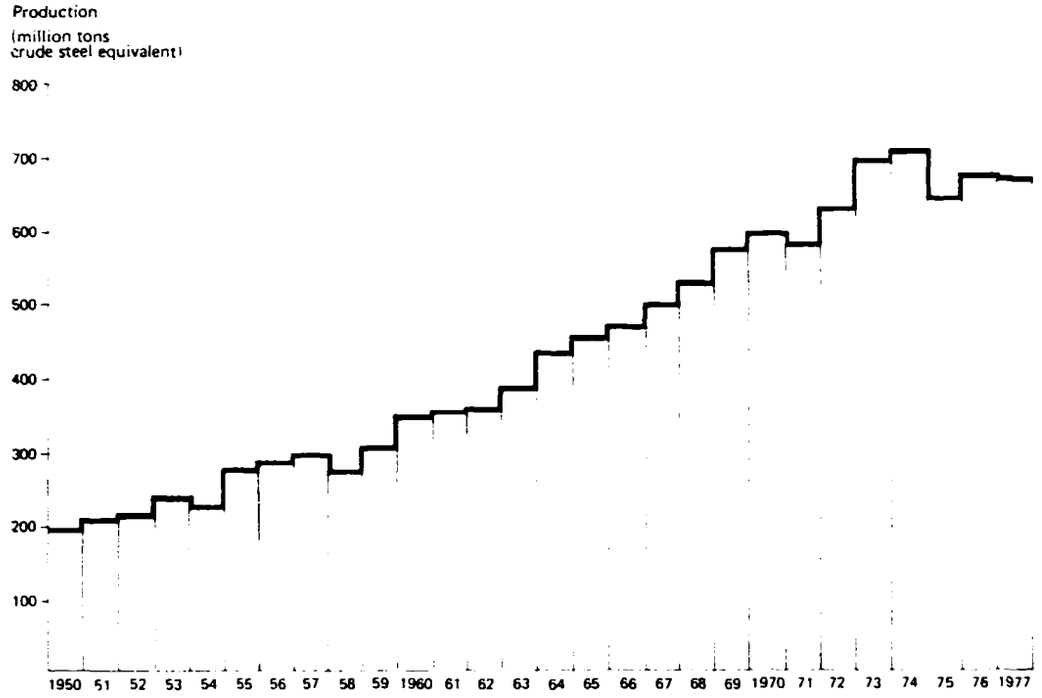
World consumption of iron and steel, measured in physical units, grew at a rate of about 6 per cent between 1960 and the mid-1970s (6.2 per cent in the period 1960-1965, 5.3 per cent in 1966-1970 and 5.4 per cent in 1970-1974). This phase of relatively steady growth was interrupted after 1974. Since this date, growth has been comparatively slow. In 1974, the world consumption of crude steel reached a new high of 709 million tons (see figure IV), but in the next year it dropped abruptly.[50] There was a slight upturn in the following years, although another drop was registered in 1977 (down 4 million tons as compared to 1976). Consumption reached 1974 levels by 1978, but it remained far below the levels suggested by an extrapolation of the pre-crisis trend.

Thus, the late 1970s were bleak years for iron and steel. The immediate reason was the drop in demand in steel-using sectors (automobiles, ship-building, machinery and equipment, construction etc.). Furthermore, various phenomena associated with the recession imposed new expenditures. Goods with a lower steel content were increasingly favoured over those with a high steel content. In this respect, the crisis may have precipitated several long-term changes in the pattern of consumption.

Although many methodological problems are involved in comparing growth trends, it is clear that the branch has expanded slowly by comparison

[50]The fall in consumption surprised the steelmen themselves. In October 1974, the Conference of the International Iron and Steel Institute predicted that production would rise in 1975 by 4.2 per cent over the level of 1974, to reach 740 million tons. Actually, production fell to 646 million tons. See UNIDO, "The world iron and steel industry; second study" (UNIDO/ICIS.89), p. 12.

Figure IV. World steel production, 1950-1977



Source: International Iron and Steel Institute, *World Steel in Figures, 1979*, p. 7.

with others. This generalization does not apply to fast-growing product groups such as speciality steels or to countries where growth has been rapid. A basic reason for the slow growth may simply be that the iron and steel industry is more mature than many other industrial branches. The growth process can conveniently be represented by an S-shaped (logistical) curve depicting a pattern where growth initially accelerates, later begins to slow down and finally levels off.

Two sets of circumstances suggest that steel production in many countries has now reached a "mature stage". Patterns of consumption have been altered largely through technical changes that have reduced the quantity of steel incorporated in traditional uses of steel, thus lowering the proportion of this product's inputs per unit of output.[51] New materials such as aluminium, plastics, highly resistant glass etc. have replaced steel in many traditional uses. The introduction of higher quality steels, such as light alloys, has led to a reduction in the quantity of steel required per unit of final product. And technical progress in steelmaking, such as continuous casting and improvements in rolling and finishing, has also reduced crude steel requirements per

[51] In the Federal Republic of Germany, the following reductions of steel consumption per unit of manufactured output occurred between 1970 and 1977: from 412 kg to 370 kg of steel per 1,000 kg of electrical machinery; from 873 kg to 668 kg of steel per 1,000 kg of shipbuilding output; from 612 kg to 557 kg of steel per 1,000 kg of rolling stock; from 883 kg to 783 kg of steel per 1,000 kg of nuts, bolts and similar products etc. See UNIDO, "Picture for 1985 of the world iron and steel industry" (UNIDO/ICIS.161, 10 June 1980), p. 18.

unit of finished steel. Finally, steel users have found new ways to economize on the quantity of steel needed by them; a current example is the design of lighter car bodies and engines.

Another explanation for the reduction in steel demand for traditional uses concerns changes in the composition of manufacturing output as economic growth proceeds. For many years modernization was closely identified with the widening use of steel as an industrial input. Steel contributed to the transformation of surface fleets, the creation of railways and the development of powerful and long-lasting machines. Today, the major growth industries (telecommunications, space and computers) are not intensive users of steel. Steel is no longer a growth industry, but depends on the strength of demand in other branches which are also losing ground by comparison with overall economic activity.

The general slow-down in steel consumption conceals important differences between various product groups and among different areas of the world. The outstanding feature of the intra-industry evolution is the shift in favour of high-quality steels at the expense of ordinary steels. In Japan, for instance, the consumption of high-grade and special steels in 1978 was 23 per cent above the 1973 level, while the consumption of ordinary steels declined by 15 per cent.[52] By using special steels manufacturers can reduce the weight and vulnerability to corrosion of their products. Furthermore, these products are able to withstand low temperatures (e.g. transportation of hydrocarbon in Arctic regions or the haulage of liquefied gas) and high pressures (as in the chemical industry). It is significant that, by 1980, Japan was expected to overtake the United States as the world's second largest steel producer after the USSR.

Different growth experiences in various countries and regions may be explained by a falling steel intensity, i.e. the stagnation of or decrease in steel use per unit of national output. This is not a general phenomenon, but it is typical of the more industrialized economies. Observers have attempted to relate the development pattern of steel production to growth in national product of market economies.[53] They note that beyond a certain level of development, corresponding roughly to "industrial maturity" (or, according to the International Iron and Steel Institute (IISI), when *per capita* income reaches $2,500 at 1963 prices), steel consumption tends to play a declining part in overall economic activity and in the country's expenditures. As development continues, the service sector's share in GDP tends to increase at the expense of the production of material goods, while investment gives way to consumption in the expenditure of national income. Since services and consumption are less steel-intensive than material goods and investment (especially non-residential private investment), the share of steel in output and income decreases.

Steel production is significant in few developing countries. In 1978, the six largest steel producers in millions of tons were: Brazil (12.1), India (10.1), Mexico (6.7), the Republic of Korea (5.0), Argentina (2.8) and Turkey (2.2). Together, these countries supplied 79 per cent of the steel produced by the developing countries. Brazil, apart from being the largest producer, was also

[52] S. Hosoki and T. Kono, *Japanese Steel Industry and its Rate of Development*, Paper for the Amsterdam Conference, September 1979; quoted in UNIDO, "Picture for 1985 . . .", p. 18.

[53] See International Iron and Steel Institute, *Steel Intensity and GNP Structure* (Brussels, IISI Committee on Economic Studies, 1974).

one of the fastest-growing, expanding at a rate of 12.7 per cent per year during the period 1974-1978. This pace was surpassed by the Republic of Korea with a yearly rate of 30 per cent for the same period.

When considered in terms of domestic steel requirements, there is a sharp contrast between two subgroups of developing countries. One comprises a small number of countries where steel consumption has expanded vigorously in recent years. These newly industrializing countries (NICs) share two characteristics: fairly rapid increases in *per capita* income, rising from very low to intermediate levels, and a development strategy that emphasizes rapid industrialization. Such countries have undergone substantial and rapid changes in their patterns of domestic consumption and production, particularly related to construction and the development of basic infrastructure, capital goods requirements and consumer durables. This type of structural change spurs the demand for steel. Furthermore, some of the NICs (e.g. Brazil and the Republic of Korea) have begun to export steel-intensive products such as automobiles. The consumption of steel is further increased by these indirect steel exports.

By contrast, in the second subgroup comprising far more countries, *per capita* steel consumption has stagnated. In these developing countries, the manufacturing sector still consists mainly of traditional industrial activities. They are too poor to invest a large portion of their income and, at the same time, consume significant quantities of durables per inhabitant.

In the centrally planned economies of Europe, steel consumption has grown at a steady pace compared with the rate of growth for other economic groupings. Accordingly, these countries' share in world consumption rose from 27 per cent in 1974 to 30 per cent in the period 1975-1978, largely at the expense of the developed market economies.

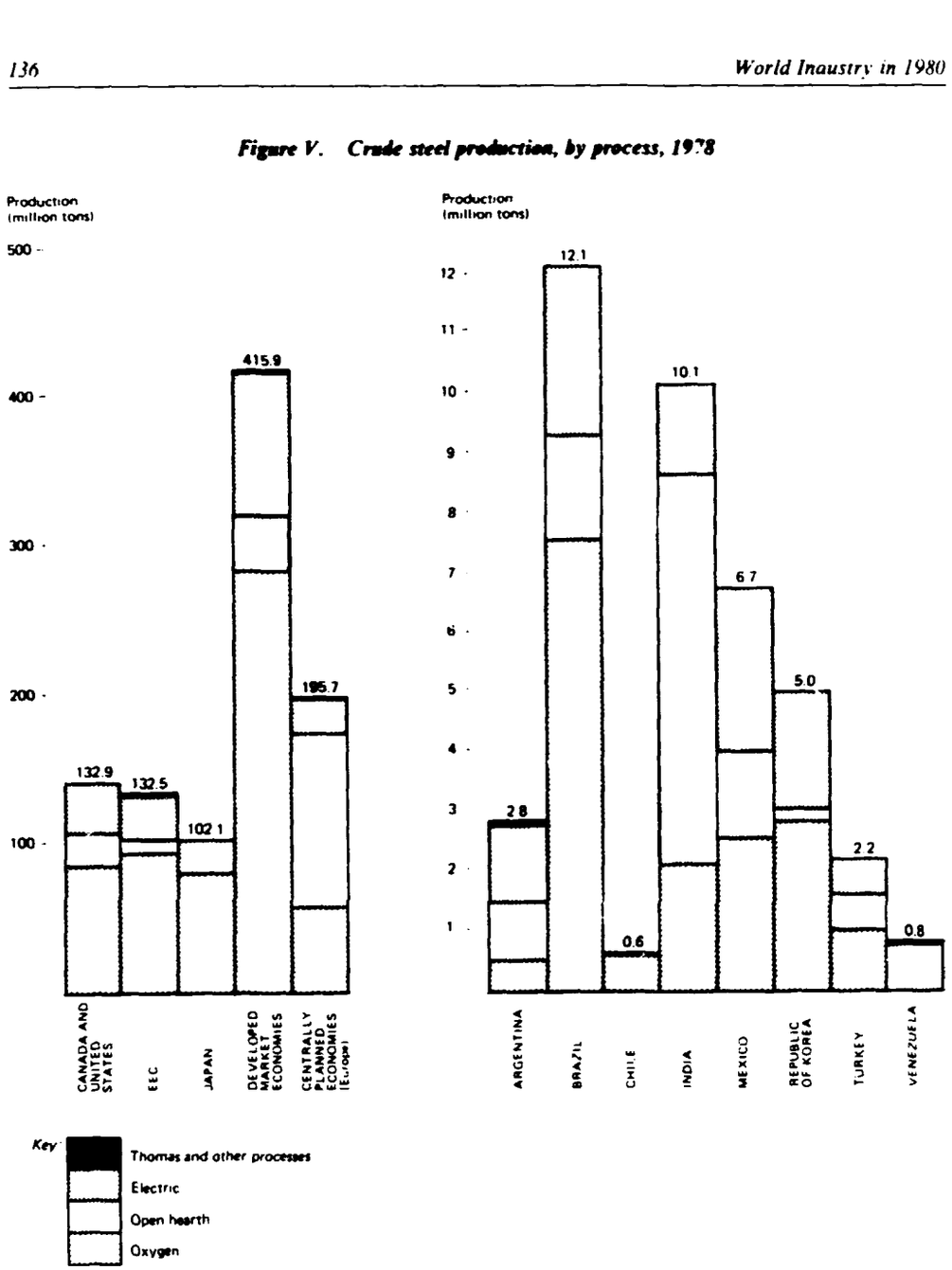
With regard to national and regional imbalances between steel production and steel consumption, the main areas with excess production are Western Europe (particularly EEC) and Japan. Exports and imports of the centrally planned economies are roughly balanced, while developing countries, together with China and the Democratic Republic of Korea have a trade deficit of approximately 32 million tons. The deficit of the United States amounts to 22 million tons.[54]

Although iron and steel is an industrial branch that is expanding slowly in terms of net output, its technology is by no means stagnant. Figure V indicates that the predominant steelmaking processes today are, first, blast furnaces with oxygen enrichment and, second, ultra high-powered electric furnaces using scrap iron to make steel. Thomas and Bessemer converters, along with open-hearth furnaces, are disappearing, having been phased out completely in Belgium, Japan, Luxembourg, the Netherlands and Norway.

Perhaps the most noteworthy innovation has been the adoption of continuous casting of molten steel directly into the form of slabs and billets, thereby bypassing the ingot stage and the necessity for hot-rolling operations. This method has resulted in a significant reduction of crude steel per ton of finished product and has been rapidly adopted by producers of various countries. In 1978, continuous casting accounted for 56 per cent of crude steel output in Denmark, 46 per cent in Japan, 41 per cent in Italy, 38 per cent in the

[54]International Iron and Steel Institute, *World Steel in Figures, 1979* (Brussels), p. 15.

Figure V. Crude steel production, by process, 1978



Source: International Iron and Steel Institute, *World Steel in Figures, 1979*, p. 7.

Federal Republic of Germany, 15 per cent in the United Kingdom and the United States and 10 per cent in the USSR.[55]

Before the slump in steel production, investment was motivated largely for reasons of economies of scale, and the expansion of capacity was rapid. Later, the emphasis in investment was on the rationalization of existing capacities and the use of the latest technological acquisitions. Rationalization has usually meant reductions in production capacity. Efforts have been made to incorporate improvements such as dry-quenching in coke production, controlled-temperature rolling and optimization of blast furnace operations. At the same time, an

[55] *Ibid.*, p. 8.

attempt has been made to develop a technology that would meet the demand for high-quality and speciality steels. As a result of these innovations, it is now becoming possible for producers to combine traditional bulk steelmaking with production of high-quality standard steels.[56]

Trade patterns and policies

Regional patterns of steel trade reveal substantial differences in net trade. In 1977, Japan and EEC had favourable trade balances of 33.2 million tons and 16.8 million tons, respectively. Most other regions recorded net deficits in their trade in steel products. In some cases, these deficits were substantial as in North America (15 million tons), Africa and the Middle East (12.9 million tons), and Latin America (5.6 million tons). The trade balance between the developed market economies, taken as a group, and the developing countries amounted to 27.4 million tons in favour of the former countries.[57]

Growth patterns since 1945 show a changing relationship between trade and production. Prior to 1974, steel exports expanded at an annual rate of 9.3 per cent, a rate less than that of world trade in manufactures but equal to that of trade in all products (see table III.6). After 1974, the growth of world trade in steel products was decidedly slower than that of total trade. As is usual in a phase of decreasing activity, world demand contracted more abruptly for basic materials and intermediate inputs than for finished manufactures. Although the growth of steel exports slowed more than trade in other products, the trade-production relationship continued to remain constant with exports expanding more rapidly than steel production.

Another illustration of the growing trade bias of steel is provided in table III.7. The share of exports in world steel production rose steadily starting from about 11 per cent in 1950 to over 24 per cent in the mid-1970s. An explanation for the relationship is to be found in the economies of scale

TABLE III.6. GROWTH RATES OF THE VOLUME OF WORLD TRADE IN STEEL PRODUCTS, MANUFACTURES AND ALL PRODUCTS, AND PRODUCTION OF STEEL, 1967-1974 AND 1975-1977

(Percentage)

Period	*World trade*			*World production of steel products*
	Steel products	*Manufactures*	*All products*	
1967-1974	9.3	10.7	9.3	5.0
1975-1977	5.7	7.8	7.4	2.1

Source: Based on figures published in International Iron and Steel Institute, *World Steel in Figures, 1979*, pp. 13-14.

[56]The new methods and processes include rolling at controlled and low temperature. In particular, ladle metallurgy and secondary refining permit a high-volume production of quality and speciality steels. See UNIDO, "Picture for 1985 . . .", p. 43.

[57]Figures based on International Iron and Steel Institute, *World Steel in Figures* . . ., p. 15.

TABLE III.7. WORLD STEEL TRADE AS A PROPORTION OF WORLD STEEL PRODUCTION, 1950-1977

(Million tons crude steel equivalent).

Year	*Exports*[a]	*Exports as a percentage of world production*
1950	20.5	10.7
1955	34.0	12.6
1960	52.7	15.3
1965	78.5	17.2
1970	117.5	19.7
1971	125.5	21.5
1972	133.1	21.1
1973	147.4	21.1
1974	169.6	23.9
1975	147.7	22.9
1976	162.8	24.1
1977	165.1	24.5

Source: International Iron and Steel Institute, *World Steel in Figures*, 1979, p. 14.

[a] including intra-EEC and intra-CMEA trade.

associated with steelmaking. These encourage long production runs of steel goods embodying specific characteristics. Trade takes on added importance because of the variety of characteristics desired by steel users on the one hand, and economies in specialization which limit the specifications produced, on the other hand. Thus far, the post-war evolution of economic and technical factors has tended to enhance the role of scale economies in the localization of steelmaking. While transport costs may offset the benefits of the economies of scale for the foreign producer, thus hindering trade, innovations made since the Second World War have led to a drastic drop in the real cost of transport. Tariffs and other barriers act on trade in a fashion similar to transport costs by increasing prices and reducing the advantage of specialization. Here, again, the downward trend has probably helped to promote more trade in steel products.

In addition to economies of scale, product differentiation and favourable circumstances for trade expansion (reductions in transport costs and tariff barriers), the emerging specialization may also have contributed to the trade-production relationship. In recent years, signs of saturation of the domestic market started to appear in more advanced industrial economies while consumption expanded in the newly industrializing countries. Thus, consumption increased more rapidly in importing than in producing countries. As economies of scale tend to give an advantage to capacity expansion rather than to "greenfield" plants, trade serves as a way to adjust the gap in consumption.

There are, of course, limits to which cost reductions achieved through economies of scale can be pursued. As world consumption grows, the opportunities for new producers will increase. Indeed, production has grown faster than consumption in the newly industrializing countries. Thus, economies of scale have not been so important that trade has been the only or even the most efficient way of offsetting the gap in consumption. New producing

countries have emerged and some—e.g. Australia, the Republic of Korea, South Africa and Spain—have become significant exporters.

Apart from economies of scale, the absolute increase in world demand for steel is not the only other factor explaining the growing number of new producers. As real income *per capita* increases, the demand for steel products becomes more diversified and product differentiation among producers is common.[58] It follows that the number of producers that can efficiently operate also increases because of the economies to be derived from limiting the characteristics of the products made in given installations.

The growth of exports, coupled with the structural trends referred to above, has prompted measures to restrict trade, especially among the developed market economies. Initially, these measures took the form of voluntary export restraints (VERs).[59] Such measures covering special steels were originally negotiated between Japan and the United States and Japan and various member states of EEC. However, as the slump continued, EEC entered into similar agreements with Brazil, Indonesia, Mexico, the Republic of Korea, South Africa etc. There is now mounting pressure in several countries to generalize VERs dealing with trade in steel and to turn them into orderly marketing arrangements.[60] Under these arrangements the exporting country agrees to restrict its exports to specified levels in order to avoid the threat of serious injury to competing producers in the importing country. Such arrangements have been negotiated by the United States with Canada, Japan, Sweden and EEC for stainless and alloy tool steel, and by EEC with Japan and the Republic of Korea for carbon steel.[61]

Trade restrictions such as VERs and orderly marketing arrangements have made entry difficult for new producers even if they have not been explicitly included in the arrangement. For example, the orderly market arrangement negotiated in 1976 by the United States with Canada, Japan, Sweden and EEC stipulates industrial quotas for these exporters and a global quota for third countries which can participate on a first-come, first-served basis. Argentina received a share in this global quota but, in July 1977, a special share was assigned to Austria, thus reducing the share given to Argentina. Since then, Argentina has tried without success to obtain a special quota of 800 tons, an increase of the global quota or a VER agreement.[62]

The VERs and orderly marketing arrangements limiting trade in steel have reportedly been bypassed by trans-shipments via third countries. In any case, as the slump in demand for steel persisted, the United States producers started filing anti-dumping complaints against foreign suppliers selling below "fair

[58] According to IISI, a group of 30 world steelmakers has introduced more than 300 new steel products in the last two years. See *Financial Times*, 22 May 1980.

[59] For a general discussion of VERs and orderly marketing arrangements, see chapter I of this *Survey*.

[60] While voluntary restraints are usually decided upon and operated by the exporters themselves, in the case of orderly marketing arrangements government intervention is explicit and formal, with specific agreements negotiated between exporting and importing countries.

[61] UNCTAD, "Growing protectionism and the standstill on trade barriers against imports from developing countries" (TD/B/C.2/194, 21 March 1978), p. 9.

[62] CEPAL, "Casos recientes de medidas proteccionistas aplicadas a exportaciones de países latinoamericanos" (E/CEPAL/L.182, 19 October 1978), p. 2.

value".[63] With the worsening of the steel crisis, the United States and EEC resorted to a number of rescue measures intended to provide a breathing space for their steel producers to restructure in an orderly fashion. Some of the measures adopted introduced new trade restraints. Early in 1978, the United States set up a "trigger price mechanism" which established a minimum price for its major carbon steel imports. The trigger prices were based on Japanese production costs which were thought to be the lowest. If imports of a given steel product entered the United States at prices more than 5 per cent below this bench-mark, an investigation could be initiated. During the investigation period the imports involved had to be covered by a bond equivalent to the estimated duties that would be due if the charges were substantiated. The trigger price mechanism apparently reduced foreign competition. The president of the United States Institute for Imported Steel declared that United States "imports actually dropped in 1979 in terms of tonnage and percentage of market and that this was largely the result of the trigger price system. . .".[64]

Nevertheless, the United States steelmakers believed that the mechanism, based as it was on low Japanese costs, allowed European producers to sell with impunity below production cost on the United States market. In March 1980, one United States steel producer filed anti-dumping complaints against steelmakers of seven EEC member states, relying on legislation other than the trigger price mechanism. As the charges ignored the trigger price mechanism, the administration temporarily suspended use of the measure.[65] In October 1980, new trigger prices were announced which, on the average, were about 12 per cent higher than those existing in the first quarter of 1980. In return, United States producers withdrew their anti-dumping complaints.[66] It is not yet clear how this new measure will cope with steel exporters in Argentina, Brazil, India, Mexico, the Republic of Korea and other developing countries.

In EEC a different, though equally elaborate, approach to steel's structural problems has developed. The plight of steel producers in several member countries has led to direct government action. The United Kingdom nationalized most of its industry in 1968 with Belgium, France and Italy following suit a decade later. In these countries state ownership is based largely on historical precedents and represents a revival of the national and international steel cartels in Europe in the 1920s and 1930s. Today, the division between public and private ownership roughly matches the pattern of specialization. State-owned or partially owned firms produce bulk steel and rolled steel, while

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[63]The Trade Act of 1974 provides that fair value can be established from the "constructed value' of the product, meaning its cost of production at 85 per cent capacity utilization plus statutorily mandated minimum additions of 10 per cent for overhead and 8 per cent for profit.

[64]"Steel in the 1980s", *OECD Observer*, No. 103, March 1980, p. 5.

[65]K. A. Jones and I. Walter, "Industrial adjustment to competitive shocks: a tale of three industries", Paper submitted at the International Symposium on Industrial Policies for the 1980s, Madrid, 5-9 May 1980.

[66]This amounted to a compromise between United States steel producers and their Government. The original trigger price mechanism had been intended to avoid a trade war which the administration feared would result from anti-dumping suits. When it became clear that the dumping investigation would reveal extensive violations, a higher trigger price was proposed by the Government. Fines would otherwise have been extensive since some European producers were found to be selling at 60 per cent below production costs. See *The Economist*, 13 September 1980.

private firms make steel products as part of a bigger metalworking and engineering operation.

In 1977, EEC formed a producers' cartel known as Eurofer and adopted the Davignon plan to alleviate problems during the slump. The plan included mandatory minimum prices for virtually all steel products along with a reference price for imports. A steel product imported at a price below the reference price for its category was subject to a compensatory levy to be applied until anti-dumping procedures were completed. This reference price for imports could be waived in exchange for adherence to "voluntary" export restraints and EEC internal "guidance" steel prices.[67] Later, quotas were negotiated with the suppliers of 85 per cent of EEC's steel imports.

The objective of the plan was to create market stability, coupled with agreed targets for production of both crude steel and finished steel products. In return, producers committed themselves to reducing excess capacity. EEC funds for workers who were laid off and for re-housing were made available to assist this process. Although some countries reduced capacity, others were reluctant to do so. However, firms gladly accepted the aspects of the plan that lessened import competition.

Towards the end of 1979, the impact of the EEC measures was appraised in the following terms: "Thanks to the Davignon Plan, imports have been frozen at 10 per cent of the EEC market and prices have been boosted by 20-30 per cent since 1977".[68] As demand kept falling, it became more and more difficult to maintain artificially high prices, and, in 1980, the system of minimum price controls was abandoned while the voluntary guidance prices were ignored *de facto*. To avoid a scramble for market shares, Eurofer accepted a cut in production of crude steel of an average of 10 per cent in the second half of 1980. By mid-1980, however, the substantial drop in steel orders again foretold serious problems of over-capacity, persuading the European Commission to announce a 14.2 per cent reduction in capacity for the last quarter of 1980 compared with the same period in 1979.

The figures in table III.8, compiled by UNCTAD, are based on a sample of imported steel products into the United States and EEC in 1976. They give a rough idea of the size of the trade flows that are "sensitive" to protectionist pressures. A comparison with similar data for chemicals (see table III.4) shows that NTBs are used more frequently to restrict steel imports. The extent of trade restrictions may be considerable in view of this fact.[69] Over 45 per cent of the EEC imports from developed countries were subject to some NTB in the mid-1970s. The corresponding figure for the United States was 38 per cent.[70] Clearly, most NTBs have been applied to imports from other developed countries. However, exporters from developing countries are by no means exempt from such restrictions, which are likely to multiply if imports from developing countries rise in the future.

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[67] UNCTAD, *op. cit.*, p. 15.

[68] *The Economist*, 24 November 1979.

[69] As indicated elsewhere in this chapter, the "tariff equivalent" of an NTB is unknown. The actual restrictive effect on imports that enter a market unencumbered by other barriers such as tariffs can often be equivalent to tariffs of 30 to 40 per cent or more.

[70] Figures refer only to a sample of steel imports into the United States and EEC. Complete coverage was not available.

TABLE III.8. TARIFF AND NON-TARIFF BARRIERS ON SELECTED STEEL IMPORTS[a] BY EEC AND THE UNITED STATES IN THE MID-1970s

Importer and origin of imports	Tariff range (percentage)/Non-tariff barrier					Value of imports considered (thousands of dollars)
	Free	0-5.0	5.0-10.0	10.0-20.0	>20.0	
	As a percentage of imports in the sample					
To EEC						
From developed countries	43.6/2.4	5.6/4.7	42.9/37.3	7.9/0.9	—	5685016
From developing countries	84.8/7.4	3.3/2.9	8.7/7.9	3.2/1.8	—	2712699
To the United States						
From developed countries	17.7/0.5	30.2/11.2	41.4/22.3	10.7/4.2	—	5132421
From developing countries	61.4/0.3	23.6/1.7	13.1/6.4	1.9/0.6	—	1328068

Source: Data on tariff and non-tariff barriers were supplied by UNCTAD, Manufactures Division.

[a]Trade data refer to imports in 1976. Many of the trade barriers included in these calculations were applicable for that year, but some refer to an earlier year in the 1970s. Thus, the size of the trade flows involved should be interpreted as indicative of the imports that are "sensitive" to trade restrictions.

Intra-industry trade

Intra-industry trade is a phenomenon that has preoccupied industrial economists increasingly in recent years. It is particularly relevant to trade in iron and steel products. Briefly, the term refers to international trade in different products that satisfy similar needs.[71]

Several studies have attempted to explain intra-industry trade in general terms,[72] but the specific question of two-way trade in iron and steel has received only limited attention. Table III.9 summarizes the results of an analysis of intra-industry trade in various types of iron and steel products. The data shown refer only to the developed market economies, but a similar exercise was carried out for developing countries. In the latter case, only three countries, Malaysia, the Republic of Korea and Singapore, were found to have even modest amounts of intra-industry trade.[73]

[71]For present purposes, an "industry" is interpreted to be composed of producers competing in the production of the same set of commodities. An empirical definition of the term must, of necessity, be somewhat subjective. In general, economists accept as a working definition of intra-industry trade, data expressed at the SITC three-digit level of disaggregation. See, for example, H. G. Grubel and P. J. Lloyd, *Intra-Industry Trade. The Theory and Measurement of Trade in Differentiated Products* (London, MacMillan Press, 1975), chap. 1.

[72]See, for instance, Hofbauer and Chilas, who argue that the main source of intra-industry trade is the reciprocal tariff concessions conceded at the industry level by groups of countries that trade within the bloc and discriminate against other countries. G. C. Hofbauer and J. C. Chilas, "Specialization by industrial countries: extent and consequences", in *The International Division of Labour, Problems and Perspectives*, H. Giersch, ed., International Symposium, Tübingen, 1974, pp. 3-38.

[73]From a total of 292 observations for trade at an SITC five-digit level of specification, only 24 indicated any intra-industry trade.

Table III.9 shows a substantial amount of intra-industry trade for the developed market economies in 1976. No precise pattern appears to exist for the degree of processing: intra-industry trade occurs in lightly processed items such as pig iron and shaped parts and pieces. The countries where intra-industry trade was significant were France, the Federal Republic of Germany,

TABLE III.9. INTRA-INDUSTRY TRADE IN PRODUCTS OF IRON AND STEEL IN THE DEVELOPED MARKET ECONOMIES, 1976

Product group	*SITC*	*Number of countries*	*Index of intra-industry trade*	
			>0.25	*>0.50*
Pig iron, iron and steel powders, ferro-alloys	671	25	14	11
Pig iron, including cast iron	6712	22	8	5
Iron and steel powders, shot and sponge	6713	20	10	6
Ferro-manganese	6714	15	4	3
Other ferro-alloys	6715	22	15	9
Ingots and other primary forms of iron and steel	672	25	14	10
Puddled bars and pilings, blocks, lumps	6721	10	5	4
Ingots of iron and steel	6723	19	11	6
Blooms, billets, slabs, sheet bars	6725	21	11	6
Iron or steel coils for re-rolling	6727	18	6	6
Blanks for tubes and pipes	6729	4	3	1
Iron and steel bars, rods, angles, shapes, sections	673	25	19	12
Wire rod of iron and steel	6731	23	13	10
Bars and rods, hollow mining drill steel	6732	22	19	15
Angles, shapes and sections, 80 mm or more	6734	21	9	7
Angles, shapes and sections, less than 80 mm	6735	22	13	6
Universals, plates and sheets of iron and steel	674	25	16	10
Universals and heavy plates, more than 4.75 mm	6741	22	16	11
Medium plates and sheets, 3 mm to 4.75 mm	6742	20	12	9
Plates and sheets, less than 3 mm, uncoated	6743	22	13	8
Tinned plates and sheets	6747	20	9	6
Plates and sheets, less than 3 mm, coated	6748	23	15	10
Hoop and strip of iron and steel	675	25	14	8
Rails and railway track construction material	676	25	9	6
Rails of iron or steel	6761	19	9	4
Sleepers and other railway track material	6762	21	9	5
Iron and steel wire, excluding wire rod	677	25	15	10
Tubes, pipes and fittings of iron and steel	678	25	19	13
Tubes and pipes of cast iron	6781	22	11	4
Tubes and pipes, other than of cast iron, seamless	6782	22	14	9
Tubes and pipes, other than of cast iron, welded	6783	23	18	15
High pressure hydro-electric conduits of steel	6784	15	7	3
Tube and pipe fittings of iron and steel	6785	23	20	15
Iron and steel castings and forgings, unworked	679	25	14	9
Iron castings in the rough state	6791	21	16	9
Steel castings in the rough state	6792	20	11	8
Iron and steel forgings	6793	20	12	9

Source: Compiled from data supplied by the United Nations Statistical Office.

Note: The index of intra-industry trade B was defined as follows:

$$B = \left[(X_j^i + M_j^i) - | X_j^i - M_j^i | \right) / (X_j^i + M_j^i) \right] \times 100$$

where M is imports, X is exports, j refers to the SITC product and i is the country.

Italy and the United States. Intra-industry trade was lower in smaller countries such as Austria, Belgium and Denmark, although such trade remained significant.[74]

One explanation for these results is that resource endowments may alter significantly the efficiency of a country's producers of finely differentiated products. For example, ready access to abundant supplies of high-grade iron-ore deposits can be important. Another likely explanation concerns the country's energy-pricing policies for industry. The cost of producing steel products that are more energy-intensive varies depending on such policies. Third, the existence of economies of scale in narrow product ranges may be sufficient to explain intra-industry trade. Domestic demand conditions and factor prices may also influence the pattern. For instance, high-income, urbanized countries, where steel is used in the construction of tall buildings and bridges, specialize in the production and export of shapes and qualities of steel required for that purpose. Similarly, automated lathes are demanded in countries with high capital-labour ratios, and their production is concentrated there.[75]

The foregoing discussion serves to point out that the plants, processes and products making up this industrial branch are extremely heterogeneous and that their location and production efficiency may depend on distinctly different sets of constraints. Blast furnaces, rolling-mills, the production of speciality steels etc. may all be considered to be separate "industries" within the broader and more conventional definition.[76] At the national level, this observation seems important, since it indicates the need for developing countries to specialize eventually in narrow product ranges in which they can realize comparative advantages. In an international or global context, the increasing specialization of steel producers would conform to the existing ideas of restructuring and could be expected to contribute to an overall increase in efficiency.

Redeployment

The global dispersion of steel-producing capacity has been continuing since the Industrial Revolution. Today, growth is most rapid among the NICs (e.g. Brazil, Mexico and the Republic of Korea). These countries have now entered a phase of industrialization in which steel consumption increases rapidly. Their steel-consuming industries are growing in importance because of favourable shifts in the pattern of domestic demand and steady gains in their competitive ability. Several of the NICs are also apparently emphasizing indirect steel exports—automobiles, ships, capital goods—as an alternative to

[74]Curiously, Japan's trade in steel products revealed little or no intra-industry trade. It is tempting to attribute this result to that country's relative geographic isolation. However, Australia was found to have a significant amount of intra-industry trade, although the same negative factor would be applicable.

[75]Grubel and Lloyd, *op. cit.*, pp. 100-101.

[76]The newer technologies of integrated steel production may eventually blur this distinction between "industries", however.

steel itself."[77] This alternative, which is pursued by the Japanese, generally yields greater returns. Export successes in these products will do much to spur domestic steel production while avoiding the restrictive environment in foreign markets.

Although iron and steel is a particularly capital-intensive branch, other characteristics may make it a possible choice for countries at an intermediate level of development. Among the common steels, technology is readily available. To some extent, large, modern plants can offset the lack of an experienced labour force. As steelmaking uses relatively few workers (4,000 to 6,000 workers per million tons produced), the training of manpower is not an unmanageable task for countries that have a good basic educational system and a relatively large population.[78] Small countries, however, may encounter serious obstacles if they want to undertake basic steelmaking. Regardless of the growth path, a critical minimum level of production must be reached to achieve scale economies, particularly for rolling-mills.[79] Direct reduction (DR), however, is a technology that small countries having extensive hydrocarbon resources might consider. Although this alternative still poses some difficulties, its possibilities and applications with regard to reducing agents and the range of ores used may be extended in the future.[80] Another alternative is non-integrated, simple rolling-mills and small semi-integrated plants using ultra high-power electric furnaces. At present, these are usually specialized plants producing a narrow range of products (concrete reinforcing rods, merchant products), but the range could be enlarged to include flat products.[81] A third alternative would be small (100,000 to 200,000 tons) integrated iron and steel units following the classical route.[82]

Developing countries[83] may encounter obstacles in procuring spare parts and repair work quickly; both are vital for the functioning of a steel plant. Transportation facilities for bulk products and for heavy machinery (e.g. 300 tons) must be available from the beginning of plant construction. Shelter for 15,000 workers and their families must be provided for a moderately sized plant. Notwithstanding these and other requirements, production is rising and is expected to continue to rise in developing countries.

From the data available, UNIDO has estimated the crude steel capacity of developing countries in 1985 as follows (million tons):

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[77] "Today, Brazil is exporting to Europe cars that for decades have been considered as the symbol of European production. The Republic of Korea is now internationally competitive in the building of supertankers and bulk carriers.

[78] However, blast furnace operation requires considerable labour skills since the metallurgical reactions occurring in it cannot be predicted completely.

[79] See UNIDO, "The world iron and steel industry . . .", pp. 92-101.

[80] See UNIDO, "Picture for 1985 . . .", pp. 40, 41 and 49.

[81] *Ibid.*, p. 49.

[82] See UNIDO, "The world iron and steel industry . . .", pp. 100-101.

[83] See M. Okaki, "Basic ideas and practices of co-operation for establishing integrated steelworks in developing countries", in International Iron and Steel Institute, *Report of Proceedings*, Eleventh Annual Conference, Rome, 10-12 October 1977, pp. 65-79.

China, Democratic People's Republic of Korea, Asian countries with centrally planned economies	52.0
Other Asian countries	50.0
Latin American countries	58.0
Arab and Mediterranean countries	22.0
African countries	5.0
Total	187.0

Source: UNIDO, "Picture for 1985 in the world iron and steel industry" (UNIDO/ICIS.161), p.13.

This total, of 187 million tons, would amount to 16.5 per cent of world capacity in 1985.[84] From 6 to 10 developing countries will have capacities to produce capital goods for the iron and steel industry (and also more or less highly developed design and engineering capabilities), 11 or 12 countries will have high-grade and speciality steels production capacities, 17 will have flat product capacities; 21 will have integrated steel mills, 28 are expected to have direct reduction installations, and almost 50 will be producing crude steel.[85]

Even if these forecasts are met by 1985, the developing countries will probably have to import approximately 60 million tons.[86] This imbalance may be partly attributed to the cancellation of several projects that were launched on the initiative of Japanese, United States or European firms when world demand was buoyant, but that were later abandoned or postponed as the downswing occurred.[87] Declining profits and the larger investment in defensive programmes reduced the finances available to producers in developed market economies.[88] Most of the projects planned for developing countries were intended to produce for the export market. However, these markets were most severely hit. While potential exporters faced shrinking demand, protective measures and tougher competition on the part of domestic steel producers in developed countries grew. Thus, these projects were cancelled, delayed or redesigned to smaller dimensions than originally planned. Restructuring trends in steel are being increasingly resisted through the defensive policies of traditional producers. However, although such policies may distort the otherwise efficient redistribution of capacity, they cannot thwart the growth (impetus) of steel production in the NICs and other countries at a similar stage of development. A greater degree of structural flexibility in developed countries would require that producers rationalize their existing capacity while moving downstream into special steels and steel-using activities where they are more competitive. Without such flexibility, continued growth in developing countries will aggravate the problem of excess (and sometimes obsolete) capacity in developed countries.

[84] See UNIDO, "Picture for 1985 . . .", pp. 11-14.

[85] *Ibid.*, annex 1.

[86] *Ibid.*, p. 22.

[87] See UNIDO, "The world iron and steel industry . . .", pp. 50-51.

[88] In the early 1970s, massive investment programmes were introduced to cope with ecological regulations, expand capacity and reduce the share of coke in the cost structure. But the rise in petrol prices upset the traditional cost structure. Investment had been intended to replace coke by petrol, then the cheap factor, and suddenly petrol became more expensive than coke. Thus, several firms were caught unawares when the recession began.

C. ENGINEERING GOODS[89]

An overview

Engineering goods, when regarded as a single product group, exhibit three salient characteristics. First, by several standards they are one of the most heterogeneous groups in the manufacturing sector. Products range from nails and screws to the most sophisticated computers and aircraft. Depending on the type of good produced, some firms' fortunes are closely tied to the behaviour of consumer demand (e.g. producers of automobiles and electrical appliances) while others producing capital goods depend on investment demand (e.g. when a major industrial branch chooses to retool). Market structures and the nature of the production process also differ according to the type of product. For example, a few large engineering firms typically produce capital goods such as chemical machinery, and supply multiple-products with small production runs. Producers of consumer goods are also large, oligopolistic firms which resort to mass production runs and use standardized processes. With regard to firms supplying materials and components, production is usually multiple-product with small quantity runs carried out by small and medium-sized establishments. They are often closely connected through subcontracting or subsidiary-parent relations to ensure that standardization requirements shall be met. Frequent changes in product models owing to technological innovation or changes in consumers' preferences require close co-ordination between actual producers and suppliers of parts.

A second characteristic is that engineering firms in developing countries differ from those in developed countries. In developing countries, these firms are quite often engaged in the production of various components or final products that entail mainly labour-intensive operations. Those with large production runs generally produce consumer goods for both export and home consumption. The rest are many small firms engaged in the supply of parts, repairs etc. In developed countries, the scope of engineering activities is much broader; it encompasses the production of capital goods and industrial supplies as well as consumer goods. The pattern of ownership has changed as large firms in other fields (chemicals, motor cars etc.), recognizing the applicability of components for use in their own products, have moved into engineering products. In many developed countries, government-industry relations are rapidly extending in many product areas.

A final characteristic is the emphasis on innovation and R and D expenditures. In several developed countries, engineering activities absorbed over one half of the R and D funds that Governments allocated to industry in the 1970s, and the research-oriented activities of these industries often accounted for a similar proportion of their total output.[90] Although not evenly distributed throughout the engineering field, innovation is drastically changing production processes and product lines both in the production of engineering

[89]Throughout this section engineering goods are defined to include the following industrial branches: metal products excluding machinery (381), non-electrical machinery (382), electrical machinery (383) and transport equipment (384).

[90]UNIDO, *World Industry since 1960 . . .*, p. 16.

goods and in other industrial areas. There is no similar trend in the developing countries.

A complete survey of structural trends among specific product groups and of national and regional performance is not feasible here because of the diverse nature of the engineering industry. The section focuses instead on three aspects of special importance in the restructuring process. These features are: *(a)* current trends in innovation and R and D, along with some possible implications; *(b)* trade performance and related policy; and *(c)* trends in product development and related policy with significant consequences for the 1980s.

World production and restructuring

Production of most types of engineering goods has been the preoccupation of countries in the established "industrial centre" since the Industrial Revolution. These few countries were the traditional suppliers of the world's engineering goods until the early 1950s. However, as industry began to flourish, the capacity to produce engineering products spread rapidly from one developed country to another.

