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COMPETING IN A GLOBAL ECONOMY

Helmut Forstner
& Robert Ballance

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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AN EMPIRICAL STUDY ON SPECIALIZATION AND TRADE IN MANUFACTURES

Prepared for the United
Nations Industrial Development
Organization by

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London
UNWIN HYMAN
Boston Sydney Wellington

Published by the Academic Division of
Unwin Hyman Ltd
15/17 Broadwick Street, London W1V 1FP, UK

Unwin Hyman Inc.,
8 Winchester Place, Winchester, Mass. 01890, USA

Allen & Unwin (Australia) Ltd,
8 Napier Street, North Sydney, NSW 2060, Australia

Allen & Unwin (New Zealand) Ltd in association with the
Port Nicholson Press Ltd,
Compusales Building, 75 Ghuznee Street, Wellington 1, New Zealand

First published in 1990

British Library Catalcguing in Publication Data

Forstner, Helmut
Competing in a global economy : an empirical
study on specialization and
trade in manufactures.
1. Foreign trade
I. Title II. Ballance, Robert
382

ISBN 0-04-445619-0

Library of Congress Cataloging in Publication Data

APPLIED FOR

Typeset in 10/12 Bembo
Printed by Cambridge University Press

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List of abbreviations

CA	current account
CPE	centrally planned economy
DME	developed market economy
FDI	foreign direct investment
GDP	gross domestic product
GNP	gross national product
H–O	Heckscher–Ohlin
H–O–V	Heckscher–Ohlin–Vanek
IIT	intra-industry trade
IITL	intra-industry trade level
IITS	intra-industry trade share
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification
MES	minimum efficient scale
MVA	manufacturing value added
NIE	newly industrializing economy
OLI	ownership location internalization
OLS	ordinary-least-squares
R and D	research and development
RCA	revealed comparative advantage
SITC	Standard International Trade Classification
TNC	transnational corporation
UDB	UNIDO data base
USSIC	US Standard Industrial Classification
UNIDO	United Nations Industrial Development Organization

Preface

Interest in the determinants of specialization and trade has a long tradition among economists. The past two decades, however, have brought substantial changes in the world trading system. Theoreticians and empiricists alike have been forced to modify their methods of analysis in an effort to stay abreast of all these changes. Theoreticians, for example, have constructed more elaborate models which better represent a trading system composed of multiple buyers and sellers who may or may not operate according to competitive dicta. Empiricists have resorted to more powerful econometric tools and have made use of data sets that are far larger than those available to their predecessors. An unintended result of all these advances is that the gap between theoreticians and empiricists has widened. This book is mainly empirical in approach. However, the compilation and analysis of quantitative material is closely linked to particular elements of economic theory. A major objective is to help bridge what we believe is a widening gap between the work of the theoretician and that of the empiricist.

This particular orientation lends itself to either of two methods of presentation. One would be to begin with a complete elaboration of the theoretical framework and then move on to empirical applications or tests. We have chosen not to do this in the present case. One reason has to do with the underlying theory. Several of the relevant models are set out in a formal manner and their distinguishing features can be easily presented. Others, however, are informal and do not lend themselves to a stylized presentation. This contrast makes it difficult to summarize concisely all the theoretical features that are relevant to an empirical study. A second reason is that even the most familiar trade models become complex once they are applied in a world of higher dimensions – one populated by a large number of buyers and sellers who trade a variety of products which, in turn, are produced with several factors of production. The complexity of the underlying theory makes it difficult for the reader to assess empirical evidence when this is separated from the conceptual framework.

The Heckscher–Ohlin approach provides much of the framework for analysis in this book. Its use leads naturally to an assessment of factor abundance as a determinant of specialization and trade. But the Heckscher–Ohlin model is not intended to suggest that factor abundance is the only relevant determinant. Once attention turns from inter-industry to intra-industry forms of specialization and trade, other less formal models may be relevant. One example is the 'economies-of-scale' model, which represents a world characterized by increasing returns to scale and imperfect competition.

Both types of models are used in the following account and their juxtaposition represents another distinguishing feature of the book. The two approaches differ in many ways. However, they can also be seen as offering complementary explanations for specialization and trade. The Heckscher–Ohlin model is interpreted as applying mainly to inter-industry patterns of change, while the economies-of-scale approach finds application in the analysis of intra-industry developments.

The book is intended to provide an empirical supplement to a more traditional analysis of specialization and trade. It is mainly, though not exclusively, concerned with subjects of interest to theoreticians, industrial economists and trade analysts. Finally, the book is designed as a global study rather than a treatise rooted in a single economy. This orientation is compatible with that of UNIDO, which is the international organization with responsibility for industry.

The contribution of various individuals is gratefully acknowledged. Charles Sawyer (University of Southern Mississippi) provided advice and comments on the entire manuscript and was the author of the annexes to the book. Tetsuo Yamada (UNIDO) was a major contributor to Chapter 8; in particular, he carried out most of the empirical analysis of that chapter. Extensive comments were also supplied by Tracy Murray (US International Trade Commission and University of Arkansas) and Mathew Tharakan (University of Antwerp). Finally, the book makes extensive use of the UNIDO Data Base, and the contributions of the statisticians and other staff of the Industrial Statistics and Sectoral Surveys Branch is gratefully acknowledged.

This publication has been prepared for the United Nations Industrial Development Organization by Helmut Forstner and Robert Ballance, who are responsible for the views and opinions expressed therein. These views and opinions do not necessarily represent those of other persons or institutions mentioned here.

CHAPTER 1

The transformation of world industry: an introduction and summary

The last thirty years have brought many fundamental changes in world industry. Two of the more important of these – the internationalization of markets, and the growing opportunities for firms to specialize – establish the themes around which this book is built. This chapter begins with a brief discussion of these two developments and some of their implications. The concluding section describes approaches and objectives of the book and summarizes the major findings.

The internationalization of industry

For nearly two centuries, manufacturers operated in a spatial context that was predominantly local. The search for inputs, materials and buyers seldom extended beyond regional markets, and it was rarer still that such activities were national in scope. This provincial character no longer applies. Whatever their country of origin, most large firms now tend to operate in an environment that is international, if not global, in scope. Crude evidence to support such a view of industry is found in the rapid growth of international trade, the development of international capital markets, the continued spread of foreign investment, and the accelerated transmission of technologies across national boundaries.

Greater internationalization has brought more opportunities for collaboration, but it has also created new types of rivalries. The traditional agent of competition in any market has always been the firm. Today, however, governments are intimately involved in the process. National policy-makers have always been concerned with their country's position in industrial hierarchies; but the potential rewards and losses of competition have risen as markets have become more integrated.

The degree of interdependence between countries has accentuated national rivalries. The expansion of an industry in one country (whether developed or developing) will often result in the contraction of the same industry elsewhere. Relative changes in any industrial hierarchy are therefore likely to induce policy responses in several countries. Such rivalries are found in both newly emerging industries and mature ones and have repercussions for producers throughout the world.

The integration of markets for manufactures has also changed the microeconomic environment. Foreign buyers of products or suppliers of raw materials and other inputs now constitute a significant part of any large firm's network for the exchange of factors and goods. The international dimension is equally evident in other types of inter-firm relationships. Manufacturers buy and sell process or product technologies from foreign counterparts. They embark on collaborative forms of R and D, share out production facilities and distribution systems, and engage in many other forms of cross-border co-operation.

Increased opportunities for inter-firm collaboration also have a competitive dimension. Foreign firms will unexpectedly challenge complacent suppliers in the latter's home or export markets. They sometimes go to great lengths to acquire vital technologies and secrets of their international competitors. Domestic firms, in turn, are often reluctant to provide the same proprietory knowledge to foreign firms that they share with their domestic collaborators. The steadily expanding network of inter-firm collaboration and competition has spilled across national boundaries. It has changed the ways firms operate, the types of strategies they adopt, and the very nature of business–government relations.