Restructuring during this period occurred in three phases. The removal of trade barriers and the rapid expansion of world trade during the 1950s marked the first phase of growth, which was largely confined to the industrial leaders of that period. A second phase began in the 1960s with the emergence of new international competitors—Canada, Italy and Japan and several centrally planned economies.

The machine tool industry illustrates the pattern of restructuring during the first two phases. In the middle of the nineteenth century, the United Kingdom's producers of machine tools dominated world production and trade. This situation changed during the first half of the twentieth century when Germany and the United States competed for the lead. The United States accounted for roughly one third of world exports during this period (see table III.10), but it rapidly lost its share to new entrants such as Italy, Japan,

TABLE III.10. SHARE OF WORLD EXPORTS IN MACHINE TOOLS, GERMANY,[a] THE UNITED KINGDOM AND THE UNITED STATES, 1913-1977

(Percentage)

Year	*Germany*[a]	*United Kingdom*	*United States*
1913	48	12	33
1924	30	14	35
1937	48	7	35
1955	35	12	30
1965	31	13	22
1975	36	8	12
1977	35	6	9

Source: Anne Daly and Daniel T. Jones, "The machine tool industry in Britain, Germany and the United States", *National Institute Economic Review*, No. 92, May 1980, p. 53.

[a]Data from 1955 on refer to the Federal Republic of Germany.

USSR and, more recently, the Republic of Korea. In the 1970s, real output of producers of machine tools in both the Federal Republic of Germany and the United States fell by about one fifth.[91] This example illustrates the dramatic transition that may occur in world leadership, in terms of a country's share of world output and trade.

In the 1970s, a third phase of expansion originated in the developing countries. On the one hand, it reflected many of these countries' industrial policy goals, such as increased self-reliance in providing their own capital-goods requirements and the desire to replace imports by domestic production or to become exporters of products (such as engineering goods) to rapidly growing international markets. On the other hand, production processes had changed considerably by the 1970s, facilitating the spread of capacity. The ability of the transnational corporations to relocate labour-intensive processes, or the labour-intensive part of component production or assembly operations (e.g. semiconductors or valves used in the assembly of capital-intensive goods), was greatly enhanced; it came to be described as the "fragmentation of the production process". Market conditions in special industrial branches reinforced the structural pressures on firms to invest abroad and to search for ways to fragment the production processes. The list of engineering products and processes involved grew rapidly. Producers of automobiles and automobile parts, clothing, standardized shipping (i.e. oil tankers and ore carriers), aircraft parts, power tools, machine tools and parts etc., to name only a few activities, shifted parts of their production processes to developing countries.

Production of electronic components and appliances provides a good illustration of the conditions that prompted a search for new locations for assembly processes. By the late 1960s, when many items (e.g. integrated circuits and other semiconductor devices) were standardized or mature products, a sharp competition in prices occurred in developed countries. At the time, price-cutting emerged in consumer electronics, especially in mass-produced items such as radio and television sets.[92] This fluid situation and the narrow profit margins forced firms in developed countries to relocate parts of their production processes, taking advantage of the lower wage costs elsewhere, including in the developing countries.[93]

Figure VI shows the world distribution of value added at constant prices in engineering branches since 1960. The growth rate during the period 1960-1977 was 7.1 per cent, or a rate considerably higher than that of world MVA. Net output of the world's engineering branches doubled in this period. The consequences of the various restructuring phases are also illustrated by figure VI. In 1960, the developed market economies accounted for 76 per cent of world MVA. After 17 years of rapid growth their share declined to 56 per cent; moreover, the predominance of established leaders (the Federal Republic

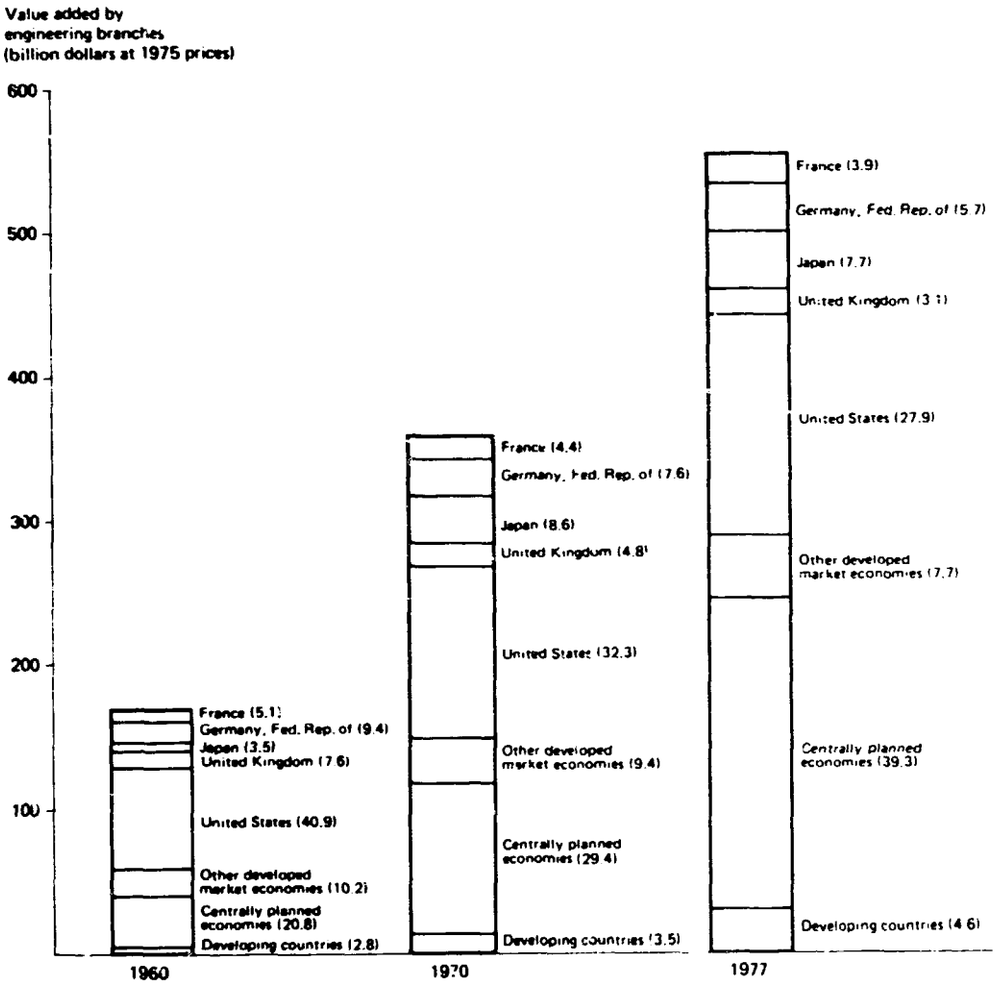
[91] Anne Daly and Daniel T. Jones, "The machine tool industry in Britain, Germany and the United States", *National Institute Economic Review*, No. 92, May 1980, pp. 53-54.

[92] In the United States, the situation was aggravated by cutbacks in defence spending.

[93] Current global shifts in production capacity are generally in response to different forces from those applicable in the case of machine tools in 1950-1970. They also involved product groups and technologies that were little known before 1960. Today, the restructuring process differs in other ways; firms and investment funds are more mobile than ever before. In this sense the process has become more international in scope, still concentrated in the developed countries but affecting some developing countries as well.

Figure VI. World distribution of net manufacturing output in engineering branches, by country and economic grouping, 1960, 1970 and 1977

(Figures in parentheses are percentage shares of world value added by engineering branches)



Source: Based on data supplied by the United Nations Statistical Office and estimates by the UNIDO secretariat.

of Germany, the United Kingdom and the United States) was reduced. The relative gains recorded by the centrally planned economies were an equally important feature of the restructuring process. The developing countries' share grew, albeit marginally, reaching 5 per cent of world MVA In 1977.

Table III.11 summarizes the relationship between growth in the engineering branches and in the manufacturing sector. A comparison of growth rates suggests that these branches generally fit the description of a "growth industry". Their rates of growth rose in the developed countries during the 1970s. In the same period, these rates declined from comparatively high values in the developing countries. This latter trend may result, in part, from the fact that production in the developing countries is oriented towards export, and in the 1970s it suffered from the consequences of new trade constraints. In any

TABLE III.11. GROWTH ELASTICITIES IN ENGINEERING BRANCHES,[a] 1960-1977

Economic grouping	*1960-1970*	*1970-1977*	*1960-1977*
Developed market economies	1.07	1.09	1.08
Centrally planned economies	1.25	1.28	1.26
Developing countries	1.65	1.50	1.59
World	1.15	1.23	1.18

Source: Based on data provided by the United Nations Statistical Office and on estimates by the UNIDO secretariat.

[a]Elasticities are defined as the ratio of annual average rates of growth in net output of engineering branches to the corresponding rates for manufacturing.

case, engineering activities continue to be an important source of growth, particularly for the developing countries and the centrally planned economies.

Despite their relatively small share in world MVA, the developing countries played an important role as producers of engineering products. In 1975, these products accounted for over 21 per cent of MVA in this economic grouping, although this share was still less than the comparable shares in the developed market economies (37 per cent) and the centrally planned economies (33 per cent).[94]

While the foregoing figures indicate global trends, such aggregate data can obscure many important developments at the regional, national or product levels. One of the few generalizations that can be made is that in most developed countries few producers of engineering goods have escaped the effects of the general slow-down of growth in the 1970s (see table III.12). Not only did machine-tool production fall off, but other major product groups (such as automobiles) experienced steep drops in demand which led to cutbacks in investment and retooling programmes, thus indirectly affecting the supplies of engineering goods.

TABLE III.12. GROWTH RATES FOR MANUFACTURING VALUE ADDED, AT CONSTANT PRICES, 1960-1970 AND 1970-1977

(Percentage)

Economic grouping	*Metal products*		*Non-electrical machinery*		*Electrical machinery*		*Transport equipment*	
	1960-1970	*1970-1977*	*1960-1970*	*1970-1977*	*1960-1970*	*1970-1977*	*1960-1970*	*1970-1977*
Developed market economies	4.7	2.8	6.5	3.4	8.5	4.5	5.1	4.1
Centrally planned economies	10.5	9.1	7.7	8.3	10.7	11.6	10.1	9.8
Developing countries	9.4	6.6	9.0	11.3	11.6	13.5	9.9	10.6

Source: Based on data provided by the United Nations Statistical Office and on estimates by the UNIDO secretariat.

[94]A "relative weights" measure was used in the calculations. For a description see UNIDO, *World Industry since 1960 . . .*, pp. 69-71.

In contrast, a few types of engineering activities have experienced a steady growth in demand and these have good prospects. For example, United States producers of semiconductors anticipated a 27 per cent growth of orders in 1980 (down from 35 per cent in 1979) and they expect a 16 per cent growth in the period 1980-1982.[95] Producers of industrial robots look forward to a per annum growth of demand at rates up to 30 per cent; one group has predicted that during the next quarter of a century the electronics complex (particularly basic components and electronic capital goods) will be the main pole of growth in the developed countries.[96]

These few examples point again to the divergence of conditions, prospects and problems in this industry, not only in its productive structure but also in its patterns of investment, innovation and trade. The discussion that follows highlights major trends that are likely to figure prominently in future developments in both the developed and the developing countries.

Investment and innovation

The world dispersion of engineering production capacity has been spurred by the international spread of technical know-how, exported in the form of patents and licences and of direct foreign investment. Transnational corporations based in the developed countries have been the main agent for relocation. Thus, the production of certain types of engineering goods has become extensively integrated in a global sense. The foreign investment of a transnational corporation may be motivated by its desire either to expand its share of the world market or to reduce production costs. The former type of investment is often in fields where the developed countries enjoy a comparative advantage (e.g. computers), and such investment is largely confined to these countries. Investment designed to reduce production costs is usually identified with activities that have a comparative disadvantage in developed countries (e.g. they require large amounts of unskilled labour), and the flow of such investment is from developed to developing countries. Examples of this investment flow are automobile CKD (completely knocked down) assembly and parts production, electronics parts and units production.

A common strategy of transnational corporations for expanding into another developed country is technological co-operation with a major firm (often a transnational also) that is already established in the market. Such integration is used as an on-site base for market penetration and expansion. This co-operation is often followed eventually by the establishment of subsidiaries.[97]

During the 1960s, direct investment by transnationals in developing countries was often in response to policies of import substitution in these

[95] *The Economist*, 26 July 1980 and 26 October 1979.

[96] Interfutures, *Facing the Future: Mastering the Probable and Managing the Unpredictable* (Paris, OECD, 1979), p. 336.

[97] Market structure has much to do with the investment of transnationals, however. For example, in the case of machine tools, the tendency for leading companies to have plants in all the major markets is less apparent than in monopolistic industries like motor cars or agricultural machinery. Increasingly, the buyers of sophisticated and expensive equipment are prepared to go to the supplier with the best product, wherever he may be located.

countries. It was therefore concentrated in the final assembly of imported parts and components. The automobile industry provides a typical example.[98] Since the Second World War, competition has been keen among a few major firms (in 1973, eight firms accounted for 85 per cent of world sales). Spurred by large economies of scale (especially in exterior body stampings) and high investment costs, firms have expanded the capacity of their home plants while searching for new markets such as large Latin American countries. In the first stage, firms exported completely finished automobiles to these markets. In the next stage, they established assembly facilities for imported kits, thereby moving behind the domestic tariff wall created as part of an import-substitution programme. At the same time, because new product design depended on close co-ordination with parts suppliers, firms encouraged home-based suppliers to open subsidiaries in those countries where laws required that the local content exceed a minimum.

With regard to direct foreign investment motivated for cost reasons, parts-producing subsidiaries of transnationals have settled increasingly in developing countries since the early 1960s. The direct foreign investment for this purpose accelerated in the 1970s as export promotion policies became more prominent in some developing countries, and as production costs began to rise in developed countries. Semiconductors, valves, tuners, and other components have been manufactured or assembled in Hong Kong, Mexico, the Republic of Korea, Singapore and elsewhere for many Japanese and United States electronic firms.[99] Automobile parts (radio antennas, piston rings, cylinder linings, lamps, braking equipment, batteries and springs), electrical appliances and machinery, sewing machines, motorcycle and bicycle parts etc. are produced in developing countries for export to firms in Japan, the United Kingdom and the United States. Because of their nature (labour-intensive and high-value, low-bulk products and small-scale production), such activities are prime candidates for transfer to developing countries. The world-wide distribution of components production, combined with increasing on-the-spot production, has resulted in a steady decrease in the proportion of assembled engineering products in world trade.

In the developed countries, the emphasis on innovation reflecting a growing government-industry relationship has already been noted. A new generation of key industries is emerging, consisting partly of new electronic components and electronic capital goods, and embracing fields such as automation, data processing and telecommunications. The nucleus for the new electronic complex consists of firms producing microcircuits (known as "chips"), which are finding widespread application in capital goods for

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[98] See Douglas Bennet and Kenneth E. Sharpe, "Transnational corporations and the political economy of export promotion: the case of the Mexican automobile industry", *International Organization*, vol. 33, No. 2 (1979), pp. 177-201.

[99] One example of technological advances that have facilitated the transnationals' ability to transfer assembly processes to developing countries while still maintaining control over the entire operation is found in the production of electronic calculators. Since 1962, the cost of the circuitry has fallen from $170 to $5, making the labour costs of assembly significant. Simultaneously, the number of components used fell from 5,000 to fewer than 40 pieces, meaning the assembly process was much less complicated and did not require substantial amounts of skilled labour. See Badiul A. Majumdar, "Innovations and international trade: an industry study of dynamic comparative advantage", *Kyklos*, vol. 32, 1979, pp. 559-568.

producing automobiles, ships and electronic products, in computers and telecommunications and in consumer electronic products.

The growth of advanced electronics may have surpassed that of any comparable industrial field during the 1970s. Output of semiconductors doubled every year in the 1970s, while the price per integrated circuit function declined at an annual average rate of 27.5 per cent. As electronic components have become cheaper they have also become essential to the production processes of many other industries. Electro-mechanical components are being replaced by electronics in almost every application, leading to improved "brains" in numerically controlled machine tools, and the improved performance and reduced size of radio and television sets.

Microcircuits have two different uses in industry. One application is as components for other goods, either to improve their performance or to cut their costs. Radio and television receivers, hand-held electric tools and high-fidelity stereos are a few examples. This trend may lead to the development of larger markets and new products which, as in the recent past, may be more efficiently produced in part and assembled in developing countries.

The second application is in the field of automation, and its probable consequences for the restructuring process are more important. Although industrial robots, or numerically controlled machine tools, have been on the industrial scene since the early 1960s, they have become "programmable" or "flexible" only recently with capabilities far beyond those of their predecessors.[100] Modern versions can be adapted to manufacturing activities ranging from welding to quality control, and from painting to intricate assembly operations. To date, automobile producers are the biggest users of robots for many assembly-line jobs (welding, painting, handling hot foundry parts and automatically assembling heavy parts). One recent study has foreseen production applications in shipbuilding, aerospace products, footwear, clothing and small hand tools.[101] The greatest potential use of these machines is in speeding the passage of materials through factories. Currently, materials are worked on only 5 per cent of the time in the production process; during the remainder of the time they are pushed from place to place or lie idle.

Concomitant with these developments, innovation is becoming increasingly costly,[102] and investment in research is not necessarily connected with immediate profits. This phenomenon has led to a drastic reduction in the number of firms through mergers and takeovers by large users of electronic components. Governments have also become much more active in the field, dispensing funds to influence the direction of research or subsidizing costs in other ways. These trends will have an important influence on procedures for the international transfer of technology in this field. Developing countries may expect that their negotiating partners in high-technology engineering fields will

[100]Most robots are simply programmable arms and not all-purpose tools. The first generation robots could do only very simple jobs (e.g. spot-welding seams of motorcar bodies). The new generation of micro-processor robots is much more skilled, however.

[101]A United Kingdom Cabinet report cited in *The Economist*, 10 November 1979.

[102]For example, in 1969 the starting costs for a medium-sized operation producing silicon wafers (which are subsequently mounted or assembled into chips) were $2 million. Comparable costs today are 25 times that amount.

either be firms with an oligopolistic structure or Governments of the developed countries themselves.

Other consequences for industry in developing countries are difficult to determine. Certainly, for production processes in which such automation proves to be expensive or impractical, the transfer of capacity to the developing countries may continue or even accelerate. Where automation takes the form of rationalizing through improved control and a new allocation of tasks (rather than replacing human labour by machines), opportunities for the developing countries may also exist. This possibility, however, will depend on the host country's ability to provide the necessary skilled labour and to maintain complete production units using automatic control systems.[103] In industries where production is a continuous process (e.g. steel, non-ferrous metals and some chemicals), electronics may increase productivity through improved control over the whole operation, but its use would lower employment.

Trade performance and trade-related policies[104]

In 1963, world engineering exports totalled $36 billion (f.o.b.), 56 per cent of which was supplied by the Federal Republic of Germany, the United Kingdom and the United States.[105] In the 1960s, new competitors such as Canada, Italy and Japan emerged as important exporters (see table III.13). In the 1970s, exports from France, the Federal Republic of Germany and Japan made rapid gains while the exports of Italy, the United Kingdom and the United States lagged, owing partly to the rapid rise in their prices.[106]

The developing countries' exports were highly concentrated in a few semi-industrialized countries and areas: Argentina, Brazil, Hong Kong, India, Mexico, the Republic of Korea[107] and Singapore. For producers of capital goods, the United States now figures prominently as an importer of engineering products. In the early 1960s, foreign companies supplied only about 5 per cent of the United States market; in the first nine months of 1979, however, this share was almost 20 per cent,[108] largely owing to the massive retooling programmes of the aerospace industry and the automobile industry—the latter dictated by the shift to smaller cars. Producers in developing countries, however, have generally not participated in this trade.

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[103]The alternative of relinquishing a large share of operation and control to the transnational may not be appealing to some developing countries.

[104]Engineering exports and imports are defined here to be those classified as SITC 69, 7 and 812, unless otherwise noted.

[105]*Bulletin of Statistics on World Trade in Engineering Products, 1977* (United Nations publication, Sales No. E/F/R.79.II.E.4).

[106]Engineering export price indices of the United Kingdom and Italy were almost doubled during the period 1970-1975, while those of the Federal Republic of Germany and Japan increased by 30 to 40 per cent.

[107]The Republic of Korea recently announced a comprehensive programme to raise the level of its machinery exports to $35 billion in the next 10 years. At that time, the Government expects machinery to account for 35 per cent of its exports compared with the present level of 15 per cent. A promotion fund of 150 billion won will be devoted to this programme between now and 1984. *Far Eastern Economic Review*, 30 May 1980.

[108]*Financial Times*, 23 April 1980.

Intra-industry trade in engineering products is an important aspect of overall trade. Table III.13 summarizes the results of an extensive exercise to measure intra-industry trade in precisely defined product lines. In developed market economies, intra-industry trade is extensive in all product groups. Notably, much of the intra-industry trade among these countries is in capital goods (machinery for metal-working, textiles, agricultural uses, telecommunications and transport). Presumably, this reflects an extensive degree of specialization among different producers in a given industry, coupled with relatively long production runs. Vertical forms of intra-industry specialization are also a factor, whereby specialization entails the exchange of an industry's final

TABLE III.13. EXPORT SHARES OF ENGINEERING PRODUCTS (SITC 7) IN WORLD TRADE, BY ECONOMIC GROUPING AND COUNTRY, 1963, 1970 AND 1977

(Percentage)

Economic grouping	*1963*	*1970*	*1977*
Developed market economies	86.1	87.9	87.7
Canada	1.8	5.9	4.3
France	6.0	6.6	7.6
Germany, Federal Republic of	18.9	17.8	18.1
Italy	4.4	5.4	4.9
Japan	4.2	8.8	14.3
United Kingdom	14.0	8.9	6.9
United States	22.7	20.0	16.3
Others[a]	14.1	11.5	15.2
Centrally planned economies[b]	13.4	11.3	10.0
Developing countries and areas[c]	0.5	1.0	2.4[d]
Total of above countries	100.0	100.0	100.0

Source: Calculations based on data given in *Bulletin of Statistics on World Trade in Engineering Products 1977* (United Nations publication, Sales No. E/F/R.79.II.E.4).

[a] Australia, Austria, Belgium, Denmark, Finland, Greece, Iceland, Ireland, Israel, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland and Yugoslavia.

[b] Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Romania and USSR.

[c] Argentina, Brazil, Colombia, Hong Kong, India, Mexico, Republic of Korea, Singapore and Turkey.

[d] Estimate.

product for intermediate products used by the industry.[109] A more detailed analysis (not shown)[110] revealed that the intra-industry trade of developed market economies was most extensive for combustion engines of various types; agricultural machinery for cultivation, harvesting, threshing; dairy farm machines; tractors; mining machinery; heating and cooling equipment; mechanical handling equipment; television sets, radios and loudspeakers; and various types of special purpose transport equipment.

The data in table III.14 clearly demonstrate that the developing countries' trade in engineering products involves a substantial though smaller degree of intra-industry trade. Most products are consumer goods: typewriters, cal-

[109] Grubel and Lloyd cite the example of refrigerator producers in Australia who export compressors and other refrigerator parts while importing complete refrigerators. *Op. cit.*, p. 101.

[110] This analysis was carried out for trade in four- and five-digit SITC items.

culating machines, loudspeakers and amplifiers, batteries and transistors. The distinction is largely explained by differences in the approach of the transnationals to investment. The proportion of electronic goods for which production siting does not depend on strategic, technical or market conditions, i.e. activities applicable for restructuring, has recently been estimated at 30 per cent.[111] The bulk of such activities are, therefore, being steadily transferred to developing countries to take advantage of low-cost wage conditions for labour-intensive processes. The global dispersion of production of semiconductors is typical: in 1976, 99 per cent of all production (excluding that in the centrally planned economies) was controlled by firms based in developed market economies, although developing countries accounted for 7 per cent of all consumption.[112]

TABLE III.14. INTRA-INDUSTRY TRADE IN ENGINEERING PRODUCTS FOR SELECTED DEVELOPED[a] AND DEVELOPING[b] COUNTRIES AND AREAS, 1976

(Number of countries)

Product group	*SITC*	*Index of 0.50 to 1.00*[c]		*Index of 0.25 to 0.50*[c]	
		Developed market economies	*Developing countries and areas*	*Developed market economies*	*Developing countries and areas*
Power generating machinery, other than electric	711	12	3	5	2
Agricultural machinery and implements	712	13	2	5	2
Office machines	714	13	7	5	3
Metal-working machinery	715	11	0	2	4
Textile and leather machinery	717	10	1	6	1
Machines for special industries	718	9	1	9	3
Other non-electrical machinery	719	12	2	8	1
Electric power machinery and switchgear	722	16	3	4	3
Equipment for distributing electricity	723	13	1	5	5
Telecommunication apparatus	724	19	5	0	2
Domestic electrical equipment	725	12	6	4	3
Other electrical machinery and apparatus	729	16	5	5	7
Railway vehicles	731	12	3	5	2
Road motor vehicles	732	10	4	3	3
Road vehicles other than motor vehicles	733	12	3	5	5
Aircraft	734	10	3	7	4

Source: Data supplied by the United Nations Statistical Office.

[a]Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Federal Republic of, Ireland, Israel, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States and Yugoslavia.

[b]Argentina, Brazil, Colombia, Congo, Cyprus, Egypt, Hong Kong, India, Indonesia, Jordan, Malaysia, Mexico, Morocco, Nicaragua, Philippines, Republic of Korea, Singapore, Thailand, Tunisia, Turkey and Uruguay.

[c]The index is defined in table III.9.

[111]Interfutures, *op. cit.*, p. 334.

[112]*Ibid.*, p. 342.

Trade in engineering products thus has several unique characteristics. Trade-related policies have significant implications not only for the exporting countries but also for the transnationals. Most of these policies are relatively straightforward types of trade impediments. Tariffs, the traditional form of trade impediment, are no longer a significant form of protection. Among the major importing markets—Japan, the United States and EEC—the weighted average of tariffs on imports of machinery, electrical and transport equipment ranged from nil to 10 per cent in 1976.[113] New protectionist measures such as VERs and orderly marketing arrangements are considerably more important, often affecting 10 to 20 per cent of engineering imports in the above markets.[114] These measures are mainly applied to goods produced using comparatively standardized production processes. Conversely, trade in new products resulting from recent innovational advances is not usually impeded. Thus, the trade barriers affect producers in developing countries as well as those in developed countries.

Product lines that are primarily the object of new protectionist measures are mainly in electronics—consumer appliances, transistor radios, television sets, tape recorders and calculators. Since the early 1960s, new protectionist measures governing electronic products have become increasingly subtle and may involve multiple legal and administrative actions depending on the importing market.[115] As for other products, the most common forms of trade restrictions are currently VERs and orderly marketing arrangements.

For producers in developed countries, one method of avoiding the negative effects of these defensive policy measures has been to invest in the protected domestic market of their trading partners. Such investments are not motivated by reasons of efficiency or cost reduction, however; rather, they are the result of protectionist pressure.

The relocation of production capacity for non-economic reasons cannot lead to secure long-term growth prospects. Foreign investment rather than export is not an alternative that is available to most producers in developing countries. Their export prospects may suffer when major importing markets attract new foreign-owned capacity that would then compete with exporters outside the protectionist wall.

Other forms of intervention by the Governments of [illegible]arket economies are prevalent and are altering patterns of produc[illegible]rade. These include the financing of R and D accompanied by increasing binding directives for research priorities and product definition. In addition, purchases by the State and support for exports are widespread and substantial. A noteworthy example of the latter type of intervention concerns the export of turnkey plants. In Japan, suppliers' credits amounted to 73 per cent of the value of these exports in 1976. "A large part of these credits originate from

[113] Andrzej Olechowski and Gary Sampson, "Current trade restrictions in the EEC, the United States and Japan", *Journal of World Trade Law*, May/June 1980, pp. 224-225.

[114] *Ibid.*, p. 228.

[115] In the United States, for example, recent litigation involving Japanese electronic products has cited various national security issues, the anti-dumping laws of 1921 and 1916 and even esoteric statutes such as the Countervailing Duty Act of 1897. See *Far Eastern Economic Review*, 26 October 1979.

institutions, and their terms are often a major factor in the choice of supplier."[116]

In conclusion, the future development of engineering activities will play a crucial role in the restructuring process, greatly affecting the overall pattern of structural change in the manufacturing sector. The transfer of standardized production processes to the developing countries, now at an intermediate stage, will continue at a slow pace. Simultaneously, the independent expansion of production capacity for mass consumption items will occur in semi-industrialized countries with large domestic markets. Activities that require high technological capacity and/or lead to increased automation in the production process will be increasingly concentrated in developed countries.

D. FOOD PROCESSING

Overview

Food processing[117] differs from the other industrial branches in this chapter in a number of important respects. First, output is intended to fill a basic consumer need, nutrition, rather than to provide industry with intermediate or capital goods. Second, the inputs are based on primary renewable raw materials, i.e. agricultural and fishery products, which in one form or another (animals, fish, grains, fruits, vegetables) are found in almost all countries. Third, the technologies required for food processing are simple and not subject to rapid change, and capital and skill requirements are comparatively low.

Food processing also differs from the other industrial activities considered in this chapter because of its international and inter-industrial dependence. It has a strong link with agriculture (processing value added tends to be about one quarter of output value), but not with other industrial branches. Much intra-industry trade exists at the four-digit ISIC level, reflecting differences in agricultural specialization from country to country according to the availability of raw materials which in turn depends on differences in soil, climate etc. The role of the transnational corporation is sometimes significant, although different from its role in other industrial branches. International marketing ties and post-colonial connections are important influences on trade, investment and the operations of the transnational corporations in the field.

In many developing countries, the agricultural sectors account for more than 50 per cent of total employment and almost one quarter of GDP. Owing to the close link between agriculture and food processing by industry, and the characteristics of demand and production technology, these branches account for a large portion of the developing countries' net manufacturing output. For example, in the mid-1970s, food-processing activities provided almost 20 per cent of the developing countries' MVA. Among the poorer countries, particularly the least developed ones, this share was substantially higher.

[116]Interfutures, *op. cit.*, p. 351.

[117]Includes ISIC group 311-312. Unless otherwise noted, beverages (313) and tobacco products (314) are not included here. Fats and oils (3115) and animal feeds (3122) are included.

The growth of net output in food processing has lagged behind that of other industrial branches in most countries for the following reasons: *(a)* the demand for food products tends to be rather income inelastic at higher income levels; *(b)* input supplies are largely limited by land availability; and *(c)* dynamic technological changes that would reduce costs are difficult to achieve. As a result, food-processing activities have not played a very large part in recent world industrial restructuring. The most important trends have been the increase in production and consumption of frozen and fancy foods in developed countries, the emergence of a few developing countries, particularly Brazil, as major exporters, and increasing levels of processing of exports by developing countries. Also significant has been the low rate of increase in the world *per capita* availability of several important food products during the period 1970-1977.

Finally, with regard to production-trade relationships, there is little variation among countries in the ratio of imports to consumption (typically around 20 per cent so that many countries are close to self-sufficiency), but ratios of exports to production vary widely. As of 1975, trade amounted to about $55 billion. Brazil, the Netherlands and the United States are the largest exporters, and France, the Federal Republic of Germany and the United States are the largest importers (as of 1977). China, the USSR, the United States and the EEC countries are among the largest producers.

Production and structural change

For the reasons discussed above, growth and structural changes in food processing have been slower than in other areas of manufacturing. Table III.15 shows long-term trends in the manufacture of foodstuffs, beverages and tobacco. World MVA grew at an average annual rate of 4.3 per cent during the period 1965-1977, a rate substantially below the comparable rate of growth for manufacturing as a whole. Growth rates of net output for the centrally planned economies (5.5 per cent) and the developing countries (5.6 per cent) markedly exceeded the corresponding rate recorded for the developed market economies.

These general trends conceal wide differences in the performance of individual countries and subsectors. To better identify these variations, data were compiled for production in physical units (thousand tons) spanning the period 1968-1977 in 53 agricultural commodities that are processed by the manufacturing sector. The data permit a comparison to be made among specific commodities and their main producers as of 1977. The results are shown in the appendix to this chapter. The main features are summarized below.

The most important meat products are beef, veal, pork and, to a lesser extent, poultry. As of 1977, the bulk of world output of these products was concentrated in a very few countries (see the appendix). For example, five countries, Argentina, Brazil, China, the United States and the USSR, accounted for over one half of world output of beef and veal. The growth in output of these products has expanded only slightly more rapidly than the growth in world population, indicating little gain in the *per capita* availability of these products.

TABLE III.15. NET MANUFACTURING OUTPUT IN FOOD PROCESSING, BY ECONOMIC GROUPING, 1965-1977

(Index numbers, 1970 = 100)

Year	*Processed food, beverages and tobacco (ISIC 31)*			
	World	*Developed market economies*	*Centrally planned economies*	*Developing countries*
1965	80	83	75	76
1966	84	87	79	81
1967	88	90	85	83
1968	91	93	89	87
1969	95	96	94	94
1970	100	100	100	100
1971	105	104	106	105
1972	110	108	111	111
1973	115	113	117	119
1974	120	115	126	124
1975	123	115	132	129
1976	128	121	133	138
1977	133	125	142	147
	Average annual growth rate (Percentage)			
1965-1977	4.3	3.5	5.5	5.6

Source: *Yearbook of Industrial Statistics, 1977 Edition*, vol. I (United Nations publication, Sales No. 79.XVII.9), part 2, table 1.

Processed fruits and vegetables are another important field of food processing. The United States is by far the largest producer. Processing of vegetables increased more rapidly than that of fruits, but, for both, freezing is displacing canning or bottling. *Per capita* availability of canned or bottled fruit declined over the period.

Among fats and oils, soya was still second in volume of production to general oils of vegetable origin, with margarine and imitation fats the third largest type. The rate of growth for soya oil, however, was the highest among oils and fats during the period 1968-1977. The United States, with a share in total output of 75 per cent, was the largest producer of refined soya oil and, together with Brazil, accounted for 61 per cent of crude soya oil production in 1977. Oils of general vegetable origin are available in various geographic areas and their production is not dominated by a few countries as is the case for soya oil.

Perhaps the most important food product, in terms of the satisfaction of basic needs and in total volume, is wheat flour. About 130 million tons were produced in 1977 (about half of this by Italy, the United States and the USSR), but this was only 7.4 per cent greater than 1970 production. In comparison, world population grew by 14.2 per cent, so that *per capita* availability of wheat flour has been dropping.

World production of raw and refined sugar, on the other hand, has been growing more rapidly than population. In 1977, Brazil, Cuba, India, the USSR

and the United States accounted for 40 per cent of raw sugar production and the Federal Republic of Germany, India, the USSR and the United States supplied 53 per cent of all refined sugar production.

Expressed in terms of value added (1970 dollars), production growth rates were higher than when calculated by quantity. Table III.16 shows growth rates of value added in food processing for a large sample of countries. Value added in food processing increased from $93 billion in 1970 to $121 billion in 1977, a gain of about 30 per cent in a total of 94 countries. The share of developing countries in the total grew slightly over this period, from 10.1 per cent to 10.8 per cent. As of 1977, the world's 10 largest producers were the United States (28.3 per cent), the USSR (23.3 per cent), Japan (4.4 per cent), Poland (4.1 per cent), the Federal Republic of Germany (3.9 per cent), France (3.8 per cent), the United Kingdom (3.2 per cent), the German Democratic Republic (2.8 per cent), and Brazil and Canada (both 2.1 per cent). Together, these countries accounted for 78 per cent of the total (data for China were not available). Of these countries, the increase in net output in the period 1970-1977 was largest in Brazil (63 per cent) and Poland (62 per cent). Among the developing countries, apart from Brazil, only Argentina and Mexico recorded levels of value added exceeding $1 billion in 1977.

The role of the transnational corporations in food processing

Food processing at early stages of development is largely done by domestic firms. Typically, the transnational corporations become involved once food is locally processed and distributed on a large scale. This is particularly true for most meat, dairy, grain and oil-based consumer products. In the case of meat products, only a few transnationals have operations in the developing countries. Moreover, there is limited cross-industry involvement between firms in the meat industry and those using the by-products (e.g. leather). In the poultry industry, the transnationals have extended their overseas operation since the 1960s. However, most production remains geared to the domestic market and is in the hands of local, small or medium-scale producers. Processed fish products are produced on a large scale by India, Indonesia, Mexico, Peru, the Republic of Korea, Thailand, Viet Nam, and the West Indies. Although production has traditionally been directed to the home market, there is a growing export orientation. About 13 transnationals are heavily involved in

TABLE III.16. GROWTH OF VALUE ADDED[a] IN FOOD MANUFACTURING (ISIC 311-312), 1968-1977, AND RANKING BY COUNTRY, 1977

Country	*Rank*[b]	*Growth rate*
United States	1	3.2
USSR	2	5.0
Japan	3	2.7
Poland	4	7.0
Germany, Federal Republic of	5	3.1
France	6	2.3
United Kingdom	7	0.8

Country	*Rank*[b]	*Growth rate*
German Democratic Republic	8	5.1
Canada	9	1.8
Brazil	10	8.0
Italy	11	3.0
Spain	12	11.0
Bulgaria	13	6.1
Netherlands	14	2.9
Belgium	15	4.4
Australia	16	2.7
Mexico	17	3.8
Czechoslovakia	18	4.3
Argentina	19	3.5
Sweden	20	1.4
Denmark	21	3.3
Yugoslavia	22	6.2
India	23	3.5
Hungary	24	4.2
Turkey	25	6.0
Philippines	26	5.1
South Africa	27	2.8
Austria	28	3.3
Republic of Korea	29	15.5
Pakistan	30	9.0
Norway	31	1.6
Indonesia	32	9.4
Colombia	33	8.1
Finland	34	2.2
Iran	35	6.5
Peru	36	2.1
Venezuela	37	5.2
Portugal	38	6.5
Greece	39	3.6
Chile	40	0.5
Ireland	41	3.7
Thailand	42	2.0
Dominican Republic	43	7.7
Egypt	44	3.7
Algeria	45	9.2
Iraq	46	9.0
Morocco	47	5.8
Israel	48	6.8
Ecuador	49	6.8
Uruguay	50	2.4
Malaysia	51	5.2
66 developing countries		4.9
28 developed countries		3.8
Total (94 countries)		3.9

Source: Based on data supplied by the United Nations Statistical Office and on estimates by the UNIDO secretariat.

[a] The share of value added in total (in 1970 million dollars) for the developing countries, 1968-1977, was as follows (expressed as percentage): 1968 (9.6), 1969 (9.9), 1970 (10.1), 1971 (10.6), 1972 (10.2), 1973 (10.4), 1974 (10.2), 1975 (10.3), 1976 (10.6), 1977 (10.8).

[b] All calculations were in constant United States dollars (1970 = 100). To maintain consistency in the total (which includes 43 countries with MVA in latest reporting year ($100 million)), where country data were missing (1975-1977 plus one observation for 1968), values for the previous reporting year are assumed to continue. The same system was used for the country ranking where 1977 data are missing.

processing and marketing fish products in the developing countries and some countries have moved to reduce the share of leading transnationals. In fruit and vegetable canning, transnational interests have expanded. Some integrated production-processing systems with an export orientation have been established in major fruit-producing developing countries.

In developing countries, most grain-based products—crackers, biscuits, macaroni etc.—are manufactured by small-scale domestic producers, and the production technology is widely diffused. This situation is being changed to some extent by the growing interests of transnationals in local operations. Such firms producing formula animal feed have expanded into many developing countries, integrating their operations with local poultry-producing and processing concerns. Technology employed in the poultry-processing industry is sophisticated and less accessible to developing country producers. In the vegetable fats industry, 13 transnationals are involved in oil-seed processing and distribution in developing countries.

Most production of groundnut, coconut and palm kernel oil is in private hands, although nationalization has not been uncommon. Nationalization is evident in the sugar-processing industry where the operations of transnationals have been largely confined to the subsidiaries of one or two countries. However, markets for refined sugar in the developed countries are dominated by a few transnationals, and suppliers from developing countries face strong barriers to entry. Furthermore, a number of beverage and confectionery transnationals have established licensing and other joint-venture agreements with domestic producers in developing countries.

From an international perspective, the involvement of transnationals in food processing is considerably more significant than the extent of their operations in developing countries might suggest, because of their emphasis on exports and need to acquire sufficient supplies of raw materials. Thus, developing countries may at times find their own objectives conflicting with those of a transnational in a variety of ways. For example, as marketing and distribution systems of most processed food products are dominated by transnationals, the export initiatives of developing countries depend crucially on the attitudes and strategies of these firms

The pattern of corporate specialization may also influence the behaviour of transnationals in developing countries. According to one study,[118] the leading transnationals number about 175 firms, half of which are based in the United States. The interests of these firms encompass production, processing, shipping and distribution. Some have long corporate histories, cover a wide range of food and non-food products and are highly diversified. Although some account for a large proportion of processing or distribution of a particular commodity, their principal source of sales may be in fields as diverse as steel, drugs, mining or finance.[119] Many non-food firms are drawn into the food-processing industries in order to extend their range of consumer products. Petroleum, machinery, transportation and financial firms sometimes diversify into the food-processing industry in order to achieve "forward integration"—i.e. to ensure expanding sales and to consolidate their hold on markets. This

[118]United Nations Centre on Transnational Corporations, "Transnational corporations in food and beverage processing" (ST/CTC/19), pp. 217-278.

[119]T. Horst, *At Home Abroad* (Cambridge, Mass., Ballinger, 1974).

trend is accelerated by the growth of mergers, which have affected the food-processing industry particularly in the Federal Republic of Germany and in the United States[120] where, in the period 1955-1969, the number of mergers in this industry exceeded those in all other branches.[121]

This pattern of ownership may undercut international competition in food manufactures. The larger food firms are more diversified in the range of food products that they process and in the number of industries into which they are extended. The growth and diversification of these firms thus reduce levels of competitiveness, not just in the food-processing industry but also in industries with which it is linked as a supplier and as a purchaser.

Table III.17 gives a distribution of 170 leading transnationals among nine different food groups or systems.

TABLE III.17. PARTICIPATION OF LEADING TRANSNATIONAL CORPORATIONS IN THE FOOD INDUSTRY, BY SIZE GROUP

Size of firm (annual sales in billions of dollars)	*Number of TNCs*	*Number of subsidiaries in each food category*								
		Meat	*Dairy*	*Fish*	*Fruits/ vegetables*	*Grains*	*Oils*	*Sugar*	*Commercial beverages*	*Spices*
>5	6	4	5	4	4	4	2	0	4	2
3-5	17	7	9	5	1	7	5	5	3	0
2-3	21	4	7	5	8	10	4	9	2	2
1.5-2	21	5	4	1	5	12	2	7	2	1
1.0-1.5	33	3	4	1	7	13	0	6	2	1
0.75-1.0	25	6	3	0	2	7	1	3	1	2
0.5-0.75	47	11	8	3	5	16	3	9	3	2
Total	170	40	40	19	32	69	17	39	17	10

Source: United Nations Centre on Transnational Corporations, "Transnational corporations in food and beverage processing" (ST/CTC/19, 1980).

Most of the larger food-processing transnationals are in grain-based products, including breweries, milling and baking, animal feed and alcoholic beverages. About 23 per cent of the firms have interests in the meat, dairy and sugar system and about 18 per cent in the fruits and vegetable system. Other food systems have not attracted significant investments by transnationals.

The international expansion of the transnationals is part of their policy of diversification. Out of 170 large food manufacturing firms, no fewer than 109 have direct subsidiary operations.[122] About 90 per cent have subsidiaries (an average of seven each) in the developing countries. However, their expansion into other developed countries has been much greater. Table III.18 indicates that these firms established over 800 subsidiaries in the developed countries compared with 655 in the developing countries. However, firms with an annual

[120] "Structure of food marketing", Technical Study (Washington, D.C., National Commission of Food Marketing, June 1966).

[121] K. George and A. Silberston, "The causes and effects of mergers", in A. Jacquereen and H. W. de Jong, *Markets Corporate Behaviour and the State* (Institute of Social Studies, The Hague, 1976), mimeo., p. 129.

[122] The retail-wholesale food firms of the Western countries are a major exception. These international operations are mainly concerned with offshore contracting for raw materials.