Greater market integration has brought more opportunities for specialization in particular products or product lines. The potential buyers in today's market represent a wider range of incomes, tastes and preferences. This diversity affords more opportunities to compete on the basis of non-price attributes. Buyers also become more demanding and discriminating as their incomes grow and as they become more experienced. These are but a few of the observable changes in demand patterns which have occurred as the incomes of households and firms have grown.

At the microeconomic level, the motives for specialization are known. Most firms choose to specialize because they accept the premise that low prices and high volumes are essential to the achievement of competitive superiority. According to conventional wisdom, firms that enlarge their market share will realize the benefits of economies of scale. Attempts to compete on the basis of other attributes such as timeliness, quality or variety have, in the past, been regarded with some scepticism. The reason for scepticism was the suspicion that in many industries the costs of achieving these goals will grow faster than the benefits they provide.

The alternative routes to specialization are contradictory in the sense that individual firms are forced to choose between them. They may compete on the basis of price (and therefore seek greater economies of scale), or they may choose non-price forms of product differentiation. That decision is a firm-specific one which lies outside the scope of this book. In another sense, however, the two views are not contradictory since both stress the importance of specialization, albeit of different types. The internationalization of markets is increasing the scope for specialization by offering firms in developing and developed countries more choice in the ways they compete.

Orientation and approach

Interest in the determinants of specialization and trade has a long tradition, but the changes that have taken place in the last thirty years have led to new theories and to revisions of existing ones. In an effort to explain the forces behind today's trading system, some trade specialists have gone outside their field by drawing on the work of analysts in the field of industrial organization. This approach is welcome: a compartmental relationship between the two broad lines of research serves no purpose in today's world.

But while some barriers have been torn down, others still exist. One division is between trade theoreticians and empiricists. Theoreticians have struggled to keep abreast of changes in the real world by constructing more realistic models of the trading system. Empiricists have launched increasingly sophisticated studies in order to identify and measure the determinants of trade. All this work has led to numerous refinements, both theoretical and empirical. However, the theoretician's task of modelling a world populated by a multiplicity of buyers and suppliers of commodities and factors of production is daunting. Progress has been achieved at the cost of much greater complexity. Empiricists, on the other hand, now have access to more powerful econometric methods and a growing volume of data. Yet their task is made no easier when they must utilize these tools within the confines of today's multi-dimensional models.

This book is mainly, though not exclusively, concerned with subjects of interest to theoreticians, industrial economists and trade analysts. It is empirical in approach, but is not intended to be merely a documentary account of long-term trends or recent developments. The compilation and analysis of quantitative material is closely linked to particular aspects of economic theory. In this sense, the book attempts to bridge the gap between the work of the theoretician and that of the empiricist.

The selection of themes had several implications. First, the emphasis placed on the internationalization of markets meant that the book should be designed as a global study and not as a treatise rooted in a single economy, however important. Issues relating to patterns of specialization and trade are just as vital for small, open economies as for large ones, and appear to have applicability whether the countries are rich or poor. Second, many of the questions arising in the book cannot be properly examined when the subject of analysis is the manufacturing sector in its entirety. Thus an industry-specific framework is adopted, and much of the subsequent discussion proceeds along that line. The following section considers some of the approaches and methods employed in the study in more detail.

The framework for analysis

The literature on international specialization can be interpreted in different ways. This book follows the practice of trade theorists who use the term to refer to production-related developments. That usage is in contrast to the work of empiricists, who often refer to specialization as a trade-related phenomenon, by which they usually mean changes in the composition of a country's exports and imports or other types of shifts in trading patterns.

Although theoretical discussions of specialization may be confined to shifts in production, supporting evidence can still be drawn from trade. In doing so, economists regard international trade as consisting of two distinct components. One of these components, inter-industry trade, figures prominently in studies of the international division of labour. The other is often referred to as two-way or intra-industry trade (IIT). It can be defined as the simultaneous import and export of products that are close substitutes, in terms of either their factor inputs or their final uses. That definition is operational in the sense that the intra-industry component of trade can be measured and distinguished from the inter-industry component.

Inter-industry trade is dependent on comparative advantage, and the structure of production is determined by a country's factor endowments. IIT, however, depends on economies of scale and perhaps other determinants not recognized by models based on comparative advantage (Krugman, 1983, p. 344). The same applies to the domestic equivalent of IIT in production, which is referred to here as intra-industrial specialization. Each industry will have a wide range of potential products, some of which will be produced under conditions of increasing returns. But the existence of scale economies implies that each country produces only a subset of the potential products available to it. Little can be said about expected patterns of intra-industrial specialization on the basis of such theories.

The distinction between inter-industry and intra-industry patterns of trade is clearly related to the issue of specialization but cannot be carried over easily to studies of the latter. Both types of trade are considered in this book, but no attempt is made to investigate intra-industrial specialization. There are several reasons for this. First, it is virtually impossible to assess the patterns of such specialization in production. The data requirements would be massive, including information on production technologies, product characteristics and inter-firm exchanges. Second, it is not possible to formulate a workable definition of an industry which would be equally applicable to a large number of countries. An unambiguous definition – even for a single country – is rarely possible, since industries consist of shifting groups of competitors which are clustered around specific products or processes. Nor are there objective criteria for such a definition. The assignment of products and/or activities to a particular industry depends instead on the researcher's subjective judgement of the extent of substitutability. Third, the usefulness of attempting any distinction between inter-industrial and intra-industrial specialization is questionable once it is recognized that the choice of products to be produced by each country is essentially arbitrary.

Trade analysts have addressed this problem in a pragmatic manner, often defining each 'industry' as the equivalent of a three-digit category in the Standard International Trade Classification (SITC). The method has not escaped criticism, but it is now a generally accepted part of the literature. This book follows the same practice, and the discussion of inter-industry and intra-industry trade patterns proceeds accordingly. The definitional problems are more serious when the subject of discussion is domestic production. The International Standard Industrial Classification (ISIC) offers the most comprehensive source of international data on production. However, each ISIC category is a heterogeneous mixture of products and activities which does not really approximate even the loosest definition of an industry. The ISIC serves as a basis for defining industries in the early parts of the book but in later stages more detailed industry descriptions are employed.

The conceptual basis for the distinction between international trade and inter-industrial specialization can be made clearer by drawing upon the tools used in the exposition of trade theory. Theoreticians, for example, usually begin their study of trade by assuming a state of autarky (that is, a hypothetical situation where the country engages in no trade whatsoever). They demonstrate the effects of trade by comparing a country's post-trade patterns of production and consumption with those that prevailed in autarky. The transition from autarky to trade is depicted as a two-step process. With no trade, patterns of production and consumption depend solely on domestic forces. Once the possibility of external demand and supply is acknowledged, patterns of consumption will change, giving rise to what is described as 'gains from international exchange'. The second step in the adjustment process involves a shift in patterns of production. After trade occurs, there is an incentive to specialize, which gives rise to 'gains from specialization'. Together, the two effects represent the 'gains from trade' and are part of the theoretician's toolkit to demonstrate the superiority of free trade rather than no trade. This book makes no attempt to measure the welfare effects of trade. Nor is it concerned with the identification of gains from specialization or international exchange. However, the theoretician's use of an imaginary two-step process is retained, since it provides a useful device to distinguish between the production and trade-related effects of specialization.

Mention should also be made of certain statistical and classificational issues. Because the volume of data included in the study is substantial, various summary measures must be used. These types of data aggregation are derived from the underlying theoretical and empirical literature. The arrangement of industry data according to factor intensity, or the categorization of trade in manufactures as resource-based, Heckscher–Ohlin and product-cycle goods, is common practice. The same applies to the distinction between intra-industry trade and inter-industry trade as well as other commonly used statistical and economic conventions.