TABLE III.18. SUBSIDIARIES OF LEADING TRANSNATIONAL CORPORATIONS IN THE FOOD INDUSTRY, BY SIZE GROUP AND ECONOMIC REGION

Size of firm (billions of dollars)	Number of TNCs	Number of subsidiaries						
		Developed market economies	Developing countries					
			Latin America	Africa	Asia	Middle East	Total	Total
>5	6	48	30	36	20	—	86	124
3-5	17	155	32	4	11	3	96	253
2-3	21	140	45	10	24	3	108	248
1.5-2	21	99	11	4	7		60	159
1.0-1.5	33	181	69	26	25	4	129	310
0.75-1.0	25	88	39	14	25	9	87	175
0.5-0.75	47	116	34	35	11	4	89	205
Total	170	827					655	1 474

Source: Data derived from United Nations Centre on Transnational Corporations, "Transnational corporations in food and beverage processing" (ST/CTC/19, 1980), tables A.1., E.1. and E.2.

turnover of over $5 billion had 86 subsidiaries in the developing countries and 48 subsidiaries in the developed countries.

It is estimated that 17.5 per cent of the investment of 30 leading United States transnationals was in activities outside the country in 1971. The confectionery and bottled drink firms were important overseas investors and fruit and vegetable processors also had large foreign interests.[123]

The behaviour of these firms is often influenced by the policies of their Governments which vary according to the objective conditions in a particular developed country. For example, some developed countries actively encourage market expansion for their surplus food products. Many policies have been devised to facilitate offshore investments, such as investment guarantees, tax relief, aid programmes and trade concessions that may encourage foreign investment in food processing. Others dependent on foreign food supplies may encourage foreign investment in the food industry to ensure supplies for home markets, to diversify sources and to reduce commodity prices. Clearly, the expansion of the operations of transnationals in developing countries can create problems, in view of the orientation of these firms towards international markets rather than concern with the basic needs of the local population. If the production contemplated has little nutritional content, or if it is meant primarily for export, it may draw resources away from the production of other agricultural commodities necessary for basic consumption. For example, investment may be drawn away from basic necessities, inflating their price and lowering the living standards of the poorest groups who spend a high proportion of their income on basic consumer goods. The direct benefit of expansion into food processing for the rural (and urban) poor could be limited in such cases. Another danger is that extensive food processing can change negatively patterns of consumption and tastes; for example, products with low nutritional content such as breakfast food, canned milk and soft beverages may be substituted for cheaper natural products of higher nutritional value.

[123] Horst, *op. cit.*, p. 102.

Investment by transnationals in the food-processing industry may also introduce inappropriate production technology. Technological innovation of a labour- or hand-saving kind has not been as rapid in this industrial branch as in other sectors, notably in agriculture.[124] Little technological change has occurred in the areas of meat processing and canning, production of malt beverages, baking, and fruit and vegetable drying. Such technology can easily be adapted by domestic producers in developing countries. Thus, the question of acquisition of technology and market access should be treated separately by developing countries. There are also important gains to be made by "breaking open the package" offered by the transnationals in this field. Domestic technological adaptations are likely to have a greater "learning-by-doing" impact than technological procurement through the transnational package. They are also likely to generate more employment,[125] although the effect on income distribution is not entirely clear. There is some evidence that unionization of the employees of transnational subsidiaries is greater than that of employees of domestic enterprises and the remuneration and conditions of work of the former are also better. This is true for skilled, semi-skilled and relatively unskilled workers, according to an ILO investigation.[126] Moreover, if the transnational depends on local food supplies—milk, vegetables etc.—the indirect effect on employment may be significant even if the processing plant itself is capital-intensive—unless the production of raw materials is reorganized to become more capital-intensive. There is some evidence that the transnationals encourage this type of reorganization by contracting local entrepreneurs who set up modern technology-intensive farming units.[127]

Trade patterns

As the foregoing discussion indicates, trade and its related distributional aspects are subject to unique determinants. A country's ability to earn foreign exchange through food exports depends largely on the extent to which these commodities are processed before export. Obviously, access to investment and technology and patterns of ownership influence this aspect of trade.[128] Table III.19 illustrates trade by stage of processing and according to end-use (household or industry) in the 1970s. Two thirds of the imports of food and beverages by the developed market economies were primary products in 1970, and the share was only slightly less in 1975. The corresponding percentages for the developing countries were somewhat less, but they exceeded 50 per cent in both years. The major shift in the exports of the two economic groupings was the declining share of primary goods in the exports of the developing countries,

[124]W. S. Greig, "The changing technological base in food processing", in *The Economics of Food Processing*, W. S. Greig, ed. (Westport, Conn., Avi Inc., 1971), pp. 152-204.

[125]TNC food-processing operations are generally capital-intensive. See E. Peter, "Agro-businesses in underdeveloped agriculture", *Economic and Political Weekly* (Delhi), 17 July 1976, pp. 1065-1080.

[126]International Labour Organisation, "Wages and working conditions in TNCs" (Geneva, 1976).

[127]J. D. Horrisey, *Agricultural Modernization through Production Contraction* (New York, Praeger, 1974).

[128]See, for example, UNCTAD, "Restrictive business practices" (TD/N/C.2/156, April 1973).

TABLE III.19. TRADE OF THE DEVELOPED MARKET ECONOMIES AND THE DEVELOPING COUNTRIES IN FOOD AND BEVERAGES, BY BROAD ECONOMIC CATEGORY (BEC), 1970 AND 1975[a]

(Percentage)

	Share of total							
	1970				*1975*			
	Developed market economies		*Developing countries*		*Developed market economies*		*Developing countries*	
Economic category	*Imports*	*Exports*	*Imports*	*Exports*	*Imports*	*Exports*	*Imports*	*Exports*
Primary products, mainly for industry	30.4	26.7	32.8	44.2	28.1	32.5	34.9	35.0
Primary products, mainly for households	32.6	27.9	20.3	28.2	29.7	24.5	16.3	24.5
Processed products, mainly for industry	8.9	7.8	14.5	16.5	12.7	8.7	17.5	25.0
Processed products, mainly for households	28.1	37.5	32.4	11.1	29.6	34.4	31.4	15.4

Source: Data supplied by the United Nations Statistical Office.

[a]For a detailed description of these categories see "Classification by broad economic categories, defined in terms of SITC/Rev.2" (ST/ESA/STAT/SER.M/53/REV.1).

which dropped from 72 per cent in 1970 to 59 per cent in 1975. This shift was matched by a corresponding increase in the exports of fully processed foods and beverages. Industrial users were more important consumers of imports of food and beverages in the developing countries than in the developed market economies. Likewise, the bulk of the exports of the developing countries were destined for industry.

The value of world trade in food manufactures in 1975 was about $55 billion.[129] Table III.20 shows trade patterns by product groups, source and destination. Trade between developed countries accounted for 48 per cent of world trade in processed foodstuffs while exports from developed to developing countries accounted for only 13 per cent of this trade. Exports from developing to developed countries accounted for 31 per cent, while trade between developing countries amounted to only 8 per cent. Thus, almost four fifths of exports went to the developed countries; trade among developing countries was of minor significance.

Almost 20 per cent of total exports were meat products. Other important components of the total were grain mill products (14 per cent), food products not elsewhere classified (13 per cent), fats and oils (12 per cent), sugar (11 per cent) and dairy products (10 per cent). Meat products were the most important export from developed to developed countries (33 per cent), and grain mill products accounted for 26 per cent of exports from the developed to the developing countries. Miscellaneous food products, grain mill products and sugar were important exports of the developing countries.

[129]Export value for a sample of 87 countries.

TABLE III.20. SHARES OF THE DEVELOPED AND THE DEVELOPING COUNTRIES IN WORLD TRADE IN PROCESSED FOODSTUFFS, 1975

(Percentage)

		1		2		3		4		5		6		7		8		9	
		Exports from developed to developed		*Exports from developed to developing*		*Exports from developing to developed*		*Exports from developing to developing*		*Exports from developed (columns 1 + 2)*		*Exports from developing (columns 3 + 4)*		*Imports to developed (columns 1 + 3)[c]*		*Imports to developing (columns 2 + 4)[c]*		*World exports (columns 1 + 2 + 3 +4)*	
Product	*ISIC*	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]	*A*[a]	*(B)*[b]
Meat slaughtering, preserving, preparing	3111	32.6	(81.4)	14.0	(9.3)	5.1	(8.0)	3.3	(1.3)	28.7	(90.7)	4.6	(9.3)	21.9	(89.4)	9.9	(10.6)	19.4	(100.0)
Dairy products manufacture	3112	15.7	(75.3)	18.6	(23.6)	0.1	(0.2)	1.1	(0 9)	16.3	(98.9)	0.3	(1.1)	9.6	(75.5)	11.9	(24.5)	10.1	(100.0)
Fruits and vegetables, canning and preserving	3113	9.1	(67.6)	3.9	(7.7)	4.5	(21.2)	2.9	(3.5)	8.0	(75.3)	4.2	(24.7)	7.3	(88.8)	3.5	(11.2)	6.6	(100.0)
Fish canning, preserving, processing	3114	6.5	(55.6)	5.3	(12.0)	5.5	(29.7)	1.9	(2.6)	6.2	(67.6)	4.7	(32.3)	6.1	(85.3)	4.0	(14.6)	5.6	(99.9)
Vegetables and animal oils and fats manufacture	3115	10.7	(43.0)	14.2	(15.1)	12.6	(32.2)	14.7	(9.6)	11.5	(58.1)	13.1	(41.8)	11.5	(75.2)	14.4	(24.7)	12.1	(99.9)
Grain mill products	3116	4.3	(15.2)	26.2	(24.8)	20.7	(47.0)	22.2	(13.0)	8.8	(40.0)	21.0	(60.0)	10.7	(62.2)	24.7	(37.8)	13.6	(100.0)
Bakery products	3117	2.1	(86.4)	1.0	(10.8)	0.1	(1.5)	0.2	(1.4)	1.8	(97.2)	0.1	(2.9)	1.3	(87.9)	0.7	(12.2)	1.2	(100.1)
Sugar factories and refineries	3118	6.4	(27.9)	8.6	(10.0)	14.0	(39.0)	32.3	(23.1)	6.9	(37.9)	17.8	(62.1)	9.4	(66.9)	1.7	(33.1)	11.1	(100.0)
Cocoa, chocolate and sugar confectionery manufactures	3119	5.5	(40.6)	1.6	(3.1)	11.4	(53.9)	1.9	(2.3)	4.7	(43.7)	9.5	(56.2)	7.8	(94.5)	1.7	(5.4)	6.5	(99.9)
Food products not elsewhere classified	31	5.2	(20.0)	4.3	(4.3)	26.0	(63.6)	19.3	(12.2)	5.0	(24.3)	24.7	(75.8)	13.3	(83.6)	10.0	(16.5)	12.6	(100.1)
Prepared animal feeds	3122	2.0	(75.3)	2.4	(23.5)	—	(0.6)	0.1	(0.7)	2.1	(98.8)	—	(1.3)	1.2	(75.9)	1.5	(24.2)	1.3	(100.1)
Food manufactures	311-312	100.1	(48.4)	100.1	(12.8)	100.0	(30.8)	99.9	(7.9)	100.0	(61.2)	100.0	(38.7)	100.1	(79.2)	100.1	(20.7)	100.1[d]	(99.9)

Source: Data supplied by the United Nations Statistical Office.

Note: Data based on a concordance between ISIC and SITC rev. 2, using a sample of 87 countries.

[a]Share of four-digit category in total for food manufactures (i.e. sum downwards).

[b]Share of trade grouping in world total (i.e. sum across, where columns 1 + 2 + 3 + 4 = columns 5 + 6 = columns 7 + 8 = column 9).

[c]Import shares based on value of exports to importing region.

[d]World exports of food manufactures equals $54,928.2 million. On the basis of this value, all shares shown in the table can be converted into dollar values.

Of the major trading countries, five accounted for 40 per cent of the exports of food products in 1975,[130] and six countries absorbed almost 60 per cent of total imports. The same countries are both major exporters and major importers of most food products. This phenomenon may be explained by product specialization within the four-digit ISIC groups, imports for processing and re-export (e.g. the Netherlands), trade at different entry/exit points in a large country (e.g. the United States) and seasonal effects. Among the developing countries, Brazil was a leading exporter of fats and oils, grain mill products, sugar, cocoa and sugar-based products, and products not elsewhere classified (n.e.c.). Other important developing country exporters were Colombia (grain mill products and food products n.e.c.); India (sugar and food products n.e.c.); the Philippines (sugar); Thailand (fruit and vegetable processing); and Ghana, the Ivory Coast and Mexico (all sugar and cocoa-based products).

In examining trade patterns it is important to understand the relationship between production, consumption and trade, for imports and exports reflect imbalances in the capabilities of local producers and in the demand of consumers. Other things being equal, exports (imports) can be expanded more easily, in percentage terms, when the share of exports in domestic production (imports in domestic consumption) is small than when the share is large. For example, when the export/output (import/consumption) ratio is 5 per cent, a 10 per cent increase in production (consumption) could result in a 200 per cent increase in exports (imports), whereas when the same export/output ratio is 50 per cent, a 10 per cent increase in production (consumption) could result in an increase in exports of only 20 per cent. Thus, ratios of export/output (import/consumption) are important in explaining the volatility of trade flows.

Table III.21 shows gross output, net imports and apparent consumption of food products in 28 countries for two years in the early and mid-1970s. Export/output and import/consumption ratios varied widely among countries as might be expected. The variations between the first and second years for many individual countries were also great, however. A comparison of the two years reveals that the export/output ratio increased for 16 countries and declined for only 10 and the import/consumption ratio increased for 18 countries and declined for only 9, suggesting a general increase in the importance of trade. The table shows the difference in structure of two countries, Brazil and the United States, both of which were large exporters, but with the difference that the former was export-market-oriented and the latter was home-market-oriented. The table also indicates that for individual countries high export/output ratios do not necessarily mean low import/consumption ratios.

Finally, for many countries import/consumption ratios are closely related to import restrictions. The major importers of food manufactures generally apply tariffs that tend to increase with the level of processing, so that effective protection (i.e. protection, net of duties on inputs, afforded value added) for agricultural activities such as animal rearing is usually low or nil, higher for intermediate activities such as slaughtering and packing, and highest for industrial activities such as the preparation of meat products. Such escalation

[130]The major exporters were Brazil, France, the Federal Republic of Germany, the Netherlands and the United States. Major importers were France, the Federal Republic of Germany, Italy, Japan, the United Kingdom and the United States.

TABLE III.21. FOOD MANUFACTURING (ISIC 311-312): GROSS OUTPUT, NET IMPORTS, APPARENT CONSUMPTION, SHARE OF EXPORTS IN PRODUCTION AND SHARE OF IMPORTS IN CONSUMPTION, FOR 28 COUNTRIES AND AREAS, EARLY AND MID-1970s[a]

Country (years covered)	Gross output		Net imports		Apparent consumption		Share of exports in output		Share of imports in consumption	
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
	(Million dollars at current prices)						(Percentage)			
Australia (1970, 1976)	4 236	8 772	—868	—2 202	3 368	6 570	25	31	6	7
Austria (1970, 1975)	996	2 444	174	322	1 170	2 766	7	8	2'	19
Brazil (1970, 1974)	5 562	12 270	—2 404	—4 173	3 158	8 097	45	37	3	4
Canada (1970, 1976)	8 156	17 799	233	1 083	8 389	18 882	7	6	9	12
Denmark (1970, 1976)	2 055	4 691	—628	—1 471	1 427	3 220	48	53	25	23
Egypt (1970, 1973)	571	964	3	14	574	978	18	10	19	11
Finland (1970, 1977)	1 622	3 749	210	516	1 832	4 265	5	6	16	17
France (1970, 1977)	6 302	15 876	785	3 503	7 087	19 379	19	29	28	42
Germany, Federal Republic of (1970, 1977)	11 831	36 133	2 604	6 596	14 435	42 729	7	13	24	27
Greece (1970, 1975)	623	2 317	88	19	711	2 336	18	15	28	16
Hong Kong (1973, 1976)	183	255	556	757	739	101	17	41	79	85
India (1970, 1976)	3 678	5 932	—428	—1 291	3 250	4 641	15	25	4	5
Indonesia (1970, 1976)	390	992	—98	—273	292	719	57	97	43	96
Iran (1970, 1974)	557	1 174	28	557	585	1 731	12	11	17	39
Iraq (1972, 1975)	195	715	86	519	281	1 234	11	3	38	44
Italy (1970, 1976)	5 493	13 687	1 263	3 665	6 756	17 352	9	9	26	28
Japan (1970, 1976)	15 440	47 016	798	5 050	16 238	52 066	4	1	8	
Malaysia (1970, 1974)	289	1 170	—37	—167	252	1 003	76	58	72	
Mexico (1970, 1976)	1 322	2 642	—287	—595	1 035	2 047	29	29	10	8
Netherlands (1970, 1975)	6 558	14 994	—905	—2 409	5 653	12 585	32	35	21	29
New Zealand (1970, 1976)	1 222	2 358	—700	—1 194	522	1 164	62	57	11	13
Norway (1970, 1976)	1 573	3 606	—25	—103	1 548	3 503	16	21	14	19
Philippines (1970, 1974)	638	2 136	—270	—1 036	368	1 102	56	59	23	21
Spain (1970, 1976)	2 871	8 236	1	384	2 872	8 620	16	12	16	16
Sweden (1970, 1976)	3 037	6 045	510	1 199	3 547	7 244	4	5	18	21
United Kingdom (1970, 1976)	12 460	25 767	3 052	4 598	15 512	30 365	4	6	23	21
United States (1970, 1976)	87 590	162 700	3 081	5 292	90 671	167 992	3	4	6	7
Yugoslavia (1970, 1976)	985	5 033	51	279	1 036	5 312	19	6	23	11

Source: Data supplied by the United Nations Statistical Office.

[a]Countries with imports or exports of at least $500 million in latest reporting year. Algeria, Argentina, Belgium, Colombia, Ghana, Ivory Coast, Saudi Arabia, Singapore and Switzerland qualify under this criterion, but they are excluded because of deficient data.

in effective protection, where it exists, may inhibit processing activities in exporting countries even when nominal tariffs seem low. Furthermore, many processed foods are excluded from the generalized system of preferences (GSP), and imports are often subject to health and sanitary regulations and other non-tariff barriers (especially for EEC countries).

The recent Tokyo Round of trade negotiations resulted in some reductions of tariffs on food manufactures, but in general the changes were not great.[131] Two multilateral arrangements were agreed upon, however, one for bovine meat and the other for dairy products. Under the arrangement regarding bovine meat, which covers beef, veal and live cattle and is intended to expand, liberalize and stabilize trade, an International Meat Council was established to promote consultation among trading countries. The international dairy arrangement is designed to stabilize trade through setting minimum prices by an international dairy product council.

Space does not permit a detailed examination of all import restrictions on food manufactures, but a brief summary of barriers set up by the three main importers, Japan, the United States and EEC, to imports of meat products, the largest component of trade in food manufactures,[132] is worthwhile. In EEC, imports face numerous, complex NTBs and variable levies often expressed in specific terms, so that their total impact cannot easily be determined. The restrictive effect on imports is considerable. Few items are subject to GSP or Tokyo Round concessions. Cattle are subject to a 16 per cent *ad valorem* rate plus a variable levy, and veal cattle are subject to licensing, health and administrative regulations, and, in Denmark, to prohibition. Pigs and poultry are subject to variable levies, and poultry is subject to administrative regulation, health regulation (United Kingdom) and prohibition (France, Denmark). Sheep enter at a 15 per cent rate of duty, along with various restrictions (licensing, global quotas, prohibition, minimum price system, administrative regulation) by individual countries. Beef faces a duty of 20 per cent plus variable levy (tariff quota) and it must meet health requirements (beef is prohibited in Italy and Denmark). A variable levy is imposed on pork; and prohibition and health, price and administrative regulations are imposed by individual countries. Other meats are subject to a 20 per cent duty plus country restrictions. Preparations of beef enter at a rate of 26 per cent, excepting a 17 per cent rate for GSP recipients, and are subject to health, packaging, labelling and price regulation (prohibition in Denmark). Other meat preparations are mostly subject to variable levies and country regulations.

In Japan, live animals enter duty-free, but the tariff on meat ranges from 7.5 per cent (sheep, lambs, goats) to 25 per cent (beef and veal); for most prepared or preserved meat (ham, bacon, sausages etc., except offals), the rate is 25 per cent. Health and sanitary regulations must be met and, for beef and veal products, discretionary licensing and quotas are applied. Few items are subject to the GSP or Tokyo Round tariff cuts.

The United States is the most liberal of the three major importers of meat products. Tariff rates are mostly well below 10 per cent (exceptions are quail,

[131] See GATT, Doc. MTN/27, 11 April 1979.

[132] Based on "Statistics relevant to the evaluation of the impact of trade on the export of primary and processed commodities of developing countries" (UNCTAD/CD/230) and "Meat and meat preparations" (UNCTAD/CD/230/Add.1), 14 March 1980.

turkey and bird meat, especially after many Tokyo Round cuts), and some items are subject to tariff quotas (many also eased in the Tokyo Round) and health regulations. Beef cattle enter at rates of 5.1 to 11.9 per cent (3.2 to 4.8 per cent post-Tokyo), depending on weight and whether or not within the quota; the rate for pigs is 1 4 per cent (0 post-Tokyo) and sheep and lambs enter duty-free. Beef and veal are subject to a rate of 5.1 per cent (3.4 per cent post-Tokyo) except where value exceeds 30 cents per pound (10 per cent being reduced to 4 per cent), and quotas (being eased) and health and other regulations. Sheep, lamb, goat and pork meats enter at lower rates of duty. Corned beef (GSP entry) and beef in airtight containers are subject to a rate of 7.5 per cent (3.0 per cent post-Tokyo) and health regulations. For other prepared meats such as pork sausages and pork preparations rates are lower.

Appendix

WORLD PRODUCTION OF PROCESSED FOODSTUFFS (ISIC 311-312), 1968-1977,[a] AND SHARES OF MAIN PRODUCERS, 1977, BY SIX-DIGIT ISIC CLASSIFICATION

(Thousand metric tons and annual index numbers (1970 = 100))

Product	*ISIC*	*1968*	*1969*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*Share of main producers,[b] 1977 (percentage)*
Beef and veal (fresh, chilled, frozen)	311101	36 249 95.9	37 191 98.4	37 541 99.4	37 704 99.8	37 882 100.3	41 172 109.0	42 124 111.5	44 447 117.6	44 607 118.1	USA (26), USSR (10), Argentina (7), Brazil (5), China (5)
Mutton and lamb (fresh, chilled, frozen)	311104	6 350 96.4	6 351 96.4	6 707 101.8	6 805 103.3	6 566 99.6	6 370 96.7	6 570 99.7	6 637 100.7	6 640 100.8	China (11), Australia (8), New Zealand (8), USSR (6), India (6), Turkey (6)
Pork (fresh, chilled, frozen)	311107	31 500 91.8	31 837 92.8	37 527 109.4	38 197 111.3	38 700 112.8	41 146 119.9	40 803 118.9	40 897 119.2	42 819 124.8	China (32), USA (14), Germany, Federal Republic of (6), USSR (6)
Poultry, dressed (fresh, chilled, frozen)	311110	12 525 84.1	13 495 90.6	15 544 104.4	16 506 110.9	17 277 116.0	18 169 122.0	18 563 124.7	19 969 134.1	20 955 140.8	USA (25), China (16)
Other meat (fresh, chilled, frozen)	311113	1 236 90.9	1 290 94.9	1 432 105.3	1 483 109.0	1 433 105.4	1 472 108.2	1 548 113.8	1 457 107.1	1 472 108.2	USSR (52)
Bacon, ham, other dried, smoked, salted pig meat	311116	1 373 96.4	1 426 100	1 484 104.1	1 440 101.1	1 459 102.3	1 474 103.4	1 458 102.3	1 552 108.9	1 549 108.7	Denmark (15), UK (14), Romania (14), Japan (9), Austria (5), Canada, Netherlands
Sausages	311122	2 038 73.9	2 131 77.3	3 052 110.7	3 240 117.5	3 214 116.5	3 253 117.9	3 455 125.3	3 916 142.0	4 109 149.0	Poland (20), Germany, Federal Republic of (13), France (6), Dominican Republic
Meat, tinned	311128	1 656 97.1	1 563 91.7	1 823 106.9	2 023 118.7	2 036 119.4	2 064 121.1	2 117 124.2	2 078 121.9	2 113 123.9	USSR (16), Poland (8), UK (6), USA
Lard	311131	3 426 94.5	3 321 91.6	3 959 109.2	3 853 106.2	3 725 102.7	4 003 110.4	3 925 108.2	3 710 102.3	3 941 108.7	USSR (18), China (17), USA (12), Germany, Federal Republic of (10)

Hides, cattle and horse, undressed	311134	5 040 98.8	5 048 99.7	5 009 98.2	5 061 99.2
Skins, calf, goat, sheep	311137	730 103.3	717 101.6	710 100.6	682 96.6
Milk and cream, condensed	311201	4 857 98.1	4 925 99.5	5 082 102.7	4 607 93.1
Milk and cream, dried	311204	4 176 104.2	4 024 100.4	4 137 103.2	4 630 115.5
Butter	311207	5 711 103.4	5 592 101.3	5 538 100.3	5 855 106.0
Cheese	311210	7 136 93.2	7 344 95.9	8 001 104.5	8 418 110.0
Fruits, dried	311301	1 015 103.5	997 101.6	882 89.9	804 82.0
Jams, marmalades and fruit jellies	311304	1 408 93.5	1 462 97.1	1 523 101.1	1 574 104.5
Fruits, frozen	311313	440 103.8	432 101.9	440 103.8	437 103.1
Fruits, tinned or bottled	311316	5 063 98.8	5 350 104.4	5 050 98.6	4 897 95.6
Vegetables, frozen	311319	2 11 .5	2 582 89.9	2 936 102.2	3 205 111.6
Vegetables, tinned or bottled	311322	10 877 96.7	10 529 93.4	11 514 102.3	11 778 104.6

5 109	5 321	5 692	5 864	6 034	USA (21), India (13),
100.2	104.3	111.6	115.0	118.3	Argentina (7), China (6), Brazil (6)
637	634	654	680	644	France (9), New Zealand,
90.2	89.8	92.6	96.3	91.2	Australia, Turkey, Argentina
4 652	4 589	4 478	4 663	4 792	USA (20), USSR (12),
94.0	92.7	90.5	94.2	96.8	Netherlands (11), Germany, Federal Republic of (10)
4 837	4 912	5 316	5 378	5 615	France (14), USA (14),
120.7	122.5	132.6	134.1	140.1	Germany, Federal Republic of (12), USSR (6), UK (5)
6 012	5 964	6 211	6 378	6 636	USSR (21), India (9),
108.9	108.0	112.5	115.5	120.2	Germany, Federal Republic of (8), France (8), USA (7)
8 631	9 086	9 220	9 830	10 101	USA (15), France (9),
112.7	118.7	120.4	128.0	131.9	Germany, Federal Republic of (12), USSR (6), Italy (6), India
983	822	890	849	848	Turkey (17), USSR (6), USA,
100.2	83.8	99.9	95.3	95.2	Greece, Italy, Iran
1 636	1 629	1 571	1 692	1 641	USSR (20), Germany,
108.6	108.2	104.3	112.4	109.0	Federal Republic of (11), France
482	466	452	517	523	USA (55), Poland (17)
113.7	109.9	106.6	121.9	123.3	
5 257	5 603	4 999	5 157	5 087	USA (36), USSR (8),
102.6	109.4	97.6	100.7	99.3	Japan (7), South Africa (5)
3 529	3 803	3 705	3 866	4 380	USA (65), UK (8), Canada
122.8	132.4	129.0	134.6	152.5	
12 663	13 735	14 037	13 115	14 139	USA (37), USSR (15),
112.5	122.1	124.7	116.5	125.6	UK (6), France

Appendix (continued)

Product	*ISIC*	*1968*	*1969*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*Share of main producers,[b] 1977 (percentage)*
Fish, frozen	311401	3 720 92.9	3 690 92.1	4 413 110.2	4 485 112.0	4 909 122.6	4 730 118.1	4 766 119.0	5 140 128.3	5 392 134.6	Japan
Fish, salted, dried or smoked	311404	2 961 98.4	2 993 99.4	2 970 98.7	3 158 104.9	3 161 105.0	3 224 107.1	3 358 111.6	3 399 112.9	3 325 110.5	Japan (22), USSR (20), Indonesia (10)
Fish, tinned	311407	1 968 89.9	1 994 91.1	2 337 106.7	2 461 112.4	2 558 116.8	2 717 124.1	2 789 127.4	2 886 131.8	3 064 139.9	USSR (28), Japan (13), USA (12)
Margarine, imitation lard, other prepared fats	311501	6 882 93.4	7 127 96.8	7 608 103.3	8 019 108.9	8 189 111.2	8 240 111.9	8 389 113.9	8 932 121.3	9 103 123.6	USA (32), USSR (13), Germany, Federal Republic of (7), UK (5)
Oils and fats of aquatic animal origin	311504	1 737 107.2	1 526 94.1	1 714 105.7	1 477 91.1	1 350 83.3	1 496 92.3	1 446 89.2	1 363 84.1	1 328 81.9	Japan (14), UK (12), USSR (9), Peru (8), Denmark (7), Norway
Oils and fats of animals, unprocessed	311507	4 483 97.6	4 475 97.4	4 853 105.6	4 839 105.3	4 819 104.9	5 439 118.4	5 020 109.3	5 477 119.2	5 753 125.2	USA (53), USSR (6), Australia
Oil, soya bean, crude	311510	4 475 73.3	5 222 85.5	6 428 105.2	7 060 115.6	7 097 116.2	8 759 143.4	8 538 139.8	9 774 160.0	9 778 160.1	USA (41), Brazil (20), China (7), Japan (5), Germany, Federal Republic of
Oil, soya bean, refined	311513	2 842 82.9	3 193 93.1	3 482 101.5	3 801 110.8	3 672 107.1	4 103 119.6	3 958 115.4	4 411 128.6	4 700 137.0	USA (75), Brazil
Oil, cotton-seed, crude	311516	2 060 91.3	2 321 102.8	2 303 102.0	2 584 114.5	2 648 117.3	2 745 121.6	2 652 117.5	2 350 104.1	2 678 118.7	USSR (25), USA (21), Egypt (6), China
Oil, cotton-seed, refined	311519	845 98.3	1 001 116.4	799 92.9	958 111.4	999 116.2	948 110.3	864 100.5	689 80.1	829 96.4	USA (62), Mexico (8), Sudan
Oil, ground-nut, crude	311522	3 189 103.5	2 855 92.7	3 129 101.6	3 198 103.8	2 646 85.9	2 751 89.3	2 862 92.9	3 296 107.0	3 167 102.8	India (45), China (12), Sudan (8), Senegal (6)
Oil, ground-nut, refined	311525	449 121.7	397 107.7	346 93.8	363 98.4	381 103.3	336 91.1	318 86.2	379 102.7	387 104.9	USA (29), Portugal (9), Senegal, Sudan, Dominican Republic

Oil, olive, crude	311528	1 520 107.4	1 430 101.1	1 663 117.5	1 634 115.5
Oil, olive, refined	311531	64 59.3	83 76.9	126 116.7	129 119.4
Oils, other, of vegetable origin, crude	311534	6 653 93.4	6 968 97.8	7 755 108.9	8 277 116.2
Oils, other, of vegetable origin, refined	311537	3 841 92.8	4 020 97.1	4 370 105.5	4 593 110.9
Flour, wheat	311601	113 791 93.7	115 368 95.0	21 857 100.4	125 549 103.4
Meal and groats of all cereals	311604	8 977 96.3	8 752 93.9	9 149 98.2	9 505 102.0
Flour, cereal, other than wheat	311607	4 790 105.1	4 415 96.8	4 401 96.5	4 435 97.3
Cereal breakfast food	311610	1 304 95.5	1 318 96.5	1 365 99.9	1 407 103.0
Macaroni, and noodle products, uncooked	311701	5 820 97.7	5 961 100.1	6 144 103.1	6 496 109.0
Bread, ship's biscuits and other ordinary bakers' wares	311704	47 087 97.5	47 159 97.7	49 787 103.1	50 281 104.1
Biscuits	311707	3 690 95.1	3 845 99.1	3 972 102.4	4 134 106.5
Raw sugar	311801	65 188 91.4	68 619 96.3	72 204 101.3	74 448 104.4
Refined sugar	311804	44 396 93.2	46 267 97.1	46 940 98.5	47 295 99.2

1 612	1 604	1 953	1 615	1 509	Italy (34), Spain (25),
113.9	113.4	138.0	114.1	106.6	Greece (17), Turkey (5)
150	136	141	153	147	Spain (73), Turkey (18)
138.9	125.9	130.6	141.7	136.1	
8 363	8 522	9 072	9 610	9 995	Malaysia (12), Japan (6),
117.4	119.6	127.3	134.9	140.3	Argentina (6), Indonesia (5), France, Philippines, Nigeria, USA, Netherlands
4 966	4 634	4 985	5 057	5 351	USA (13), UK (8),
119.9	111.9	120.4	122.1	129.2	Romania (7), Belgium (6), Netherlands, Argentina
125 582	124 668	125 399	129 138	130 444	USSR (33), USA (9),
103.4	102.7	103.3	106.4	107.4	Italy (6)
10 623	10 553	10 602	10 823	11 095	USSR (36), Italy,
114.0	113.1	113.7	116.1	119.0	Australia, Algeria
4 569	4 615	4 546	7 987	7 850	Dominican Republic (43),
100.2	101.2	99.7	175.2	172.2	Poland (11)
1 440	1 466	1 474	1 521	1 539	UK (15), USA, Canada
105.4	107.3	107.9	111.3	112.7	
6 785	6 670	6 826	7 212	7 316	Italy (27), USSR (20),
113.9	112.0	114.6	121.0	122.8	Japan
50 263	49 764	50 536	51 934	50 979	USSR (66), Poland (7)
104.1	103.0	104.6	107.5	105.6	
4 324	4 490	4 463	4 755	4 900	USSR (13), UK (13),
111.4	115.7	115.0	122.6	126.3	France (7), Italy, Japan
76 772	77 649	79 786	84 630	86 960	USSR (10), Brazil (10),
107.7	108.9	111.9	118.7	122.0	Cuba (8), USA (6), India (6)
49 949	49 359	50 358	51 567	57 060	USSR (21), USA (18),
104.8	103.6	105.7	108.2	119.7	India (8), Germany, Federal Republic of (6)

Appendix (continued)

Product	*ISIC*	*1968*	*1969*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*Share of main producers,[b] 1977 (percentage)*
Fruit, glacé or crystallized	311901	44 102.3	44 102.3	41 95.3	43 100	39 90.7	38 88.4	39 90.7	37 86.0	36 83.7	USA, Canada, Brazil, Australia
Sugar confectionery	311904	4 315 94.0	4 545 99.0	4 692 102.2	4 398 95.8	4 491 97.9	4 544 99.0	4 367 95.2	4 541 99.0	4 872 106.2	USSR (35), Japan (8), UK (8), Germany, Federal Republic of (7)
Cocoa powder	311907	176 93.6	176 93.6	191 101.6	195 103.7	194 103.2	207 110.1	216 114.9	231 122.9	222 118.1	Germany, Federal Republic of (21), UK (9), France (8), Ivory Coast (6), Cameroon (5)
Cocoa butter	311910	174 100.6	171 98.8	186 107.5	205 118.5	199 115.0	197 113.9	198 114.5	200 115.6	197 113.9	Germany, Federal Republic of (17), Brazil (10), Ghana (9), UK (6), Ivory Coast (6), Netherlands
Chocolate and chocolate products	311913	2 238 98.6	2 248 99.0	2 504 110.3	2 659 117.1	2 812 123.9	2 809 123.7	2 772 122.1	2 955 130.2	2 736 120.5	Germany, Federal Republic of (15), UK (15), USSR (12), France (8), Netherlands
Coffee extracts, essences and concentrates	312101	189 97.9	193 100.0	239 123.8	215 111.4	238 123.3	246 127.5	279 144.6	269 139.4	288 149.2	India (36), Germany, Federal Republic of (6), USA, Australia
Prepared animal feeds	312201	72 548 81.3	80 266 90.0	93 204 104.5	102 624 115.0	118 347 132.6	119 595 134.0	121 970 136.7	133 726 149.9	140 854 157.9	Japan (14), France (9), UK (8), Germany, Federal Republic of (7), Poland (6), Netherlands, Italy

Source: Derived from *Yearbook of Industrial Statistics*, 1977 edition, volume II. Population index numbers derived from "Single-year population estimates and projections for major areas, regions and countries of the world, 1950-2000" (ESA/P/WP.56).

[a]Production index numbers may be compared with the following population index numbers:

1968	*1969*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*
96.3	98.2	100	101.9	103.8	105.8	107.8	109.9	112.0	114.2

[b]Countries with shares of 5 per cent or more of world production. Countries listed without shares did not report data for 1977; their last reported production was at least 5 per cent of 1977 world production.

IV. ENERGY REQUIREMENTS IN THE MANUFACTURING SECTOR

Energy supplies and requirements are national and international issues of the highest priority. This chapter is concerned with the response of industry to changing conditions in world energy markets, which have implications for the restructuring process. Two types of structural adjustment are emphasized in the discussion. One relates to the effects that adjustments in energy prices may have on the choice of location for industrial processing capacity. The second pertains to energy-induced changes in industrial technology. A survey is first given of the developing countries' involvement in world production and trade in energy. The discussion then turns to an analysis of the empirical evidence among specific industrial branches, with a review of energy expenditures and recent technological changes. Some considerations of international policy arising out of the discussion are pointed out. The chapter concludes with a country study based on the experience of India.

A. THE IMPLICATIONS OF WORLD ENERGY NEEDS FOR INDUSTRY IN DEVELOPING COUNTRIES

Long-term adjustments to changing energy conditions promise to accelerate the pace of structural change and to alter the pattern of industrial growth in all countries. As the developing countries' share of world manufacturing value added rises, so too will their energy requirements both in absolute terms and relative to the requirements of the developed countries. While oil is at present the preferred source of energy, its consumption should fall as other energy sources progressively replace it. The two main alternatives are coal and nuclear energy. Coal, though abundant, is unevenly distributed; only a few developing countries possess adequate deposits.

Most developing countries have no alternative to their continued dependence on conventional energy sources. Furthermore, this dependence may grow as agriculture is modernized and industry expands. Currently, about 25 per cent of total world oil production is said to be consumed in developing countries. If the global changes discussed elsewhere in this *Survey* continue, this share will clearly rise in the future.

Energy and industrial processing of raw materials

Recent energy forecasts and likely policy responses suggest that energy shortages or inadequate access to energy supplies in even a limited number of

countries may have serious international consequences. It is difficult, however, to relate structural changes or policy prescriptions to forecasts of such magnitude.

Once the discussion is focused on the manufacturing sector, the consequences of energy shortages for the growth of industrial capacity and its location become apparent. As part of their industrial strategy, many developing countries attach a high priority to increasing the extent of local processing of raw materials. Three microeconomic cases provide instructive examples of the ways in which energy has altered the economics of industrial processing.

A classic example pertains to the differential changes in the selling prices of competitive products that can be attributed to adjustments in the price of energy. A comparison of jute and its major competitor, polypropylene, serves as a case in point. During the 1950s and 1960s, demand for jute in such end-uses as carpet backing, linoleum backing, bags and sacks and other industrial purposes declined markedly, chiefly because of the growing acceptance of polypropylene, a cheap synthetic substitute. A steadily narrowing price spread,[1] coupled with frequent technical advances and a strong marketing effort, all helped to displace jute. The substitution process was rapid. In the United Kingdom, jute's market share ranged from 71 per cent (for carpet backing) to 88 per cent (for bags, sacks etc.) in 1966. By 1973, the corresponding market shares were 5 and 50 per cent, respectively. Polypropylenes had a negligible share of both markets in the earlier year, but, by 1973, had captured 84 per cent of the market for carpet backing and 50 per cent of that for bags and sacks.[2]

The upward trend in energy costs during the late 1970s widened markedly the price differential, so that polypropylene cost twice as much as raw jute per ton. By autumn 1979, after further increases in energy costs, the Indian Commerce Ministry was able to contemplate removing its export subsidy on hessian and related jute items. Rapid domestic growth of demand for jute sacks (notably for the output of the fertilizer and cement industries) in the late 1970s also helped resuscitate the industry.[3]

A second case demonstrates how competition between producers of the same product at different locations may be affected by changes in energy prices. Chipboard producers in developed countries experienced considerable difficulties after the oil price adjustments in 1973 owing to the rising cost of drying wood.[4] Ironically, this same factor also acted to relieve import competition from developing countries by causing a sharp increase in the landed price of chipboard and particleboard made in developing countries as the result of augmented shipping fuel costs. For the first time in years producers in developed countries gained a significant price advantage.[5] The volume of

[1] The price spread between the two products in dollars/tons had narrowed almost to equality by 1966, although only in one year, 1972, did jute actually cost more than polypropylene polymer.

[2] See S. McDowell and P. Draper, *Trade Adjustment and the British Jute Industry: A Case Study* (London, Overseas Development Institute, 1978), pp. 15-17.

[3] *Financial Times*, 4 September 1979.

[4] See section D of this chapter for details.

[5] *Financial Times*, 10 July 1979.

imports to the United Kingdom fell 16 per cent in 1978 while domestic manufacturers increased their sales by 45 per cent. Thus, items with a low value-to-weight ratio have encountered greater competition as the price of tanker fuel has risen.

A third example concerns the rising costs of fuel subsidies, a traditionally favoured form of industrial aid in developed countries. As the real cost of energy has risen, the cost of public subsidies to energy-intensive processing facilities has risen correspondingly. Primary aluminium processing in the United Kingdom is an example. In 1968, cheap energy inputs were ensured by the Government to induce the construction of smelters in areas of high unemployment. Since that time the price of electricity has risen appreciably. The best-practice technology, using the conventional Hall-Heroult method of processing alumina into aluminium, led to a 40 per cent drop in net energy requirements. Consequently, between 1950 and 1975 electricity input per ton of output fell from 79 to 47 giga joules. None the less, the industry remains an intense user of electricity.[6] The steadily rising cost of subsidizing this energy input has become a substantial burden with political ramifications.[7]

A problem similar to that encountered in the United Kingdom may soon emerge in the main centre of aluminium production in the United States, the Pacific north-west, where the successful attraction of industry to the hydro-electric power network built in the 1930s has led to excessive power demand. The Bonneville Power Authority (the chief hydropower agency) proposed that energy prices be raised 173 per cent unless some form of state or federal subsidy was provided. The legislation now through the United States Congress (but not yet signed by the President) would increase aluminium producers' power costs from 0.14 cents per kilowatt hour (kWh) to about 1.2 cents per kWh. While the region will remain one with relatively low-cost energy, such a large jump in prices might induce investors seriously to consider alternative sites.[8] At the least, both cases suggest that relocation or retrenchment may follow from a Government's reluctance to subsidize energy inputs.

In each of these cases the output mix, the location of production facilities, or the technology used to produce a certain product was altered in response to changing energy-input costs. As adjustments in the price of energy continue, the relative costs of various industrial inputs (e.g. raw materials, labour, machinery and capital equipment, energy) will change. Depending on the input mix, the costs and availability of energy may become an even more important determinant of the location of industrial processing facilities in the future. Similarly, as Governments persist in subsidizing energy costs or in maintaining artificially low energy prices, the relationship between industrial location and energy considerations will become more complex. While the survey of a wide range of production processes that follows indicates that industrial adjustments may be considerable, in only a few instances can relocation to developing countries be attributed to changing energy costs.

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[6] G. Leach and others, *A Low Energy Strategy for the United Kingdom* (London Science Reviews Press, 1979), p. 55.

[7] *Guardian*, 31 August 1979.

[8] *Metal Bulletin Monthly*, December 1978, p. 33.

Energy-induced technological change

The second form of structural adjustment discussed here concerns innovational responses to changing energy conditions and their consequences for industry. The rise in the price of energy compared with the price increases of other inputs has changed drastically the current economics of many industrial processes. In many instances, however, the current investment plans, rationalization programmes and research programmes of leading producers have been undertaken prior to this basic alteration in relative prices. Most of these programmes were formulated with the implicit assumption that the relative price of energy in the early 1980s would differ little from that in the early 1970s. Firmly committed to development programmes by the mid-1970s, such enterprises were caught unprepared when this assumption proved to be highly erroneous. Many are just beginning to respond concretely to the new set of relative prices.

Previous experience has led one economist, M. A. Adelman, to liken relative prices to a glacial drift, "imperceptible in the short run, irresistible in the long run".[9] He argues that structural adjustments will be slow in coming because *(a)* economies naturally respond slowly to changes in relative prices and *(b)* oil-product prices have risen much less sharply than crude prices. For these reasons perhaps no more than one half of the structural adjustments associated with the change in energy prices have so far been realized. Recent calculations by the International Energy Agency show that the difference between short-term and long-term adjustments is considerable. For example, a 1 per cent rise in real energy costs reduces energy demand by only 0.15 per cent in the short term. In the long term, however, as the stock of capital assets is adjusted to the new price pattern, the same increase in the real price of energy will reduce energy demand by 0.45 per cent.[10] Adelman estimates that only by 1990 will energy use per unit of GNP be reduced by 20 per cent or more in many developed countries.[11]

In fact, savings in energy by the industrial sector during the 1970s typically exceeded those of other economic sectors. In 1978, when the real price of oil was falling in the United States, industry used only four fifths as much energy per unit of output as it did in 1973. In comparison, the final energy consumption per unit of GDP dropped only 8 per cent between 1973 and 1978.[12] A similar pattern was noted in Western Europe where Government efforts to spur research in energy fields and to restrain energy consumption by households have been less encouraging. A significant research programme is naturally important for long-term progress in this area. Figure I shows government expenditures on energy research per unit of energy consumed in selected developed market economies. Total spending reached $7 billion in 1979. In real terms, expenditures exceeded the 1974 level by 130 per cent—a

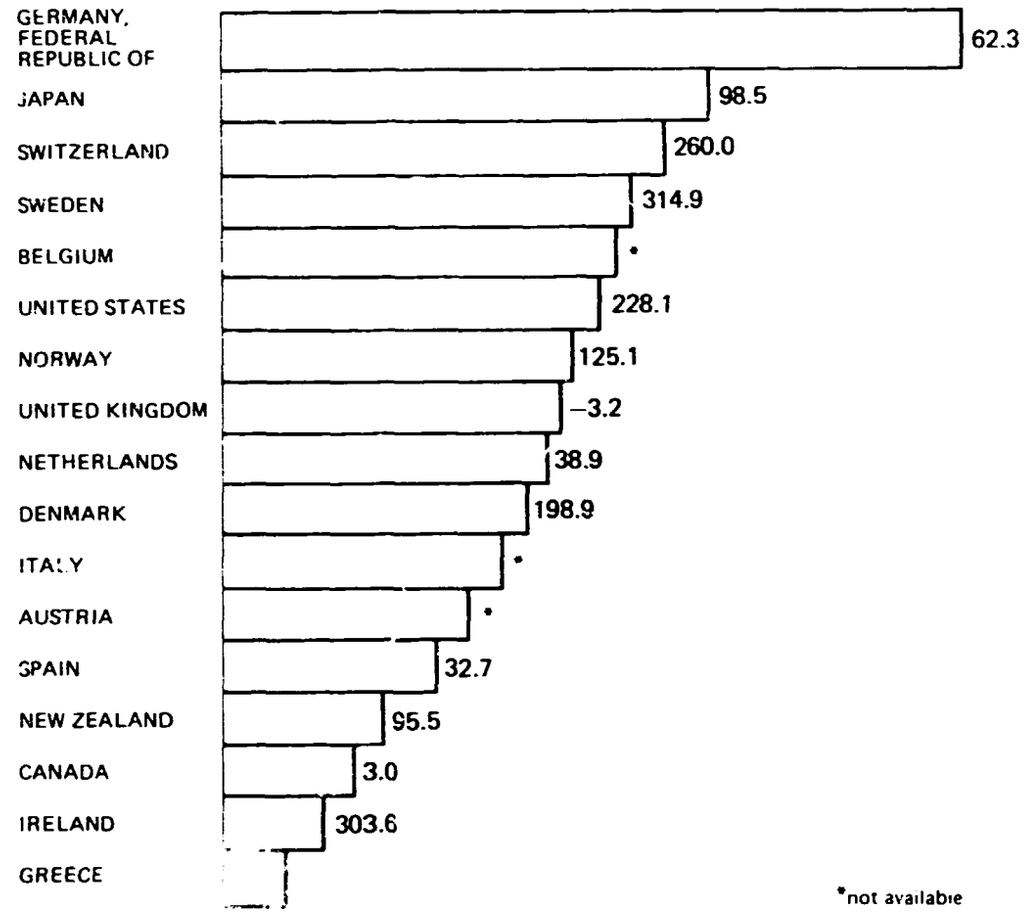
[9]M. A. Adelman, "An agenda for the eighties: decisions and research", Paper presented to the International Association of Energy Economists, Cambridge, England, 23-25 June 1980, p. 3.

[10]International Energy Agency estimates presented at the eleventh World Energy Conference in Munich, 8-12 September 1980.

[11]Adelman, *op. cit.*

[12]International Energy Agency estimates as cited in *The Economist*, 13 September 1980.

Figure I. Government expenditure on energy research per unit of energy consumed



Source: Based on figures from International Energy Agency, *The Economist* (12 July 1980).

Note: Figures to the right of bars denote percentage increase in real terms, 1974-1979.

substantial increase. However, if the United States programme is excluded, the real gain over these years was only 57 per cent.[13]

Governments of developed countries have also been slow to formulate policies designed to restrain the consumption of household energy. Recent calculations have shown that, in seven developed market economies, the real price of energy purchased by households rose only 21 per cent between 1972 and 1979. Relative to price trends for imported oil, this would amount to a 42 per cent decrease in the energy prices paid by households.[14] Government policies to regulate the consumption of gasoline show a similar paradoxical trend. During the period 1970-1978, gasoline taxation in OECD countries

[13] The United States itself ranks only sixth in terms of its research expenditures ($2.05) per unit of energy consumed.

[14] Figures are from the *Financial Times*, 14 July 1980. The seven countries included in the calculation were Canada, France, the Federal Republic of Germany, Italy, Japan, the United Kingdom and the United States.

generally declined in real terms.[15] The explanations for these anomalies vary from country to country, but they often result from price controls, below-market pricing by state corporations and taxes that are levied in specific terms and are thus eroded by inflation. There is also the (possibly) misplaced fear that stronger measures will contribute significantly to inflation.[16]

Industry has made progress in energy conservation and savings through technological innovations, however, as the subsequent discussion indicates. At the same time, there is clear evidence that the demand for energy will steadily grow, largely because of the developing countries' industrial aspirations. As world demand climbs, the need for a more equitable international distribution of supplies becomes more pressing. Under these conditions the desirability of more rapid advances in energy conservation, coupled with the equally rapid transfer of these technologies throughout the world's industrial sectors, can hardly be denied.

B. ENERGY CONSUMPTION AND SUPPLIES IN DEVELOPING COUNTRIES

Most discussion of the involvement of countries in the energy field has concentrated on the energy-abundant developing countries (chiefly those in OPEC) or on the developed countries. The focus here is on other developing countries that have the option to change their conditions of access to refined petroleum products. There are, in fact, few developing countries that do not possess some indigenous crude oil supplies and fewer still that are not prospecting. Indeed, many of the least developed countries are running a trade surplus in oil products. In 1975, the least developed countries exported oil products valued at $212 million, an amount equivalent to 7.5 per cent of their total exports.[17]

Important differences in the degree of self-sufficiency do exist between developing countries. There is a reasonable consistency regarding non-oil fuels, however. The non-OPEC developing countries as a group are 97 per cent self-sufficient in most conventional fuels.[18] Only in crude and refined oils is there substantial trade among the developing countries. Table IV.1 roughly indicates the extent of the developing countries' dependence on oil imports. The picture is not complete, however, since the information is for only one year (1975) and coverage is confined to "commercial" fuels (i.e. fuels conventionally bought and sold rather than produced and consumed in the same family unit). Still, the data provide a basis for some broad conclusions. First, it appears that 60 per

[15] Alan A. Tait and David R. Morgan, "Gasoline taxation in selected OECD countries, 1970-1979", Staff Papers, *International Monetary Fund*, vol. 27, No. 2 (June 1980), p. 439.

[16] Tait and Morgan, *ibid.*

[17] UNCTAD, "Energy supplies for developing countries: Issues in transfer and development of technology" (TD/B/C.6/31, 1978).

[18] A. Lambertini, "Energy and petroleum in non-OPEC developing countries, 1974-1980", World Bank Staff Working Paper No. [illegible] (Washington, D.C., IBRD, 1976), p. 10.

cent of the total population of the developing countries live in countries that depend on imported crude oil for less than 25 per cent of their requirements. Second, another 25 per cent of the total population of these countries (i.e. 471 million) rely on imported oil for 75 per cent or more of their energy inputs Broadly speaking, in terms of *per capita* GNP the poorer countries depend more than the more advanced countries on imported oil.

It should be pointed out, however, that in many instances non-commercial fuels are crucial to cottage and rural industries. In general, the poorer the region within a developing country, the more likely it is that non-commercial

TABLE IV.1. IMPORTS OF ENERGY AND *PER CAPITA* ENERGY CONSUMPTION IN DEVELOPING COUNTRIES AND AREAS, 1975

(Kg coal equivalent)

Net imports of energy as percentage of total energy use	Per capita *energy consumption*		
	Below 200	*200-1 000*	*Over 1 000*
Less than 25 per cent	Afghanistan	Algeria	Argentina
	Angola	Bolivia	Bahrain
	Burma	China	Brunei
	Indonesia	Colombia	Gabon
	Nigeria	Congo	Iran
		Ecuador	Israel
		Egypt	Kuwait
		India	Libyan Arab Jamahiriya
		Iraq	Mexico
		Malaysia	Qatar
		Oman	Republic of Korea
		Syrian Arab Republic	Saudi Arabia
		Tunisia	United Arab Emirates
			Venezuela
25 per cent to 75 per cent	Mozambique	Brazil	Democratic People's Republic of Korea
	Pakistan	Chile	Mongolia
	Rwanda	Peru	
	Viet Nam	Zambia	
Over 75 per cent	Bangladesh	Belize	Barbados
	Benin	Costa Rica	Cuba
	Burundi	Democratic Yemen	Cyprus
	Central African Republic	Dominican Republic	Guyana
	Chad	El Salvador	Jamaica
	Ethiopia	Fiji	Malta
	Gambia	Guadeloupe	Singapore
	Ghana	Guatemala	Suriname
	Guinea	Honduras	
	Guinea-Bissau	Ivory Coast	
	Haiti	Jordan	
	Kenya	Lebanon	
	Lao People's Democratic Republic	Liberia	
		Mauritius	
	Madagascar	Morocco	
	Malawi	Nicaragua	
	Mali	Panama	
	Mauritania	Papua New Guinea	
	Nepal	Philippines	
	Niger	Thailand	
	Paraguay	Uruguay	

TABLE IV.1 *(continued)*

Net imports of energy as percentage of total energy use	Per capita *energy consumption*		
	Below 200	*200-1 000*	*Over 1 000*
Over 75 per cent *(continued)*	Senegal Sierra Leone Somalia Sri Lanka Sudan Togo Uganda United Republic of Cameroon United Republic of Tanzania Upper Volta Yemen Zaire		

Source: Adapted from UNCTAD, "Energy supplies for developing countries: issues in transfer and development of technology" (TD/B/C.6/31), p. 18.

fuels will be important.[19] Figure II provides estimates of the intensity with which such fuels (chiefly firewood) are used. For countries such as Nepal or the United Republic of Tanzania, the consideration of commercial fuels only would be seriously misleading. The impact of the rise in energy prices in the 1970s has not been direct for consumers of non-commercial fuels, but there has been an impact none the less. The chief source of concern for these people has been the impossibility of using the best firewood substitute (kerosene) because of its higher price; hence they have exhausted their woodland.[20]

The list of recent entrants of developing countries into world oil production, reveals the global spread of production facilities. In the period 1978-1980, wells were being drilled in Angola, Congo, Egypt, Morocco, Togo, Trinidad and Tobago, Tunisia, Zaire, most South American and many Asian countries. Several others—Benin, Chad, Ivory Coast, Niger and Sudan—have found oil but are not yet producing it. While these countries did not account for a major share of world drilling in this period, their share was growing.[21]

In the first half of 1979, substantial increases in crude output over the corresponding period in 1978 (in percentage) were recorded by Barbados (70); United Republic of Cameroon (67); Chile (27); Guatemala (23); and India (21).[22]

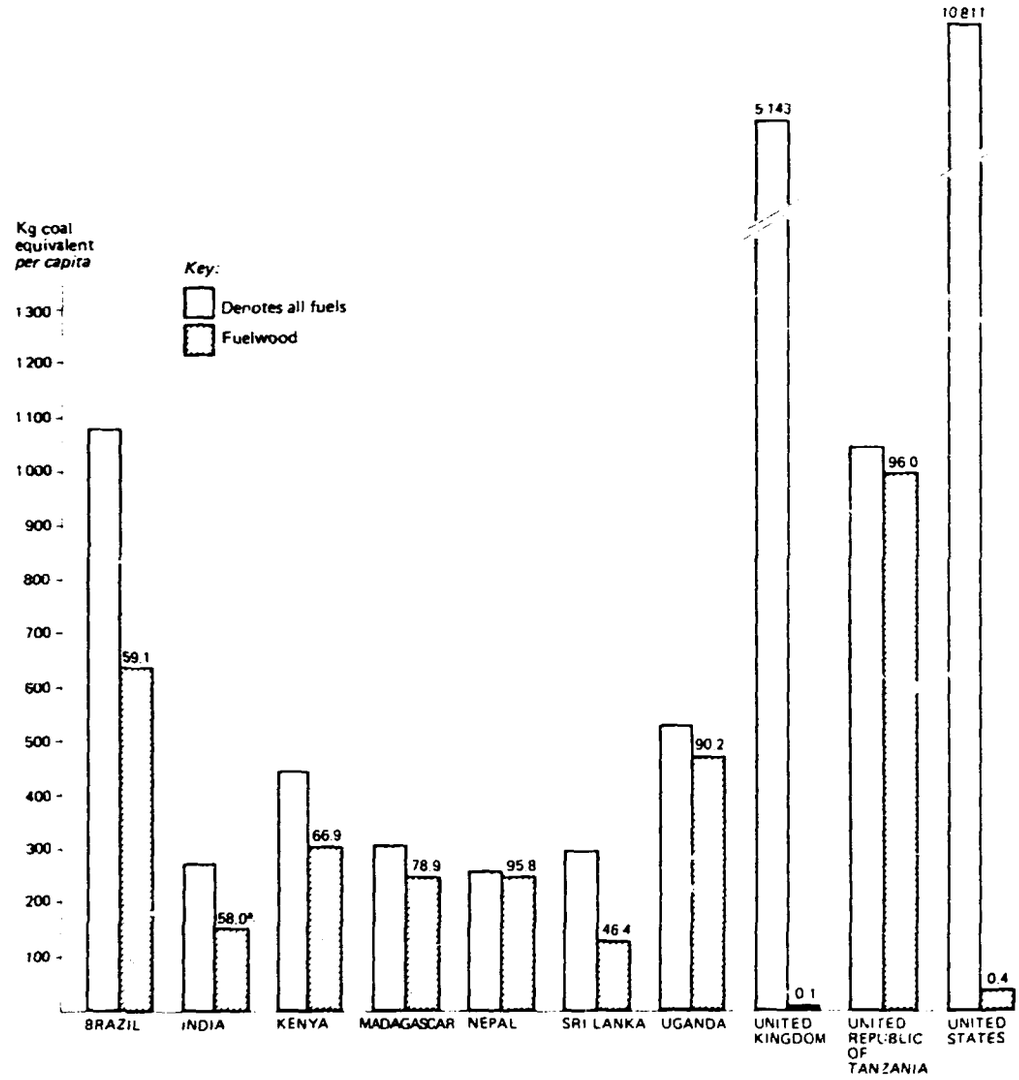
[19]A. V. Desai, "India's energy consumption: composition and trends", *Energy Policy*, vol. 6, No. 3 (September 1978), pp. 217-230.

[20]See, for example, the points raised by T. Hoffmann and B. Johnson, "Bypassing oil and the atom: the politics of aid and world energy", *Energy Policy*, June 1979, pp. 90-101; and the case study of Guatemala, which directly attributes the deforestation in rural areas to the high price of kerosene. A. K. Fitzsimmons and T. L. McIntosh, "Energy planning in Guatemala", *Energy Policy*, vol. 6, No. 1 (March 1978), pp. 14-20.

[21]The United States, with 46,106 wells drilled in 1977, had the largest share of the world total of 57,816. See *World Oil*, 15 August 1979, p. 43 and *The Economist*, 24 November 1979, p. 94.

[22]*Petroleum Economist*, September 1979, p. 366.

Figure II. **Per capita *energy consumption in selected developing countries, the United Kingdom and the United States***



Source: L. Pyle and P. Dunn, *Petroleum Economist*, August 1979, p. 328.

Note: Figures above shaded bars denote percentage of fuelwood to total fuels.

[a] Includes animal dung.

The share of OPEC in world crude output has remained at about 47 per cent for two years. But many non-OPEC countries—25 in 1977—also make a contribution to the total. As shown in table IV.2, 13 of these countries were net exporters in 1976. Together, these oil exports were equivalent to over 4 per cent of the total exports of OPEC. The importance of Mexico may well increase considerably; exports by mid-1980 were over 14 times the level recorded in 1976. By 1981, the exports of non-OPEC developing countries are likely to approach 2.4 million barrels per day.

Despite their small share of world crude output and an even smaller share of trade in crude petroleum, developing countries outside OPEC have

substantial refining capacity. At the end of 1978, they possessed 149 refineries, or nearly three times the number in OPEC countries (57). The world total was 843, of which 20 were in China and 68 in the centrally planned economies.[23] In fact, several developing countries operate refineries without having any crude oil output of their own; they are Ethiopia, Ghana, Kenya, Mozambique, Sierra Leone and Zambia.[24] The spread of refineries among non-oil producers reflects the belief of planners that valuable foreign exchange can be conserved by importing crude oil to refine locally rather than importing more costly refined products.

TABLE IV.2. EXPORTS OF CRUDE OIL BY NON-OPEC DEVELOPING COUNTRIES AND AREAS, 1976, AND ANNUAL GROWTH, 1970-1976

	1976		
Country or area	*Net oil exports (thousand barrels per day)*	*Percentage of total*	*Annual growth of oil exports, 1970-1976 (percentage)*
Angola	75	5.9	0.2
Bolivia	21	1.6	20.1
Brunei	207	16.4	9.4
Egypt	111	8.8	—5.5
Mexico	58	4.6	46.0
Oman	353	28.0	3.2
Syrian Arab Republic	121	9.6	21.8
Trinidad and Tobago	171	13.6	4.3
Tunisia	40	3.2	—3.7
Others (4)	102	8.1	92.6
Total	1 259	100.0	5.2

Source: Calculated from *Petroleum Economist*, October 1979, p.427.

Local refining also increases a country's flexibility in its choice of petroleum products to be supplied to the domestic market. In East Africa, the high profits from crude oil sales in the 1950s and 1960s, rather than prospects of a profitable market for refined products, induced firms to set up refineries.[25] In general, however, the larger developing countries that could promise reasonably high rates of capacity utilization and growth in crude demand were able to obtain advantageous terms from oil companies wishing to set up refineries.[26]

Finally, the developing countries' demand for imports of oil-based products had slowed noticeably by the mid-1970s. In Central America and the Caribbean for example, growth in the annual volume of demand during the period 1967-1973 dropped from 7.4 per cent to 1.1 per cent; in Latin America

[23] *Oil and Gas Journal*, 25 December 1978. China's production may rise substantially in the next few years, reaching 2.4 to 3.3 million barrels per day in 1982. See *The Economist*, 3 March 1979, p. 100.

[24] *Petroleum Economist*, September 1978.

[25] B. Herman, "A case of multinational oligopoly in poor countries: oil refinery investment in East Africa", *Journal of Development Economics*, vol. 2, No. 2 (1975), pp. 121-143.

[26] P. Odell, *Oil and World Power*, 5th ed. (Penguin, Harmondsworth, 1979), p. 168.

demand fell from 5.3 per cent to 3.2 per cent; in Africa, the corresponding figures were 7.8 per cent and 6.2 per cent; and in Asia, demand (excluding China) plummeted from 13.3 per cent to 2.9 per cent.[27] These figures should not be taken as evidence of a collapse in the level of economic activity since the energy/GNP ratio, even in the short term, is a fluid relationship. For instance, in the Republic of Korea, imports of refined oil products fell by more than in any other country; annual growth in volume dropped from 25.8 per cent during the period 1967-1973 to 13.0 per cent during the period 1974-1977. Despite this drop, industrial output grew at an average annual rate of 19 per cent in the later period, a rate that could hardly have been constrained by oil product shortages.

C. ENERGY CONSUMPTION IN THE MANUFACTURING SECTOR—RECENT EVIDENCE

Although manufacturing is one of the major energy-using sectors of any economy, information on the extent of changes in that sector's energy requirements is limited. In fact, most Governments began seriously to monitor the consumption patterns of individual industrial branches or of manufacturing as a whole only after the rise in energy prices. The available statistics for many developing countries are still too incomplete to permit a wide-ranging investigation. Hence, the focus here is first on an analysis of the available evidence for the developed countries in the years since 1963. A review is then made of the evidence available for the developing countries. The section concludes with a look at likely trends in the near future.

Developed countries

The figures in table IV.3 show the growth of energy costs relative to the growth of value added for the manufacturing sector in several developed countries. The estimations, based on data expressed in value rather than physical units, should be regarded as no more than tentative indicators. Two subperiods, 1963-1973 and 1973-1976, were chosen to reflect the changes in the ratios over time. Most ratios for the period 1963-1976 were near unity, indicating that the rate of growth of energy expenditure in manufacturing roughly matched that of value added. Exceptions were in Australia and Czechoslovakia, where ratios were relatively low, and in Portugal and the United States, which recorded extremely high values of 1.63 and 1.56, respectively.

While, with very few exceptions, the growth rates for manufacturing value added exceeded the corresponding rates of energy expenditures during the earlier subperiod,[28] this relationship was significantly reversed in the period

[27] United States Bureau of Mines, *International Petroleum Annual* (Washington, D.C., Government Printing Office, 1979), table 13.

[28] The only exceptions, again, were Portugal and the United States.

TABLE IV.3. RATIOS[a] OF GROWTH IN ENERGY COSTS TO GROWTH IN VALUE ADDED FOR TOTAL MANUFACTURING, BY SELECTED DEVELOPED COUNTRIES, 1963-1976

Country	*1963-1976*	*1963-1973*	*1973-1976*
Australia	0.68	0.50	1.34
Austria[a]	1.42	0.94	2.68
Canada	1.09	0.91	2.15
Czechoslovakia[c]	0.83	0.98	0.65
Denmark	1.06	0.64	2.36
Finland	1.04	0.84	1.47
Greece[d]	1.01	0.78	2.14
Ireland	. . .	0.77	. . .
Japan	1.03	0.67	4.10
New Zealand	0.98	0.88	1.55
Norway	1.17	0.97	1.57
Portugal	1.63	1.70	1.53
Spain	0.98	0.81	1.73
Sweden	1.03	0.72	1.84
United Kingdom[e]	. . .	. . .	1.09
United States	1.56	1.08	3.80

Source: Based on data supplied by the United Nations Statistical Office.

[a]Including the cost of all purchased fuels and of electricity consumed by manufacturing.

[b]Data refer to the period 1969-1976.

[c]Data refer to the period 1966-1976.

[d]Data refer to the period 1963-1975.

[e]Data refer to the period 1974-1976.

1973-1976. Only one country, Czechoslovakia, recorded a ratio of less than unity. Moreover, most of the results show energy expenditures rising at rates 2 to 4 times faster than the growth of value added.

These figures clearly indicate that the era of cheap energy ended in the 1970s as prices were adjusted to reflect growing scarcity. Corresponding estimates for later years, if available, would probably be lower for two reasons. First, subsequent adjustments in energy prices have been more closely related to the price movements of other goods including manufactures. Thus, the growth of energy expenditures in this case would be balanced by growth in the value of net output. Second, the period 1973-1976 was too early for the figures to reflect many energy-saving modifications or changes in the industry mix.

Subsequent changes in the manufacturing sector's energy requirements depend on a variety of factors operating at the branch level. First, a country's industrial mix is important. Higher ratios of energy expenditure to value are recorded when energy-intensive branches account for a large or increasing proportion of a country's net output. This type of industrial mix may reflect national policy decisions made in the 1960s and 1970s or the composition of domestic demand for industrial products. Second, the rate of technological innovation has been uneven among the various industrial branches, although, before 1976, new production processes probably tended to be energy-using rather than energy-saving. Thus, the pattern of energy consumption is in a state of flux as the emphasis of innovation shifts from material-saving to

energy-saving. Third, production technologies in any given branch often permit energy to be replaced by other types of inputs and conversely. During periods when energy was cheap relative to other inputs, various producers may have tended to substitute energy for other inputs. These producers recorded higher growth in energy expenditures than they now would with present input prices. Fourth, and perhaps most important, recent studies have suggested that energy use may be substantially altered by changes in tastes or patterns of consumption.[29] Should this observation prove to be accurate, it would mean that measures such as the one used here may be more subject to change in the short term than they would if they were determined primarily by existing technology.

The net effect of these factors, in addition to the rise in the relative price of energy, is summarized in table IV.4. In every case, energy expenditures in manufacturing per unit of MVA rose between the periods 1963-1964 and 1975-

TABLE IV.4. INCREASE IN ENERGY COSTS, BY MANUFACTURING BRANCH, IN SELECTED DEVELOPED COUNTRIES,[a] 1963-1964 TO 1975-1976

(Million national currency units)

Branch	*ISIC*	*1963-1964*	*(Ranking)*	*1975-1976*	*(Ranking)*	*Percentage increase*
Food products	311-312	38 357	(8)	50 473	(8)	31.6
Beverages	313	26 251	(11)	41 730	(11)	59.0
Tobacco	314	7 716	(21)	13 252	(21)	71.7
Textiles	321	39 133	(7)	59 081	(6)	51.0
Wearing apparel	322	9 399	(20)	15 090	(19)	60.5
Leather, fur products and footwear	323-324	15 247	(17)	23 105	(15)	51.5
Wood and cork products	331	45 164	(6)	49 182	(9)	8.9
Furniture and fixtures	332	17 887	(13)	23 428	(14)	31.0
Paper and paper products	341	87 962	(4)	145 130	(4)	65.0
Printing and publishing	342	9 908	(19)	13 848	(20)	39.8
Chemicals, refining and miscellaneous products of petroleum and coal	351-354	67 664	(5)	135 901	(5)	100.8
Rubber products	355	32 332	(10)	51 520	(7)	59.3
Plastic products	356	32 636	(9)	45 961	(10)	40.8
Non-metallic mineral products	361-362, 369	104 619	(3)	158 391	(3)	51.4
Iron and steel	371	115 868	(2)	243 961	(1)	110.5
Non-ferrous metals	372	118 674	(1)	184 403	(2)	55.4
Metal products	381	22 012	(12)	28 688	(12)	30.3
Non-electrical machinery	382	17 401	(14)	21 850	(17)	25.6
Electrical machinery	383	15 481	(16)	22 330	(16)	44.2
Transport equipment	384	17 059	(15)	28 118	(13)	64.8
Professional and scientific equipment, photographic and optical goods	385	10 080	(18)	15 393	(18)	52.7

Source: Based on data supplied by the United Nations Statistical Office.

Note: Figures are averages over two-year periods weighted by the country's share in United States dollars in total MVA for each branch.

[a]Countries included in the sample are those listed in table IV.3.

[29]See *Petroleum Intelligence Weekly*, 21 July 1980.

1976, so that the ranking of industries according to this measure showed little change between these years. The ranking of wood products and non-electrical machinery fell mainly owing to modest rates of increase in their consumption of energy per unit of value added.

The most significant trends concern the more energy-intensive branches: iron and steel; non-ferrous metals; non-metallic mineral products; paper products; and chemical, refining and related products. Energy consumption in these five branches far exceeds the levels recorded in other parts of the manufacturing sector. Moreover, each branch showed very high percentage increases during the period, ranging from 51 to 110 per cent. These facts help to substantiate the opinion expressed elsewhere in this *Survey* that changing energy costs have altered many of the basic economic principles on which producers of steel, chemicals or non-ferrous metals have traditionally operated.[30]

The preceding figures provide a picture of average trends in energy consumption by developed countries. However, they shed little light on energy consumption in individual countries. The data in table IV.5 supplement the foregoing discussion, indicating median and interquartile values for relative energy expenditures along with the range of observation for each industrial branch.[31] For example, a comparison of the figures for iron and steel show that in at least some countries energy propensities were near or even below unity. Other branches—including paper, rubber, chemicals, plastic and even textiles—proved to have higher median values. In general, the gap between the five branches identified in table IV.4 as major consumers of energy in the developed countries—iron and steel, chemicals, non-ferrous metals etc.—and the rest of manufacturing is not so pronounced when compared in these terms. Although these branches have been by far the major energy consumers, the present data show that this is not the case in all developed countries. This contrast is explained by the fact that the average values shown in table IV.4 mainly reflect the bigger weights accorded to those countries with relatively large shares in the developed countries' net output at the branch level. In other words, countries with smaller weights in the calculation (and hence smaller shares of value added in each branch) have not increased their energy propensities so rapidly as those with large chemical or non-ferrous metals branches.[32]

Developing countries

In the developing countries, industry (including construction and utilities as well as manufacturing) as a rule accounts for approximately 50 per cent of all energy consumption, while transportation uses over 30 per cent and the

[30] See chapter III.

[31] The median value is that observation which divides the set of data into two equal parts. Interquartile limits are those values within which the mid-50 per cent of all observations fall. The range indicates the upper and lower extremes among the observations.

[32] It does not necessarily follow that if an industrial branch has a relatively large share of a country's manufacturing sector, it is less energy-efficient. This may depend on the product mix within the branches. Countries with large chemical branches, for example, may have tended to specialize in specific products whose production is comparatively energy-intensive.

TABLE IV.5. RATIOS OF GROWTH IN ENERGY COSTS TO GROWTH OF VALUE ADDED BY MANUFACTURING BRANCH, IN SELECTED DEVELOPED COUNTRIES,[a] 1963-1973 AND 1973-1976

Branch	ISIC	1963-1973			1973-1976		
		Relative growth rates (energy/MVA) median value	Interquartile values	Range	Relative growth rates (energy/MVA) median value	Interquartile values	Range
Food products	311-312	0.64	0.58 to 0.99	—0.61 to 1.82	1.31	1.20 to 1.93	—4.80 to 3.42
Beverages	313	0.70	0.43 to 0.91	0.15 to 1.21	1.83	1.45 to 2.44	—3.35 to 4.33
Tobacco	314	0.99	0.69 to 1.23	0.45 to 1.81	1.74	1.25 to 2.06	0.49 to 3.86
Textiles	321	0.81	0.55 to 1.05	0.47 to 1.49	1.95	1.37 to 3.32	0.98 to 13.78
Wearing apparel	322	0.79	0.66 to 1.10	—6.57 to 1.40	1.41	1.06 to 2.00	0.75 to 6.58
Leather, fur products and footwear	323-324	0.60	—0.30 to 0.86	—2.69 to 1.97	1.51	1.09 to 1.87	0.66 to 5.52
Wood and cork products	331	0.80	0.76 to 0.96	0.55 to 3.79	1.89	1.05 to 4.89	—4.45 to 32.68
Furniture and fixtures	332	0.98	0.76 to 1.12	0.06 to 25.08	1.44	0.93 to 1.81	0.74 to 8.66
Paper and paper products	341	0.81	0.66 to 1.19	0.54 to 2.31	2.46	1.90 to 3.24	1.12 to 5.22
Printing and publishing	342	0.76	0.64 to 0.89	0.26 to 1.64	1.25	1.12 to 1.46	0.72 to 3.42
Chemical refining and miscellaneous products of petroleum and coal	351-354	0.85	0.74 to 0.95	0.22 to 1.65	2.20	1.87 to 2.98	0.57 to 6.67
Rubber products	355	0.92	0.74 to 1.05	0.20 to 1.40	2.29	1.55 to 2.98	0.17 to 17.80
Plastic products	356	0.91	0.76 to 1.06	0.54 to 3.59	2.00	1.36 to 2.21	—0.42 to 3.71
Non-metallic mineral products	361-362, 369	0.81	0.67 to 0.95	0.56 to 1.63	1.83	1.45 to 2.27	1.00 to 4.90
Iron and steel	371	0.84	0.78 to 1.09	—0.31 to 3.82	1.22	—15.17 to 4.08	—17.64 to 11.00
Non-ferrous metals	372	1.04	0.78 to 1.27	0.59 to 7.15	1.90	1.38 to 4.35	—16.98 to 54.39
Metal products	381	0.92	0.57 to 0.92	—3.80 to 1.23	1.01	0.95 to 1.58	0.03 to 3.00
Non-electrical machinery	382	0.79	0.52 to 0.85	—0.26 to 2.72	1.14	0.88 to 1.45	—1.67 to 2.68
Electrical machinery	383	0.73	0.61 to 0.87	0.30 to 1.44	1.52	0.90 to 2.07	0.24 to 5.68
Transport equipment	384	0.84	0.73 to 0.95	0.25 to 1.69	1.41	1.07 to 1.69	0.44 to 4.06
Professional and scientific equipment, photographic and optical goods		0.99	0.73 to 1.18	0.51 to 3.25	1.12	1.03 to 1.77	0.20 to 2.59
Total manufacturing	300	0.84	0.72 to 0.94	0.50 to 1.70	1.73	1.53 to 2.15	0.65 to 4.10

Source: Based on data supplied by the United Nations Statistical Office.

[a] Country coverage is the same as that shown in table IV.3.

services and household sectors consume the remainder.[33] Industry absorbs somewhat less than one half of a country's final energy consumption in low-income countries and a greater portion at higher-income levels.

Most of the figures in table IV.6 refer specifically to the manufacturing sector's share in total energy consumption. They suggest that the manufacturing sector accounts for the bulk of all industrial requirements, from 30 to 45 per cent of total energy consumption. Available estimates of the ratios of energy expenditures to MVA are too few to provide any impression of trends in

TABLE IV.6. SHARE OF THE MANUFACTURING SECTOR IN TOTAL ENERGY CONSUMPTION, IN SELECTED DEVELOPING COUNTRIES, VARIOUS YEARS

Country	*Percentage*	*Period*	*Relative growth rates (energy/MVA)*[a] *1967-1977*
Algeria	...		4.84
Argentina	...		0.48
Brazil[b]	40.9	1976	1.00[c]
Colombia	38.5	1977	3.03
Costa Rica[b]	13.5	1976	...
Ecuador	11.0	1977	...
Guatemala	15.9	1977	...
India[b, d]	64.9	1977-1978	1.86[e]
Indonesia	...		1.42
Iran	...		2.32
Jamaica	48.8	1977	...
Jordan[b, d]	48.5	1977	...
Mexico	41.0	1977	1.30
Nicaragua	14.4	1976	...
Nigeria	...		0.76
Peru	43.2	1976	...
Philippines[e]	29.2	1973	...
Republic of Korea	35.7	1974	0.89
Saudi Arabia	...		0.40
Suriname	33.8	1976	...
Thailand	...		1.51
Turkey	27.7	1977	...
Uruguay	26.7	1977	...

Source: Compiled from Latin American Energy Organization (OLADE), *Anuario Estadistico;* data provided by the United Nations Office of Development Research and Policy Analysis; United Nations, *Handbook of World Development Statistics 1979;* OECD, *Workshop on Energy Data of Developing Countries* (December 1978); national censuses and other national sources.

[a] Data refer to all industry, which includes manufacturing, mining and quarrying and construction. Growth rates were calculated from data expressed in kWh and value added at constant prices. Thus, their basis of measurement differs from that shown in table IV.3.

[b] All industry.

[c] 1967-1976.

[d] Electricity consumption only.

[e] Petroleum products only.

[33] B. J. Choe, Helen Hughes and Adrian Lambertini, "Energy prospects for developing countries", Paper submitted to the Symposium on Industrial Policies for the 1980s, Madrid, 5-9 May 1980, p. 19.

the pattern of energy consumption over time. They indicate an extremely wide range and should be regarded with caution. The data suggest that several developing countries (Argentina, Brazil, India and the Republic of Korea) with relatively large and diversified manufacturing sectors have recorded ratios no greater than those in developed countries (see table IV.3).[34]

Logically, the share of manufacturing in energy consumption varies according to the structure or composition of the sector. In the preceding discussion, certain industrial branches such as chemicals, iron and steel, non-ferrous metals and paper were shown to consume relatively high levels of energy per unit of value added. These branches make up a large part of heavy industry, while less energy-intensive branches (e.g. textiles, clothing, wood products) fall in the category of light industry. Heavy industry now accounts for about 50 per cent of net manufacturing output in the developing countries, up from 33 per cent in 1955. (In developed countries the share of heavy industry is now around 70 per cent.)[35] An accepted dictum of industrial growth is that, in developing countries, the share of heavy industry in manufacturing output tends to rise as industrialization progresses. As it does, the manufacturing sector becomes more energy-intensive. Although the use of energy is becoming more efficient, the energy requirements of the developing countries are bound to rise as structural change continues.

Data on the pattern of energy consumption in the developing countries, at the branch level, are extremely limited. Consequently, the figures shown in table IV.7 should be regarded with caution; they are not necessarily represen-

TABLE IV.7. RATIO OF ENERGY CONSUMPTION TO VALUE ADDED,[a] BY MANUFACTURING BRANCH, IN DEVELOPING COUNTRIES IN THE 1970s

Branch	*ISIC*	*Median value*
Food products	311	0.69
Beverages	313	0.50
Textiles	321	0.91
Wearing apparel	322	0.28
Paper and paper products	341	1.50
Printing and publishing	342	0.24
Chemical refining and miscellaneous products of petroleum and coal	351-354	0.76
Plastic products	356	0.64
Non-metallic mineral products	361-362, 369	5.08
Iron and steel	371	1.37

Source: Unpublished data provided to UNIDO by the Economic Commission for Latin America; *The 1973 World Programme of Industrial Statistics* (United Nations publication, Sales No. 79.XVII.3) and national industrial censuses.

[a]The ratios shown here are the share of each branch in total energy consumption by manufacturing divided by its share in total manufacturing value added. Owing to a lack of comparable data, the country sample includes only nine developing countries in the three developing regions.

[34]The method of calculating these ratios, as dictated by the available data, may lead to underestimation, however, in comparison with those for developed countries. See footnote *a*, table IV.6.

[35]*World Industry since 1960: Progress and Prospects* (United Nations publication, Sales No. E.79.II.B.3), p. 66.

tative of the general pattern of energy consumption in developing countries. According to the data, the share of the non-metallic products group in energy consumption is typically about three times greater than its share in value added of all manufacturing. Paper and iron and steel are also relatively heavy energy users, as they are in the developed countries. The mix of products produced by one branch is obviously an important determinant of energy consumption particularly if the branch is still at an intermediate stage of development. This applies to chemicals and petroleum, for example, and would explain why the median value is less than that found for textiles, which is a comparatively advanced industrial branch in many developing countries.

D. TECHNOLOGICAL CHANGE AND INDUSTRIAL LOCATION: SOME CASE STUDIES

This section examines empirical evidence documenting technological changes that can be attributed mainly to new supply and cost conditions in the energy field. A variety of industrial activities often identified by economists as having potential for further expansion in developing countries is assessed, together with recent and impending technological changes and the extent to which each is a result of higher energy costs.

Estimating the share of energy costs in the costs of raw materials processing is, at best, hazardous for several reasons. First, the appropriate measure of total costs may vary. One question is, should the measure include capital costs (i.e. interest-rate charges) and a depreciation factor to recognize the accounting and opportunity costs of operating capital goods. Ideally, measures that both include and exclude capital costs would be desirable to permit the more appropriate figure to be chosen. Second, the share of energy cost can vary considerably from firm to firm depending on the vintage of their capital installations. For example, in 1978, a modern steel mill with the latest blast furnace refinements required about 457 kilograms of fuel per ton of steel output. Comparable figures for 1975 through 1977 were 494, 478 and 466 kilograms per ton, respectively.[36] Even within one plant the constant effort to reduce fuel use results in continuing changes in the ratio of energy to total cost. Third, in several processing chains, different techniques exist for attaining the common goal of processed output. In the case of steel, again, there are several established energy sources and different methods of obtaining molten steel. When several production options are available, one figure for energy use may be misleading. Finally, a different set of problems arises when the fuel inputs themselves are being costed. In the case of aluminium smelting, for instance, owners of primary aluminium capacity in the United States pay different rates for their electricity inputs depending on their location. The Pacific north-west has generally been the cheapest area. In smelters located

[36] Figures refer to the Nippon Steel Corporation of Tokyo. See *Metal Producing*, June 1979, p. 49.

there electric power, until recently, accounted for 8 to 10 per cent of total costs; elsewhere in the country these costs are closer to 30 per cent.[37]

A broader consideration is the identification and quantification of energy inputs used in industrial processing. One contention is that as this procedure (known sometimes as the "energy audit") becomes more sophisticated, it will become increasingly apparent that energy is a principal input. Moreover, since the "total energy content in a product will not be accurately reflected in its cost . . . partly because the total energy cost of a raw material is not known . . . and (due to) state subsidies", energy input is as a rule understated.[38]

The following survey of energy-related developments in various industrial activities[39] takes these qualifications into account.

Aluminium

Prior to the adjustment in world energy prices, an authoritative view of the world aluminium industry was that: "While favourable power costs exert a major location pull, they are not so compelling as to be able to override the influence of moderate tariff levels or of disadvantages in other components of cost."[40] Also noted were the attractions of abundant hydroelectric power available in some bauxite-producing developing countries, although it was observed that there had been "no stampede" to take advantage of this power. This mildly pessimistic view was qualified in the same study by the statement that "the lure of inexpensive power in areas now passed over may grow".[41]

Since the early 1970s, however, those concerned with the international location of the aluminium industry have had a quite different view. The conventional wisdom now is to predict substantial relocation. The new trend is reflected in a recent description of the outlook for processing industries in the United Kingdom: " . . . the sensitivity of aluminium production economies to the cost of energy . . . means that investment in smelting capacity will tend to be in areas of low energy cost, for example, the Gulf States and South America . . . chances of investment in new smelters in Britain are currently very low."[42] Another writer argues in the same vein that: " . . . energy accounts for between 40 and 50 per cent of aluminium ingot production. That basic fact is going to force radical changes upon the world aluminium industry during the next five years."[43]

These predictions can now be tested. An account of new capacity in the developing countries is given here, followed by an analysis of the relationship

[37] *Chemical Week*, 31 January 1979, p. 29, and *Metal Bulletin Monthly*, December 1978, p. 33.

[38] W. O. Alexander, "Designing to conserve energy and materials", Paper presented at Design Engineering Conference, Birmingham, England, 22-26 October 1979, p. 2.

[39] In addition to the industrial branches reviewed below, chemicals is an important consumer of energy. This branch is discussed, along with its energy requirements, in another chapter of this *Survey*.

[40] S. Brubaker, *Trends in the World Aluminium Industry* (Baltimore, Johns Hopkins Press, 1967), p. 178.

[41] *Ibid.*, p. 201.

[42] National Economic Development Office, *Technology Prospects in the Process Industries* (London, 1979), p. 4.