Of more significance perhaps is the arrangement of country data used here. Information on a large number of countries is included in the book, and space constraints dictated that various country groupings be used. The most familiar of these groupings is the developed market economies (DMEs). These economies are a fairly homogeneous group, being similar in terms of relative factor endowments, structure of manufacturing production, composition of trade and other attributes. The same degree of homogeneity does not apply to the developing countries. A certain amount of country-specific data is presented in the following chapters, but, more often, the developing countries are arranged in different sub-groups: newly industrializing economies (NIEs), second-generation NIEs, and other developing countries. These types of country groupings are familiar to most readers, although economic theory provides no clear criteria to determine group membership (see e.g. Bradford and Branson, 1987; Cline, 1982; Michaely, 1985).

No generally accepted definition of group membership is available. Instead, the selection of first- and second-generation NIEs has merely drawn upon the work of others. In the case of the first-generation NIEs, the group is pictured as consisting of countries that are 'super competitors' in many international markets for manufactures and are likely to embody production and trading attributes that distinguish them from most other developing countries. The same claims do not necessarily apply to second-generation NIEs, though their involvement in world exports would still seem to distinguish them from other developing countries.

Other elements of the book's framework are conceptual in nature and are drawn from the theoretical literature. The choice of theoretical tools is determined partly by the types of broad issues mentioned above. For example, the book's emphasis on empirical issues requires that theoretical tools be operational in the sense that data requirements are realistic and attainable. Propositions that can be closely linked with underlying theory are also favoured over those that can be stated only intuitively. Finally, because the study is international in scope, there is also a preference for theoretical material that is of general applicability rather than valid only for specific cases.

Based on these considerations, the H–O model (also described as the factor proportions, factor endowments or factor abundance approach) provides much of the theoretical framework for analysis. The factor abundance approach operates reasonably well when inter-industry aspects of trade and specialization are the subject of investigation and the scope of study is international or global. But the model is not intended to suggest that factor abundance is the only source of trade or specialization. Once attention turns to intra-industry aspects, it faces a strong challenge. A theoretical counter-culture has emerged which Krugman describes as being represented by 'a set of informal arguments stressing sources of trade other than those in formal models' (1987, p. 132).

The conceptual basis for analysis

The two approaches mentioned above are distinct in several ways, but they are also complementary in the sense that the H–O model is concerned with inter-industry characteristics while the alternative approaches referred to by Krugman are especially useful for an analysis of intra-industry forms of specialization and trade. Both lines of argument are utilized in the following account. Because several characteristic assumptions are the subject of empirical inquiry in later chapters, it is helpful to summarize them here.

The distinguishing assumptions of the H–O model as outlined in Chipman (1988) can be most easily described for the simple case involving only two countries which produce two goods and make use of two factors of production. The factors are assumed to be qualitatively identical between countries. They are completely mobile between industries but are immobile between countries. Goods, however, move freely between countries. The production functions for each good are the same in both countries and are subject to constant returns to scale. A further assumption is that factor requirements (intensities) will never be reversed between the two goods, no matter how factor prices change.

The H–O model goes on to assume perfect competition in markets for both goods and factors. This postulate, together with the insistence on constant returns to scale, enables the analyst to construct the general equilibrium framework for trade which the H–O model represents. In order to highlight the role of factor abundance, the possible impact of demand on trade patterns is excluded by the assumption that consumption patterns are identical between countries at any given set of goods' prices. Finally, it is assumed that trade in goods is balanced.

Differences in factor proportions – with respect to both country endowments and input requirements – are necessary for international trade to arise. Differences in factor endowments relate to factor abundance, while input requirements are represented by factor intensities. On the basis of these assumptions, factor abundance will determine the pattern of international trade. A country will export the good that uses its abundant factor most intensively and will import that which uses its scarce factor intensively.

The approaches that represent the alternative to the H–O model are referred to here as the 'economies-of-scale' models. Perhaps the best version is that presented by Krugman (1979a). He assumes that international trade takes place in the presence of increasing returns, product differentiation and monopolistic competition. In the simplest case, involving only two countries, each economy is capable of producing any of a large number of goods by using one factor of production. Production technology is the same for all (potential) goods in both countries, so that firms can differentiate their products costlessly. The decisive technological feature is that of increasing returns to scale: the cost functions in the two countries reflect decreasing average costs.

With regard to demand, all consumers of a country are assumed to have the same utility function, which treats goods (or rather, versions of one differentiated good) symmetrically. This concept represents the consumers' 'love of variety' – that is, the consumers have no overwhelming preferences for any particular version of the differentiated good. The market structure is assumed to be one of Chamberlinian monopolistic competition. Each producer faces a downward-sloping demand curve for his particular version of the differentiated good and can choose the output level that maximizes his profits. Since a great number of producers is assumed, no interaction between them takes place.

Even if the two countries are identical with regard to technologies and tastes, they will engage in international trade. This trade will take the form of intra-industrial exchange. The pattern of trade (which country exports or imports which version of the differentiated good) is indeterminate but the volume can be related to the size of the two trading partners. In general, the Krugman model depicts new forms of trade as 'a way of extending the market and allowing exploitation of scale economies' (Krugman, 1979a, p. 479).

Further contrasts between the H–O and economies-of-scale model are found in terms of their 'power' or explanatory capability. Krugman (1983) asserts that the factor endowments approach can not provide an adequate account of world trade. That criticism is perhaps fair when a 'strong version' of the H–O hypothesis is employed. But more general, and 'weaker', versions of the H–O proposition are also available. Models incorporating scale economies and product differentiation seem to perform no better than the weaker versions of the H–O model. The lack of more robust predictive abilities is due mainly to the fact that the scale economies model is concerned not so much with patterns of commodity production or trade but with the relative extent of inter-industry and intra-industry trade. The H–O approach is treated in a fairly rigorous manner, and weaker versions of the model are used extensively in the following account. Scale economies, product differentiation and other aspects of imperfect competition will necessarily receive less formal treatment.

Organization and summary of findings

The following chapters fall into three parts. Chapters 2, 3 and 4 are mainly documentary in nature. They represent an empirical survey of manufacturing production, inter-industry trade and intra-industry trade. Although the chapters are broad in scope, an industry-specific orientation is retained and various theoretical concepts find application.

Chapters 5, 6 and 7 constitute the second part of the study and make extensive use of the H–O model. Chapter 5 is concerned with country differences in factor endowments, while Chapter 6 focuses on the role of factor intensities. The results obtained in these two chapters are drawn together in Chapter 7 where a synopsis of the H–O model is presented. Most of this discussion is concerned with differences in the economic attributes of countries, but Chapter 7 also addresses the possibility that country similarities can influence specialization and trade.

This alternative line of reasoning is expanded in Chapters 8 and 9 as the discussion moves from an H–O framework to the 'economies-of-scale' model. Empirical evidence concerning economies of scale, market structure and product differentiation is examined for specific industries and groups of countries. Various attributes of intra-industry trade involving different sets of countries are studied, and some of its potential determinants are considered. Chapter 10 concludes the study by summarizing the major results and considering their implications for the future work of theorists and empiricists. Some of the main findings of later chapters are summarized below.

Inter-industrial trends in manufacturing production

The analysis begins with a survey of inter-industrial patterns in world industry in the DMEs and in several groups of developing countries. The main purpose is to provide an empirical backdrop for the more detailed analysis of specialization in production and trade in later chapters.

The DMEs' share of world manufacturing value added (MVA) is declining, though they continue to dominate almost all markets for manufactures. This decline, however, is not reflected by any change in the inter-industrial composition of output. Specific industries in specific countries have contracted substantially, but the inter-industrial structure of total manufacturing output in DMEs has proven to be relatively stable. The contradiction between these two trends is attributed to three factors. One is the decline in manufacturing relative to services, which seems to have affected several DMEs. A second is that a major source of contractive pressure is often competitors in other DMEs and the resultant shifts are not reflected in group averages. The third reason is that major firms in some industries have suffered not from inter-industry shifts in demand or supply, but from changes that are intra-industry in character.