[43] *Financial Times*, 11 October 1979, p. 1.

between relocation and technological change in aluminium. In Latin America, Brazil and Venezuela are likely to become important sites for primary reduction activity. In Venezuela, Alcasa has increased its capacity to reach 130,000 tons per year throughput and, in an effort to become an integrated producer, has also begun work on a direct reduction plant costing $2.6 billion.[44] Eventually, an annual output amounting to 280,000 tons of primary aluminium is the goal, most of which will be for export to Japan. In Brazil, annual capacity was increased by 30,000 tons in 1978, and further capacity additions are planned. At present that country imports over $500 million of non-ferrous metals annually, and its desire to achieve a better balance of trade is leading to greater efforts in aluminium production. The Amazon Basin has some 4 billion tons of bauxite reserves and unique hydroelectric potential, put at over 55 million kilowatts. Output of 1.5 million tons per year is sought, to permit net exports of 500,000 tons and greater domestic use. Additional exports of unprocessed bauxite are also envisaged.[45]

In West Asia, interest in aluminium smelting is mainly related to the abundance of oil and gas. The natural gas currently being flared in these countries each year is sufficient to produce one half of the world's annual output of aluminium, or some 7 million tons. Moreover, this energy could be gathered at only about 7 per cent of the cost in EEC.[46]

Despite the absence of any indigenous bauxite reserves, or alumina plants in West Asia, several primary aluminium plants are in operation. These plants currently import 1 million tons per annum of bauxite, a figure that is expected to triple by 1982 and to rise to 8 million tons by 1985. Primary aluminium capacity exists in Bahrain, Egypt and Iran and smelters are under construction in Algeria and Dubai, with others planned in Abu Dhabi, Iraq, Kuwait, Libyan Arab Jamahiriya, Qatar, Saudi Arabia and Syrian Arab Republic. Total output from the plants existing in 1977 was 216,000 tons.[47]

In Bahrain, the aluminium smelter (Alba) began operation in 1972 and uses over 3 million cubic feet of natural gas per day to drive its own power station. Alumina is imported from Australia in 35,000-ton carriers under a long-term contract entered into in 1977. Coke is imported from Louisiana, United States, pitch from Australia, and cryolite and aluminium fluoride from Italy and Japan. The composition of these inputs is shown below in table IV.8.

Once processed, most of the aluminium is exported, 70 per cent of it to China and Japan and 15 per cent of it to other countries in the Middle East and North Africa.[48] The second major smelter on the Gulf, in Dubai, will be producing 135,000 tons per year by 1981, while that to be built at Jubail in Saudi Arabia will be producing 225,000 tons per year by 1986.

In developed countries, the impact of increased energy costs on aluminium production has been mixed. The Government of Japan has assisted its aluminium industry in reducing smelting capacity by 500,000 tons per year and has become a net importer of some 800,000 tons per year of aluminium. A

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[44] *Engineering and Mining Journal*, July 1978, p. 43.

[45] *Ibid.*, July 1979, p. 115.

[46] *Metal Bulletin Monthly*, October 1978, p. 57 and September 1979, p. 69.

[47] *Ibid.*, April 1979, p. 29.

[48] China's own first smelter, to give 80,000 tons per year, is under way with Japanese help. It should ultimately provide 1 million tons per year. *Metal Bulletin Monthly*, March 1979, p. xvii.

TABLE IV.8. INPUT TO ALBA SMELTER, BAHRAIN, 1975-1977

(Thousand tons)

Input	*1975*	*1976*	*1977*
Alumina	235.0	239.0	243.0
Cryolite	4.8	2.8	2.4
Aluminium fluoride	3.8	4.3	5.1
Coke	64.0	53.7	50.8
Pitch	14.2	13.5	12.6

Source: *Metal Bulletin Monthly*, November 1978, p.13.

further 10 per cent cut is now being planned, which will bring the country's primary aluminium production down to 1 million tons. These cuts have been dictated largely by the rising cost of imported oil.[49] In the United Kingdom, the British aluminium smelter at Fort William in Scotland is to be rebuilt to take advantage of the hydropower nearby, and capacity will be raised by one third to 37,000 tons per year.[50] In the United States, mention has already been made of the fact that smelters in the Pacific north-west face large price rises in power; according to the view expressed in the industry's journal, "all in all the outlook for the north-west is not bright".[51]

In the short term, technological advances are not likely to have significant consequences for relocation. For example, no major technological change seems imminent in any of the stages of aluminium processing. The Bayer process for alumina production is already highly efficient, although modest energy savings could be attained by improving the electrolyte and cathode materials used. Even if the process were not particularly energy efficient, the fact that bauxite is transformed into a much lighter (by half) and more readily transported material would tend to diminish the urgency of technological change at the site of the bauxite mine itself. Only a small volume of co-operant inputs (soda chiefly) are required at that stage.[52]

For the electrolysis of alumina in the smelting of aluminium, most analysts expect the conventional Hall-Heroult method to be in use at least until the end of the century. New methods (e.g. subhalogenizing or carbothermic smelting) are not economic,[53] although the Alcoa process, when fully operational, will require 30 per cent less energy than the Hall-Heroult method.[54] The major attraction of the Alcoa process, which will require several years' additional research, is its small economies of scale. Small-scale alumina importers will be able to operate economically.

[49] *Financial Times*, 28 August 1980.

[50] *Ibid.*, 11 October 1979.

[51] *Metal Bulletin Monthly*, December 1978, p. 33. Partly as a result of these impending rises in power costs, the latest (and the largest) alumina refinery in the United States has been built at Port La Vaca on the Gulf Coast of Texas, close to natural gas supplies. See *Engineering and Mining Journal*, July 1979, p. 115.

[52] Brubaker, *op. cit.*, pp. 163-172.

[53] *Metal Bulletin Monthly*, April 1979, and E. P. Gyftopoulos, L. J. Zazoridis and T. F. Widmer, *Potential Fuel Effectiveness in Industry* (Cambridge, Mass., Ballinger, 1974), p. 72.

[54] *Metal Bulletin Monthly*, July 1977, p. 45.

The use of energy in the smelting process, which unlike that for other minerals does not purify the metal, has steadily dropped. In 1920, 12 kilowatts were required to produce 1 lb of aluminium, but, by 1979, best practice used only one half of that amount and the industry average was 8 kilowatts per hour.[55] Despite the urgent need to save energy in this process, another line of technology has been followed in the industry that is more energy-intensive than proceeding from bauxite itself. This is an attempt to recover alumina from clay, but clay derivatives can be economically attractive only if the price of alumina soars.[56] There are predictions of a short-term, sharp rise in the aluminium price.[57] In the meantime, the rising cost of bauxite acts as an impetus to the search for other sources of alumina.[58]

While energy-saving efforts that change the nature of aluminium-smelting technology are impressive in their cumulative impact, their effect is slight in comparison with the effect on total energy use of recycling end-products. In 1976, the United States Bureau of Mines reported that 4 to 8 billion aluminium-bearing cans had been recycled, 15 per cent more than in 1975. The recycling of such end-uses of aluminium saves fully 95 per cent of the energy used in obtaining aluminium from bauxite.[59]

The recycling of aluminium scrap within the smelter process itself also offers substantial energy savings per unit of output. While most of the scrap produced in an aluminium plant is recycled, the fact that 40 per cent of the inputs are used in creating scrap output means that strenuous efforts must be made to maximize the utilization of scrap. In the United Kingdom, 73 per cent of the aluminium produced is obtained from scrap, whereas in the United States, the aggregate figure is only 20 per cent.[60] In general, interest in EEC countries in recycling waste and scrap is concentrated on paper and plastics, since the proportion of aluminium in total waste is lower than in the United States, where the all-aluminium beverage can is ubiquitous.[61]

Iron and steel

The iron and steel industry has long been the largest single absorber of energy in developed countries. In the United Kingdom, iron and steel used 11 per cent of all energy supplied in 1972, and 28 per cent of all industrial

[55] *Engineering and Mining Journal*, July 1979, p. 115.

[56] *Metal Bulletin Monthly*, January 1979, p. 23.

[57] A period of excess demand is predicted for 1982-1985 followed by a period of excess supply. See Chase Econometrics, "The world metals economy to 1990: The developing supply crisis", as cited in *Engineering and Mining Journal*, March 1979, p. 228.

[58] White mud formations and alumina-holding ash in coal mines are two potential sources. Anorthosite is a third. See *Metal Bulletin Monthly*, January 1979, p. 4.

[59] *Metal Producing*, December 1977, p. 46.

[60] D. A. Reay, *Industrial Energy Conservation*, 2nd ed. (Oxford, Pergamon Press, 1979), p. 62.

[61] M. E. Henstock, "Second recycling world congress—resources report", *Resources Policy*, September 1979, p. 222. This is confirmed for the United Kingdom by a survey carried out for the British Glass Manufacturers' Federation. As a proportion of total waste, cans accounted for only 4.7 per cent of all rubbish (paper was over 70 per cent), although as a proportion of all beverage containers cans (as opposed to bottles) accounted for 56 per cent of the total. See "The glass container industry and the environmental debate", Report by the Glass Industry Liaison Working Party to the British Glass Manufacturers' Federation (London, 1977), p. 38.

energy used in 1976. Figures for the United States were similar, while in the Netherlands the proportion was substantially higher, about 35 to 40 per cent of energy consumed by industry. With its enormous relative size, the steel industry of Japan probably required a slightly greater share of that country's total industrial consumption—between 37 and 44 per cent in 1978. The magnitude and wide variation in these percentages suggest important implications for developing countries entering the field. Obviously, the choice of technologies and product lines will be crucial for countries with limited domestic energy supplies and/or persistent balance-of-payments problems.

The energy intensity of this branch, measured as inputs of energy per unit of output, is also one of the highest. In 1976, iron and steel producers in the United Kingdom used over twice the energy per billion pounds worth of output of the second-ranking branch, building materials.[62] Despite these high energy requirements, consumption per ton of finished steel has consistently fallen in developed countries since the 1940s.

Japan has made the most significant strides as an energy-saving steel maker among the developed countries. During the period 1953-1977, energy input per unit of steel output fell 40 per cent, and in 1978-1980, a further 10 per cent reduction was anticipated.[63] These advances were achieved by several means, including better gas recovery from the basic oxygen furnace, waste-heat recovery and reusing energy hitherto wasted in the water-quenching of coke.[64] Apparently, such energy-saving efforts are not so widespread in other developed countries. Many further energy savings have been identified in the industry. For example, a 1977 study of the United Kingdom found only four other industries with greater potential savings in this respect. Energy savings of over 35 per cent per man-year were thought to be feasible.[65]

The preceding figures suggest that during the 1970s traditional steel economics underwent a substantial change. Iron and steel production is no longer just a capital-intensive industry. As in certain other fields (e.g. petrochemicals), the variable cost of feedstock and energy is becoming critical.[66] The slow rate of investment in many of the older steel makers in developed countries leads to a widening gap between the variable costs of these firms and those of their newer competitors in Japan, the Republic of Korea, and elsewhere. Thus, two types of structural forces are drastically changing the iron and steel industry's global situation: *(a)* the pressure to introduce technical changes in response to a new input-pricing pattern and *(b)* the emergence of new producers in developing countries.

To turn to the question of prospective trends in technology, the overall impression in the iron and steel industry as it enters the 1980s is that there will be few radically new developments with energy-saving consequences but a

[62]Leach and others, *op. cit.*, p. 37.

[63]*Industrial World*, April 1977.

[64]A coke dry-quenching (CDQ) system using inert gas, not water, to absorb heat from the coke as soon as it is discharged from the ovens saves significant energy. *Ironmaking and Steelmaking*, No. 4, 1979, p. 145.

[65]"A preliminary analysis of the potential for energy conservation in industry" (London, United Kingdom Department of Industry), 1977.

[66]In part, the industry's rising energy costs during the 1970s were accelerated by the longer-term tendency (beginning around 1960) to replace coal by oil and electricity as fuel sources. For relevant data on the United Kingdom, see Reay, *op. cit.*, p. 54.

persistent stream of small improvements. "Rather than develop radical new capabilities, industry builders are seeking out the 'best available' technologies when expanding or modernising capacity."[67] Technological breakthroughs are not regarded as necessary to overcome present constraints; instead, the lack of sufficient profits in recent years to invest in existing technologies is the major problem in developed countries. A United States survey confirms this, arguing that "fundamental research is the most prominent casualty of the American [steel] industry's need to adapt to the realities of high costs and low profits".[68] None the less, five areas may be distinguished in which technologies are expected to change in the next 5 to 10 years; each of these is described below.

In the blast-furnace method the limit of energy efficiency has now been attained. Further savings on coke inputs could, it is felt, be made only by replacing it with fuels less abundant than coal. The main hope for the future, direct reduction (DR), is, however, misleadingly titled. The name was devised when it was thought that the process would lead directly to steel. But it was developed to use gas or oil inputs as reducing agents rather than coke (using the Wiberg process of 1952) and is comparatively energy-intensive.[69]

Despite this drawback, DR is foreseen as a major type of ironmaking for the next decade. By 1990, a significant proportion of existing iron capacity will have been retired, and some 250 million tons of new capacity will be needed world-wide.[70] Four fifths of the developing countries' effective steelmaking capacity to be added between 1978 and 1985 will be in nine countries of which several—Algeria, Iran, Mexico, Nigeria, Saudi Arabia and Venezuela—are oil producers.[71] Nearly all the new capacity to be found in oil-producing countries will be via direct reduction of ore and electric-arc furnaces. Elsewhere, however, the price of energy will be a major determinant of the spread of DR facilities. In the longer term, from 1985 to 2000, DR fuelled by natural gas may be affected by falling supply, and some observers expect that this will encourage the use of nuclear power in DR plants.[72] Apart from its energy intensity, DR is attractive owing to its lower capital costs, which are some 60 per cent below those of conventional techniques chiefly because ancillary facilities such as cooling and sintering plants are not needed.

In 1979, seven DR plants existed—in Argentina, Canada, the Federal Republic of Germany, the United States and Venezuela—and one was planned for Saudi Arabia. They have throughputs of from 400,000 to 750,000 tons per year, matching the minimum size of downstream steel mills, and all are thought to be successful.[73] Latin American steel output, forecast to be 75 million tons per year by 1985, will largely be supplied by coke-fed blast furnaces, but DR output should be rising. DR using gasified coal could account for some 15 million tons per year of steel by the year 2000, and this amount, together

[67] *Metal Producing*, June 1979, p. 43.

[68] *Ibid.*, p. 79.

[69] *Ironmaking and Steelmaking*, No. 4, 1979, p. 146.

[70] *Metal Producing*, December 1978, p. 42.

[71] Based on projections by the OECD Steel Secretariat as cited in *The Economist*, 12 April 1980, p. 73.

[72] At present, Japan is the only country actively pursuing a nuclear steelmaking alternative, but even a pilot plant will not be built before 1990.

[73] *Industrial World*, February 1979, p. 27.

with a further 30 million tons per year from oil-based DR and 15 million tons per year from charcoal-using furnaces, is expected to account for 60 million tons per year or 25 per cent of the region's consumption.[74]

The spread of electric furnaces will continue. Not only are capital costs for the construction of conventional blast furnaces higher, but the built-in energy value contained in scrap is better utilized by electric furnaces.[75] Even more economical will be plasma furnaces, which can produce steel at $400 per ton less than electric-arc furnaces and do not need particularly sophisticated installation or maintenance skills. These are thought to be suitable for initial installations in developing countries.[76]

Further energy savings are anticipated by using still other techniques. Scrap, sponge iron and other charge materials (that is, materials entered into the furnace to create the steel itself) can be continuously melted in a shaft furnace, and the liquid metal will then flow into an electric furnace for refining. This system, called KYS (Klockner-Youngstown steelmaking), is now under way in the United States at present installation costs of $40 million.[77] Iron-ore pelletizing is used in the latest Chilean steel complex at Huasco Valley and helps hold down fuel consumption in the $250 million state-owned plant which began production in December 1977. The use of turbines to collect power from the blast furnace (let out to ensure an even air pressure during forming) can also save substantial amounts of energy. A Japanese firm collects from 80 to 85 per cent of the power let out of the furnace in this way.[78]

Foundries are exceptionally energy-intensive. On average a foundry uses six times the energy of a typical manufacturing plant employing the same number of people. Melting, material handling and heating air for ventilation require energy, and a massive effort in conservation has been mounted on all these fronts.[79] In the 1980s, computers in foundries will assist in infra-red thermography, which shows the places in the plant where heat is escaping most. Objects losing heat show the thermal (infra-red) energy radiating from their surfaces. As 30 per cent of the heat consumed by furnaces can be lost from surfaces by radiation, the cost of the device is quickly recovered.[80]

Continuous casting also promises major energy savings. In this process, iron from a blast furnace goes into the convertor to become steel, whence it is poured out directly as slabs ready for rolling instead of first being set as ingots, which have to be expensively reheated before being made into finished plate or coil. Steel thus made is about 15 per cent cheaper than that from more traditional methods. Japan appears to be the leader in this development; between 1973 and 1980, the proportion of steel continuously cast rose from 20 to 47 per cent. By contrast, the proportion continuously cast in the United Kingdom and the United States is currently 15 per cent.[81]

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[74] *Ibid.*, November 1978.

[75] *Metal Producing*, June 1979, p. 44.

[76] *Industrial World*, August 1979, p. 24.

[77] *Metal Producing*, April 1976, p. 38.

[78] Reay, *op. cit.*, p. 56.

[79] *Foundry Management and Technology*, March 1979, p. 80.

[80] *Ibid.*, September 1979, pp. 56 and 116.

[81] *The Economist*, 12 April 1980, p. 73.

The difficulties encountered with this system in the early 1970s (e.g. cracking furnaces, surface damage to the output) were largely solved; in one opinion, "the 1970s marked the turning point for the acceptance of continuous casting as a legitimate breakthrough in steelmaking technology".[82] However, the high capital cost of replacing existing casting systems in steelworks may limit the rate at which casting is introduced and will tend to restrict its application to new ("greenfield") sites.

Glass

The glass industry was directly affected by the rise of energy prices during the 1970s. Evidence from a variety of sources confirms that glassmaking in developed countries has been a relatively energy-intensive operation. In the United Kingdom, glass firms (plants employing 100 or more people) were the sixth most intensive energy users (621.1 terajoules per employee) in 1977. Considerable potential for energy savings, almost 10 per cent annually, was also indicated. Despite this finding, producers have made considerable strides. One study of energy use in the United Kingdom found that glass and building material firms (including bricks, tiles, fire-clays) realized the largest proportionate energy savings of any industrial branch during the period 1966-1976. The drop in overall energy intensity (64 per cent) during the 11-year period was considered "a remarkable performance".[83]

Such data from developed countries support the impression of industry analysts that energy saving has long been an imperative. Technological innovation has for years embraced (and indeed on occasion been initiated by) the desire for fewer energy inputs to be used per unit of output. In the production of glass there are four areas in which energy-conservation measures can be taken: in insulation, heat recovery, combustion control and process modification. In all, 23 operations in a glass factory use energy, although only 2 (melting and forming) together account for 82 per cent of total energy requirements.[84] A brief account of the manufacture of glass will help put these figures into perspective.

The main ingredients of glass are sand (50 per cent), crushed glass for cullet (20 per cent), soda ash (16 per cent), limestone (12 per cent), and other materials (2 per cent). These are mixed at the factory and fed into a furnace that works at around 1,500°C. This furnace uses oil, natural gas or liquefied petroleum. The biggest furnaces melt 250 tons of glass daily. The molten glass then flows into a trough, then a feeder that forms gobs of glass. These are cut off by shears, moulded more fully and then heated again in an annealing oven, where the temperature is lowered gradually to avoid strains in the glass, which weaken the structure.

The significance of insulation can be seen at once. The objective is to melt pure glass as cheaply as possible, but in the construction of furnaces there is always a trade-off between the degree of insulation and the longevity of the

[82] *Metal Producing*, June 1979, p. 58.

[83] Leach and others, *op. cit.*, p. 68.

[84] *Glass*, March 1979, p. 6.

refractory lining.[85] Heat recovery can be improved, since about 30 per cent of the energy input to a glass furnace leaves in the form of heat in combustion exhaust gas and from 25 to 30 per cent leaves in the molten glass. Energy-saving opportunities exist in reclaiming exhaust gases for preheating the air.[86] Combustion control can be improved by using computers and by installing cooling recirculation systems for the total process. Cutting waste glass output is naturally also an option.[87]

The glass industry did not suffer a notable drop in sales during the 1970s. The flat glass market continued to grow, and, as the industry has been quick to point out, it can make a contribution to energy saving by developing a type of heat-retaining architectural glass.

A second area of debate and research concerns the choice of the energy source. Lately much interest has been shown in the idea of using solar power for glass production (not least because of the growth in demand for glass-topped solar collectors).[88] At present, however, there is no uniformity of energy source. One central coal-fired plant yields enough electricity for all Seattle's 373 glass furnaces, each of which produces some 120 tons of glass daily.[89] Electricity is believed to give the most consistent quality conditions, while gas is used where minimizing costs is the objective. Oil burning requires more complex burners and storage, while coal and electricity in turn demand still more in the way of capital installations. Initially, coal was expected to be the norm, but the increasingly costly environmental protection safeguards of the United States made this unlikely. For each furnace the cost of meeting the requirements of the Environmental Protection Agency (EPA) is put at $107,000. (Partly to offset these problems, EPA has awarded a $1.7 million grant for further research on energy-saving ideas.) Similarly, natural-gas users have become worried about their choice since shortages in the United States have sometimes occurred. Overall gas demand in the United States glass industry is 200 billion cubic feet per year. There seems to be no consensus on the likely energy moves in the industry, although two seminars on energy saving in the industry (in March 1977 and October 1978) suggested that, 20 years hence, glass melting would be performed by all-electric melting units, with coal being used in the short term.

The glass industry in the developed countries appears to be constantly searching for energy-saving methods. Energy input per unit of output in the United States glass industry fell by 12 per cent during the period 1972-1977.[90] During the period 1977-1980, the industry expected to achieve a further cut of 13.5 per cent. Furnace efficiency is estimated to be improving by from 3.5 to 4 per cent annually. Moreover, the nature of the product has been continually redesigned, so that for each end-use a smaller volume of glass is now needed. Bottles with lower masses will also consume less energy (e.g. in the form of

[85] *Glass Industry*, November 1978, p. 29.

[86] *Ibid.*, December 1978, p. 34.

[87] *Ibid.*, April 1977, p. 17.

[88] *American Glass Review*, February 1978, pp. 7-9; January 1978, pp. 6-9; April 1977, pp. 6-9.

[89] *Glass Industry*, March 1977, p. 12.

[90] *Ibid.*, April 1977, p. 17.

heat) when they are in the cycle of collection, washing and drying after consumer use.[91]

Lumber and paper

The changing price of fuel has had a clear effect on the lumber-processing industry. The most energy-intensive part of that operation is kiln drying (which uses from 4 to 6 million British thermal units per ton of paper output), for which natural gas has traditionally been used. After the operation of oil-fired kilns became appreciably more costly than wood-fired ones, there was a tendency in the 1970s to switch to the latter. Using wood-fired kilns is advantageous so long as the particles from the mill are worth more as substitutes for oil fuel than as inputs to particleboard subsidiaries to the firm. A related aspect of this trade-off is that the rising cost of shipping has tended to put suppliers in developing countries at a geographic disadvantage owing to the longer distances over which their products are typically moved.[92] Solar energy is being tried where the lost particleboard inputs are thought to be too valuable.[93]

Modified heat pumps to minimize the unnecessary over-drying of timber are also in use. The difficulty is that as the warm air full of moisture from the drying wood is let into the atmosphere to remove the accumulated water, heat is lost. The heat is reabsorbed into the cycle by means of a heat-pump drier with a condenser.[94] Closed-circuit ring-drying systems, whereby dried products leave the heating stage earlier and exhaust heat is returned to the furnace, are also in use in timber industries.[95]

The United States lumber industry now accounts for 1.5 per cent of total industrial energy. Of this amount, 8.2 per cent is used by the paper industry in the form of wood, or some 16.1 million tons per year. The paper industry is in fact the fourth most energy-intensive in the United States. The composition of wood used for the paper industry's own fuel needs is roughly as follows: mill-produced bark (69 per cent); sawmill waste (12 per cent); forest residue (1 per cent); and mixed wood (18 per cent). The problem with burning wood at present is that the collection, or "harvesting", of suitable logs uses equipment costing $0.5-$0.8 million, and small trees cannot be gathered economically. This implies that the paper industry may become hard pressed as fuel prices rise. However, unmerchantable parts of trees (e.g. the top branches and foliage, which constitute 18 per cent by weight of the southern pine tree) are now used whenever possible. In this way local fuel can be burned and commercial energy costs minimized.[96]

Energy-saving advances in papermaking apparently vary widely from country to country. For example, in the United Kingdom, energy costs for papermaking doubled between 1974 and mid-1980 and now amount to 15 per

[91] Reay, *op. cit.*, p. 91.

[92] *Wood and Wood Products Journal*, January 1979, p. 21.

[93] *Ibid.*, March 1978, p. 69; *Pima*, June 1978, p. 41; *Processing*, April 1979, p. 61.

[94] *Petroleum Economist*, September 1979, p. 51.

[95] *Processing*, April 1977, p. 33, and *Industrial World*, June 1978, p. 45.

[96] *Pima*, November 1979, p. 24.

cent of total costs. Comparable firms in Europe and Canada have apparently succeeded in reducing their energy costs below this level through better practices.[97] Obviously, producers in developing countries should attempt to follow the lead of these latter firms.

Within the paper-mill itself, a reasonably wide scope exists for fuel savings; in particular, the selection of a low-energy drying system can reduce the water throughput fourfold and thereby cut fuel demand by 55 per cent. In addition, if the physical geography of the site allows, energy may be saved by integrating the pulping and papermaking operations so that there is no need to dry the pulp prior to shipping it across to the paper-mill.[98]

The industry has benefited from the recent construction trend in timber-frame houses, which have proved to be superior to brick houses in preventing the escape of heat. Another incentive for the switch is the rapid rise in the price of cement. Two fifths of the cost of cement manufacture is for fuel. The selling price of cement has almost doubled in the past three years, while that of softwood and plasterboard has risen only 25 per cent.[99]

Other industries

Rising costs of energy (as well as of labour, packaging, capital borrowing and distribution) are reportedly also having an effect on the food-processing industry. A trend is emerging towards fewer and larger-than-average plants to exploit economies of scale. Technical change now permits 400 cans per minute or 1,200 to 2,000 glass bottles per minute to be filled and capped, but the equipment needed is initially much more costly than older equipment. Continued rising demand for convenience foods in developed countries, coupled with government legislation tending to close smaller plants for insufficient cleanliness, are seen as the basis for expansion by large and established firms in developing and developed countries.[100]

Manufacturers in developed countries are expected to make greater efforts to meet efficiency codes for household appliances. In the United States, the Department of Energy expects to set energy requirements on 13 major domestic appliance categories such as refrigerators. To take as an example only one innovation induced by these impending changes: a United States firm is building power factor controllers into heavy energy-using items such as washing machines. These controllers, which can cut energy consumption by 50 per cent, sense shifts in the relationship between voltage and current as their motor's workload changes and they then cut the voltage to the minimum required.[101]

Developments in the textile industry have also led to some energy savings. The wet processors, which dye, bleach and print textiles, perform most of the functions whereby significant energy savings can be made. So far the major innovation is using less moisture when applying the chemicals to the fabric, so

[97] *The Economist*, 16 August 1980.

[98] See Gyftopoulos, Zazoridis and Widmer, *op. cit.*, pp. 58-68.

[99] *The Economist*, 9 August 1980.

[100] *Industrial World*, April 1978.

[101] *Appliance Manufacturer*, November 1979.

that less heat is needed to dry it. Then, radio-frequency drying can be used to reduce further the energy required to dry the wool.[102]

Given the importance of the private automobile as a user of household energy in developed countries, the effect of rising energy prices on its manufacture is worth considering. There is increasing scope for the use of aluminium and plastics in cars. In 1974, one United States model contained 70 lb of aluminium on average; by 1979, the average was 120 lb and it is expected to reach 180 to 200 lb by 1985.[103] Plastics, which accounted for only 0.4 per cent of the weight of the typical European car in 1950, accounted for 9 per cent of the weight by 1979.[104]

A different type of shift in demand within developed countries and one that will inevitably make an impact on developing countries is in packaging. In the developed countries, packaging is a major consumer of raw materials. For example, the total weight of materials used in packaging in the United States in 1979 was 68 million tons, or a rise of 25 per cent in 10 years. By weight, it absorbed in that year the following proportions of the output of each of these industries: paperboard (80 per cent); glass (65 per cent); plastics (25 per cent); paper (22 per cent); aluminium (19 per cent); wood (15 per cent); and steel (7 per cent).[105] The movement away from traditional materials (notably paper sacks and fibreboard) and towards plastic and aluminium products is expected to continue. The materials for which demand is predicted to grow at above-average rates within packaging as a whole are aluminium, glass and tinplate; whereas the demand for paper, board, jute and wooden containers should grow more slowly.[106]

Some implications for industrial location and local processing

The identification of similarities and general trends in such a complex field as energy-induced technological change is difficult. Table IV.9 provides a useful basis for a brief summary. The table shows four broad trends that appear to be related to technological change. First, it is likely that many innovations related to changing energy costs will favour the location of industry in developed countries. To give three examples only—chemicals, glass, and lumber and paper—in each case there is unlikely to be substantial relocation of manufacturing or processing work purely as a result of changing energy costs. In the case of chemicals, firms have simply been able to use their accumulated technical expertise to improve energy efficiency throughout their operations. However, a possible exception is that petrochemical production may shift towards certain OPEC sites during the next decade.[107] For glass, firms in developed countries are well advanced in their technological innovatory work.

[102] *Financial Times*, 25 October 1979.

[103] *Foundry Management and Technology*, July 1979, p. 60; *Chemical Week*, 31 January 1979, p. 29, and *Modern Plastics*, October 1979, p. 38.

[104] National Economic Development Office, *op. cit.*, p. 4.

[105] *Fortune*, 7 May 1979, p. 180.

[106] *Financial Times*, 8 March 1979.

[107] See chapter III.

and the energy cost rise has prompted other innovations besides those related to energy. In the lumber and paper industry, two effects have worked to the detriment of firms in developing countries. One is that firms in developed countries, forced to contemplate adopting as fuel inputs forest materials once thought useless, have now devised equipment to make fuller use of hitherto wasted branches and trees and have thereby consolidated their position in the business. The other effect, which applies to developing countries, is that the changing price of transport fuel has made some processed goods (e.g. particleboard) with a relatively low value-to-weight ratio, less attractive in the markets of developed countries.

A second conclusion is that the evidence refutes the idea that large-scale and widely disseminated technological changes of a clearly defined and universally applied nature are being undertaken. Instead, in all the industrial branches whose experience was examined, recent or anticipated changes are modest, have a parochial application and a phased introduction. Two exceptions to this generalization are automobiles, for which up to $50 billion in investments are expected by 1990, and, to some extent, aluminium. More typical instances of energy-induced technological changes are those that cut across industry boundaries such as modified heat pumps or oil re-refining.

Notwithstanding the piecemeal or parochial nature of these changes, their cumulative effect is significant. Despite the inherent difficulties of interpreting measures such as energy/output ratios, it appears that, in many cases, industrial energy use has been reduced. Moreover, this applies to the period 1973-1980 when the real price of energy was often declining rather than rising to encourage further energy saving. Some figures for the United States illustrate the extent to which the Energy Policy and Conservation Act of 1975 has been successful. In the period 1972-1975, per unit energy needs declined in steelmaking (4.8 per cent), foundries (18.4 per cent), the refrigeration industry (14.2 per cent), paper mills (10.7 per cent), textiles (11.8 per cent), brickmaking (14.2 per cent), flat glassmaking (19.5 per cent), chemical processing (8.8 per cent), and rubber goods (6.1 per cent).[108] Regrettably, no such figures for industries in developing countries are yet available and, indeed, it may be some time before such thorough investigations of energy use by industrial branch levels are made.

The third conclusion suggested by table IV.9 is that gas inputs will be of increasing importance to industrial processing. After a shift to oil during the 1950s, 1960s and early 1970s, the share of gas in industrial energy use fell back, but it is now likely to increase, especially in the production of iron and steel, glass and chemicals. While the consequences of industrialization for the gas reserves of developing countries cannot be discussed fully here, a few figures will illustrate the extent of the potential. Developing countries with significant known reserves are Algeria, Nigeria and, in the Middle East, Abu Dhabi, Iran, Kuwait and Saudi Arabia. Algeria currently exports all its gas by liquid natural gas (LNG) tankers but will eventually be linked to Italy by an underwater pipeline. There may also ultimately be a link to Spain. Nigeria has been flaring much of its gas, since the infrastructure to capture and transport it has not

[108] *Industrial World*, April 1977.

TABLE IV.9. TECHNOLOGICAL CHANGE AND INDUSTRIAL LOCATION—A SYNOPSIS

Processing chain	*Technological change*	*Location involved*	*Timing*	*Implications/comments*
Bauxite/alumina/ aluminium	Existing or slightly improved technologies to be used	Brazil	Current	Constant appraisal of the rising opportunity costs of energy allocated to this industry is required
		Venezuela	Current	
		Middle East (Algeria, Dubai etc.)	1982-1985 completion	
		Bahrain, Egypt, Iran	Current	
	(Capacity contraction in developed countries)	Japan	Current	
	Slight improvements in Bayer process	Existing sites in developed countries	Current/1980s	
	New electrolysis of alumina techniques	Developed countries	2000(?)	Prompts relocation back to developed countries?
	Alcoa process		1983-1985	Can be used on small scale
	New sources for alumina-clays	North America	1990s(?)	In long run may shift location to North America
	Recycling	Developed countries	Current	Cuts demand for bauxite
Iron and steel	Better gas recovery from furnace Waste heat recovery reusing energy	Firms of developed countries	Already made/current	
	Direct reduction		1980-2000	May entail shift to gas sources New developing countries' gas sources (Nigeria, Middle East) may export gas for use in DR or use gas inputs domestically then export goods

	Electric plasma furnaces	Developed countries, developing countries
	Continuous casting	Developed countries, developing countries
Glass	Insulation, heat recovery, combustion control, process modification	Firms of developed countries
	Energy sources: move to solar power?	Sunny areas
	Shortage of natural gas in developed countries' sites	Developed and developing countries' gas areas
Lumber and paper	Switch to wood-fired kilns	Firms of developed countries
	Solar energy experiment, modified heat pumps, forest waste as fuel input, low-energy drying systems in paper-mills	
Chemicals	No major changes. Switch from oil to coal and gas burners. Waste heat recovery to be enhanced	Firms of developed countries

1990-2000(?)	Some nuclear inputs possible
Current, future	Suitable for installations in developing countries
Current	Teething troubles apparently over. Suited to greenfield sites
Under way before 1973	
1990(?)	May involve developing countries
Current	*(a)* May entail shift to gas-producing areas in developing countries, or *(b)* trade with new developing countries' gas sources intensified. In view of cost structure, *(b)* more likely
1973 to present	Diminish developing countries' cost advantage. Transport costs and trade barriers also impede entry of developing countries' firms
1973 to present	Developing countries' chemical production losing some input-competitive edge: gas inputs may be significant for developing countries' suppliers

existed. The significance of this move to gas for developing countries is underlined by the fact that, in 1977, less than 3 per cent of the 21.5 billion cubic metres of gas found in association with oil was used; the rest was flared.[109] By 1985, one country (Nigeria) should be able to export (or use at home) some 16 billion cubic metres per year. It is expected that markets in both Western Europe and the United States will develop quickly. While much of the current discussion of the developing countries' gas reserves concerns their liquefaction or pipelining and subsequent export, it may be that more extensive indigenous use of gas will evolve.

The final point to emerge from an examination of table IV.9 was anticipated in the earlier discussion, where it was pointed out that despite advantageous energy resources a developing country may still fail to attract energy-intensive investments if other co-operant inputs are lacking. For example, several Latin American countries that already have the capacity for primary reduction of bauxite, have found themselves handicapped by their dependence on imported raw materials. The need for co-ordinating inputs efficiently becomes extremely important in these circumstances. The Bahrain smelter, which requires co-operant inputs to be imported from many different countries, illustrates the substantial investment in port facilities, inland transport and skilled manpower that is needed.

The main conclusion illustrated by table IV.9 and suggested throughout the chapter is that firms in developed countries have already acted to a very considerable extent to ensure smaller increments to their future energy needs. Across a wide range of firms, economies are in effect. Half the world's energy is used in making metals and other materials and, in the short run, energy will be saved by processing improvements and by concentrating on materials that can be recycled without losing their intrinsic properties. Increased reliance will be placed on low-energy materials (i.e. those requiring relatively little energy for economic use) such as timber and concrete.[110] In the latter case, the "energy value" of a material's properties will increasingly be considered. There is, of course, a trade-off between the qualities of the material (e.g. its tensile strength and thus its suitability, for example, in bridges) and the energy required to make it usable. Thus, "total energy criteria will throw a completely different light on the true value of materials".[111]

In the longer term, industrialists, assisted to varying extents by Governments and public agencies, could achieve very substantial economies. The recent study by Leach *et al.* shows "how the United Kingdom could have 50 years of prosperous material growth and yet use less primary energy than it does today".[112] Technological changes of the sort illustrated earlier, along with changes in the output mix of industry and substitution of material inputs, will all contribute to this evolution.[113]

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[109]P. W. Tucker, "European gas prospects", Paper presented to the Institute of Petroleum (London, 14 January 1980).

[110]*Metals and Materials*, June 1979.

[111]Alexander, *op. cit.*

[112]Leach and others, *op. cit.*, p. 9.

[113]*Metal Progress*, November 1978, p. 23.

E. ENERGY AND INDUSTRIAL DEVELOPMENT IN INDIA

In India, almost 29 per cent of public investment in the sixth plan[114] is earmarked for energy, thus underlining its importance to the economy. This is the highest allocation to any sector, followed by agriculture[115] (25 per cent), transport (15.7 per cent) and industry (15.3 per cent). These figures show that energy itself is an enormous economic sector in India, where the major energy resource is coal and investment for the sector must be generated internally. The situation contrasts with that of some other developing countries whose major energy resource is oil, often imported. Of course, payment for oil requires investment in other sectors or trade in primary goods.

The industrial sector is the largest consumer of commercial energy from various sources in India. In 1978/79, industry consumed 64 per cent of the country's supply of electricity,[116] 73 per cent of coal and 60 per cent of fuel oil. Consequently, the interrelationship between the industrial and energy sectors is central to the country's industrial future. This section analyses the pattern of structural change in industry along with the implications for energy requirements. Trends in energy use by industrial branches are then considered. The section concludes by considering likely developments in the next two decades, taking into account the various energy sources and possible adjustments in patterns of energy consumption.

Structural changes in the industrial sector

Not surprisingly, the extent of structural changes in the Indian economy has been substantial over the past three decades. In the period 1950/51 to 1975/76, growth of the primary, secondary and tertiary sectors was 2.2 per cent, 5.4 per cent and 4.7 per cent, respectively. In the initial years, agriculture dominated the economy, accounting for 60 per cent of GDP while industrial activities amounted to 10 per cent. By 1978/79, the share of agriculture had declined to 44 per cent as the share of industry reached 16 per cent.[117] Growth in manufacturing was led by registered[118] rather than unregistered firms during most of this period. However, owing partly to deliberate policy and partly to

[114]The Planning Commission of the Government of India printed a "Revised draft sixth plan" in 1979, wherein the targets for the sixth, seventh and eighth plans were indicated for 1977/78 to 1982/83, 1982/83 to 1987/88 and 1987/88 to 1992/93, respectively. After the election in 1980, the new Government decided to revise the plan, and new figures are not yet available. The Government also decided to shift the plan periods by two years, i.e. 1980/81 to 1984/85 etc. In this paper, the reference to the sixth plan is made according to the printed version available. It is, however, expected that the growth rates for the energy sector and the large energy-consuming industries will not change drastically in the new plan.

[115]However, a portion of the investment for these sectors also comes from private enterprise. In the case of energy, the contribution of the private sector is very small.

[116]For consumption of electricity by major industries in India, see appendix I to this chapter.

[117]Figures are taken from *National Accounts Statistics 1970/71-1976/77* (New Delhi, Central Statistical Office) and press note, 7 February 1980.

[118]Registered firms are those with 10 or more workers using power, or 20 or more not using power.

the emergence and spread of skills and entrepreneurship, these trends were, to a small degree, reversed in the late 1970s.

Energy requirements for industry, particularly coal and electricity, have had to adjust in response to these structural changes. The consumption of coal in specific lines of industrial activity is shown in table IV.10. Industry has long been the predominant user of electricity in the country. For example, in 1953/54 that sector absorbed 66 per cent of the electricity produced. This share exceeded 70 per cent in the late 1960s and early 1970s. The proportion declined slightly in later years and was estimated to be 64 per cent in 1978/79. In the same period, total production increased more than elevenfold, exceeding 84 billion kilowatts.[119]

TABLE IV.10. COAL CONSUMPTION IN SELECTED INDUSTRIES IN INDIA, 1974-1979

(Million tons)

Industry	*1974/75*	*1975/76*	*1976/77*	*1977/78*	*1978/79*
Steel	18.51	20.93	22.30	21.54	20.26
Power	20.04	23.44	27.70	27.98	28.72
Railways	13.31	14.30	13.30	13.93	12.39
Cement	3.62	4.44	4.70	5.10	4.94
Fertilizer	0.95	0.93	0.70	1.26	2.66
Bricks				3.36	1.46

Source: Department of Coal, Ministry of Energy (New Delhi, 1980).

Within the registered sector, the following industries are large energy-consuming (LEC) branches: textiles, fertilizers, inorganic heavy chemicals, pulp and paper,[120] non-ferrous basic metals, iron and steel, and cement. In 1975, these branches accounted for 65 per cent of the energy used in the industrial sector and produced 35 per cent of the value added by industry. Thus, their activities are central to the industry-energy relationship. The share of net output in the unregistered sector declined from 45 per cent in 1951/52 to 38 per cent in 1975/76. This decline was offset by an increase in the share of non-LECs in the registered sector. LECs maintained a relatively constant share of net output in manufacturing.[121]

Table IV.11 shows value added by industrial branch. During the period 1970/71-1976/77, growth rates for net output in registered and unregistered firms were roughly similar. In 1971, unregistered firms typically supplied a lesser share of the total value added and this proportion had declined further by 1976.

[119]Figures are based on the *Report of the Working Group on Energy Policy* (New Delhi, Planning Commission, 1979).

[120]Although pulp and paper and textiles are not particularly highly energy-intensive branches, when regarded in terms of their physical output, their total energy consumption is high owing to the high volume of production.

[121]The trend may be partly owing to the fact that several energy-intensive branches are publicly owned and their prices are controlled. Figures were derived from *National Accounts Statistics 1970/71-1976/77, op. cit.*

TABLE IV.11. GROWTH RATES OF VALUE ADDED OF SELECTED INDUSTRIES IN THE REGISTERED AND UNREGISTERED SECTOR IN INDIA 1970/71 TO 1976/77

(In Rs 100,000 at 1970/71 value)

Industry	Registered sector			Unregistered sector		
	1970/71	1976/77	Growth rate (percentage)	1970/71	1976/77	Growth rate (percentage)
1. Food products	26 815	29 084	1.36	18 411	19 474	0.94
2. Beverages, tobacco and tobacco products	9 911	14 193	6.17	10 409	14 013	5.08
3. Textiles	59 730	76 559	4.22	44 611	61 621	7.10
Cotton textiles	40 139	47 591	2.88	...	...	...
Wool, silk and synthetics	9 378	12 635	5.09	...	...	...
Jute, hemp and mesta textiles	8 780	12 294	5.77	...	...	...
Textile products	1 433	3 808	17.69	...	...	...
4. Wood and wood products	3 094	2 601	(—2.95)	22 043	33 257	7.10
5. Paper and paper products	14 959	16 124	1.26	5 106	5 227	0.39
6. Leather and leather and fur products	2 260	2 010	(—1.97)	6 907	7 481	1.34
7. Rubber, plastic, petroleum and coal products	12 890	13 346	0.58	1 820	2 966	8.48
8. Chemicals and chemical products	36 707	52 394	6.11	5 837	8 753	6.99
9. Non-metallic mineral products	11 399	12 992	2.20	9 342	15 097	8.33
10. Basic metal and alloys industry	28 451	42 429	6.89	462	733	7.98
11. Metal products and parts	9 454	11 292	3.01	11 772	14 152	3.12
12. Machinery, machine tools etc.	19 386	32 860	9.19	6 375	8 679	3.28
13. Electric m/c	18 213	29 380	8.30	3 627	4 443	3.44
14. Transport	24 396	28 832	2.82	5 346	7 025	4.68
15. Miscellaneous manufacturing industries	18 652	14 293	(—4.54)	13 258	16 530	3.75
16. Repair services	6 397	9 769	7.31	10 603	13 346	3.91
17. Net value added including imputed bank charges	296 317	392 198	4.78	...	...	...
18. Less imputed charges	1 055	1 797	9.28	...	...	...
19. Net value added	295 262	390 401	4.77	175 929	232 797	4.78

Source: J. K. Parikh and A. Chaitanya, comps., "Are our industries energy-efficient?", *Economic and Political Weekly*, vol. XV, 1980, p. 559, with data from National Accounts Statistics (New Delhi, Central Statistical Organization, 1979).

Some brief comments may serve to put the energy resources and requirements of India in perspective. Coal is the major resource and the economy is structured to make the maximum use of coal. While India has 100 billion tons of reserves and resources, its annual use of coal is about 100 million tons. Only 6 to 10 per cent of oil products are used by industry. Previously, natural gas was mostly associated with crude oil and was often flared. The recent finds of free offshore gas in South Basein, near Bombay, are expected to be used mostly for non-energy purposes, i.e. as feedstock for fertilizer production. Since the preferred use of natural gas is in the production of fertilizer, the demand for which grows at more than 9 per cent per annum, natural gas is not likely to be available for other industrial uses in the near future. However, discoveries of more fields of natural gas cannot be ruled out, and to that extent natural gas may be available for purposes other than non-energy uses, although only in the long term. The recent working group on energy policy, therefore, found it appropriate not to consider natural gas as a basis for future energy policy, at least for the next two decades.

Furthermore, new energy resources are not likely to be substantial for the next 20 years, particularly with regard to industry's requirements. At best, nuclear power plants are expected to contribute 5-10 GW to installed capacity by the year 2000 as against the requirement of 100-130 GW. Thus, industry will have to be organized to make maximum use of energy resources that the country has, namely, coal (direct) and electricity coming from coal and hydro potential. The choice of technology should thus be such that these two sources can provide the necessary energy.

Trends in energy use, by industrial branch

Table IV.12 shows energy consumption by source in the major energy-using branches. Iron and steel is by far the largest consumer of energy from all sources followed by fertilizers and textiles. Energy intensities of these industries

TABLE IV.12. CONSUMPTION OF ENERGY BY LARGE ENERGY-CONSUMING INDUSTRIES IN INDIA, 1976

Industry	Energy consumed (10^6t coal replacement)				Output (10^6t)
	Coal and coke (1)	Fuel oil (2)	Electricity (3)	Total (4)	(5)
Crude iron and finished steel	22.30	0.96	5.48	28.74	10.20
Textiles	2.60	1.17	5.12	8.89	5.36
Fertilizers	4.70	0.88	4.30	9.88	2.47
Chemicals	0.32	1.57	3.12	5.01	3.50
Cement	4.70	0.09	2.43	7.22	18.68
Aluminium	0.10	0.28	4.01	4.39	0.21
Pulp and paper	1.47	...	1.33	2.80	8.99
Total	36.19	4.95	25.79	66.93	49.41

Source: Data supplied by the Department of Coal, Ministry of Energy (New Delhi, 1976); statistics by the Ministry of Petroleum and Petro-chemicals (New Delhi, 1977); and *General Review: Public Electricity Supply* (New Delhi, Central Electricity Authority, Ministry of Energy, 1977).

Note: Categorization of industries is not exactly the same as the data sources of (1) to (5). Some are for the financial year 1976/77 and some for the calendar year. Thus the table is only indicative of approximate magnitudes, ranking etc.

have different orders of ranking because of the differences in volume of production and value added by each industry.

Previous studies[122] have noted that in India and other developing countries, the energy use per physical unit of output and per unit of value added is increasing and is high compared with that in some other developing countries. Table IV.13 indicates some reasons for this phenomenon.[123]

To clarify some of the international and intertemporal relationships, an examination of cross-country and long-term trends in the main energy-using branches is helpful. In general, the norm for energy consumption, i.e. consumption per unit of physical output, in producing a given product depends

TABLE IV.13. COMPARISON OF ENERGY CONSUMPTION NORMS AND ENERGY INTENSITIES IN INDIA OVER TIME AND BETWEEN INDIA AND OTHER COUNTRIES

Increase	*Energy/output (consumption norm)*	*Energy/value added*
Compared with the past in India[a]	Improvements in quality of products	Wage increase is slow
	Substitution of human and animal energy	Controlled prices for some of the outputs
	Substitution of non-commercial energy	Increase in consumption norms
Relative to developed countries	Technology of production is not improving fast enough	Wage increase in developed countries is higher
	Scale of production	Corrections for purchasing power of a rupee are necessary
	Capacity utilization not good due to interruptions in production, for a variety of reasons	
	Problems of measurement and comparison of energy use between countries	
	Increased use of coal instead of gas or oil and decreasing quality of coal	
Relative to other developing countries	Increased use of coal	Comparatively large production base of energy-intensive industries such as iron and steel, chemicals, fertilizers, and metals
	Sometimes better quality product	

[a]Not true of all products.

[122]See, for example, W. Häfele, *Energy in a Finite World* (Baltimore, Ballinger Press, forthcoming).

[123]The reader may also note that energy consumption norms and energy intensities may be interrelated. Thus, when one measure increases, the other may rise for the same reason. For example, if the energy intensity I is defined as energy E per unit of value added VA, and the energy consumption norm C is taken to be energy per unit of output O, then $I = E/\text{VA}$ and $C = E/O$. Thus, when value added and physical output are constant over time (or, should both measures decrease), energy intensities and energy norms would both rise.

on three factors: the production technology and plant capacity, capacity utilization and the quality of products and product mix.

Table IV.14 shows a comparison of energy consumed per unit of output for various countries. Even though international comparisons are beset with definitional problems, the relative position of India seems clear. It consumes more energy per unit of output of crude steel, aluminium and cement than many developed countries. Developed countries may have already experimented with new, energy-efficient technologies, and those that are large importers of energy are cautious in their use of energy and have more energy-efficient technologies. Developed countries may also benefit from economies of scale to a greater extent than several Indian industries.

With regard to crude steel production, the pattern of energy consumption in India may be owing to the large number of integrated plants, which include coal washeries, iron-ore processing etc. It is possible that in other countries these operations are done outside the steel plants. As data on energy consumption at different points of the steel-production process are not available, it is difficult to say exactly how much energy is used in the production of crude steel alone.

The country's pattern of energy consumption in the pulp and paper and aluminium industries also suggests relatively high levels. These measures, however, are sensitive to conditions such as the rate of capacity utilization and the extent to which various processes (e.g. paper drying) are carried on outside the reporting establishments. In cement production, energy requirements are more closely in line with trends in developed countries.

With regard to the intertemporal aspect of energy measures, table IV.15 shows the changes in norms that have taken place in India. The norms vary with the vintage of the plants, measured by the date of their commissioning. While the crude steel plant commissioned in 1953/54 requires 1.6 tons of coal per ton of steel, the plant commissioned in 1972/73 consumes only 1.2 tons of coal. Similarly, in cement consumption, norms for the wet process have dropped from 0.46 tons of coal to 0.3 tons (in spite of low capacity utilization). It is also interesting to note from the table that when the capacity utilization of the cement plant commissioned in 1970 was 50 per cent, it consumed 0.3 tons of coal as against the plant commissioned in 1940 which at 90 per cent utilization consumed 0.28 tons of coal.

In the aluminium industries fluctuations in the capacity utilization lead to fluctuations in the use of electricity. As interruptions in the production process are many in those countries that are just beginning to industrialize, their effects show up in the consumption of energy.

The observations that *(a)* Indian energy intensity in industry has risen over time (e.g. 1,267 in 1960 to 1,433 in 1970[124]) and that *(b)* these intensities are large compared with those of other developed and developing countries, seem surprising in view of the labour-intensive technologies that are often used. With regard to the first observation, table IV.16 shows that even among the large energy-consuming industries, growth rates of those that consume more energy per unit of value added (such as iron and steel) are higher than those that consume less energy (such as paper and pulp and textiles). Thus, although large energy-consuming industries have been contributing roughly 33 per cent

[124]Ton of coal replacement per Rs 1,000 of value added.

TABLE IV.14. INTERNATIONAL COMPARISON OF ENERGY CONSUMED PER UNIT OF OUTPUT IN FOUR INDUSTRIES, SELECTED COUNTRIES

Country or area	*Crude steel*	*Country or area*	*Paper and pulp*	*Country or area*	*Cement*	*Country or area*	*Aluminium*
Ireland	140	Spain	220	Austria	90	United States	949
	167[a]	Italy	340	Germany, Federal		Netherlands	1 290
Spain	180[b]	Austria	344	Republic of	91	Austria	1 346
Norway	189[b]	Denmark	353	Canada	95[d]	Japan	1 365
Denmark	236	Germany, Federal			148[e]	Other Asia	1 464
Germany, Federal		Republic of	438	Italy	96	Germany, Federal	
Republic of	326	Other Asia	476	Turkey	98[d]	Republic of	1 481-1 503
Italy	334	Sweden	489		139[e]	Norway	1 591[b]
Sweden	398	Japan	512	Other Asia	115	Sweden	1 648
Austria	450[c]	Switzerland	557	Norway	115	United Kingdom	2 107
Netherlands	470	United States	579	Japan	121	New Zealand	2 165
United Kingdom	478	United Kingdom	627	Spain	130	India	2 295
Other Asia	485	Norway	659	Netherlands	131	Spain	2 800
Turkey	500	Canada	673	United Kingdom	138		
Japan	513	New Zealand	692	Sweden	140		
United States	533	India	1 130	Ireland	153		
Canada	555			United States	161		
Luxembourg	701			Denmark	164[e]		
New Zealand	738			India	170[e]		
India	1 161[c]			New Zealand	175		

Source: *Energy Management in Selected Asian Countries* (Tokyo, Asian Productivity Organization, 1977); J. K. Parikh and A. Chaitanya, comps., "Are our industries energy-efficient?", *Economic and Political Weekly*, vol. XV, 1980.

[a] Scrap iron.

[b] Electricity only.

[c] Pig iron.

[d] Dry process.

[e] Wet process.

TABLE IV.15. ENERGY EFFICIENCY ACCORDING TO AGE OF PLANT AND CAPACITY UTILIZATION

Plant	Year of commissioning of plant	Coal consumed per ton of product (tons)	Capacity utilization (percentage)
Crude steel			
IISCO	1953/54	1.64	—
Bhilai	1959/60	1.42	—
Bokaro	1972/73	1.19	—
Cement—wet process			
Lokhari	1917	0.460	76
Vijayawada	1940	0.283	90
Sankovidmy	1963	0.220	82
Alangulam	1970	0.300	50
Cement—dry process			
Kistna	1939	0.327	66
Wadi	1968	0.219	96
Udaipur	1970	0.208	111

Source: J. K. Parikh and A. Chaitanya, comps., "Are our industries energy-efficient?", *Economic and Political Weekly*, vol. XV, 1980.

TABLE IV.16. CHANGING SHARES OF FIVE LARGE ENERGY-CONSUMING INDUSTRIES IN THEIR COMBINED TOTAL VALUE ADDED, 1950-1976

(Percentage)

Industry	1950/51	1960/61	1965/66	1970/71	1974/75	1975/76
Textiles	64.75	51.83	43.67	37.17	39.85	38.12
Paper and paper products and allied industries	6.90	8.38	9.45	9.31	7.80	7.81
Chemicals and chemical products, including fertilizers	10.19	13.75	15.87	22.84	24.91	23.42
Non-metallic mineral products	4.74	7.22	7.99	7.09	5.60	5.91
Basic metal industries and metal products	13.45	18.85	23.05	23.58	21.15	24.75

Source: *National Accounts Statistics*, 1979 and previous volumes (New Delhi, Central Statistical Organization).

Note: Totals may not add to 100 because of rounding.

of value added for the last 25 years, their composition has been changing. Moreover, the share of net output in the non-LECs, which are more energy-intensive than industries in the unregistered sector, is also increasing.

With regard to the second observation, three points are relevant. First, in the developing countries the major component in the value of net output is usually raw materials. The cost of labour is of secondary importance. Wages are often so low that the energy requirements per unit of value added prove to be higher in the developing than in the developed countries.

Second, in an international comparison, energy intensities may be exaggerated by differences in the purchasing power of the countries. Table IV.17 gives such comparisons with allowance made for differences in purchasing power.[125] It can be seen that the industries in India consume very high amounts of electricity and thermal energy per dollar of value added. Even after corrections for purchasing power, electricity consumption per dollar of value added in India is still high compared with the developed countries and specially so in the case of thermal energy use. This may be attributable to inefficient use of energy owing to old, obsolete technology, bad maintenance and low economy of scale.

Third, the poor quality of coal can also be a reason for high energy consumption. Industries based on natural gas or oil which can be more efficiently used than coal are less prevalent in India than in Western and Eastern Europe. Often, when coal is of a poor quality (e.g. 3,000-4,000 kcal/kg rather than the normal standard of 7,000 kcal/kg), the record of only the quantity and not the quality is made in some statistics.

Expected structural changes in industry

To adapt to high energy prices or supply shortages, a number of structural changes in industry may occur and may be broadly classified as follows: *(a)* changes in the existing production system; *(b)* use of alternative processes of

TABLE IV.17. INTERNATIONAL COMPARISON OF ENERGY INTENSITIES IN INDUSTRY

Unit of energy	*Western Europe*	*Eastern Europe*	*India*
Electricity (kWh per $ of value added)	1.26	2.05	5.52
Thermal energy (kWh per $ of value added)	4.48	11.82	43.2
Thermal, useful/final energy (%)	65.40	74.5	30.0[a]
After corrections for purchasing power:			
Electricity (kWh per "$"[b])	1.411	1.414	1.520
Thermal energy[c] (kWh per "$")	5.02	8.156	11.985

Source: J. K. Parikh, "Modelling approach to long-term energy demand and policy implications" (New Delhi, Planning Commission, 1980).

[a] Approximate figure.

[b] "$" is corrected $ for purchasing power of one dollar's worth of national currency within the country. Data for the Federal Republic of Germany and Hungary were used in developing the "representative" indicator.

[c] Thermal energy is converted into kcal and then to electricity using 0.123 tce = 1,000 kWh (i.e. the comparison is in heat units, not in million tons of coal replacement units, conventionally used in India, e.g. Fuel Policy Committee).

[125] It has been shown that for a comparable mix of commodities, the purchasing power of a rupee within India is 3.3 times larger than that indicated by the official exchange rate for the traded commodities. This factor, if used, would partly correct for the wage component of the value added (for example, value added generated from a taxi driven for 1 kilometre would be small in India compared with the developed countries and, therefore, energy per value added would be correspondingly high for that activity). See I. Kravis and others, *A System of International Comparisons of Gross Product and Purchasing Power* (Baltimore, Johns Hopkins, 1977).

production; *(c)* changes of industrial mix and substitution of products; and *(d)* changes in the energy supply systems.

The first three changes relate to reductions in demand and the last to alternative energy supplies. Each is discussed below in the order of their feasible dimensions, i.e. short-term changes are discussed first. Some changes that have been taking place for some time—the substitution of human, animal and non-commercial energy, which is mentioned above—may slow down in the event of a steep rise in energy prices.

The investments for many existing industrial activities were made before 1973, and production processes cannot be easily altered. At best, proper management measures to cut down wasteful uses of energy can be introduced. Very old plants in some of the LEC industries may close down altogether if the products are not competitive with others on the market.

Steel industries are envisaging a 5 per cent cut in fuel oil consumption at the open-hearth furnaces owing to improved operation practices. Efforts are also under way to reduce coking rates of blast furnaces. The aluminium industry, which often does not attain full capacity utilization, can reduce 5 to 7 per cent of its electricity consumption by avoiding breaks in its production.

The biggest contribution may be made by energy producers themselves. Proper maintenance and scheduling of only a few thermal power plants could result in considerable savings of coal. The average coal consumption norm for a thermal power plant is 0.67 tons per 1,000 kWh, and average efficiencies range from 0.26 to 0.3, in contrast to 0.35 to 0.37 efficiencies in some developed countries. Similarly, there is some scope for saving coal and electricity in coal mines and some oil in the refineries.

The choice of alternative technologies involves several considerations. One is the selection of energy-efficient processes; while existing industries gear themselves to achieve energy conservation through better management and minor modifications, new industries must seek more efficient production processes. Examples are the Alcoa process in the aluminium industry; natural-gas-based fertilizer plants, which are more energy efficient and economic; and the chemical process for caustic soda. In India, 72 per cent of the capacity in the cement industries uses wet processes, which consume 0.3 tons of coal per ton of cement. In comparison, the dry processes require only 0.21 tons of coal. The electricity requirements for the two types of processes vary between 96 and 145 kWh and between 110 and 150 kWh, respectively.

A second consideration relates to the appropriate scale of technology. Most developing countries, including India with its massive population, do not benefit from economies of scale. For example, the unit sizes for power plants are often from 50 to 120 MW, for fertilizer plants from 600 to 900 tons per day, for cement from 500,000 to 700,000 tons per year. Efforts are being made to increase these sizes to from 220 to 500 MW, 1,300 tons per day, and 1 million tons per year for the same industries, respectively.

In most cases, energy use is reduced as the scale of production rises. With increasing population and prosperity, the growth of domestic demand may enable producers to achieve economies of scale up to some point. However, such an approach can obviously not continue to be energy-efficient beyond certain limits. As the scale of production increases, equally formidable

problems of transporting the inputs and distributing the products arise. Thus, as the demand centres diversify, it may be more desirable to have several medium-scale industries than one giant supplier. Large-scale economies may continue to be preferred in the short term, although this trend may be reversed in the next two decades.

The technological changes in the production system, whether in the existing or the new industries, may not be sufficient to alleviate energy constraints. Changes in the industrial mix may also be required. This step could entail the replacement of products requiring large amounts of energy by others needing less energy to produce. Such an industrial mix would have greater shares of demand for hand-loom fabrics rather than synthetic materials, wood and perhaps even steel rather than aluminium, low-quality paper as a replacement for highly bleached and fine varieties of paper, and wood and fibreglass instead of finished steel products of certain types. In such product substitution exercises, it is important to realize that the developing countries would require indigenous R and D efforts. Comparable activities are often non-existent in developed countries or are of little interest, particularly those processes that are relatively labour-intensive.

It is difficult to quantify the reductions in the total energy use to be achieved by product substitution but, in general, they could be much larger than the results of energy-conservation efforts. Also, it is possible to reduce energy costs as well as energy needs merely by switching from one type of energy supply to another. With regard to oil products, the replacement of oil-fired boilers by coal-fired boilers is a promising economic alternative. While coal prices are about from Rs 100 to Rs 250 per ton of delivered coal, fuel oil prices are above Rs 900 per ton. Similarly, the ratio of oil-based to gas-based fertilizer plants is declining rapidly. All the new plants may use natural gas as feedstock.

Although the predominant trend is to use more commercial energy, in isolated cases—in the rural areas—increased use of non-commercial energy sources may be practical. Some observers recommend wood-based power plants in rural areas and charcoal for rural industries.

Future energy demand for industries

Given the present pace of structural change and the uncertainties in the energy field, projections of industrial requirements over the next two decades may have little meaning. Instead, illustrative scenarios have been devised to demonstrate the significance of changing energy intensities and related shifts. Historical energy-intensity coefficients are derived, and it is assumed they will vary in the future because of technological change. The implicit assumptions made in the subjective process take account of the structural changes discussed in the foregoing sections. Assumptions for the reference scenarios are given in table IV.18. The industrial contribution to GDP is assumed to grow at 7.2 per cent per annum for the reference scenario for India, in line with the analysis of the Indian Working Group on Energy Policy (WEP) and the revised draft sixth plan. Two levels of industrial disaggregation, LEC and non-LEC industries, and a much more specific grouping of 19 energy-using activities are considered.

TABLE IV.18. ENERGY DEMAND IN THE INDUSTRIAL SECTOR—REFERENCE SCENARIO FOR INDIA

Energy form and user	*1978/79*	*1984/85*	*1989/90*	*1992/93*	*2000/01*	*Average annual growth 1978-2000 (percentage)*
Electricity (10^9 kWh)						
LEC industries		54.8	77.7	102.2	133.3	
Non-LEC industries		35.9	54.7	90.4	132.8	
Subtotal	53.9	90.7	132.4	192.6	266.1	7.5
Fuel oil (10^6 t)						
LEC industries		4.1	5.8	6.4	6.7	
Non-LEC industries		0.3	0.4	0.6	0.8	
Subtotal	4.5	4.4	6.2	7.0	7.5	2.3
Coal, coke, charcoal (10^6 t)						
LEC industries		60.0	90.0	125.6	185.0	
Non-LEC industries		32.6	45.5	75.6	132.8	
Subtotal	50.5	92.6	135.5	201.2	317.8	8.7

Source: J. K. Parikh, "Modelling approach to long-term energy demand and policy implications" (New Delhi, Planning Commission, 1980).

Note: The scenario assumptions are: LEC value-added growth 7.3 per cent per annum, non-LEC 7.1 per cent; LEC/YIND = 33.4 per cent (YIND = industrial contribution to GDP).

Table IV.18 shows energy demand for the reference scenario during the period 1984-2000.[126] Given the assumed growth rate of 7.2 per cent in GDP, the growth required in the consumption of electricity would be 7.5 per cent; in oil, 2.3 per cent; and in coal, 8.7 per cent.[127]

If different rates of growth for GDP and different shares of LEC producers in the industrial mix are resumed, the impact of policies favouring either LECs or non-LECs may be demonstrated. Since the difference between two alternative sets of assumptions is accentuated over time, only the results for the year 2000 are compared, as shown in table IV.19. The difference between the high and the low scenarios is found to be 11 billion kWh, 1 million tons of fuel oil and 19 million tons of coal. The gap illustrates the effect of reducing the output share of LEC industries from 31.3 per cent to 26 per cent. These estimates do not consider the possibility of the improved energy efficiency in LEC industries to be gained by introducing energy-saving practices already applied in other countries. On the other hand, measures required for energy conservation are not so well identified in the non-LEC industries.

Industrial policies may, of course, be crucial in changing the assumed results of this exercise.[128] In fact, several scenarios were carried out in order to gauge the sensitivity of the energy intensities to various sets of policies. In the absence of any counter policy and R and D efforts, electricity intensities in

[126] This aspect is discussed further in J. K. Parikh, "Modelling approach to long-term energy demand and policy implications" (New Delhi, Planning Commission, 1980).

[127] The magnitudes of the results given in table IV.18 are somewhat similar to the WEP projections for electricity and oil and are higher for coal by 43 million tons.

[128] The assumptions are given in appendix II to this chapter.

non-LEC industries are expected to exceed—substantially—those assumed here. For example, should the electricity intensity of LEC branches be increased by 12.5 per cent and that of the non-LEC branches by 25 per cent in the year 2000, nearly 50 billion units more would be required for the reference scenario.

Similarly, coal intensities in the LEC industries are assumed to stabilize; but if they were to increase by 14 per cent because of lack of fuel oil and poorer quality of coal, then 26 million tons more coal would be required for the reference scenario.

TABLE IV.19. ENERGY DEMAND FOR THE INDUSTRIAL SECTOR IN INDIA—COMPARISON OF ALTERNATIVE SCENARIOS FOR THE YEAR 2000

Energy form and user	*Low*	*High*[a]
Electricity (10^9 kWh)		
LEC industries	111.7	133.3
Non-LEC industries	143.6	132.8
Subtotal	255.3	266.1
Fuel oil (10^6 t)		
LEC industries	5.6	6.7
Non-LEC industries	0.9	0.8
Subtotal	6.5	7.5
Coal, coke, charcoal (10^6 t)		
LEC industries	155.0	185.0
Non-LEC industries	143.6	132.8
Subtotal	298.6	317.8

Source: J. K. Parikh, "Modelling approach to long-term energy demand and policy implications" (New Delhi, Planning Commission, 1980).

Note: The scenario assumptions are:

H GDP = High GDP = Rs 1.622×10^9; compound growth for 1982-2000 = 5.8 per cent; YIND growth 7.1 per cent.

H LEC = LEC value-added growth 7 per cent per annum; non-LEC 7.1 per cent; LEC/YIND = 31.3 per cent.

[a]This represents approximately the WEP scenario.

The emerging energy needs and intensities of the future are compared with the past ones in table IV.20. The intensities in electricity for 2000 rise to over 0.8 TWh per billion rupees, but their growth rates are much lower than they have been in the past. A comparison of the overall intensities with the past performance, therefore, provides a check and a means of assessing the consequences of various shifts. One important implication of the results is that if the growth of non-LEC branches is to be emphasized, the increase in the energy intensities of these activities must be curbed. Thus, they would require greater R and D support—which only the LEC industries receive at present.

Further insight and additional consistency checks for this simplified macro-method may be obtained by a look at the energy requirements of

TABLE IV.20. ENERGY/VALUE ADDED IN THE INDUSTRIAL SECTOR IN INDIA FOR SELECTED YEARS, PAST AND FUTURE

Energy form and units	1960/61	1965/66	1970/71	1975/76	1984/85	2000[a] Low	2000[a] High
Energy consumed by industries							
Coal (10^6 t)	20.90	30.10	31.07	51.01	84.58	220.20	317.80
Oil (10^6 t)	3.61	4.04	5.45	3.77	3.91	4.78	7.49
Electricity (10^9 kWh)	11.60	22.62	34.55	43.35	82.90	188.20	266.05
Value added in industries (10^9 Rs)[b]	31.30	44.60	53.20	62.80	101.40	245.00	332.00
Energy intensities							
Coal/value added (10^6 t/10^9 Rs)	0.667	0.675	0.584	0.812	0.834	0.899	0.957
Oil/value added (10^6 t/10^9 Rs)	0.115	0.0908	0.102	0.0601	0.039	0.019	0.022
Electricity/value added (10^9 kWh/10^9 Rs)	0.370	0.508	0.645	0.690	0.817	0.768	0.801

Source: J. K. Parikh, "Modelling approach to long-term energy demand and policy implications" (New Delhi, Planning Commission, 1980).

[a]The figures for 2000 are used later for the projections for 2000. This point is discussed later in this chapter, as well as in Parikh (see source note).

[b]In 1970/71 rupees.

individual industries. The basis for such comparisons is provided in table IV.21. Unfortunately, targets of physical units of production are available up to the year 1992/93 only in the revised sixth plan. It is expected that even in the new plan for 1984/85, yet to be formulated, targets for energy-intensive industries may not be drastically altered. Nearly 54 per cent of electricity used industrially is consumed by the major industries listed in table IV.21; the remaining 46 per cent is used by "other industries". It can be seen that the electricity demand derived by the detailed end-use method agrees remarkably well with the projections made by the macro-method given in table IV.20, interpolated for the years 1982/83, 1987/88 and 1992/93, since these are the years for which projections are available. If however, the share of "other industries" were to rise, the end-use method would agree with the reference scenario of the macro-method.

Highlights and recommendations

The preceding discussion points to certain general conclusions and recommendations. What is true for India also holds for other developing countries, unless otherwise stated.

In India, the growth of industrial GDP has been (and will be) higher than the total GDP (5.2 per cent *versus* 3.5 per cent). Therefore, in the past, energy growth had to be higher than the growth of industrial GDP because of structural changes taking place in the economy as well as in the industrial

TABLE IV.21. ELECTRICITY DEMAND USING LONG-TERM PLAN TARGETS FROM THE REVISED SIXTH PLAN OF INDIA

Item	Unit	1982/83		1987/88 (projection)		1992/93 (projection)	
		Production target	Electricity consumption (GWh)	Production target	Electricity consumption (GWh)	Production target	Electricity consumption (GWh)
Sugar-cane	10^6 t	207.00	898	250.00	1 085	303.00	1 315
Jute and mesta	10^6 bales (180 kg)	8.60	697	10.60	859	12.10	980
Oil-seeds (major)	10^6 t	11.20	523	13.00	601	15.80	730
Coal	10^6 t	143.00	2 145	201.20	3 018	275.00	4 125
Crude oil	10^6 t	18.00	361	20.52	411	20.60	412
Iron ore	10^6 t	57.50	862	68.00	1 020	84.00	1 260
Petroleum products	10^6 t	33.10	1 028	44.90	1 392	61.40	1 903
Cement	10^6 t	28.00	3 360	41.00	4 920	69.00	7 080
Mild steel	10^6 t	11.30	8 490	15.30	11 475	22.00	16 500
Cloth	10^6 m	12 200.00	6 603	16 000.00	8 659	20 000.00	10 824
Paper and paper board	10^3 t	1 350.00	1 890	1 945.00	2 723	2 800.00	3 920
Newsprint	10^3 t	190.00	399	265.00	557	370.00	777
Synthetic fibres	10^3 t	85.00	428	204.00	1 026	490.00	2 959
Nitrogenous fertilizers (N)	10^3 t	3 900.00	5 499	6 100.00	8 601	8 350.00	11 774
Phosphatic fertilizers (P_2O_5)	10^3 t	1 125.00	1 294	2 000.00	2 300	3 000.00	3 450
Aluminium	10^6 t	300.00	6 000	475.00	9 500	700.00	14 000
Copper, refined	10^6 t	35.00	7	50.00	10	70.00	14
Zinc	10^3 t	80.00	336	105.00	441	150.00	630
Lead	10^3 t	16.00	8	27.00	14	45.00	23
Subtotal			40 828		58 612		82 676
Other industries			34 417		99 409		69 189
Totals:[a]							
(A) *End-use method*			75 245		108 021		151 865
(B) *Macro method*							
High (L)			77 804		110 240		155 463
High			77 970		113 771		165 792
(C) *WEP scenario*							
Optimal forecast			85 000		114 500		162 300

Source: *Report of the Working Group on Energy Policy* (New Delhi, Planning Commission, 1979).

[a] (A) is from the end-use method; (B) is from the model assuming energy intensities for the two sectors (L means that a low urban population growth rate was assumed); and (C) gives the projections made by the WEP.

sector. Industry consumes nearly 60 per cent of commercial energy and therefore energy itself should be considered as one of the most important industries and not merely as infrastructure. In India, energy will continue to require nearly 30 per cent of the plan allocations for the next two decades.

Owing to the substitution of human, animal and non-commercial energy by commercial energy, and also to increases in the quality of the outputs, energy consumption norms have increased in some industries. The consumption norms are high compared with those in the developed countries because of old technologies, the low scale of production, interruptions in capacity utilization and the high use of coal rather than gas or oil, which are more efficient. Energy intensities also appear to be high because of the same difficulties described above and because of the necessity for corrections in the purchasing power of the rupee *versus* the dollar.

The structural changes necessary to meet the new challenge will require careful analysis of alternatives for industrial production, energy consumption and energy supply. If the appropriate R and D efforts are made, conservation measures in the existing industries may lead to 5 to 10 per cent savings, alternative production processes to 20 per cent savings, and changing the industrial mix to considerable savings. Changes in the energy-supply mix may be towards more utilization of coal and the beginning of solar alternatives for process heat. In the next two decades, for a 7.2 per cent growth rate in the industrial sector, India may require growth rates in energy consumption of 7.5 per cent, 2.3 per cent and 8.7 per cent for electricity, fuel oil and coal, respectively.

Conservation measures in the industrial sector are extremely necessary, but even so, they can barely offset the increase in consumption norms likely to occur for the reasons discussed above. Thus, conservation can at best be a partial solution.

For a variety of reasons, the developing countries are not availing themselves of the best of technologies existing elsewhere in the world. The issue of technology transfer to the developing countries, particularly in the LEC industries, needs to be examined very carefully in view of the associated energy requirements. Non-LEC industries produce 76 per cent of the value added in industries while consuming 35 per cent of the energy in India. The selection of the kind of technology, such as that used in textiles, needs careful consideration and requires a different kind of R and D effort from that carried out so far in either developed or developing countries.

In addition to the efforts for conservation in the LEC and non-LEC industries, efforts to make use of solar furnaces, solar boilers, hot-water and steam systems based on solar energy may be feasible. Energy-efficient production processes might have to be adapted from the developed countries for which information systems could be helpful. Some of these measures would require investment. Thus there would be competition for investment in new energy facilities, and in energy-saving and new industries. Foreign investment and aid to the developing countries for this transformation could be most helpful in promoting industrial development.

Appendix I

ELECTRICITY CONSUMPTION BY MAJOR INDUSTRIES IN INDIA AND THEIR SHARE IN TOTAL, 1977/78

Industry	*Electricity consumption (GWh)*	*Share (percentage)*
Aluminium[a]	3 552	10.66
Cement[a]	2 345	7.04
Chemicals	3 377	10.13
Colliery	786	2.36
Fertilizers	3 888	11.66
Iron and steel[a]	5 480	16.47
Crude oil and petroleum	707	2.12
Paper	1 487	4.46
Plastic and rubber	448	1.34
Sugar	795	2.39
Textiles	5 255	15.77
Non-ferrous metals	1 643	4.93
Miscellaneous	3 568	10.70
Subtotal[b]	33 331	100

Source: Abridged from "General review of public electricity supply", New Delhi, All India Statistics, 1977/78.

Note: Includes energy generated by captive plants, energy used in auxiliary and energy purchased.

[a]Includes primary and secondary consumption.

[b]Other minor industries with individual use below 150 GWh all together consumed 9,314 GWh giving a total of 42,635 GWh in the industrial sector.

Appendix II

ENERGY CONSUMPTION NORMS USED FOR THE INDUSTRIAL SECTOR IN THE SCENARIO FOR INDIA

Energy form and user	*1976/77*	*1984/85*	*1989/90*	*1992/93*	*2000/01*
Electricity (10^9 kWh per Rs 10^9)[a]					
LEC industries	1.39	1.521	1.439	1.355	1.200
Non-LEC industries	0.39	0.486	0.557	0.607	0.600
Fuel oil (10^6 t per Rs 10^9)					
LEC industries	0.1126	0.113	0.108	0.085	0.060
Non-LEC industries	0.0037	0.0037	0.0037	0.0037	0.0037
Coal, coke, charcoal (10^6 t per Rs 10^9)					
LEC industries	1.648	1.666	1.666	1.666	1.666
Non-LEC industries	0.421	0.442	0.463	0.508	0.600

[a]Including contribution from non-utilities.

V. THE TRANSNATIONAL CORPORATION AS AN AGENT FOR INDUSTRIAL RESTRUCTURING

As argued in chapter I, restructuring entails a global reallocation of industrial investment in accordance with changing national comparative advantages. Often, a shortage of investment funds prevents developing countries from fully realizing their industrial potential. Although the transnational corporations (TNCs) can be an important source of industrial investment, their operations may also pose problems for host Governments. Thus, it is important to determine the contribution that TNCs can make to international industrial restructuring.

This contribution has three broad positive aspects. First, transnationals can channel finance away from contracting industrial branches in the developed market economies to industries that are expanding in the developing countries. They can also help these industries by investing a larger proportion of their own profits in them. Second, this investment can enhance the capability of a developing country to better utilize its resources. Since most developing countries have an abundant labour force, the investment by transnationals can have an important effect on the domestic economy by generating employment.

An expansion of industrial production unaccompanied by a corresponding increase of industrial employment in most developing countries will not be sufficient to propel the country into a higher stage of development. But where industrial employment has risen, its rate of growth has been an important index of the extent to which industrial growth leads to industrial restructuring and improved international competitiveness. For example, in many newly industrializing developing countries (NICs)—including Brazil, Mexico, the Republic of Korea and Singapore—the share of industry in total employment has risen sharply over the past two decades.[1] These countries have developed strong competitive positions in the international markets for a varied range of industrial products.

Finally, since the transnationals have developed well-knit production and marketing structures which can serve as powerful instruments for overcoming protectionist barriers and establishing competitive positions, their investment, if properly controlled, can strengthen the bargaining power of developing countries. In the absence of an adequate policy, however, gains in industrial productivity may be eroded by reductions in the price of the exports of a developing country or by its inability to gain access to the markets of the developed countries.

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[1] World Bank, *World Development Report, 1980* (Washington, D.C., 1980), pp. 146-147.

While investment by the TNCs in developing countries offers benefits, it may also entail substantial costs. A transnational's investment policies may be designed to exploit "sourcing" opportunities and to profit from fiscal incentives provided by liberal taxation policies. It may not be concerned with the relocation of industrial capacity in accordance with long-term changes in national comparative advantage. It is therefore essential that the Governments of developing countries formulate policies based on a careful assessment of the part transnationals can play in international industrial restructuring.

The first section of this chapter concerns the role of the transnationals as industrial producers and investors. Attention is focused on the contribution they can make to increasing industrial production, employment and exports and to developing links between manufacturing and other sectors of the economy. In the section, an empirical analysis is undertaken to identify the determinants of the investment behaviour of transnationals. Finally, some suggestions are made relating to the implications of this analysis for government policy in developing countries.

A. THE ROLE OF TRANSNATIONAL CORPORATIONS IN WORLD-WIDE INDUSTRIAL RESTRUCTURING

It is now generally recognized that the transnationals have demonstrated a remarkable capacity to integrate diverse economic factors, evolving organizational structures with a high degree of adaptability. Today, according to researchers in this field, "TNCs overwhelmingly dominate not only international investment, but also international production, trade and technology—so much so that any analysis of the present structure of international economic relations that does not take them into account and, indeed, concentrate its attention on them runs the gravest risk of being unrealistic and irrelevant."[2] Many attempts have been made to estimate the share of the transnationals in world production, investment and trade. According to a United Nations study undertaken in the early 1970s, "the value added of all multinational corporations is about one fifth of world gross national product not including centrally planned economies"[3] (32 per cent of the world's leading transnationals accounted for 14 per cent of global GNP). The transnationals also play an important part in foreign investment. For example, 180 transnationals provided 80 per cent of the United Kingdom's overseas investment, 300 TNCs provided over 70 per cent of the United States' foreign capital flows, and 82 TNCs provided over 20 per cent of the Federal Republic of Germany's foreign investment in the early 1970s.[4] These firms are also assuming increasing

[2]S. Lall and P. Streeten, *Foreign Investment, Transnationals and Developing Countries* (London, Macmillan, 1977), p. 4.

[3]United Nations Centre on Transnational Corporations, *Multinational Corporations in World Development* (New York, 1973), p. 32.

[4]United States Tariff Commission, *Implications of Multinational Firms for International Trade and Labour* (Washington, D.C., Government Printing Office, 1973), p. 7.

importance in foreign trade. According to United States official sources, they accounted for 20 per cent of world exports and for 25 per cent of all manufacturing exports in 1971. United States TNCs accounted for 62 per cent of that country's exports in that year.[5] Similar figures can be cited for many other developed market economies such as Sweden and the United Kingdom.[6] The growth in the investment of the transnationals and their expanded role in world trade has been facilitated by the strong ties with international banking institutions. The access of these corporations to international liquid assets and their influence in international capital markets is now substantial.

Finally, there is a high degree of concentration of technology in the hands of the transnationals. Thus, during the period 1963-1965, the 100 largest firms (most of them TNCs) in each OECD country accounted for over 50 per cent of total industrial R and D expenditure.[7] More recent data show that in the United States the transnationals provide over 60 per cent of R and D expenditure in the high-technology industries.[8] It is thus clear that transnationals are responsible for the bulk of technological innovations in world industry today.

The preponderant role of the transnationals in the organization and management of world industrial production and trade make them an important agent for the restructuring of manufacturing investment in the developing countries. Their increasing significance has spurred the growth of counterbalancing forces in the restructuring process. In many developing countries—e.g. Brazil, India and Kenya—the domestic private industrial sector is growing. Moreover, public manufacturing enterprises have become increasingly important. Thus, "public enterprises accounted for three quarters of total sales of LDC companies listed in *Fortune*'s (1978) 500 largest non-US industrials".[9] In the larger, resource-rich and relatively industrialized developing countries, public manufacturing concerns have considerable scope for independent action. Even the smaller developing countries can greatly enhance the role of public manufacturing enterprise as an agent of industrial restructuring through the development of effective policies of regional co-operation.

However, interaction between domestic public and private enterprises, on the one hand, and the transnationals, on the other, is unavoidable. Each group possesses resources and has access to the same decision-makers that are necessary for the achievement of its operational objectives. Developing countries should therefore carefully assess their need for the involvement of transnationals in the process of domestic industrial restructuring and should be aware of the costs and benefits of this involvement to the national economy.

There are two principal reasons for the need for increased TNC involvement. The first relates to the significant differences in the interindustrial costs of acquiring production technology. In general, the wider the diffusion of technology in the developed market economies, the less costly its acquisition will be for the developing countries. The diffusion of technology varies greatly

[5] *Ibid.*, pp. 7-13.

[6] See Lall and Streeten, *op. cit.*, for a review of the evidence.

[7] OECD, *Gaps in Technology Analytical Report* (Paris, 1970), table 23.

[8] United States Tariff Commission, *op. cit.*, chap. 6.

[9] L. P. Jones, "Public enterprises in less developed countries" (Boston, Boston University), p. 1.

among industrial branches. In the pharmaceutical industry, especially in patented drugs, scientific information may be specific to individual firms. In the aluminium industry, scientific information may be widely available, while in cement plants, technological information is easily accessible to experts and technicians outside the industry. The terms on which scientific information and production technology can be acquired by developing countries in the pharmaceutical industry usually involve an expansion of transnational investment in the developing country. This need not be the case in either the aluminium or cement industry, in which licensing arrangements and direct hiring of technical expertise are quite common.

The second reason has to do with the characteristics of international markets which are also likely to be important determinants of the need for co-operation between transnationals and the Governments of developing countries. For standardized products, the international market is relatively accessible. These goods can be distributed through an existing specialized network of trading concerns. For many other mineral and manufactured exports, however, there are powerful market barriers, and the cost of acquiring access to a distributive network may be considerable. In such cases, the transnationals may well provide the means for acquiring market access to industrial producers in developing countries.

The contribution that transnationals can make to industrial restructuring in developing countries is likely to be determined by their organizational objectives and their institutional structures. Industrial restructuring implies a relocation of investment in accordance with changing comparative costs. However, TNCs may not be particularly responsive to input cost reductions in the developing countries and may not direct investment to industrial branches whose production costs are declining. If an industrial activity—notably food processing and mineral extraction—is integrated within a larger production complex, a reduction in the input price of one product may not outweigh other considerations that determine the level of investment and the location of the units producing this product. Furthermore, the decision to reduce the input price of a particular industrial branch may be contested by economic actors interested in maintaining its present location or its present level of production. These actors may reduce the price of other inputs within this production process, substitute the cost-reduced input by other inputs, alter the output mix of the industrial branch or pursue a host of other strategies.

A firm's ability to respond to cost reductions and technological changes is related to its size, its market share and the rate of growth of the industrial branch (or branches). Most transnationals have a high potential of technological adaptability on these counts. However, they can modify long-term investment opportunities in specific industrial branches by concentrating large amounts of R and D expenditure on inputs that have most recently become comparatively expensive. The resulting innovations ensure that the cost of these inputs shall be reduced, and a comparative cost advantage is created in product lines that abundantly use factors originally considered to be scarce.[10] This reaction can offset the extent of redeployment or the growth of investment in branches in which input costs have been lowered.

[10]This is demonstrated in the case of the United States. See W. H. Davidson, "Factor endowment, innovation and international trade theory", *Kyklos*, 1979, pp. 764-774.

Even when the investment of transnationals moves to developing countries in response to changes in international comparative advantages, its impact on the domestic economy need not be entirely beneficial. Different industrial branches provide different possibilities for the Governments of developing countries to combine direct investment, joint venture and licensing agreements; and specific combinations may entail different costs and benefits. In some instances, "breaking open the package"—i.e. combining joint ventures and licensing arrangements with the operation of TNC subsidiaries—may result in important gains. Furthermore, the extent to which the organization and policy-making structure of a transnational corporation is centralized may be an important determinant of the ability of its subsidiaries to adapt their policies to the economic strategy of a given developing country. The headquarters office plays a supervisory and co-ordinating role in all TNCs—indeed, this dominance of headquarters over branch offices distinguishes a TNC from an international holding company.[11] But the extent of centralization varies considerably. Branches and affiliates of transnationals may enjoy a substantial autonomy if they are product-based[12] (i.e. if executive authority and responsibility is delineated in terms of the production and distribution of specific products). All these factors should be borne in mind by the Governments of developing countries when adopting a policy towards these firms.