Close agreement in national endowments and demand patterns should mean that the inter-industry structure of countries is similar. This prognosis, however, finds little support. The DMEs are the only group of countries that can claim more than a modest degree of similarity in inter-industry structure. Nor does the inter-temporal pattern of change show any evidence of a tendency for inter-industrial structures to converge, although differences in relative factor endowments and tastes have certainly narrowed.

The lack of any evidence of increasing similarity may imply that the inter-industry patterns are moving in the opposite direction, towards greater specialization in particular industries. Although the DMEs have the greatest degree of similarity, they also tend to specialize in much the same industries. Only the NIEs come close to matching the DMEs in terms of inter-industrial specialization. No similar evidence of specialization was found for second-generation NIEs.

These impressions are based on comparisons between individual countries or averages for country groups. However, the dynamics of inter-industry change can also be examined in relation to an international reference or norm. Here also, there is little agreement between patterns of change in DMEs and developing countries. Industries that tend to be expanding in DMEs (according to an internationalized measure) are often contracting in developing countries, and the reverse is also true. Nor do the internationalized patterns of change agree with measures expressed in purely 'domestic' terms. An industry that is faring poorly in relation to other parts of domestic manufacturing may still be performing better than competitors in other countries.

The pace of inter-industrial change is also considered. Indices of structural change show that inter-industry shifts are proceeding more rapidly among the NIEs and second-generation NIEs than in DMEs or in non-NIEs. This distinction must be discounted to some extent, however, since patterns of change in the two former country groups are comparatively erratic: periods of rapid growth in the NIEs and second-generation NIEs are often preceded or followed by equally abrupt periods of contraction.

Conventional analysis distinguishes between industries according to their factor intensities, growth elasticities or other characteristics. When industries are classified by such criteria, the results for various country groups are substantially different. Manufacturers in the DMEs have moved rather quickly out of industries that are relatively labour-intensive, but there has not been a concomitant rise in industries that are especially large users of capital. The developing countries have been comparatively slow to withdraw from labour-intensive operations, but the growth of capital-intensive industries has been rapid – proportionately much greater than the corresponding shift in DMEs. The move into capital-intensive industries has been fastest among the non-NIEs and was attributable mainly to trends in several of the larger countries (India, Pakistan and Turkey). Such a result is surprising, since the relative prices of investment goods are thought to be highest in developing countries other than the NIEs. Direct government action rather than differences in relative factor prices would seem to be the most likely explanation for this particular result.

Inter-industry trade in a global system

Chapter 3 begins with a survey of long-term trends in the world trade. The dynamic nature of trade in manufactures is impressive in comparison with growth in other parts of the world economy. Another prominent feature is the dominance of the DMEs: these countries have accounted for at least four-fifths of world exports of manufactures in every year between 1970 and 1982. The developing countries' share of world trade in manufactures remains small (13 per cent in 1985), although it has more than doubled since 1970.

The fact that the bulk of the DMEs' manufactured trade is with other members of the same group is somewhat of a theoretical curiosity. The factor proportions model predicts that countries with significant differences in factor endowments will have the greatest incentive to trade. The tendency towards factor convergence among the DMEs should have reduced the potential for trade between these countries, though, in fact, intra-DME trade has continued to grow rapidly.

A first attempt to link patterns of inter-industry trade with their underlying determinants makes use of three trade models. Statistics for 22 DMEs and more than 150 developing countries were compiled for all years during the period 1970–85 and were then arranged in product categories that approximate the Ricardian, H–O and product-cycle models. Net exports of Ricardian goods (i.e. resource-based products) have had little impact on world trade balances. The DMEs have usually had a slight deficit in their trade in Ricardian goods, while the developing countries have maintained a small, but favourable, trade balance.

Results for the two other trade categories are of more interest. The DMEs have long enjoyed a favourable – and relatively stable – balance of trade in H–O goods. That situation was reversed in the 1980s, and after 1984 the group became a net importer of H–O goods. The reversal did not apply to all DMEs, however. Among the six largest DMEs, the USA and the UK were the only ones to experience a significant deterioration in their trading position for H–O goods. By 1985, the US net imports of H–O goods exceeded the corresponding net exports of France, the Federal Republic of Germany, Italy and Japan combined.

The developing countries' trade in H–O goods is much different. They were traditionally net importers of such goods, and the size of their trade imbalance grew steadily during the 1970s. That relationship, too, had changed by 1985, when the developing countries became net exporters of H–O goods. The turnaround was due largely to trade successes of the NIEs. These countries had only modest net exports of H–O goods in 1975 ($0.5 billion), but ten years later their net exports exceeded $31 billion.

The pattern of world trade in product-cycle goods is the most volatile of the three categories. The DMEs excel in the production and export of these goods. Net exports of product-cycle goods from DMEs rose almost sixfold between 1970 and 1980. The value of the DMEs' net exports has fallen in the 1980s, but this was largely due to circumstances in the USA (which is now a net importer) and to a decline in the net exports of the UK.

As expected, the developing countries' net trade in product-cycle goods has been negative throughout the 1970s and 1980s. There was a steady increase in net imports of these countries in the 1970s, but, again, the beginning of the 1980s marked a watershed. The developing countries continue to be net importers of product-cycle goods, but the deficit is now lower than the level recorded in 1980. The pattern of trade in product-cycle goods differs among various groups of developing countries. The NIEs have the lowest level of net imports, and these have declined since 1980. In big countries such as India, Pakistan and Yugoslavia, net imports of product-cycle goods have increased modestly, while in many of the smaller and generally poorer developing countries, net imports of these goods have steadily grown.

Two-way trade in similar products

Chapter 4 completes the 'survey' portion of the book with an analysis of two-way trade. Such trade occurs in several forms. The chapter begins with a description of each of these and then goes on to discuss methods of measurement.

An examination of bilateral trade for developed countries and a sample of developing countries shows that IIT is most important among the DMEs, where it accounts for more than two-fifths of all trade in manufactures. This figure is substantially higher than the average for developing countries or any subset of these countries. The analysis of the pattern of IIT suggests that a positive relationship exists between a country's level of development and the share of IIT. Furthermore, similarity between trading partners fosters IIT. Support for these hypotheses is found in calculations of IIT shares in world trade, in the trade between different country groups, and in the figures for individual countries. In addition, an examination of trade growth shows that, almost without exception, IIT is growing more rapidly than its inter-industrial counterpart.

The second half of the chapter adopts an industry-specific view of IIT. Further support for the 'similarity hypothesis' mentioned above is obtained when the two-way trade of each industry is considered separately for the DMEs and developing countries. Although the extent of product differentiation is probably greatest in consumer goods industries, producers of capital goods are the most heavily involved in IIT. The prominence of capital goods producers results from their large share in the two-way trade of DMEs. Consumer goods figure most prominently in the IIT of developing countries.

Difficulties in the measurement of two-way trade arise from the fact that certain types of IIT are not statistically distinguishable. This has led to a tendency for analysts to focus on rates of change rather than levels of IIT. Of the 90 industries considered in this study, more than two-thirds experienced increases in the share of IIT in total trade between 1970 and 1985. More generally, two-way trade has become an important phenomenon and is not restricted to any particular group of countries or industries.

International patterns of factor endowments

Chapter 5 embarks on an analysis of inter-industry patterns by considering the role of factor endowments. The factors considered in this exercise are physical capital, skilled labour, semi-skilled labour, and unskilled labour. Prior to presenting the results, several conceptual and definitional issues are discussed.

The first step in the empirical analysis is to obtain a picture of the international distribution of factor endowments and to determine how the pattern has changed over time. The results for DMEs present no surprises. These countries are comparatively well endowed with physical capital. Their shares of skilled and semi-skilled labour are smaller but still high by international standards. The endowment pattern of developing countries is characterized by a relative scarcity of both skilled labour and physical capital.

More interesting is the distinction between various sets of developing countries. The NIEs have a fairly balanced resource structure with semi-skilled and skilled labour being most important. The pattern is similar among second-generation NIEs. These countries, however, are relatively better endowed with unskilled and semi-skilled labour than are the NIEs. The remaining developing countries account for an overwhelming portion of unskilled labour while physical capital is relatively scarce.

Long-term shifts in the distribution of factor supplies reveal a significant trend which concerns the redistribution of factors between the two major country groups. Changes have not been great, but have clearly favoured the developing countries. The largest shifts were in the shares of physical capital, mainly owing to the rapid accumulation of this factor in several NIEs and second-generation NIEs. Changes in the endowment pattern for semi-skilled labour were also significant. In 1970 all the developing countries accounted for 46 per cent of the total supply in the country sample, but by 1985 they claimed 53 per cent.

In the closing section of Chapter 5, the discussion turns to the role of factor abundance (rather than factor endowments). Using dichotomous indicators of abundance/scarcity, trading patterns in broad product classes are examined. Three classes of traded products are identified: they include labour-intensive H–O goods, capital-intensive H–O goods, and product-cycle goods. Relationships in accordance with the factor abundance hypothesis are observed between skilled labour and net exports of product-cycle goods, as well as between semi-skilled or unskilled labour and net exports of labour-intensive H–O goods. Most of the countries that are net exporters of product-cycle goods are relatively well endowed with skilled labour, while most of the net exporters of labour-intensive H–O goods are characterized by an abundance of semi-skilled or unskilled labour.

Although the results linking endowments of physical capital with net exports offer less support for the factor abundance hypothesis, the 'weak' version of the hypothesis is not refuted. The reason is that this version depends not on a robust relationship between factor endowments and net trade but merely on a tendency, or an on-average association, between the two variables. A possible explanation for the results on physical capital is the H–O assumption that factors are not internationally mobile. Clearly, such an assumption does not apply to physical capital. It is more applicable to semi-skilled and unskilled labour, and the results for those two factors support the factor abundance hypothesis.

Factor requirements, output and trade

Chapter 6 provides a detailed account of factor intensities in specific industries. After discussing issues of measurement, the relationship between factor intensities and patterns of output and exports in specific industries are examined.

Ordinal comparisons of factor intensity are made for a large number of countries during the period 1970–85. Variations over time were not great: the industries that tended to be relatively heavy users of a particular factor during the 1970s remained so in the 1980s. Industry rankings by physical- and human-capital intensity were also similar, suggesting a close relationship between the two inputs. The cross-industry pattern confirms most casual impressions regarding factor requirements. Industries typically regarded as being heavy users of physical capital, human capital or labour generally matched expectations.

Contrasts are more apparent when variations in factor intensities across countries are examined on an industry-by-industry basis. Large differences in labour intensity are found – even among the most labour-intensive industries. Cross-country variations in physical- and human-capital intensity were similar in magnitude and considerably lower than those for labour. Statistical tests reveal a high level of agreement in the international rankings of industries, but in no instance is this agreement perfect.

The relationship between factor intensity on the one hand and specialization and trade on the other is tested with the help of an empirical hypothesis. This hypothesis is based on the premise that competitive advantage will be concentrated in a set or 'bloc' of industries which are intensive users of a country's abundant factor. Tests of the 'bloc hypothesis' are conducted for both output and trade. Predictions of the H–O model are confirmed for DMEs. The competitive strengths of these countries are determined by ample supplies of human and physical capital, while they are at a substantial disadvantage in the production of labour-intensive goods. The results for developing countries are somewhat different: the expectation that competitive advantages in production would be concentrated in labour-intensive manufactures is not borne out by the data. However, when tests of the bloc hypothesis are repeated with export data, some support for H–O propositions is obtained for the developing countries too. Thus, there is evidence for the NIEs' competitive advantage in activities using intensively labour or physical capital. Furthermore, shares in world exports of labour-intensive products were particularly high for one-half of the second-generation NIEs and some other developing countries in the 1980s.

The role of country differences and similarities

Chapter 7 begins with an examination of factor endowments as a determinant of net trade. The discussion is industry-specific, being based on data for 90 industries in each of 46 countries. Subsequent sections consider the interaction between factor endowments and factor intensities and how these variables influence patterns of trade and specialization.

The analysis makes use of the concept of 'factor orientation'. The term is employed in an industry-specific context and refers to those instances where the availability of a particular factor has a discernible impact on net trade. The 'direction' of the orientation may be either positive or negative depending on the availability of the particular factor and the industry's factor intensity. In other words, relative abundance of a factor may enhance an industry's competitive advantage, or, alternatively, its scarcity may result in a competitive disadvantage.

The overall impression obtained from these tests is that factor endowments do not exert an overwhelming impact on net trade. Less than half of the 90 industries considered are found to have any 'visible factor orientation'. That picture is altered somewhat when the volume of each industry's trade is taken into account. Industries with a visible factor orientation are found to account for over half of all manufactured trade in the country sample, and their share has been increasing over time.

Confirmation that factor abundance is an important determinant of trade patterns does not, by itself, provide much useful information to the analyst or policy-maker. It is more important to know which factors have the greatest influence on trade and whether their significance is changing over time. This issue is considered first in terms of the manufacturing sector as a whole. The same question is later addressed in an industry-specific context.

The sector-wide investigation of this issue demonstrates that in the 1970s physical capital had the greatest influence on sectoral comparative advantage in manufactures. The situation changed during the 1980s, however. Skilled labour replaced physical capital as the most important of the factors considered here. The two remaining factors – semi-skilled and unskilled labour – were of much less importance as determinants of comparative advantage in manufactured goods.

A related point concerns the way in which the two major factors affect trade in manufactures. Physical capital is generally found to make a positive contribution to trade performance. In countries with an abundance of physical capital, those industries with a matching orientation tended to excel. The same description does not apply to skilled labour: this factor usually had a negative impact on net exports.

The discussion goes on to analyse circumstances in specific industries. These results are too detailed to summarize here, though several generalizations can be made. First, the way in which each factor influences the trade of different industries varies over time. Second, the results show that only a portion of net trade is subject to factor-abundance effects. That is not surprising, since the factor abundance model considers only a single set of determinants (factor endowments).

Although factor endowments do not always yield a convincing or complete explanation of trading patterns, the results are sufficiently encouraging to attempt a more general application of the H–O model. A multi-dimensional version of the H–O model is used to assess the interaction between factor abundance, factor intensities and trade simultaneously. Results of the exercise support a weak (or on-average) interpretation of the H–O model. Even in a complex trading world of many factors, goods and countries, there is a tendency for net trade to be influenced by the interaction between factor endowments and factor intensities.

The results for semi-skilled labour match most closely with the predictions of the H–O model. Physical capital and skilled labour seem to be more important determinants of sector-wide trading patterns, although neither set of results fits comfortably with industry results. There may be several explanations for these ambiguities. Semi-skilled labour represents a category of workers whose skills are closely related to the production process. That factor is a vital input for many industries, and a large reservoir of semi-skilled labour would provide a solid basis for specialization and trade. Physical capital and highly skilled labour may be even more crucial to the operation of many industries, but it may also be very difficult for many countries (particularly developing countries) to develop adequate supplies of these factors. Here, it is relevant to note that neither of these two resources fulfils the H–O model's assumption of factor immobility.

In the concluding section of the chapter, interest turns from the issue of national differences in factor endowments to similarities. Studies based on models other than the H–O genre have concluded that country similarities actually contribute to the international exchange of goods. The two interpretations, however, are concerned with different types of specialization and trade. Inter-industry forms of specialization and trade are the primary concern of the factor abundance model, while explanations that stress the degree of similarity between countries focus on intra-industry forms of specialization and trade.