It is clear that industrial restructuring in the developing countries requires the increased availability of international capital and technology and easier access to world manufacturing markets. The transnationals can be an important channel for procuring capital and technology and for increasing developing countries' exports. The extent to which this potential has been realized is examined below in an analysis of the existing evidence on the impact of transnational investment on growth, employment creation and export expansion in the developing countries.

B. THE INVESTMENT BEHAVIOUR OF TRANSNATIONAL CORPORATIONS: CONSEQUENCES FOR GROWTH, EMPLOYMENT AND TRADE IN DEVELOPING COUNTRIES

According to conventional economic theory, foreign investment can make a significant positive contribution to income growth in the host country, provided that there is a scarcity of capital, a high elasticity of substitution between domestic saving and foreign capital and a significant unemployment of labour. At the same time, the beneficial effects on income through increased employment may be offset by a rise in the productivity of the export sector and an increase in foreign-exchange spending for servicing the foreign capital. In general, it is assumed that the inflow of foreign capital is beneficial to host countries. And it is usually assumed that borrowing takes place under competitive conditions and that Governments are sufficiently powerful to offset monopolistic tendencies.

[11] C. Tugenhadt, *The Multinationals* (Harmondsworth, Penguin, 1971), p. 31.

[12] In contrast to TNCs that are area-based.

Empirical studies have not fully borne out these theoretical expectations, however. Researchers have found a negative association between the inflow of foreign resources and domestic saving, that frequently the degree of TNC penetration (defined as the ratio of capital stock controlled by transnationals to the total capital stock of the host country) is negatively related to the subsequent level of income growth in the host country. This relationship is described as "particularly strong for less developed countries with a large modernized sector".[13] In other words, the higher the level of TNC involvement in a developing country in a given year, the less probable it is that the country will achieve high rates of growth in the subsequent period. This empirical finding lends support to the "decapitalization thesis". According to this view, TNC operations lead to a reduction of the supply of funds available for investment in the host country. Transnationals may transfer resources out of the host economy by repatriating declared profits or by over-pricing production inputs. This drain of investment resources leads inevitably to a reduction in growth.

The negative effect of transnational penetration on the growth of the developing countries has been explained in terms of its impact on the domestic industrial structure. In particular, when the transnational presence fosters high levels of industrial concentration, which increase income inequalities and lead to a rapid depletion of investment funds in agriculture, it can be argued that such TNC involvement has reached a point of "saturation". In such a case, domestic demand fails to rise sufficiently, import-substitution possibilities become increasingly difficult, and foreign trade opportunities may be limited by protectionist policies of trading partners and the reluctance of transnational subsidiaries to encroach on the markets of sister companies. Hence, profit rates fall, investment levels are reduced, and the high growth rates associated with high levels of domestic and foreign investment do not pertain.

All these possibilities point to the importance of the effect of transnational investment on the industrial structure of the host developing countries. If the TNCs drain a disproportionately high share of investment resources from the developing countries, then policy measures are needed to limit these firms' possibilities of transferring domestic investment resources and to make the domestic deployment of these resources more attractive. The former objective can be achieved most effectively by reducing concentration and increasing competition within the manufacturing sector.

Some studies investigating the relationship between transnational penetration and concentration have shown that TNCs predominate in industrial branches with the highest levels of concentration in Brazil, Mexico and some Central American countries.[14] However, there is little systematic evidence on the impact of transnational policies on levels of concentration within specific industrial branches in developing countries. It has sometimes been argued that the TNCs exhibit a strong preference for entering new markets through mergers

[13] V. Bornischer, "Multinational corporations and economic growth", *Journal of Development Economics*, vol. 7, June 1980, pp. 191-210.

[14] See R. S. Newfarmer and S. W. Mueller, *Multinational Corporations in Brazil and Mexico* (Washington, D.C., United States Senate Sub-Committee on TNCs, 1975), pp. 62 and 185, and L. Wilmore, "Direct foreign investment in Central American manufacturing", *World Development*, 1976, pp. 490-578.

or take-overs—particularly in the "low" technology industries[15]—but it must be stressed that higher levels of concentration in specific industrial branches may be the consequence of factors that have little to do with prevailing forms of ownership. For example, economies of scale or production technologies may lead to wider differences in concentration levels of different industrial branches than marketing or financial policies. If the transnationals employ a more capital-intensive technology than that prevalent among domestic enterprises in a given industrial branch, then firm concentration is likely to be pronounced. Evidence of this phenomenon is mixed, however, as will be shown in the next section.

The tendency of transnationals to transfer investment funds from host developing economies can also be countered by increasing linkages between domestic firms and these corporations. Little systematic research has been devoted to an assessment of the impact of transnational operations on the performance of domestic enterprises. In India, there is evidence of extensive subcontracting, a clear tendency to increase locally purchased components and an indication that the level of vertical integration in the TNCs operating in the automotive industry is declining, all of which would imply greater autonomy for domestic subsidiaries. Indian imports as a proportion of total components have been declining: they represented 62.5 per cent of automotive manufacturing output in 1956, but declined to less than 4 per cent by 1969.[16]

In both Morocco and Peru, the share of procurement from local firms for in-house manufacturing was considerably lower. This circumstance is explained by differences in levels of industrial development and in government policy. Although Morocco and Peru have higher levels of *per capita* income than India, the latter has an advanced and integrated industrial structure. In India, the Government has followed a policy of encouraging the local manufacture of components and local procurement—a policy not pursued by Morocco or Peru. Moreover, the policy of the Indian Government—particularly its licensing procedures and encouragement of small enterprises—has precluded transnational subsidiaries from moving into the manufacture of components. Local procurement has also been stimulated by the Government's emphasis on import substitution.

Studies have sometimes emphasized the ability of host Governments to increase the degree of domestic integration. "Empirical findings suggest that a main determinant of linkage creation is host government policy. Measures focusing on the specifics of the process of the creation of linkages seem to be more effective if they are implemented in the framework of a broad industrialization strategy, where actions related to the stimulation of TNC linkages are guided by the dynamic comparative advantages of the host country."[17]

Government policy can modify the impact of transnational investment on a developing economy in other ways, by reducing levels of industrial concentration and by increasing the domestic linkages of foreign investment. If

[15]Lall and Streeten, *op. cit.*, pp. 220-221.

[16]United Nations Centre on Transnational Corporations, *Transnational Corporation Linkages in Developing Countries* (New York, 1980), p. 41.

[17]*Ibid.*, p. 43.

successful, these policies can increase the attractiveness of the domestic economy to foreign investors by ensuring a high growth of domestic demand. Sustaining this growth, however, requires that investment be concentrated in industrial branches with international comparative advantages, and their development requires the optimum utilization of productive resources.

Since most developing countries have abundant labour, sustained growth would entail a substantial long-term expansion in employment. Estimates of total direct employment provided by transnationals—admittedly subject to a large margin of error—range from 13 to 30 million.[18] The estimates vary in terms of the definition of foreign control[19] and thus reflect different statistical populations. However, even if the most liberal estimates are accepted, the proportion of total world employment accounted for by TNCs is only 1.3 per cent. In terms of industrial employment, these firms contribute approximately 4.8 per cent of total employment.[20] In developing countries, transnationals have created a total of between 2 to 4 million jobs (representing 0.3 per cent of total employment and 2 per cent of total industrial employment).[21] It is thus apparent that employment in these firms is mainly concentrated in the developed market economies.

For some developing countries, however—Brazil, Mexico, Peru, Republic of Korea, Singapore—transnational employment is a significant proportion of total industrial employment. In some countries these firms accounted for over one fifth of total industrial employment in the mid-1970s. Transnational employment in developing countries seems to be concentrated mainly in the manufacturing sector, although their investment is spread fairly evenly between manufacturing and the extractive industries. Table V.1 estimates the proportion of transnational employment in the total employment of industrial branches in four developing countries in various years.

In Mexico and the Republic of Korea, the transnationals accounted for a large proportion of total employment in heavy industries such as chemicals, petrochemicals, electrical machinery and metal products. In Peru—which is at an earlier stage of industrial development—this employment was significant in consumer goods industries such as beverages and tobacco. The transnational share of employment in capital-intensive equipment, electrical machinery and metal products was also high.

These estimates relate only to the direct employment effects of TNC investment. Depending on the extent of backward and forward linkages

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[18]These estimates are evaluated in United Nations Centre on Transnational Corporations, *Transnational Corporation Linkages* . . . . pp. 7-19. All data in this section (unless otherwise specified) are taken from this report.

[19]If 20 per cent foreign ownership is regarded as the cut-off point between TNC and domestic firms, it would lead to a higher direct TNC employment estimate than a cut-off point of 30 per cent.

[20]Figures are for the late 1970s (mainly 1978). The second estimate assumes that all TNC direct employment is in the industrial sector. United Nations Centre on Transnational Corporations, *Transnational Corporation Linkages* . . . . p. xl and *World Development Report, 1980*, pp. 110-111, 146-147.

[21]These estimates exclude China, Cuba, Democratic People's Republic of Korea and Mongolia, but include Viet Nam.

TABLE V.1. SHARE OF TRANSNATIONAL EMPLOYMENT IN INDUSTRIAL BRANCHES IN SELECTED DEVELOPING COUNTRIES, VARIOUS YEARS

(Percentage)

Industry	*Mexico (1970)*	*Peru (1973)*	*Republic of Korea (1974)*	*Singapore (1968)*
Food	12.9	18.5	2.6	19.5
Beverages		23.5		
Tobacco		61.2		
Wood	8.1	11.1	1.9	25.5
Paper	24.8	59.8		
Printing	6.7	1.1		
Leather	40.2	33.1	11.5	35.9
Chemicals		37.8		
Petroleum		59.0	70.3	93.7
Non-metallic	13.0	13.5	10.2	
Basic metallic	30.0	48.6	11.7	20.0
Metal products		12.8	29.7	
Electrical machinery	75.4	49.2	58.0	65.8
Transport	42.0	40.1	2.7	
Textiles	4.0	18.7	8.1	61.0

Source: United Nations Centre on Transnational Corporations, *Transnational Corporation Linkages in Developing Countries* (New York, 1980), pp. 14-17.

developed by such firms, some indirect employment may be generated.[22] While this employment is relatively limited in the extractive industries, it may be substantial in manufacturing. Thus, for the Republic of Korea, it has been estimated that the indirect employment effects of TNC investment have been substantial; such investment generated 102,000 jobs through backward linkages with domestic producers. In general, indirect employment stimulated by these corporations is likely to be less significant than the indirect employment created by domestic manufacturing enterprises, since the former are larger net importers of both raw materials and capital than local firms.[23] Moreover, the output mix of TNC subsidiaries may not be particularly suitable for generating high employment in some developing countries. Transnationals may also specialize in the production of "luxury" goods. An increase in the production of such goods is less likely to generate a demand for unskilled labour than an expansion of products to meet basic necessities.

The impact of investment on employment is most directly influenced by the investor's choice of production technology. Many attempts have been made to compare the relative capital intensity of domestic and foreign firms in developing countries. Technologies employed by transnationals are likely to be rigid since these firms tend to predominate in modern, complex industries with

[22]Indirect employment is employment generated in industries associated with the industry in question. For example, increased activity in one industry will mean an increase in that industry's supply requirements, thus leading to an increase in employment in supplying or associated industries.

[23]G. L. Reuber, *Private Foreign Investment in Development* (London, Oxford University Press, 1973), pp. 151-154.

continuous production processes. This rigidity is also enhanced by increased vertical integration between the units of a transnational family, although there is scope for some technological flexibility in processes such as handling, transport and administration. Flexibility may also be incorporated in production processes by using more shifts, increasing the level of subcontracting and using lower-quality material inputs. TNC subsidiaries have been induced to adopt a relatively labour-intensive production technology in many Asian and Latin American countries.

The choice of an industrialization strategy is an important determinant of the effect that transnational investment may have on employment. In particular, an export-oriented industrialization strategy has in many instances—for example in the Republic of Korea[24]—had a significant impact on employment. Export-oriented subsidiaries are likely to have more labour-intensive production processes than domestic-oriented firms. However, the linkages of the former firms with the rest of the economy are sometimes weak because their operations are often self-contained and because they tend to import a high proportion of their inputs. Hence the indirect employment generated by export-oriented TNC subsidiaries is likely to be limited.

In most developing countries, an export-oriented industrialization strategy cannot be effectively pursued without co-operation from transnationals, particularly where market barriers are substantial. TNC subsidiaries are often more successful exporters than domestic firms. Therefore, a restructuring of investment in accordance with changing comparative advantages requires the support of these firms. Such restructuring implies that countries concentrate on the production of goods in which they have an international comparative advantage. Market barriers and protectionist policies can effectively frustrate this pattern of international specialization. It is therefore essential to explore the potential of the transnational as an instrument for overcoming protectionism and hence for redistributing industrial capacity in accordance with changing comparative advantages.

The transnationals have rapidly increased their level of international involvement during the past decade. The United Nations Centre on Transnational Corporations (UNCTC) has estimated that over the period 1971-1976 the foreign subsidiaries of 251 of these firms grew 25 per cent faster than the parent companies. A large proportion of the exports of the developed market economies are manufactures of transnationals, and there is some evidence that this proportion may be increasing.[25]

The expanded role of these corporations in the export sector of developed market economies has led many researchers to assume that they have also been instrumental in articulating the export-led growth strategy adopted by some newly industrializing economies. Foreign firms have played a dominant part in the organization of international trade in primary commodities in the past. It was expected that they would adapt their structures easily to participate in the drive for expanded manufactured exports in the developing countries. A few countries and areas—Argentina, Brazil, Colombia, Hong Kong, India,

[24]S. Watanabe, "Exports and employment: The case of the Republic of Korea", *International Labour Review*, vol. 107, No. 10 (December 1972), p. 495.

[25]United Nations Centre on Transnational Corporations, *Transnational Corporation Linkages . . .*, p. 43.

Malaysia, Mexico, Pakistan, the Republic of Korea and Singapore—currently account for about 60 per cent of the developing countries' manufactured exports.[26] Six—Brazil, Hong Kong, India, Mexico, the Republic of Korea and Singapore—account for approximately 57 per cent of the stock of direct foreign investment in the non-OPEC developing world.[27] In many of these countries, transnational subsidiaries account for over 20 per cent of the manufactured exports.

Table V.2 gives estimates of the export shares of the United States subsidiaries of transnationals in developing countries. Exports of these TNCs grew at an annual rate of 48 per cent over the period 1966-1974. During the same period total manufactured exports grew at a rate of 60.8 per cent annually.[28] Thus, the share of United States firms in the total manufactured exports from developing countries fell from 10 per cent in 1966 to 8.7 per cent in 1974. The estimates show that United States subsidiaries have been important exporters in Latin America, although their significance has recently declined. They have been far less important exporters in other developing regions, and their share has steadily declined, particularly since 1970, in the exports of developing countries as a whole.

TABLE V.2. SHARE OF UNITED STATES TRANSNATIONAL SUBSIDIARIES IN THE MANUFACTURED EXPORTS OF THE DEVELOPING COUNTRIES, 1966-1974

(Percentage)

Year	*Latin America*	*Africa*	*Middle East*	*Other Asia*	*All developing countries*
1966	37.8	—	1.3	7.0	10.0
1967	40.0	2.6	1.1	7.7	11.5
1968	33.0	5.7	0.9	8.2	11.0
1969	29.4	6.0	1.0	6.5	9.2
1970	22.3	6.4	0.9	8.8	10.8
1971	23.7	6.3	1.1	6.0	9.5
1972	22.1	7.2	2.0	4.9	8.5
1973	19.2	5.6	2.2	5.4	8.1
1974	19.2	6.1	2.8	5.8	8.7

Source: D. Nayyar, "TNCs and manufactured exports from developing countries", *Economic Journal*, vol. 88, March 1978, p. 65.

Two components of TNC exports have been growing rapidly, however, over the past decade. First, intra-firm trade has been expanding rapidly. Estimates for the early 1970s indicate that 50 per cent of United States exports are of this type. Corresponding percentages for Canada, Sweden and the United Kingdom are 60, 29 and 39 respectively. Second, tariff provisions for off-shore assembly have encouraged the rapid growth of international subcontracting. United States imports of goods assembled or processed abroad

[26] Estimates are at current prices.

[27] D. Nayyar, "TNCs and manufactured exports from poor countries", *Economic Journal*, vol. 88, March 1978, pp. 61-63.

[28] Both estimates are at current prices.

from materials and components originally produced in the United States have grown rapidly. Tariffs on these imports are levied only on the foreign value added. In 1966, their gross value represented 1.6 per cent of developing countries' exports of manufactures to the United States. By 1974, this figure had risen to over 7 per cent. A very few (five) developing countries accounted for 85 per cent of imports permitted into the United States under tariff items 807.00 and 806.30.

Export-oriented transnationals in developing countries are not likely to create domestic linkages and to facilitate restructuring if they are concerned primarily with transferring fairly complex technologies to these countries in order to serve established world markets. "Border industries", such as the electronic industrial complexes of Mexico and Singapore, are relevant examples; they rarely use locally available components. Domestic linkages are also likely to be limited where the subsidiaries transfer only a (labour-intensive) part of the production process to a developing country. Once again, the electronic industry is a good example, in which the rapidly changing technology, the demanding specifications, and requirements of cost minimization reduce the possibility for domestic linkages to practically nothing.

Significant domestic linkages may be created by transnational affiliates that have switched from import-substitution to export-oriented policies in response to changing international comparative advantages. Such firms generally use standardized, mature technologies. They have usually been located in the developing countries for a relatively long period of time and have strong links with local markets and domestic suppliers. In some industrial branches, such as in textiles, footwear and leather manufacturing, comparatively small foreign firms, many of them based in other developing countries, are likely to be as labour-intensive as their local counterparts.

Governments should seek continuously to develop a strategy that attracts transnational investment in the industrial branches in which they retain an international comparative advantage. They should attempt to establish an understanding with TNCs in order to overcome protectionist barriers. These barriers increasingly take the form of administrative controls and are often less applicable to intra-firm trade than to "arms-length" trade. Such an understanding can also help to induce the TNCs to reduce private "non-tariff barriers"—particularly in the form of restrictive business practices—which these firms sometimes impose at a heavy cost to developing countries.[29] Similarly, co-operation between the Governments of developing countries and transnationals can improve access to technological resources and marketing and distributive networks.

Such co-operation, however, requires an appreciation of transnational performance and policies. An examination of the policies of TNC affiliates operating in developing countries is presented in the section that follows, and a comparison is made between the policies of these firms and those of domestic enterprises. In particular, an attempt is made to intensify the main determinants of TNC investment in developing countries. It has been argued that an expansion of this investment is a necessary element for industrial restructuring

[29]See A. J. Yeats, "Monopoly power, barriers to competition and the patterns of price differentials in international trade", *Journal of Development Economics*, vol. 5, No. 2 (1978), for evidence that small countries pay more for imported capital equipment than do larger ones.

in these countries, but that such an expansion may entail significant costs. Subsequently, these costs are assessed by focusing on the impact of TNC investment growth on the level of industrial concentration in the developing countries. Indirect evidence of the existence of transfer pricing is also presented. Finally, some conclusions are drawn about the implications of this analysis for government policy in developing countries.

C. DETERMINANTS OF TNC POLICIES: AN EMPIRICAL INVESTIGATION

This section is concerned with the main determinants of the growth and profitability of transnationals and the principal factors influencing their investment behaviour. These questions have been widely studied within the context of the theory of the growth of the firm and the theory of investment.[30] Empirical tests of several hypotheses based on these theories have led to many varied explanations of the behaviour of firms' investment and financing. Although foreign investors have attracted considerable attention, in the words of a recent study, "there is still a large grey area of semi-ignorance, illuminated only by fragmentary and scattered evidence from small samples or else provided on a highly aggregated basis".[31] The size of the sample available in the present study is also small, but it is hoped that some of the issues discussed may provide an insight into aspects of TNC policies that could prove useful in assessing their impact on industrialization in the developing countries. Such an assessment is indispensable for international negotiations seeking to evolve an efficient strategy for world industrial restructuring.

The study relies mainly on data gathered from balance sheets and profit-and-loss statements of individual companies. Standardized "analyses of accounts" were available for India and Thailand. For the United Kingdom, documents were procured directly from the companies themselves. Estimates

[30]The major writings in this area are: Edith Penrose, *The Theory of the Growth of the Firm* (London, Oxford University Press, 1959); R. L. Marris, *Economic Theory of Managerial Capitalism* (London, Cambridge University Press, 1964); Myron Gordon, *The Investment, Financing and Valuation of the Corporation* (Illinois, Irwin Press, 1962); O. Williamson, *The Economics of Discretionary Behaviour: Managerial Objectives in a Theory of the Firm* (Englewood Cliffs, N.J., Yale University Press, 1964); J. Steindl, *Random Processes and the Growth of the Firm* (London, Allen and Unwin, 1965); P. Hart and S. Prais, "The analysis of business concentration: a statistical approach", *Journal of the Royal Statistical Society*, Series A, 1956, pp. 150-181; T. Barna, *Investment and Growth Policies in British Industrial Firms* (London, Cambridge University Press, 1962); H. Simon and G. Bonini, "The size distribution of business firms", *American Economic Review*, September 1958, pp. 607-617; S. Hymer and B. Pashigan, "Firm size and the rate of growth", *Journal of Political Economy*, December 1962, pp. 556-569; E. Mansfield, "Entry, Gibrat's Law, innovation and the growth of firms", *American Economic Review*, December 1962, pp. 1023-1051; A. Singh, *Takeovers* (London, Cambridge University Press, 1971); G. Whittington, *Prediction and Profitability* (London, Cambridge University Press, 1971); J. Palmer, "The profit variability effect of the managerial enterprise", *Western Economic Journal*, 1973; E. Kuh, *Capital Stock Growth: A Microeconometric Approach* (Amsterdam, North Holland Press, 1963); A. Singh and G. Whittington, *Growth Profitability and Valuation* (London, Cambridge University Press, 1968).

[31]Lall and Streeten, *op. cit.*, p. 98.

based on company accounts are, of course, subject to wide margins of error. They do not provide wholly satisfactory criteria for evaluating a TNC's performance, particularly when (as is often the case) many of the costs are determined on the basis of the internal transactions of the firm and its affiliates. Moreover, these estimates are generally based on accounting conventions that do not adequately represent the effect of inflation on, for example, the valuation of fixed assets. There are also ambiguities in the method of valuation employed and often errors of omission, particularly in the appropriation of income statement. Items such as wages and purchases of raw material are often absent. Statements on "sources and uses of funds" omit "book" transactions—i.e. those internal to the company, such as the revaluation of fixed assets and the conversion of debenture stock to ordinary or preference shares. Obviously, these omissions are of particular importance when consolidated statements are being considered, for these require that adjustments be made in fixed assets, current assets and liabilities, and provisions. However, subsidiary accounts could not be procured and the necessary adjustments could not therefore be made.[32]

There are shortcomings and limitations to which such data are subject. However, the existence of a broadly similar framework of presentation and of broadly similar company objectives (most companies seek to maximize profits or growth and the choice of one or the other objective does not lead to significant differences in business strategy)[33] ensures that there is a basic consistency in the figures. Thus, it can be predicted that fixed assets will usually be undervalued in balance sheets. "It is considered almost criminal to overvalue and prudent to undervalue."[34] Accounting conventions remain fairly stable over time and across continents. Thus, many problems that arise in the use and interpretation of accounting data—the inability to take inflation into account in the valuation of assets, the arbitrary nature of depreciation estimates, conceptual ambiguities in the definition of categories such as "capital employed" and "net worth"—are in principle amenable to theoretical handling. Estimates of the gross value of foreign investment and of value added created by such enterprises, and explanations of the financial policies that they pursue are usually available only in data of this type. To avoid the use of such data because of the problems inherent in their interpretation and the difficulties of comparison between countries and over time would limit the scope of investigation of TNC behaviour to an aggregate level.

There is a need to gather data of this type from many developing and developed countries over an extended period, and to scrutinize the data in order to develop an appropriate conceptual framework for reconciling their contradictions, improving their estimates and widening the possibility of international (and intertemporal) comparability of the trends that they reveal.

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[32]The annual balance sheets and the flow may contain other defects. See H. Rose, "Disclosure in company accounts" (London, Institute of Economic Affairs, 1965), and F. W. Paish, *Business Finance* (London, Pitman, 1965). On how some of the problems can be solved, see C. A. Wilk, *Accounting for Inflation* (London, Sweet and Maxwell, 1960).

[33]See R. Larner, *Management Control and the Large Corporation* (New York, Johns Hopkins University Press, 1970); P. Holl, "Effect of control type on the performance of the firm in the U.K.", *Journal of Industrial Economics*, June 1975, pp. 257-271.

[34]Singh and Whittington, *op. cit.*, p. 221.

These exercises should also involve the transnationals themselves in order to acquire more detailed and specific information. In the developed market economies, such attempts have usually proved fruitful since large firms today provide many more details of their activities than they did two decades ago. Such co-operation, including the development of accurate and realistic estimates of firm performance, is in the interests of all parties.

For the present study, data were compiled from three sources. On the basis of this information three samples were formed comprising transnational corporations in the United Kingdom and subsidiaries in India and Thailand. For the data on British firms, UNIDO sent requests for information to those manufacturers in the United Kingdom that were listed in *Fortune*'s analysis of the 500 largest industrial corporations outside the United States[35] and that were judged not to be affiliates of other TNCs.[36] Firms were asked to supply annual consolidated accounts and financial statements for the period 1975-1979 and annual accounts and financial statements of their subsidiaries operating in developing countries in this period. The firms included in the study are estimated to account for approximately 36 per cent of the net assets of manufacturing companies in the United Kingdom during the period 1975-1977.[37] The companies in the group accounted for 53 per cent of the sales by the 65 largest manufacturers in the United Kingdom.[38] Although the accounts of subsidiary firms were not considered in this exercise, there are sound reasons to believe that foreign investment by the companies considered is substantial. This aspect, along with a more detailed description of the United Kingdom sample, is discussed in the appendix to this chapter.

Data for Indian companies were taken from the volume *Top 300 Companies*, published by the Economic and Scientific Research Foundation of India.[39] This source provides an analysis of accounts of the largest public limited companies in the period 1966-1971; it distinguishes between companies on the basis of ownership. A total of 46 manufacturers were included in the present study. All were in continuous operation during the period 1966-1971 and are subsidiaries or affiliates of foreign companies. The net sales of these 46 companies were equivalent to almost 20 per cent of the net sales of the 300 largest Indian public corporations, suggesting that the group includes many of the large foreign manufacturers in India. In the absence of a proper scientific sample design, it is not possible to assess the "representativeness" of this group. But it is clear that the companies included account for a significant proportion of foreign manufacturing investment,[40] and their policies are likely to be of considerable importance in determining the overall impact of TNC investment

[35] *Fortune*, 13 August 1979, pp. 193-207. For a more detailed description of this data, see the appendix to this chapter.

[36] This judgement was formed on the basis of information supplied by the United Nations Centre on Transnational Corporations.

[37] Estimates were based on supplementary information from *Government Business Monitor MA3* (London, HM Stationery Office, 1980), table 7, pp. 32-33.

[38] The relatively high proportion of sales of companies covered by the study shows that, in general, it was the larger companies that responded.

[39] V. Sriram and Associates, *Top 300 Companies* (New Delhi, Economic and Scientific Research Foundation of India, 1979).

[40] The exact figures may be found in the *Reserve Bank of India Bulletin*.

on the Indian economy. The firms are located in the chemical, petrochemical, machinery, electrical machinery, food, metal manufacturing and transport equipment industrial branches. The largest group is in the chemical industry.

The third source of data was the *Directory of Thailand's 300 Largest Companies*, published by Thamasat University.[41] This volume gives the balance sheets, income statements and financial highlights of the 100 largest manufacturing companies in Thailand for the years 1976 and 1977. Information is included on 21 subsidiaries and affiliates of foreign companies located in Thailand.[42] These latter companies were selected as the Thai group of foreign manufacturing firms. Their performance and policies were compared with those of the top 20 national Thai firms. The total sales of the foreign manufacturers in the Thai group accounted for 34.2 per cent of the sales of the 100 largest manufacturing firms in Thailand in 1977. Although it was not possible to estimate the total foreign investment in Thai manufacturing, the Thai firms included are clearly an important component of this investment.

The total sample drawn from three sets of country data comprised 96 firms.[43] For 76 of these firms, data spanning a five-year period were available. Comparability between the national samples was limited because of differences in accounting concepts and in the presentation of financial statements.

An attempt was made to develop a set of common indicators that could be used to assess financial policies and performance. It was decided, however, not to pool the sets of national data for the subsequent analysis, because of the large differences in national environment and policies, the nature of the enterprises in the sample and the periods covered by the national data. Moreover, some measures could not be calculated for all the countries in the overall sample.

The measures calculated are described in some detail in the appendix to this chapter. They represent financial estimates of the growth of individual companies, and of changes in their size and financial policies. Alternate measures of corporate profitability have also been estimated. These variables are defined according to conventional and generally accepted criteria. The first question studied was the relationship between size of firms and the growth of their assets. This investigation was useful for studying the impact of TNC growth on industrial concentration in the host economy. The growth of concentration can be a powerful barrier restricting the process of industrial restructuring in developing countries. The theory of the growth of the firm,[44] which was developed after the Second World War, unlike its neo-classical progenitor treats growth as a strategic choice of management. In certain circumstances, management may prefer a strategy that emphasizes the maximization of growth rather than profits. The two major themes emerging from this literature seem to be the relationship between growth and size of the

[41] Faculty of Commerce, Thamasat University, *Directory of Thailand's 300 Largest Companies 1977-1978* (Bangkok, Thailand, 1979).

[42] Identified on the basis of company profits given in *ibid.*, pp. 205-240.

[43] Lall and Streeten's sample consisted of 109 Indian and Colombian firms for which data were available for the year 1968-1969. See Lall and Streeten, *op. cit.*, chap. 6, pp. 99-129.

[44] For a review of developments in the theory of the growth of the firm, see *Fortune*, 13 August 1979, pp. 193-207.

firm, on the one hand, and between growth and the level of profitability, on the other.

The first theme has been the subject of a number of empirical studies designed to test "The Law of Proportionate Effect" (Gibrat's Law). This Law states that the probability of a firm's growing at any (given) rate is independent of the initial size of the firm. Hence, the Law implies that there is no "optimal" size of the firm.[45] Neither of these assertions are generally supported by the modern theory of the growth of the firm.[46]

Gibrat's Law also implies that the rate of growth of a firm in one period does not influence its rate of growth in the subsequent period. A related hypothesis is that there is an inherent tendency towards increasing concentration (if large and small firms grow at the same rates, large firms will eventually predominate and concentration will occur).

To test the Law of Proportionate Effect for the sample of companies in this study, the following linear regression models were applied to the data.[47]

$$G = a + bS + \varepsilon$$
$$\ln G = a + b \ln S + \varepsilon^{48}$$

where G is the rate of growth of the firm, measured as the difference between its net assets at the beginning and end of the period, as a ratio of its assets in the first year of the period; S represents the net assets of the firm at the beginning of the period; ε is a disturbance term; a and b are parameters, b indicating the difference in growth for every difference of one unit in size. Thus, if a value of, say, 0.5 was estimated for b, firms that had a size of £1 million at the beginning of the period would be expected to grow at twice the rate of firms that had an opening size of only £500,000. If the value of $b = 0.0001$, on the other hand, it could be concluded that initial size made little difference for growth prospects. The first equation implies that percentage growth changes by the same amount (given by the coefficient b) for any given change in size for all sizes of firms. The logarithmic equation, on the other hand, asserts that the proportional change in percentage growth is the same for any proportional change in size for all firm sizes.

These models were tested in order to acertain whether the growth rates varied in some systematic fashion with the size indicator. Each equation was estimated separately for the British, Indian and Thai data. None of the resultant equations (six) suggested the existence of a conclusive relationship between growth and size.[49] The result implies that no simple linear or log-linear relationship exists between size and growth for the firms in the sample. The

[45]Gibrat's Law suggests that the technology and market demand will not generate an optimal size for a "typical" firm. But this may not necessarily mean that individual firms within an industry do not have optimal induced sizes.

[46]Some economists have countered with the opinion that firms of medium size tend to grow faster than either small or very large firms, while others maintain that a firm's "willingness to grow" beyond a certain size may be reduced because of the nature of the association between growth and profitability.

[47]These specifications are generally used in empirical studies of Gibrat's Law. See Singh and Whittington, *op. cit.*, p. 113.

[48]This equation could be estimated for firms with positive growth rates only.

[49]Neither the regression coefficient nor the coefficient of determination differed significantly from zero when tested at a 5 per cent level of confidence.

findings do not, of course, establish conclusively that Gibrat's Law operates—growth may have a non-linear relationship with initial size.

Table V.3 shows average growth rates for different size classes of the firms in the sample. It is evident that there is some form of association between average growth and firm size. In all three cases, the lowest rate of growth was recorded by firms in the largest size class and, in the data for the Thai and the United Kingdom firms, the average rates of growth in the two smallest size classes exceeded the growth rate for large firms. Moreover, the results were statistically tested for significant differences in the value of the means of different size classes. In most cases statistical comparisons between pairs of means led to the conclusion that they were significantly different.[50] It is thus probable that there is a systematic, though weak, association between size and growth. Larger firms tend in general to grow more slowly than the relatively smaller TNCs.

TABLE V.3. AVERAGE RATES OF GROWTH OF FIRMS IN DIFFERENT SIZE CLASSES

	India		*Thailand*		*United Kingdom*	
Opening size class	*Mean rate of growth*	*Standard deviation*	*Mean rate of growth*	*Standard deviation*	*Mean rate of growth*	*Standard deviation*
I. Small	115.8	134.8	36.8	36.2	73.8	74.6
II. Small to medium	57.4	61.0	46.1	48.1	100.2	109.6
III. Medium to large	33.8	39.2	7.2	23.0	30.5	18.8
IV. Large	30.8	39.8	6.5	15.0	9.7	23.9

Source: Data compiled by UNIDO from company balance sheets.

Differences in the standard deviation of the different size classes were also tested[51] and showed a distinct association between size class and the variability of growth performance. This difference was most marked in the case of the United Kingdom group were the growth of the larger TNCs was considerably less dispersed. In that country group the value of the standard deviation of the average growth rate for the largest size class was less than one third of that found among the smallest firms. It can be concluded, therefore, that the larger firms have a relatively uniform growth performance while growth rates among smaller firms, on the other hand, differ widely. These results can only be regarded as tentative, because in no country group did the value of the standard deviation decline consistently with size class.

For the United Kingdom firms, these results are similar to those of Singh and Whittington who found that for a sample of over 200 United Kingdom firms there was a clear association between initial size and the dispersion of growth rates during the period 1948-1960.[52] The same study noted no statistically significant difference in the growth performance of different size

[50]The Welch-Aspin test was used. This test does not assume equal variances of growth rates in different size classes. See A. C. Aspin and B. C. Welch, "Tables for use in comparisons whose accuracy involves two variances", *Biometrika*, vol. 36, 1949, pp. 290-296. The following comparisons did not prove to be significantly different: United Kingdom, class III and class IV; India, classes I and IV and III and IV; Thailand, classes I and II and III and IV.

[51]The standard F test for testing significance of differences in variances was applied.

[52]Singh and Whittington, *op. cit.*, p. 80.

companies. However, for the period 1954-1960, firms in the largest size class had an average growth rate that was (statistically) significantly greater than the average growth rate of firms in most other size classes [53]

It is not possible to tell how many firms within each size class were transnationals in Singh and Whittington's data. But the present finding that the growth rate is smallest in the largest size class for firms in the sample is clearly at variance with studies that provide evidence of increasing levels of concentration. It may be that transnationals as a group grow more rapidly than other companies, but within the group of TNCs and TNC subsidiaries analysed here, the larger firms were clearly not growing more rapidly than the smaller. So far as the TNC subsidiaries are concerned, this finding might give some support to the "decapitalization" thesis according to which beyond a "saturation" point growth in TNC investment tends to fall off. Table V.3 may provide some evidence that a saturation level had been attained by the larger TNC affiliates in Thailand and perhaps also in India.[54] Thus, in the case of the Thai and Indian companies, neither proposition associated with the Law of Proportionate Effect—that (1) average growth rates and (2) their dispersion will be similar for different size classes—is confirmed by this analysis.

The validity of the Law of Proportionate Effect has also been tested by examining the relationship between the size of a firm at the beginning and end of a time period[55] using the following regression equation:

$$\log S_{t+1} = a + b \log S_t + \varepsilon$$

If $b = 1$ and the variance of ε is in fact constant, this implies that for all firms irrespective of size the average and the variance of the logarithms of proportionate growth are the same.[56] This equation was estimated for the United Kingdom TNCs and the Indian subsidiaries.[57] The estimate of b for the British TNCs was 0.997, or not significantly different from unity, thus contradicting the earlier finding[58] that growth was negatively associated with size. It also contradicts Singh and Whittington's results, which showed a positive relationship.[59] On the other hand, Hart found evidence of the validity of the Law of Proportionate Effect for a sample of British firms.[60] For the Indian subsidiaries, the value for the regression coefficient was only 0.89, which was significantly different from zero and considerably below unity. This result implies that the smaller TNC subsidiaries were growing at a more rapid rate than the larger ones, and that the gap between them was closing. The result (or fit) obtained for the Indian firms was not particularly good and there is some doubt about the extent to which the estimated equation correctly represents the distribution of growth rates. In general, the result was not conclusive enough to reject the possibility of the operation of the Law of Proportionate Effect.

[53] *Ibid.*, p. 77.

[54] Bornischer, *loc. cit.*, pp. 191-193.

[55] J. M. Samuels, "Size and growth of firms", *Review of Economic Studies*, 1965, pp. 183-197.

[56] This is a restricted version of the Law which implies that the frequency distribution of opening size and closing size represents a log-normal surface.

[57] Thai companies were excluded because data extended over only two years.

[58] See pages 247-248.

[59] Singh and Whittington, *op. cit.*, pp. 63-65.

[60] P. E. Hart, "The size and growth of firms", *Economica*, vol. 28, 1962.

One important aspect of the results presented in table V.3 is that they show no evidence of increasing concentration. This is contrary to findings of Prais for the United Kingdom,[61] according to which the share of the top 100 manufacturing companies increased from about 20 per cent of net output in 1950 to almost 50 per cent by 1980.[62]

From Thailand, the distribution of growth rates for size class in a sample of national firms is presented in table V.4. Once again it is evident that there is a marked (highly statistically significant) difference between the growth performance of firms in the smallest size class[63] and other firms. The table cannot provide any direct evidence on increasing levels of concentration.

TABLE V.4. DISTRIBUTION OF GROWTH RATES BY SIZE CLASS, THAI NATIONAL SAMPLE, 1976-1977

Opening size class	*Mean growth percentage rate*	*Standard deviation*
I. Small	94.1	144.1
II. Small to medium	5.3	35.6
III. Medium to large	—2.3	11.9
IV. Large	3.3	23.4

Source: Data compiled by UNIDO from company balance sheets.

Industrial concentration may be studied from both a static and a dynamic point of view. The former involves the use of an index of concentration that measures the predominance of the largest firms in the economy over a period. The dynamic approach studies the way in which the firms in the industrial sector have changed ranks as a result of growth. A "transition matrix" has been built to study the internal mobility of firms in the present sample.

Table V.5 shows, for example, that for the United Kingdom group, 57.1 per cent of the firms in the lowest size class at the beginning of the period remained in the same size class at the end of the period, while 42.8 per cent went up by one size class. For the Indian group 71.4 per cent of the firms in the second highest size class remained in the same size class; 14 per cent moved up by one size class, and another 14 per cent went down by one size class.

The results shown in table V.5 are biased downward in that the construction of the matrices does not permit firms in the highest opening size class to move up. The results are biased upward in that the matrix does not permit firms in the lowest size class to move down. In the case of the Thai and United Kingdom groups of firms, this is not an important limitation;[64] the

[61] J. Prais, "A new look at the growth of industrial concentration", *Oxford Economic Papers*, vol. 29, July 1974, pp. 78-85.

[62] *Loc. cit.*, p. 8.

[63] Even if the one firm that tripled its net assets over 1976-1977 is excluded, the mean growth rate of this size class is 30.36 per cent, which is significantly greater than the mean growth rate of all other size classes.

[64] No firm in the Thai group and only one firm in the United Kingdom group in the "highest" size class had net assets in the final year in sufficient excess of net assets in the first year of the period to justify being placed in a higher size class.

TABLE V.5. TRANSITION MATRIX FOR MEASURING THE MOBILITY OF FIRMS

(Percentage)

	Closing size[a]											
	India				*Thailand*				*United Kingdom*			
Opening size	*I*	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*
I. Small	20	50	10	20	75	25	—	—	51.7	42.8	—	—
II. Small to medium	—	46.6	40	13.4	20	80	—	—	—	81.8	9.1	9.1
III. Medium to large	—	14.3	71.4	14.3	—	20	60	20	—	—	100	—
IV. Large	—	—	—	100	—	—	50	50	—	—	—	100
	Change											
	-1	*0*	*+1*	*+2*	*+3*	*-1*	*0*	*+1*	*-1*	*0*	*+1*	*+2*
Proportion of total firms changing size class	2.1	60.8	23.9	6.5	4.3	15	70	15	—	83.3	13.13	3.3

[a] I, small; II, small to medium; III, medium to large; IV, large.

majority of the firms—83 per cent of the United Kingdom TNCs and 70 per cent of the Thai firms—did not change size class. There is little evidence of internal mobility. The present findings are not irreconcilable with the studies of United Kingdom industry that have found rising levels of concentration. Specifically, the present results show that in the case of manufacturing TNCs in the United Kingdom, although growth rates tend to be inversely related to size, the difference in the growth performance of firms within the sample was not sufficient to alter the size distribution. Very few firms switched size class. It seems, therefore, that the impact of the higher growth rates of the smaller TNCs on overall levels of concentration is small.

For the Indian subsidiaries, on the other hand, adjustments in table V.5 would make significant differences. The top three firms in the highest size class had closing sizes that were over 25 per cent in excess of their opening sizes. If these firms were to have moved to a "largest-plus-one" size class, 21 of the 46 firms (i.e. 45.6 per cent)[65] would have gone up by one size class or more. Thus, although the majority of the firms once more seemed to have remained in their initial size class, the possibilities of switching were greater as was the impact of growth rate differentials on the levels of industrial concentration.

The finding that levels of industrial concentration are most likely to be affected by differential growth performances among the Indian firms is also confirmed by a rank correlation analysis. The value of the Spearman γ for firms ranked by opening and closing size was 0.953 for the Thai group, 0.927 for the United Kingdom TNCs, but only 0.629 for the Indian firms. The lower the value of γ the greater the relative mobility of firms. Thus, while mobility was comparatively high among the group of Indian subsidiaries, it was virtually non-existent for the United Kingdom TNCs and the Thai firms. It is important to note that for the latter two groups the estimates of mobility were significantly lower than similar estimates for national industry. The value of γ_s (Spearman) for the 20 national firms in Thailand was estimated as 0.83. Singh and Whittington's estimates of γ_k for surviving registered (i.e. large) British firms for a 12-year period ranged between 0.69 and 0.72.[66] For a 6-year period, their estimates ranged from 0.771 to 0.873.[67]

The results indicate a weak negative relationship between size and growth. Smaller firms grew at a faster rate in all three country groups, but their growth performance was more erratic than that of the larger enterprises. Moreover, except perhaps in the case of the Indian firms, the difference in growth rates was not sufficient to lead many firms to switch ranks within the respective group and was thus not likely to have a pronounced impact on the level of industrial concentration.

Growth and profitability

The relationship between growth and size has been shown to be negative for the firms in the present sample; this finding is contrary to the predictions of

[65] According to table V.5, this proportion is 34.78 per cent.

[66] Although γ_k (not γ_s) is estimated, Singh and Whittington note "the same pattern of relative mobility is observed when Spearman's γ is computed as where γ_k is used". Singh and Whittington, *op. cit.*, p. 102.

[67] Singh and Whittington, *op. cit.*, p. 102.

economic theory, which postulate that there is no relationship between these variables. Conventional theory postulates that in equilibrium no relationship will exist between growth and profitability, that all firms will have achieved their optimum size and will have ceased to grow. If equilibrium does not exist, the relationship between growth and profitability will be determined by the causes of disequilibrium and the speed with which firms adjust to their equilibrium position.[68] The theory regards a firm's growth as dependent on ability and willingness to grow. Profitability clearly adds to a firm's potential for growth, and, therefore, in an expanding economy a positive association between these two variables should be expected. A firm's willingness to grow, on the other hand, is likely to be related to its level of profitability in a more complicated manner. With regard to TNC subsidiaries, there may be a tendency to transfer profits from the host country to the home country or to other host countries; hence the observed association between profits and growth may be a weak one within a given national sample. Moreover, in the case of a TNC, the willingness to grow may also depend on demand and labour conditions in a wide range of industries that it seeks to integrate. Furthermore, inasmuch as such TNCs are likely to be predominantly management-controlled rather than owner-controlled firms, the relationship between growth and profitability may be weak. Some authors argue that the former type of firm maximizes growth subject to a "profit-satisfying" constraint. Such firms may, beyond a certain point, consciously sacrifice higher profits for higher growth.[69]

The following equations were estimated for the firms in the sample:

$$\text{Growth} = a + b \times (\text{Profitability index}) + \varepsilon$$
$$\text{Growth} = a + b \times (\log \text{Profitability}) + \varepsilon$$
$$\text{Log Growth} = a + b \times (\log \text{Profitability}) + \varepsilon$$[70]

Profitability indices were *(a)* rate of return of net assets; *(b)* net profits to sales; *(c)* net profits to equity assets. There were a total of 18 estimates. The "best" estimates are reproduced in table V.6. For the United Kingdom and Indian firms, a positive relationship between levels of profitability and growth can be discerned. However, estimated equations clearly do not provide a good

TABLE V.6. IMPACT OF PROFITABILITY ON G[illegible]

Coefficient	*India*	*T[illegible]*	*ited Kingdom*
Independent variable	Net profit to net assets	Net profit to net sales	Log of rate of return on net assets
Value of regression coefficient	2.61[a]	—0.94[b]	1.105[b]
Value of coefficient of determination	0.12	0.18	0.11

Source: Data compiled by UNIDO from company balance sheets.

[a]Significantly different from zero at a 5 per cent confidence level.

[b]Significantly different from zero at a 10 per cent confidence level.

[68]Marris, *op. cit.*, chap. 1.

[69]*Ibid.*, chap. 2.

[70]For specification of these models, see Singh and Whittington, *op. cit.*, pp. 150-153.

explanation of the relationship between profitability and growth. The value of R^2 (the coefficient of determination) is very low, indicating that the estimated curve does not adequately fit the actual scatter of points on the graph that related growth to profitability. It is clear that a simple linear relationship between profitability and growth is not obtained. The low value of the coefficient of determination may be accounted for by a significant specification error in the regression models. This may be owing to heteroscedasticity in the variance of the distribution of the errors in the models and/or owing to the fact that the relationship between growth and profitability was not linear. Evidence of differences in the relationship between growth and profitability at different growth rates has been estimated.[71] Hence some non-linearity in this relationship can clearly be discerned.

It may be argued that some of the weakness of the association between growth and profitability discerned here is because the independent variables include amounts payable to the Government as taxation. On the basis of the information available, it was not possible to determine the duration of the payment of this taxation in the case of the Indian and the Thai firms. Some of the taxation may have been deferred and have served as a source of financing growth. For the United Kingdom group, an analysis of the firms' financial statements permitted a reasonably accurate estimate of "profits net of taxation". Six equations were fitted and the equation that related the logarithm of the profitability indicator to the logarithm of growth gave the "best" approximation of the relationship.[72] It is thus clear that there is a closer relationship between profits net of taxation and growth. Of course, it is *net* profits that enhance a firm's "ability to grow", and a closer relationship with growth is to be expected, particularly if growth is defined with reference to financial assets as in the present study. It is all the more interesting to note, therefore, that even if the figures on net profits provided by the sources used in this study are accepted, there is no appreciable change in the estimates of the equation relating profitability to growth for either the Indian or the Thai firms.

Results for the Thai firms may be regarded largely as inconclusive because of the shortness of the period under study. Clearly, it is long-term, or at least medium-term, profitability that is expected to influence growth. It must be emphasized that the regression models did not yield significantly superior results for the sample of Thai national firms either.[73] Thus, there is no conclusive evidence to show that the low association between profitability and growth is peculiar to the subsidiaries or that it is accounted for by their policies.

On the other hand, a marked difference was found between Indian subsidiaries and Indian national firms. Six equations relating profitability indices to growth were estimated for 50 of the largest Indian manufacturing companies for the period 1966-1971. Double-log models provided the best fit.[74]

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[71] But not reproduced.

[72] The fit obtained by these models was superior to that reproduced in table V.6, and variations in profitability were found to have a significant impact on the growth performance of the firms. All *b* estimates in these models had the expected sign.

[73] The best estimate yielded an R^2 of 0.10 and a regression coefficient which, though positive, was significant at a 10 per cent confidence level.

[74] With R^2 ranging from 0.48 to 0.51.

Four of the six equations demonstrated a significant impact of profitability on growth. There is, therefore, some justification for arguing that Indian subsidiaries were either growth-maximizing firms and not dependent on high profit rates for growth, or that they did not use their profits for domestic expansion. For about 46 per cent of the subsidiaries, the rate of growth of net profits exceeded the rate of growth of net assets. Thus, it can be argued that a significant number of the subsidiaries did not employ a large proportion of earnings for domestic expansion.

The results for the United Kingdom TNCs corresponded broadly with Singh and Whittington's estimates of the relationship between profitability and growth for larger firms.[75] They found that there were differences in the relationship between profitability and growth among large and small firms within their sample. In the majority of the cases, they obtained a higher value of R^2 for the smaller firms than for the larger ones.[76] This phenomenon implies that changes in levels of profitability explain a larger proportion of the variation of growth among smaller firms than among larger ones.

The relatively modest estimates for R^2 and for the regression coefficient arrived at in the present investigation suggest that the United Kingdom TNCs—the largest British firms in existence—are less constrained by short- and medium-term profitability. Profitability is a longer-term constraint on these firms than on the comparatively smaller firms, which make up the majority in the Singh-Whittington sample. It is not possible, however, to establish the extent to which the TNCs in the present sample are "profit-satisfying" entities and deliberately "sacrifice" profits for maximizing growth, on the basis of the preceding analysis. The lack of association between growth and profitability once again indicates a lack of evidence about increasing industrial concentration—the firms with the highest potential to grow (as measured by the profitability indices) do not exhibit a growth performance different from the other firms in the present sample.

Thus, growth is not explained by levels of profitability by the preceding method of investigation for the firms in the sample. According to economic theory, variables measuring the level of capacity utilization explain the growth patterns of such firms more adequately. This theory, however, takes a more restricted view of the growth process than that implied by the definition that has been used so far in this study. It is concerned with analysing changes in the level of firms' investment—defined as changes in fixed assets—over a period of time. This theoretical framework is used below in an examination of the investment behaviour of the TNCs and subsidiaries in the present sample.

Determinants of investment

A theory of investment behaviour concerns factors that induce a firm to increase its demand for capital equipment and that influence the availability of funds for investment purposes. The former may be regarded as a demand function and the latter as a supply function. An adequate investment theory

[75]Singh and Whittington, *op. cit.*, pp. 162-168. Their estimates of the coefficient of determination for the period 1954-1960 range from 0.10 to 0.29.

[76]Singh and Whittington, *op. cit.*, pp. 154-157 and p. 163.

should integrate both demand and supply factors in seeking an explanation for changes in capital expenditure.

In capacity-utilization theories of investment it is postulated that changes in capital stock are strictly proportional to the (positive) rate of change in output. Investment is held to be proportional to the difference between the desired capital stock and existing capital stock at the beginning of a period. The desired capital stock is predicted on the assumption that the current level of sales will continue into the future. This approach assumes that investment varies with output and sales. Some authors have pointed out that in capacity-accelerator theories of investment profits are also adequately accounted for, since they are closely associated with both sales and capital stock. Capacity-acceleration models have been developed by using more complex distribution lags and taking irreversibilities into account. However, the basic framework has remained largely unchanged.

The main alternative to the capacity-utilization theories of investment are the profit theories. These may be divided broadly into two: *(a)* those that hold that investment depends on present profit rates since these reflect future profits, and *(b)* those that postulate a linear relationship between profits and sales and hence consider the profit theories to be hypotheses subsidiary to the capacity-utilization theories. Some theories also take market imperfections etc. into account and predict that the investment rate will be restricted mainly to gross profit levels.

The investment behaviour of the firms in the present sample was analysed by fitting a number of single equation regression models to the data. It was not possible to use any but the simplest specifications. The most important drawback of the models was the inability to experiment with a number of distributed lag systems, which may allow a better specification of the relationship between investment and the independent variables included in the model. Moreover, it was not possible to take asset appreciation or other price changes into consideration.

The capacity-utilization models have regressed sales, capital stock and the ratio of sales to capital stock (which is a measure of capital intensity) on investment. In the profit models, profits after taxes, fixed assets and the capital-intensity indicator have been regressed on changes in capital stock. Equations combining the capacity-utilization and profit models have also been estimated. The specifications of the models are along conventional, generally accepted lines.[77] The results are summarized in table V.7. For the United Kingdom and the Indian firms, the accelerator models gave better explanations.

For the United Kingdom TNCs the best fit was obtained by the model that relates the ratios of capital stock and capacity utilization to total capital, to investment.[78]

For the Indian data, the best fit was given by a profit model, but only one profit coefficient was significant at a 5 per cent confidence level. Thus, the capital-utilization variables are again judged to be the better estimators of the relationship between investment growth and the economic variables.

The results for the Thai firms were largely inconclusive. The best fit was obtained by models that combined the profit and the capacity-utilization

[77] They are primarily based on the work of Kuh, *op. cit.*

[78] The two ratio models yield an R^2 of 0.99 and 0.79.

TABLE V.7. INVESTMENT BEHAVIOUR OF TRANSNATIONAL CORPORATIONS AND SUBSIDIARIES[a]

Characteristics	*India*	*Thailand*	*United Kingdom*
Largest R^2 obtained for capacity-utilization models	0.80	0.20	0.99
Largest R^2 obtained for profit models	0.84	0.31	0.78
R^2 obtained for combined models (containing both capacity-utilization and profit indicators as independent variables)	0.80	0.35	0.81
Sales coefficient; number of significant coefficient	6	1	3
Capital stock coefficient; number of significant coefficient	8	0	3
Capital-intensity coefficient; number of significant coefficient	8	0	6
Profit coefficient; number of significant coefficient	1	0	0

[a]A small minority of regression coefficients were significant at the 5 per cent level but had the "wrong" (i.e. not predicted by economic theory) sign. These have not been included in the table.

variables; only one regression coefficient was significantly different from zero. This indicates that changes in capacity utilization and profit are not shown to influence the level of investment. It is interesting to note that a better fit for the data on Thai national firms was obtained by the combined models. The fit obtained for the national data was significantly superior to that obtained for the Thai subsidiaries. Moreover, both profit and capacity-utilization estimations were found to have a significant impact on investment.[79] It is thus evident that the investment behaviour of the national firms was adequately explained by the simple combined models, and that profits were an important determinant of the investment decisions of these firms.

The results for the Indian subsidiaries were also at some variance with the studies of Indian national firms. Although capacity-utilization variables were shown to be associated with growth in capital stock,[80] financial variables were also important determinants of the investment decision.

For the period 1962-1970, Krishnamurty and Sastry have analysed the behaviour of about 360 Indian firms in a number of industries and have concluded that: "In the capital goods sector the cross section results suggest the importance of financial variables, (but) the accelerator estimators do not seem to have any impact at all".[81] The few significant profit coefficients estimated for the Indian subsidiaries in the present study thus reveal that domestic demand conditions are more important determinants of their investment decisions, and medium-term profitability is a less important determinant than for the national Indian firms. It is important to note that the present estimates of R^2 are invariably higher than those of Krishnamurty and Sastry.[82] This may in part be accounted for by differences in model specifications.

[79]R^2 is 0.79 for the "best" estimated equation: four regression coefficients for profit estimators and five regression estimates for capacity-utilization estimators (four in the combined models, one in "accelerator" models) were significantly different from zero.

[80]K. Krishnamurty and D. N. Sastry, *Investment Accelerator and Financial Factor* (Delhi, Institute of Economic Growth, 1973), p. 29.

[81]D. N. Sastry, *Investment Behaviour in the Capital Goods Industry* (Delhi, Institute of Economic Growth, 1973), p. 19.

[82]Krishnamurty and Sastry, *op. cit.*, p. 41.

In the case of the Thai subsidiaries, the inability of the models to explain the relationship between investment, on the one hand, and the accelerator and profit variables, on the other, may be because factors external to the Thai economy are the main determinants of the growth of capital stock of these subsidiaries. Such factors could be the level of economic and political stability in other potential host economies, or factors not easily taken into account by these models, such as high levels of intra-firm trade that are effectively camouflaged by transfer pricing.

With regard to the better performance of the capacity-utilization models for the United Kingdom TNCs, it has been argued that in periods of economic expansion, capacity-utilization is more likely to be an important determinant of the decisions to invest than profit variables. In periods of recession, on the other hand, external borrowing becomes difficult, and the ability of a firm to make profits becomes an important determinant of its ability to expand its capital stock.[83] The period 1975-1979 was one of industrial contraction in the United Kingdom. It is interesting to note that during this period a decline in profit rates was not an important constraint on the investment plans of the large TNCs included in this study. Their investment schedules were based on longer-term planning. They could mobilize resources to maintain investment levels, and, clearly, demand conditions were important in determining investment levels.

On the basis of the foregoing analysis, it is possible to state that systematic variations in the growth process of TNCs in the United Kingdom and subsidiaries in India have been identified. For the Thai firms, the results are inconclusive. In none of the three cases, however, was there any systematic association between profit estimators and other variables. An attempt will be made below to identify the determinants of profitability.

Determinants of profitability

The theory of the growth of the firm emphasizes the relationship between profits and the size of the firm. If a positive relationship can be established or if the dispersion of profits can be shown to decline systematically with size, then it can be argued that higher profits provide an incentive for growth. If there is no systematic variation of profits with size, profitability will not provide an incentive for expansion. The evidence on the relationship between size and profitability for firms included in this study is presented in table V.8. It appears that there is no clear association between the size of firms and their profitability—as measured by the rate of return on net assets—for either the United Kingdom or the Indian firms. For the United Kingdom TNCs, however, if firms of the smallest size are ignored, a negative association between profitability and size does emerge. The average profit rate in size class II is significantly different (statistically) from that of the two larger size classes. There is no systematic variation in the standard deviation of the rate-of-return measure by size class in any of the country groups.

[83] M. Meyer and E. Kuh, *The Investment Decision* (Cambridge, Mass., Harvard University Press, 1957), pp. 116-136.

TABLE V.8. DISTRIBUTION OF PROFITABILITY BY SIZE CLASS: RATE OF RETURN ON NET ASSETS

Size class	India (1966-1971)		Thailand (1976-1977)		United Kingdom (1975-1979)	
	Mean rate of return	*Standard deviation*	*Mean rate of return*	*Standard deviation*	*Mean rate of return*	*Standard deviation*
I. Small	39.44	26.94	6.13	11.17	11.49	4.30
II. Small to medium	29.03	16.58	9.80	9.90	31.35	19.20
III. Medium to large	31.86	20.80	13.86	16.15	17.03	4.83
IV. Large	25.84	13.44	21.46	40.70	15.40	13.48

Source: Data compiled by UNIDO from company balance sheets.

For the Thai subsidiaries, there is an apparent positive association between size and profitability. However, if one extreme case is eliminated from the largest size class, the average profit rate for that size class declines to 3.5 per cent, a rate significantly below that of any other size class. Thus, the evidence on the relationship between size and profitability is once again obscured.

The inconclusive character of the results shown in table V.8 is even more clear when account is taken of the inherent limitation of the measure of profitability that was employed. Differences in methods of fixed asset evaluation may introduce systematic biases in the estimation of the profit indicators. Unfortunately, it was impossible to account for these biases. Furthermore, the small number of firms included in the individual size classes rendered the average figures highly dependent on extreme values, as is illustrated by the Thai firms. In order to deal with this second difficulty, regression analysis was employed to estimate the relationship between size and profitability.

The following regression models were used:

$$P = a + bS + \varepsilon$$
$$P = a + b \log S + \varepsilon$$
$$\log P = a + b \log S + \varepsilon$$[84]

where

P was estimated variously as:

- *(a)* rate of return on net assets
- *(b)* post tax rate of return on equity assets
- *(c)* post tax profits to net sales

S = opening size of the firm
ε = the disturbance term.

The relationship between profits and size was found to be very weak. There was no association whatsoever in the case of the United Kingdom firms. For the Thai subsidiaries, the logarithmic equation relating net profits as a proportion of net sales to opening size of firms yielded evidence of a significant negative association, indicating some reason to believe that the larger Thai subsidiaries were less profitable than the smaller ones.

[84]The specification of these models is given in Singh and Whittington, *op. cit.*, pp. 120-124.

A comparison of these results with those for national firms reveals diverse trends. For Thai national firms, no significant association was discerned between opening size and the profitability indices. For a sample of 50 Indian national firms, on the other hand, there was a significant negative association between profits to net assets and opening size. However, the fit obtained by the equation was very weak. Figures were not available for United Kingdom national firms for the same period covered by this investigation. For an earlier 12-year period, Singh and Whittington found no systematic association between size and average profitability, although they did find that larger United Kingdom firms had less variable profit performances.[85] The present study did not find evidence of such a relationship.

The overall conclusion is therefore that size is not a prime determinant of profitability of firms in the present sample. This is thus not a distinguishing characteristic of transnational enterprises and their subsidiaries. Nor do national firms exhibit a marked association between size and profitability.

In line with other research, an attempt was also made to relate profitability to financing patterns.[86] The results are briefly summarized below. For the Thai subsidiaries, net profits to sales were significantly negatively associated with measures of liquidity and gearing.[87] For the Indian data, on the other hand, there was evidence of a significant positive association with both total liquidity and levels of profit retention.[88] Also for the Indian firms, there was a significant positive association between profitability and dividend payments, suggesting that the financing patterns of the Thai and Indian subsidiaries differed significantly. The latter group of firms apparently borrow more "efficiently" and effectively. Profitable Thai subsidiaries tend to rely mainly on internal resources. (It should be stressed that this is a finding derived from indirect evidence. It was not possible to estimate the retention ratio for the Thai firms in the sample.)

The results for the United Kingdom TNCs indicated a weak positive association between profitability and indicators measuring retention.[89] There was also a relatively strong association between profitability and dividend payments, indicating the relative importance of equity resources. No significant association appeared between profitability and measures of external financing, a result not unexpected in a period generally characterized by a trend towards industrial contraction.

The general conclusion is that conventional analysis is not a particularly adequate tool for explaining differences in levels of profitability of subsidiaries and of transnationals.[90] On the other hand, a number of studies of corporate

[85]Singh and Whittington, *op. cit.*, p. 144.

[86]Lall and Streeten, *op. cit.*, pp. 123-129. Data on advertising expenditure and indicators measuring barriers to entry were not available for inclusion in this analysis.

[87]The value of the coefficient of determination was 0.61 when net profits to sales were regressed on estimates of total gearing, and rose to 0.67 when an aggregate liquidity indicator was added to the equation

[88]The value of R^2 was 0.54.

[89]The value of R^2 was only 0.17.

[90]These results are not at variance with those of other researchers. One study found relatively few statistically significant regression coefficients in an analysis of the impact of financial policy on profitability levels in a sample of Indian and Colombian subsidiaries.

profitability of national Indian firms have shown a significant association between profitability indicators and financing variables, thus supporting conventional theory as an adequate framework for an analysis of profitability variations among national firms in India. For the group of Thai national firms described earlier, the association between profitability and financial variables was found to be very low.

Finally, an attempt was made to determine the persistency of profits. If a firm enjoys monopoly power or possesses superior management resources, it could be expected to remain relatively more profitable over a period of time. Persistency of profitability was estimated by the equation

$$P_t = a + P_{t-1} + \varepsilon$$

where t is the last year of the period and $t - 1$ the first year, and P represents different indicators measuring pre- and post-tax profitability. These equations were fitted to the Indian and United Kingdom groups of firms. For the Indian data, a significant positive relationship was discerned although the fit was poor.[91] For the United Kingdom TNCs, on the other hand, a good fit was obtained[92] and once again there was evidence of a strong positive association. Further, the correlation coefficient (Spearman) for firms ranked by the profitability indices in the first and last years of the period under study was 0.763 for the sample of United Kingdom TNCs and 0.422 for the Indian subsidiaries. It is clear, therefore, that whereas the persistency of profits was comparatively high for the United Kingdom firms, it was moderate for the Indian subsidiaries. A corresponding coefficient for the 50 largest Indian national firms, ranked by profitability in the first and last years of the same time period, was 0.399, or not significantly different from the estimate for Indian subsidiaries. On the other hand, the value of the coefficient of correlation for United Kingdom TNCs was significantly higher than that found in other studies of 364 British manufacturing firms over a 12-year period.[93] Thus, there is a distinction in the persistency of profitability for the United Kingdom and Indian firms. In neither case, however, was the preceding analysis particularly successful in revealing the major determinants of interfirm variations in profitability.

Implications for host government policies

The lack of association between profitability and what are generally regarded as its financial and economic "determinants" may be explained partly by the existence of transfer pricing within TNC systems.

The level of transfer pricing is associated with the extent of the intra-firm trade of a given industrial branch. This in turn is affected by technological intensity, the divisibility of the production process and the need for after-sales servicing.[94] Potential for and incidence of transfer pricing is highest in product

[91] The average value of R^2 was only 0.201.

[92] The average value of the coefficient of determination was as high as 0.87.

[93] Singh and Whittington, *op. cit.*, p. 139.

[94] S. Lall, *The Multinational Corporation* (London, Macmillan, 1980), p. 106.

areas characterized by high levels of specialization. It is also associated with high economies of scales and significant levels of international integration of production structures. Industries that operate on R and D intensive technologies of production and that maintain a close co-ordination between production and marketing systems use firm-specific products and are usually dominated by TNCs that can "maximize the profitability of possessing special monopolistic advantages by internalizing trade".[95] It has been found that intra-firm trade—and hence the potential for transfer pricing—is highest in the technology-intensive industries, such as office machines, plastics and transport equipment. Textiles and apparel have what is described as "an intermediate level of intra-firm trade" attributable mainly to their highly integrated marketing structures. Industrial branches with low levels of intra-firm trade are characterized by the existence of standardized products, a widely diffused technology and a relatively loose international marketing structure. These industries include metals, non-metallic minerals and industrial chemicals. In general, it may be argued that the more generally a product is traded and the less specific it is, the smaller the likely difference will be between "arms-length" and transfer prices. Governments of developing countries need not be overly perturbed by such industries. In other industries, with highly specific products (e.g. pharmaceuticals), differences between arms-length and intra-firm prices have been found to be very extensive.[96] In such cases, it is important to identify factors inducing a TNC to increase this difference, and to take countervailing measures in the interests of the host and home economies.

The neo-classical theory of pricing does not adequately explain the process of transfer pricing within transnationals. Price theory is concerned with explaining behaviour when buyers and sellers seek to maximize profits at each other's expense. In intra-firm transactions, on the other hand, the aim is to maximize profits over the whole spectrum of activities integrated within the TNC system. An important incentive for making use of transfer pricing is provided by international differences in tax and tariff rates, by the operation of multiple exchange-rate systems (which apply relatively costly exchange rates to profit transmissions) and by limits imposed on the legal remittance of profits from host and home countries. Transfer prices may also be used by TNC subsidiaries to increase the share of parent company profits or to appreciate the value of the capital equipment provided by way of equity participation. Obviously, these policies may be at the cost of local shareholders. Local and foreign equity holders may, however, collude and use transfer pricing as a means for foreign accumulation of funds.

While there is no *a priori* reason to expect that transfer pricing will always be to the detriment of the host developing countries,[97] many analysts have

[95] *Ibid.*, p. 139.

[96] C. Vaitsos, *Intercountry Income Distribution and Transnationals* (Oxford, Clarendon Press, 1974).

[97] The present study finds a lack of association between declared profits and what are usually recognized as variables determining the variation in interfirm profitability for the United Kingdom as well as for the Indian and Thai firms. There is thus indirect evidence of the existence of some transfer pricing in both home and host countries. Many "home" developed market economies—notably the United States—have enacted measures to control transfer pricing. See M. C. Duess, *Tax Allocations and International Business* (New York, The Conference Board, 1972).

held that "the cards are in fact stacked heavily against the DCs".[98] Tax rates tend to be higher, import duties on intermediate inputs tend to be comparatively low, quantitative restrictions on repatriations of profits are usually in force, and the socio-economic environment is vulnerable to external and internal destabilizing pressures. It is therefore important that developing countries pay some attention to devising a consistent policy for dealing with problems of transfer pricing.

A first step in this direction could be to estimate the extent of transfer pricing in specific areas. It has been argued that this varies considerably between industries. It also varies with the extent of organizational integration within TNC systems. The greater the degree of centralized control and the greater the subordination of subsidiaries to a head office, the greater the potential for transfer pricing. On the other hand, area-based TNCs—as against TNCs that delegate executive responsibility for product coverage—are more prone to require subsidiaries to be fairly autonomous profit-making enterprises. In such cases, the scope for transfer pricing is likely to be more limited. The Governments of developing countries should therefore not assume that transfer pricing is an all-pervasive problem unvarying in intensity and a necessary and unavoidable consequent of TNC investment. For example, there is some evidence that despite the fact that TNCs dominate certain branches of the food-procuring industry, they do not usually resort to transfer pricing in this sector.[99]

On the basis of the foregoing arguments, Governments of developing countries can adopt a number of means for dealing effectively with the problem of transfer pricing. Some of these are listed below:

(a) An attempt may be made to harmonize tax and tariff structures;

(b) Imports to local subsidiaries may be channelled through an independent importing agency;

(c) Use may be made of international organizations, particularly those within the United Nations system, to monitor prices of important imports and compare them with prices charged by transnationals;

(d) Encouragement of local participation in the equity of TNC subsidiaries may also help persuade these firms to adopt internal restraints or to avoid excessive use of transfer pricing.

(e) Through regional co-operation schemes, the activities of regionally based TNCs may be jointly monitored and access may be requested to more detailed information than is currently available in balance sheets and other financial statements.

These measures are naturally not without cost—both administrative and financial—but they are unlikely to be a major impediment to increased TNC investment in developing countries. A number of studies have shown that TNCs are not particularly responsive to fiscal incentives, and, in any case, taxes on corporate income in developing countries are generally lower than in the

[98] Lall, *op. cit.*, p. 117.

[99] *Ibid.*, p. 140

developed market economies. Moreover, many developed market economies—including the Federal Republic of Germany, Holland, the United Kingdom and the United States—have been able to impose fairly stringent controls on transfer prices without in any way affecting the inflow of direct foreign investment.[100] The general economic environment of a country, its growth performance and its prospects are the primary influences affecting TNC investment. This is a finding supported by the analysis of investment behaviour undertaken in this study.

An expansion of TNC investment in developing countries can make a contribution to international industrial restructuring. The Governments of developing countries should pursue policies that facilitate its location in industrial branches in which these countries have a dynamic comparative advantage, in industries with the brightest medium- and long-term growth prospects. Co-operation between TNCs and developing countries can ensure that the costs and benefits of the expansion of these branches shall be equitably shared.

The main findings of the present analysis of investment patterns may be summarized as follows:

1. Growth—measured in terms of (net) fixed and current assets—is weakly associated with size in the present sample. This implies that there is some evidence to support the "saturation" thesis which holds that foreign investment falls off after a certain level of foreign participation has been achieved. No evidence has been found to substantiate the claim that TNC investment contributes to increased industrial concentration. Therefore, measures that limit industrial concentration should be applied with equal efficacy to subsidiaries and local firms.

2. Variations in levels of investment are best explained by the "accelerator" theories, which employ sales and capacity-utilization variables. This trend was most clearly evident for the United Kingdom transnationals and the Indian subsidiaries. For the Thai subsidiaries, on the other hand, the models combining accelerator and profit variables provided the "best" fit. Only one profit coefficient was significant, however, and therefore little can be inferred from this result. The closer association between investment and the capacity-utilization variables suggests that the economic conditions prevailing in host economies are likely to be important determinants of the level of TNC investment. In growing economies with high levels of capacity utilization, such investment is likely to expand rapidly. On the other hand, since TNCs and their subsidiaries appear to be less constrained by the availability of finance, government tax concessions and the liberal treatment of TNCs (in terms of permission to retain monopoly control of markets and thus to ensure the continued existence of artificially high levels of profits) is not likely to be particularly useful in attracting foreign investment, particularly in the long term.

[100] *Ibid.*, p. 148.

The Governments of developing countries and TNC investors have a mutual interest in realizing the full economic potential of host economies. Clearly, the short-term costs incurred by different economic actors may be substantial. The finding that TNC investment levels are related to the rate of output growth and to the degree of market stability (for it is this second factor that induces high levels of capacity utilization) gives reason to expect that TNCs can be persuaded through a process of protracted negotiation to accept lower levels of short-term profitability in order to overcome structural bottlenecks in specific industrial branches in developing countries. The relatively industrialized developing countries with potentially large domestic markets are advantageously placed to persuade TNCs to take a longer-term perspective and to share the cost of industrial consolidation and rationalization within the developing world. This is evident from the present analysis of the investment behaviour of Indian subsidiaries. For the smaller developing countries with limited domestic markets—such as Thailand—opportunities in this field are perhaps more limited. It has been shown that short-term profitability is a significant determinant of subsidiary investment in the case of the Thai firms (although it is less significant than in the case of domestic manufacturing enterprises in Thailand). But the size of the domestic market is by no means necessarily limited by the rate of growth of domestic income and population. In the case of Thailand, for example, regional economic co-operation within the Association of South-East Asian Nations framework may be an important determinant of the size of the market in a wide range of industrial branches. "Collective bargaining" with the TNCs under the auspices of ASEAN may be an effective means of enhancing the development impact of foreign investment. Small developing countries—and many less developed countries—can make effective use of regional economic programmes in this respect.

3. The preceding analysis failed to show any systematic association between interfirm variations in profitability and growth size or the financial variables that were examined. This is not an entirely unexpected result. Since the mid-1970s a number of authors have opined that TNCs have considerable ability to transfer profits between home and host countries. If this is true, then declared profits may not be an accurate index of actual profitability, and hence the relationship between balance sheet estimates of rates of return and other variables may be obscured. Given the nature of the data available, the present study has not attempted to estimate the profit transfer. But a lack of association between profitability estimates and estimates of financing and investment behaviour may be explained in part by the existence of some elements of transfer pricing. Moreover, the fact that this lack of relationship is found for both the TNCs and the subsidiaries suggests that transfer pricing was not confined to transactions from host to home countries. Some transfer may also take place in the opposite direction, particularly if the home country is experiencing economic difficulties and the subsidiaries of the TNC are located in healthy and rapidly growing economies.

However, as the analysis demonstrates, there are many effective measures that the Governments of developing countries can take—both individually and collectively—to restrict the extent of transfer pricing by transnationals in specific industries.

Appendix

A DESCRIPTION OF THE SAMPLE

This appendix discusses the representativeness of the United Kingdom sample,[a] describes the method of calculation of the indicators of firms' behaviour and performance and presents zero order correlation matrices for the three groups of firms included in the study.

A. REPRESENTATIVENESS OF THE GROUP OF UNITED KINGDOM TNCs

In April 1980, UNIDO sent out requests to the British manufacturing firms listed in *Fortune*'s analysis of the 500 largest industrial corporations outside the United States[b] that were judged not to be affiliates of other TNCs.[c] The total number of requests was 56. Firms were asked to supply:

(a) Annual consolidated accounts and financial statements for the period 1975-1979;

(b) Annual accounts and financial statements of their subsidiaries operating in developing countries over this period.

Thirty companies (53.6 per cent of the sample) complied with the first part of the request. A small number sent only one annual statement and could therefore not be included in the study. A surprisingly large number—21 (i.e. 37.5 per cent of the sample)—did not reply. This reaction is partly explained by one firm's response. It wrote that "the task of complying with requests for information which we are obliged, by statute or otherwise, to supply has now become extremely onerous and time consuming. As a result we have felt it necessary to adopt the policy of not replying to other requests for information." There is nothing in the data available to suggest that the firm that sent this reply was atypical of its group in any respect.

The extent of overseas involvement of these firms could not be ascertained with accuracy, since only consolidated balance sheets were available for the period under study. A small number of respondents did send annual reports and financial statements of some majority-held subsidiaries in the developing countries. The total number of such accounts was 16. Only 8, however, covered the whole 5-year period. The respondent subsidiaries were located in Bangladesh (1), India (6), Jamaica (1), Kenya (2), Malaysia (2), Nigeria (2) and Pakistan (2).[d] It was clear from the information supplied by the Centre on Transnational Corporations that this represented a tiny fraction of the total number of subsidiaries of the companies in developing countries. Four parent companies sent subsidiary balance sheets. Table A.1 lists the number of subsidiaries for which accounts were sent and the total number of subsidiaries and associated companies

[a] This discussion does not cover the representativeness of the Indian and Thai firms, because those data were procured from secondary sources, and estimates of representativeness have been presented in the text.

[b] *Fortune*, 13 August 1979, pp. 193-207.

[c] This judgement was formed on the basis of information supplied by the Centre on Transnational Corporations.

[d] Three companies also sent financial statements of subsidiaries located in developed countries.

TABLE A.1. NUMBER OF SUBSIDIARIES FOR WHICH ACCOUNTS WERE AVAILABLE AND TOTAL NUMBER OF SUBSIDIARIES AND ASSOCIATED COMPANIES IN DEVELOPING COUNTRIES

Company	*Number of subsidiaries for which accounts sent*	*Total number of subsidiaries and associated companies*
A	3	21
B	8	41
C	4	65
D	1	68
	16	195 (8.20)[a]

[a]Number of subsidiaries for which accounts were sent to total number of subsidiaries (percentage).

of the TNC concerned in the developing countries. One company, which wrote that it "did not have any subsidiaries in the developing countries", according to the estimates of the Centre on Transnational Corporations, had four—three in India and one in Zimbabwe.[e] The small number of accounts made available is again explained in part by one of the responding companies. In its reply, it wrote: "This group of companies trades divisionally on a world-wide basis and accordingly certain of the information that you have requested is not generally available to outside third parties." Consolidated accounts can accommodate a number of inconsistencies that may become evident if the whole set of balance sheets are made available to "outside third parties".[f] In view of the small number of subsidiary accounts available, and of the diversity of their national and industrial origin,[g] it was decided to omit these accounts from the subsequent analysis.

However, despite the absence of subsidiary accounts, the foreign investment in developing countries by the group of companies included in this study was not insubstantial. Over the period 1975-1978,[h] investment by British firms in the manufacturing sector of developing countries constituted about 22 per cent of total overseas manufacturing investment.[i] In the early 1970s, 19 per cent of the stock of British foreign manufacturing investment was in developing countries (as compared to 28 per cent for the Federal Republic of Germany and 17 per cent for the United States).[j] Moreover, over the period 1975-1978, foreign manufacturing investment by British firms grew at a rate of 38.9 per cent. Morgan has estimated that for the years 1975 and 1976 British foreign manufacturing investment constituted 4 per cent of gross domestic fixed capital formation and 24.18 per cent of domestic manufacturing investment. In terms of the first ratio, the United Kingdom is clearly ahead of both the Federal Republic of Germany and Japan.[k] For a group of large British companies, the same study reports

[e]This may be accounted for by differences in the company's and the Centre on Transnational Corporations' definition of a subsidiary.

[f]A number of responding firms wrote that they did not have subsidiary balance sheets available at headquarters.

[g]Twelve of the subsidiaries were in the beverages industry, three in chemicals and one, which could not be classified, was itself a holding company.

[h]The latest year for which data were available.

[i]*Business Monitor MA4* (London, HM Stationery Office, 1978), p. 12.

[j]A. Morgan, "Foreign manufacturing by U.K. firms", in F. Blackaby, *De-industrialization* (London, National Institute of Economic and Social Research, 1978), p. 79.

[k]*Ibid.*, p. 85.

that overseas production constituted 34.7 per cent of group sales[l] and 215 per cent of their exports from the home country.[m]

The "multinationalization" of British big business proceeded rapidly during the period 1950-1970.[n] Over this period the number of firms with more than six foreign subsidiaries increased from 20 per cent of the total number of British firms to over 50 per cent. "By lower indices of multinationalization effectively all the top 100 British manufacturing companies by the early 1970s were multinational in operation."[o]

The Centre on Transnational Corporations made available information on the number and location of the subsidiaries and affiliates of 19 companies in the sample. Table A.2 indicates that the sample mean for total number of subsidiaries was 125.6. The sample mean for subsidiaries in developing countries was 24.8. As expected, the number of subsidiaries in developing countries is positively associated with the total number of subsidiaries.

On the basis of the information in table A.2, it is clearly evident that the British companies included in the sample had substantial overseas involvement.

TABLE A.2. DISTRIBUTION OF SUBSIDIARIES AND AFFILIATES OF COMPANIES IN THE UNITED KINGDOM GROUP OF FIRMS

Total number of subsidiaries	*Number of firms*	*Number of subsidiaries in developing countries*	*Number of firms*
<20	0	0	2
20-49	5	1-5	4
50-99	4	6-20	5
100-199	4	21-50	5
>200	6	>50	3

B. INDICATORS USED FOR THE POLICIES AND PERFORMANCE OF ALL FIRMS IN THE SAMPLE

The following indicators were calculated:

1. Opening size = current assets + fixed assets at the beginning of the period
2. Closing size = current assets + fixed assets at the end of the period
3. Average size = ε (current assets + fixed assets)/(number of years)
4. Growth rate = (closing size — opening size)/(opening size)
5. Rate of return on equity assets = ε (profits before tax)/ε (capital employed — preference shares)
6. Rates of return[p] on net assets = (profits before tax)/(current assets + fixed assets)

[l] *Ibid.*, p. 86.

[m] This figure is taken from S. Holland, comment on paper by Morgan, *op. cit.*, p. 95.

[n] For a detailed discussion, see D. Channon, *The Strategy and Structure of British Enterprise* (London, Macmillan, 1973).

[o] Holland, comment on paper by Morgan, *op. cit.*, p. 96.

[p] Post tax rates of return measures have also been calculated but are not reproduced in the correlation matrices.

7. Net profits to sales ratio = (net profit before tax)/sales
8. Dividend ratio = (total dividend payments)/(total capital employed — preference shares)
9. Retention ratio = (gross profits — tax provisions — dividend payments)/(gross profits)
10. Internal finance ratio = (tax provision + depreciation provision + retention funds)/(tax provision + depreciation provisions + retention funds + external funds)
11. Liquidity ratio = (liquid funds)/(current assets + fixed assets)
12. Debt equity ratio = debt/(shareholders equity)
13. The new issue ratio = (.1 new issues)/(.1 capital employed)
14. Factor-intensity ratio = (fixed assets)/sales

The basic zero order correlation matrices for these indicators are given in tables A.3 to A.5. Owing to data limitations, all indicators could not be estimated for each country group. The correlation matrices present evidence on the relationship between the various indicators. It must be emphasized, however, that the zero order correlation coefficient γ is a measure of association between any two variables based only on *linear* dependence. A low value for γ may not necessarily be taken to be conclusive evidence of the lack of relationship between any two variables. It may imply that the relationship between these variables is non-linear. Similarly, a high value for γ between two variables may arise owing to their association with a third variable. What is more important, the correlation matrices say nothing about the direction of causation. In the Indian matrix, for example, the value of γ between net profit to sales and the factor-intensity ratio is quite high. Does this imply that capital-intensive firms are relatively profitable or that firms with high profits employ capital-intensive techniques of production? This question can only be answered by referring to economic theory. The correlation matrices do, however, provide a wealth of information about the economic behaviour of the firms in the sample.

TABLE A.3. ZERO ORDER CORRELATION MATRIX FOR INDIAN FIRMS

Item	*Opening size*	*Closing size*	*Average size*	*Growth*	*Rate of return on net assets*	*Net profit to sales*	*Rate of return on equity assets*	*Liquidity ratio*	*Debt/equity ratio*	*Factor-intensity ratio*
Opening size	1.00	0.97	0.99	—0.32	—0.25	—0.31	—0.29	—0.07	0.41	0.36
Closing size		1.00	0.99	—0.20	—0.22	—0.30	—0.25	0.00	0.36	0.24
Average size			1.00	—0.26	—0.24	—0.31	—0.27	—0.03	0.40	0.30
Growth				1.00	0.30	0.06	0.22	0.19	—0.21	—0.34
Rate of return on net assets					1.00	0.64	0.73	—0.15	—0.23	—0.28
Net profit to sales						1.00	0.52	—0.01	—0.29	—0.23
Rate of return on equity assets							1.00	0.03	—0.78	—0.29
Liquidity ratio								1.00	—0.33	—0.47
Debt/equity ratio									1.00	0.30
Factor-intensity ratio										1.00

Source: Data collected by the UNIDO secretariat from primary sources.

TABLE A.4. ZERO ORDER CORRELATION MATRIX FOR THAI FIRMS

Item	*Opening size*	*Closing size*	*Average size*	*Growth*	*Rate of return on net assets*	*Rate of return on equity assets*	*Net profit to sales*	*Dividend ratio*	*Retention ratio*	*Liquidity ratio*	*Debt/equity ratio*	*Factor-intensity ratio*
Opening size	1.00	0.69	0.82	—0.30	—0.15	—0.16	—0.19	0.05	0.07	—0.47	0.06	—0.12
Closing size		1.00	0.97	—0.10	—0.28	—0.21	—0.22	—0.12	0.09	—0.57	0.13	—0.05
Average size			1.00	—0.18	—0.24	—0.20	—0.20	—0.02	0.08	—0.51	0.10	—0.08
Growth				1.00	0.000	0.18	0.12	—0.14	0.08	0.09	0.09	0.28
Rate of return on net assets					1.00	0.73	0.61	0.67	0.27	0.49	—0.35	0.07
Rate of return on equity assets						1.00	0.71	0.30	0.35	0.24	—0.23	0.55
Net profit to sales							1.00	0.34	0.21	0.08	—0.18	0.60
Dividend ratio								1.00	0.02	0.27	—0.31	—0.10
Retention ratio									1.00	—0.07	0.20	0.18
Liquidity ratio										1.00	—0.24	—0.18
Debt/equity ratio											1.00	0.02
Factor-intensity ratio												1.00

Source: Data collected by the UNIDO secretariat from primary sources.

TABLE A.5. ZERO ORDER CORRELATION MATRIX FOR UNITED KINGDOM FIRMS

Item	*Opening size*	*Closing size*	*Average size*	*Growth*	*Rate of return on net assets*	*Rate of return on equity assets*	*Dividend ratio*	*Retention ratio*	*Internal finance of growth*	*New issue ratio*	*Factor-intensity ratio*
Opening size	1.00	0.97	0.99	—0.20	—0.09	—0.04	—0.09	0.11	0.02	0.18	0.26
Closing size		1.00	0.99	—0.10	—0.07	—0.03	0.08	0.07	0.00	0.17	0.23
Average size			1.00	—0.17	—0.08	—0.03	0.08	0.09	0.01	0.17	0.24
Growth				1.00	—0.13	—0.18	—0.21	—0.26	—0.21	—0.01	—0.22
Rate of return on net assets					1.00	0.89	0.59	0.41	0.17	0.37	0.45
Rate of return on equity assets						1.00	0.74	0.31	0.21	0.36	0.46
Dividend ratio							1.00	0.09	0.00	0.07	0.34
Retention ratio								1.00	0.28	0.32	0.13
Internal finance of growth									1.00	0.57	—0.24
New issue ratio										1.00	0.19
Factor-intensity ratio											1.00

Source: Data collected by the UNIDO secretariat from primary sources.

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