Bilateral patterns of trade in specific industries are used to examine the effects of country similarities. The hypothesis tested with this large body of data is that greater country similarities will give rise to larger amounts of bilateral IIT. The test confirms that similarities in income, market size or relative endowments are positively associated with the level of IIT. In fact, there is no industry where country similarities prove to have a negative impact on IIT.

Economies of scale, market structure and international trade

Chapter 8 moves from the H–O model to a set of issues more commonly associated with the new trade theories. These include scale economies, industrial concentration and product differentiation. A full-fledged empirical assessment of these topics is not attempted. Instead, the chapter represents an empirical excursion into a non-H–O world rather than an attempt to test existing theory.

The chapter begins with a series of inter-industry comparisons for each of the three variables mentioned above. The role of scale economies naturally varies across industries but generally tends to be of more significance in developing countries than in DMEs. The distinction appears to reflect the greater disparities between large and small establishments in the developing countries. Another reason is that large establishments in developing countries often operate in highly protected markets.

Scale economies may also represent a barrier to entry. The data presented in Chapter 8 indicate that manufacturers in developing countries face the highest entry barriers. This is especially true in industries requiring relatively large amounts of physical capital or depending on scale economies. The pattern in DMEs is much less clear. The existence of excess capacity in some industries along with capacity rationalization in others presents a very mixed picture.

Entropy indices are used to measure the degree of industrial concentration. The results reveal a much more consistent pattern than was found for scale economies. The same industries tend to be highly concentrated in both DMEs and developing countries. The degree of concentration in DMEs, however, is less than in developing countries. These impressions, however, are based on a set of industries that are defined in rather broad terms, which make it difficult to interpret the results. In order to remedy this weakness, similar tests are carried out with detailed data for over 400 US industries. The major finding of the exercise is that industrial concentration is positively correlated with both scale economies and capital intensity.

The concluding section of the chapter examines the relationship between industrial concentration and export concentration. It is shown that the two characteristics are positively correlated across industries. Furthermore, both domestic (industrial) and export concentration are high in Ricardian industries but low among H–O industries. Export concentration is also high in product-cycle industries, although the degree of domestic concentration seems to depend on the nature of research and development expenditures and the extent of scale economies.

Intra-industry trade revisited

Chapter 9 returns to the subject of IIT but examines it from a perspective that differs from the discussion in Chapter 4 and the approach used in other studies. Analysts have usually adopted a rather broad frame of reference by studying IIT in relation to total trade in manufactures. However, tthe present chapter is concerned with aspects of the new trade theories and an industry-by-industry approach is adopted. The main purpose is to gain some impression of how patterns of IIT are influenced by the types of industry-specific characteristics that were introduced in earlier parts of the book.

The analysis considers 90 industries located in 47 countries. Only a moderate portion of the variation in IIT shares across industries is explained by scale economies, product differentiation and industrial concentration. In the DMEs, the share of IIT appears to be positively related to scale economies. The relationship is a weak one, however, and does not apply to developing countries. Nor does product differentiation exert a particularly strong influence on IIT. That result is partially discounted, however, since methods of measurement can take account only of vertical (not horizontal) forms of differentiation. The relationship between industrial concentration and the share of IIT is much stronger. Higher levels of concentration reduce the share of IIT in total trade.

The mixed results obtained for scale economies and product differentiation, together with the relatively strong influence of industrial concentration on IIT, suggest the desirability of modifying the hypothesis used in the above tests. A basis for such a revision is the expectation that low-concentration industries are the likely candidates for the type of IIT that models of monopolistic competition attempt to explain. Scale economies perform much more impressively in tests of this narrower hypothesis. In the DMEs, the share of IIT among industries with relatively low concentration is significantly and positively influenced by scale economies. A similar, though weaker, result is obtained for the NIEs.

Other analysts have often confined their study of IIT to trade of the DMEs. This framework is adopted in the second section of the chapter. However, the investigation departs from conventional practice in another way: it focuses not on the share of two-way trade but on IIT 'intensity'. The results corroborate and build on those described in the first section of the chapter. The negative influence of concentration on IIT intensity was most evident among the smaller DMEs. In large DMEs the effects of market size apply across a wide spectrum of industries, but in smaller countries the intensity of IIT is more closely related to the characteristics of each particular industry. The analysis of IIT intensity also reconfirms the importance of scale economies, particularly among industries that are not highly concentrated.

A lacuna exists in the foregoing results which is addressed in the concluding section. Despite expectations that the degree of product differentiation influences the share of IIT, no reliable quantitative measure of the independent variable can be constructed. Vertical forms of differentiation (for example, differences in product quality) are more easily quantified, however. Drawing on 'factor-abundance' models of IIT, several testable hypotheses are constructed. Because these models emphasize differences in country endowments, they are best suited for an analysis of IIT between the 'North' (that is, the DMEs) and the 'South' (developing countries).

Data on bilateral trade between pairs of individual countries in North and South are the subject of a regression analysis. The tests incorporate several variables in addition to product quality, including country size and income level. From factor abundance models of IIT, it can be inferred (though not necessarily proven) that the probability of bilateral IIT in a given industry is greater when there is substantial opportunity for vertical differentiation between trading partners. The results show that conventional forces such as country similarities, income levels and market size influence two-way trade between North and South in the same way they affect all of this trade. The role of quality differences is of special interest. Substantial differences in the quality of the products traded by North and South are associated with larger shares of bilateral IIT. The 'distance' between qualities exerts a positive influence on IIT. Industries where vertical differentiation has the largest positive effect on two-way trade would be promising fields for developing countries that wish to build new trade relations with DMEs, and the remainder of the chapter focuses on this aspect.

A retrospective view

The concluding chapter briefly reconsiders some of the book's main implications. These are presented in the form of a three-part thesis which deals with patterns of specialization and trade in the manufacturing sector in its entirety, in specific industries, and among products within an industry.

Competitive abilities in the manufacturing sector as a whole are positively associated with countries' relative endowments of physical capital. The availability of skilled labour is also important, but the role of this factor is ambiguous. At the level of specific industries, abundance of semi-skilled labour has the impact predicted by theory. Capital and technology can flow freely across today's borders; it is people that, relatively speaking, are immobile. How they are used, and how skilful they are, have become vital elements of competitiveness in many industries.

Finally, the determinants of specialization within industries are somewhat more complex. Country characteristics such as market size and similarities in relative resource abundance are important, but so are industry characteristics like scale economies and the degree of concentration.

CHAPTER 2

Inter-industrial trends in manufacturing production

Patterns of change in manufactured output can be examined from either a domestic (i.e. national) or an international perspective, though the emphasis in this book is mainly on the latter. Moreover, attention is focused on long-term changes rather than on the sort of adjustments that occur over the course of the business cycle. Such an orientation leads to a discussion of industrial structure, structural change, and inter-industrial patterns of specialization.

The meaning of these structural terms can vary widely; and before embarking on this survey, some elaboration is helpful.[1] The notion of structural change may refer to either a relative or an absolute shift in output or employment. Absolute changes in output or employment are more relevant for studies of a single country. Though a decline in the share of output or employment could change the relative power of industrial workers or even the character of society, an absolute decrease in the level of output or employment involves greater, and more costly, adjustments.[2]

An emphasis on absolute shifts in output or employment is less appropriate when the subject of discussion is international in scope. Any deterioration in an industry's relative international standing is more likely to bring a response from policy-makers than if the industry were to decline in relation to other domestic industries. Public policies in support of a particular industry (e.g. import restrictions, favourable tax treatment, a relaxation of anti-trust laws or other methods) are more easily justified as a response to foreign competition than to competition between domestic firms.

This chapter begins by looking at inter-industrial patterns of specialization. The main purpose is to provide a comprehensive picture of world industry and patterns of change since the early 1970s. The subsequent discussion is concerned with the degree of industrial similarity between the developed and developing countries and some of the general factors that may influence patterns of specialization.

Global pattern of manufacturing output

The geographical distribution of world industry is well known. Table 2.1 shows the distribution of world MVA among major groups of countries

Table 2.1 Share of economic groups and developing regions in world MVA, 1970–86[a] (percentages)

Year	DMEs	CPEs	Developing countries/areas[b]	Developing regions: Africa	West Asia	South and East Asia[b]	Latin America	Europe
1970	74.3	15.2	10.5	0.8	0.7	2.4	6.1	0.5
1973	73.2	15.8	11.0	0.8	0.8	2.6	6.3	0.5
1975	69.0	18.9	12.2	0.9	0.9	2.9	6.8	0.6
1977	68.7	19.0	12.3	0.9	0.9	3.2	6.7	0.6
1979	68.2	19.1	12.7	0.9	0.9	3.4	6.8	0.7
1980	67.3	19.6	13.1	0.9	0.9	3.5	7.0	0.7
1981	67.0	19.9	13.0	1.0	1.0	3.7	6.6	0.7
1982	66.2	20.6	13.2	1.0	1.1	3.9	6.5	0.7
1983	66.3	20.7	13.1	1.0	1.1	4.1	6.2	0.7
1984	66.8	20.2	13.0	1.0	1.1	4.2	6.1	0.7
1985	66.7	20.4	12.9	1.0	1.1	4.1	6.0	0.7
1986	66.1	20.7	13.3	0.9	1.1	4.3	6.2	0.7

Source: UNIDO

a/ Percentages were calculated from data at 1980 prices. For a list of the countries and areas included in each group, see the statistical appendix.

b/ Excluding Afghanistan, China and Taiwan Province.

and regions. The share of MVA in DMEs has fallen since 1970, while the shares of centrally planned economies (CPEs) and developing countries have risen. The most rapidly industrializing countries are in South and East Asia, but the industrial progress of other developing regions has been somewhat disappointing. For example, the share of Latin America – the most industrialized of the developing regions – has declined since 1980, and that of Africa has been virtually unchanged since 1970.

The relative importance of any group of countries will vary from industry to industry. Table 2.2 provides an overview of the global pattern of inter-industry specialization in a number of industries. The prominence of DMEs has waned but they continue to account for a disproportionate share of world output in many industries – notably paper, metal products, electrical machinery and transport equipment. The decline is explained primarily by the gains of CPEs. The latter countries have made considerable progress in industries such as textiles, industrial chemicals, non-ferrous metals and non-electrical machinery.

Figures for the developing countries present a somewhat different picture. Given the abundance of unskilled labour in these countries, it is logical to expect relative progress to be concentrated in labour-intensive industries. The most widely accepted example of such an industry is textiles. Though the developing countries have recorded modest gains in several labour-intensive industries (for example, wearing apparel and footwear), their share of world textile production has changed very little since 1965. In contrast to expectations, these countries' most impressive gains have been in resource-intensive industries such as petroleum refining, industrial chemicals and steel – none of which is labour-intensive.

Shifts in the inter-industry composition of world industry have their parallel at the domestic level. Table 2.3 summarizes the latter feature, showing the average structure of MVA in several country groups. The figures for DMEs are of some interest. The inter-industry structure of output in these countries has changed very little since 1970. Apart from a notable increase in the share of electrical machinery, the relative gains and losses of most industries were negligible. This fact runs counter to the claims of policy-makers and industrialists in some DMEs who describe the plight of various industries in alarming terms.

Foreign competitors are usually regarded as the major source of contractive pressures in specific industries. However, the fact that the DMEs' share of world MVA has fallen without accompanying changes in the structure of manufacturing suggests other reasons. One obvious explanation is that the service sector in DMEs has grown dramatically – and at the relative expense of manufacturing. Another possibility is that the major source of competitive pressure is the DMEs themselves. The list of senescent industries and industrial successes varies across DMEs, and their rise and fall may be concealed by group averages. A third reason could be that much of the structural change experienced by DMEs has been not inter-industry but rather intra-industry in

Table 2.2 Share of economic groups in world value added of selected manufacturing branches and years[a] (percentages)

Industry (ISIC)	DMEs 1965	DMEs 1975	DMEs 1986	Developing countries/areas 1965	Developing countries/areas 1975	Developing countries/areas 1986	CPEs 1965	CPEs 1975	CPEs 1986
Food products (311/2)	58.9	54.0	50.6	16.7	16.3	18.9	24.4	29.7	30.5
Beverages (313)	60.1	54.9	56.7	13.3	15.4	21.3	26.6	29.7	22.0
Tobacco (314)	49.4	50.4	42.9	35.8	33.0	37.6	14.8	16.6	19.5
Textiles (321)	54.8	47.6	43.8	21.5	21.3	22.7	23.7	31.1	33.5
Wearing apparel (322)	69.1	58.9	51.0	12.9	14.4	16.9	18.0	26.7	32.1
Footwear (324)	68.3	57.2	45.9	14.8	17.3	19.4	16.9	25.5	34.7
Paper products (341)	87.2	82.7	80.8	7.3	9.3	11.4	5.5	8.0	7.8
Industrial chemicals (351)	73.0	64.4	59.3	7.3	9.6	13.5	19.7	26.0	27.2
Other chemicals (352)	74.3	69.5	68.1	15.8	17.1	19.3	9.9	13.4	12.6
Petroleum refineries (353)	64.6	59.5	46.3	24.6	24.6	36.2	10.8	15.9	17.5
Rubber products (355)	70.8	62.9	57.1	11.9	13.9	16.6	17.3	23.2	26.3
Pottery,china,earthenware (361)	77.6	68.1	60.1	9.8	12.1	13.4	12.6	19.8	26.5
Glass products (362)	80.3	73.2	70.1	10.2	13.2	13.9	9.5	13.6	16.0
Other non-met.min.prod.(369)	71.5	61.6	54.3	10.9	14.7	20.5	17.6	23.7	25.2
Iron and steel (371)	81.3	74.7	67.7	5.8	8.9	13.3	12.9	16.4	19.0
Non-ferrous metals (372)	76.5	67.6	66.9	9.0	9.4	11.3	14.5	23.0	21.8
Metal products (381)	87.0	80.5	73.1	7.8	9.7	13.3	5.2	9.8	13.6
Non-electrical machinery (382)	79.3	67.6	59.5	3.2	4.9	4.5	17.5	27.5	36.0
Electrical machinery (383)	86.8	81.1	80.2	5.4	7.1	8.4	7.8	11.8	11.4
Transport equipment (384)	87.2	80.4	77.9	5.3	7.5	7.4	7.5	12.1	14.7

Source: UNIDO

a/ Percentages were calculated from data at 1980 prices. Owing to a lack of data, not all three-digit industries are shown here.

Table 2.3 Structure of MVA,[a] by economic groups (constant 1980 prices)

Industry (ISIC)	DMEs 1970	DMEs 1986	CPEs 1970	CPEs 1986	All developing countries[b] 1970	All developing countries[b] 1986	Advanced developing countries[c] 1970	Advanced developing countries[c] 1986	Other developing countries[d] 1970	Other developing countries[d] 1986
Food products (311/2)	8.8	8.8	18.3	15.0	18.6	15.9	16.6	14.7	24.8	20.3
Beverages (313)	1.9	1.9	3.6	2.0	3.0	3.4	2.8	2.8	3.6	5.5
Tobacco (314)	0.7	0.6	1.0	0.7	3.3	2.4	1.9	1.7	7.6	4.7
Textiles (321)	4.6	3.5	10.1	7.6	12.3	8.7	13.3	8.8	9.3	8.6
Wearing apparel (322)	2.9	2.2	4.8	4.0	4.0	3.4	4.3	3.7	3.1	2.4
Leather and fur products (323)	0.6	0.4	0.9	0.6	0.9	0.6	1.0	0.6	0.7	0.6
Footwear (324)	0.3	0.5	1.3	1.1	1.6	1.0	1.6	1.0	1.5	1.1
Wood and cork products (331)	2.9	2.4	1.9	1.5	2.9	2.4	2.8	2.5	3.1	1.9
Furniture, fixtures, excl. metal (332)	2.0	1.9	1.0	1.2	1.4	1.1	1.5	1.2	1.3	1.1
Paper products (341)	3.5	3.6	1.0	1.0	2.3	2.5	2.3	2.4	2.0	2.8
Printing and publishing (342)	4.6	4.9	0.9	0.7	3.7	2.5	4.3	2.6	2.0	1.9
Industrial chemicals (351)	3.9	4.3	5.0	5.7	2.6	4.7	2.8	5.3	1.9	2.3
Other chemicals (352)	3.1	3.9	2.1	2.0	3.9	5.0	4.0	5.3	3.7	4.3
Petroleum refineries (353)	2.4	1.7	2.2	1.8	6.3	6.1	3.7	3.4	14.4	15.9
Products of petroleum and coal (354)	0.4	0.3	2.5	1.9	0.7	0.7	0.7	0.7	0.7	0.5
Rubber products (355)	1.3	1.1	1.5	1.5	1.6	1.6	1.8	1.8	1.1	1.0
Plastic products (356)	1.4	2.3	0.6	0.8	1.5	1.6	1.4	1.7	1.6	1.4
Pottery, china, earthenware (361)	0.5	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.3	0.3
Glass products (362)	0.9	0.9	0.5	0.6	0.9	0.8	1.0	0.9	0.5	0.6
Other non-metallic min.products (369)	3.0	2.4	3.8	3.2	3.6	4.3	3.6	4.1	3.6	5.2
Iron and steel (371)	7.5	4.9	5.4	3.9	4.5	4.8	5.3	5.4	2.1	2.4
Non-ferrous metals (372)	2.2	2.1	2.5	1.9	1.9	1.7	1.6	1.5	2.8	2.4
Metal products (381)	7.0	6.1	2.4	3.2	4.5	5.4	4.9	5.8	3.2	3.8
Non-electrical machinery (382)	11.5	12.5	13.5	21.4	3.2	4.7	4.0	5.3	0.8	2.4
Electrical machinery (383)	8.1	12.1	3.5	4.9	3.5	6.1	4.2	7.1	1.2	2.4
Transport equipment (384)	10.0	10.6	5.1	5.7	4.7	5.0	5.6	5.7	1.9	2.5
Professional scientific equipment (385)	2.0	2.3	2.1	2.8	0.3	0.6	0.4	0.8	0.1	0.1
Other manufactures (390)	1.4	1.4	2.0	2.8	1.8	2.5	2.0	2.7	1.1	1.6
Total manufacturing (300)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: UNIDO

a/ In deriving these figures, all data were first expressed in 1980 United States dollars and shares weighted by the value of each industry's output were then calculated.

b/ Percentages were calculated from data for 69 developing countries and areas which, together, accounted for 95 per cent of that group's total MVA in 1980, the latest year for which base weights were available.

c/ Countries and areas include NIEs, second generation NIEs, India, Pakistan, Turkey and Yugoslavia.

d/ Includes 47 countries.

character. Ready examples would be the emergence of the mini-steel sector at the expense of integrated producers and the successes of specialized automobile producers at times when the major automobile firms were experiencing severe pressure.

Table 2.3 also shows the structure of output for all developing countries and for two subsets. The first of these subsets is made up of the 'more advanced' countries,[3] while the second is a heterogeneous group which includes many of the smaller and often poorer developing countries. The structure of the advanced developing countries is close to the average for all developing countries, a result that reflects the importance of the former group in the total.

The most significant inter-industry shift is the substantial drop in the share of textiles in total MVA. The industry's share declined by roughly one-third in both subsets of developing countries. This deterioration was balanced by modest gains spread across several industries including chemicals, electrical machinery, transport and steel. The composition of MVA in the advanced developing countries is also more diversified than in the poorer ones. A disproportionate amount of MVA in the poorer countries is accounted for by only five industries – food, beverages, tobacco, textiles and petroleum – which supplied 55 per cent of MVA in 1986. Only one of the remaining 23 industries produced more than 5 per cent of MVA.

These results show an inter-industry pattern that is most diversified in the DMEs, moderately so in the advanced developing countries, and highly concentrated in the poorer ones. Such a generalization is based on group averages and does not necessarily imply that inter-industry diversification is systematically related to a country's level of development. It may, however, suggest that economic growth is first reflected by greater inter-industry diversification, while intra-industry forms of diversification are more important among DMEs.

Structural trends and inter-industry specialization are, of course, partially determined by the overall performance of the world economy. The early 1970s were characterized by dramatic increases in the price of oil and other commodities followed by a period of rapid inflation. These developments subsequently led to a slow-down in growth of investment, productivity and income. An international comparison of growth rates vividly illustrates the marked difference between the present economic climate and that prevailing before 1973.

Table 2.4 documents some of these changes, showing growth of output in key industries for 1963–73 and 1973–86. No industry proved to be exempt from the slow-down. Food products are the only field that has not experienced a substantial absolute fall in rates of growth after 1973. Electrical machinery, on the other hand, continues to be one of the most dynamic industries (especially in the developing countries), although in some instances growth rates fell by almost one-half after 1973.

Japan's performance continues to surpass that of other DMEs though recent experience has brought that country's rates of growth more closely in line with

Table 2.4 Growth of output in selected industries and country groups, 1963–86 (average annual percentage rates of growth)

Economic group and countries/areas	Food products (311)[a]	Textiles and wearing apparel (321+322)[a]	Industrial chemicals and products (351+352)[a]	Fabricated metal products (381)[a]	Non-electrical machinery (382)[a]	Electrical machinery (383)[a]	Transport equipment (384)[a]
DMEs							
1963-1973	3.81	3.49	7.87	5.28	5.67	8.21	5.50
1973-1986	1.91	-0.39	2.54	0.53	2.30	4.75	1.60
United States							
1963-1973	3.01	3.80	7.51	3.79	5.53	6.99	2.89
1973-1986	2.61	0.27	3.72	0.98	2.72	4.08	2.07
Japan							
1963-1973	5.39	7.13	15.14	15.53	14.43	20.22	16.58
1973-1986	1.41	-0.33	3.66	0.85	6.01	11.90	2.77
Germany, Fed.Rep.of							
1963-1973	3.51	2.05	7.69	3.36	3.68	7.32	6.22
1973-1986	1.93	-1.81	1.58	0.76	1.43	2.71	3.70
Developing countries[b]							
1963-1973	5.29	3.96	10.91	7.66	10.49	11.72	7.80
1973-1986	4.52	2.39	6.32	4.72	3.00	7.29	2.30
NIEs[c]							
1963-1973	5.21	5.67	13.44	8.81	13.50	12.12	11.31
1973-1986	2.58	1.83	6.35	3.45	1.60	6.53	1.33
Second-generation NIEs[d]							
1963-1973	5.83	6.11	8.78	4.53	2.83	10.40	8.34
1973-1986	7.70	4.73	5.96	9.35	5.04	10.54	2.26

Source: UNIDO

a/ Numbers in parentheses refer to ISIC code.

b/ Figures are based on data for 31 countries which accounted for 79 per cent of MVA in all developing countries in 1980, the latest year for which base weights are available.

c/ Figures for China (Taiwan Province) were not available.

d/ Data were not available for Jordan, Sri Lanka and Thailand.

those of the USA and the Federal Republic of Germany. The deceleration of growth in the developing countries was milder than in the DMEs. The consequences, however, are no less severe, given the former countries' relatively small industrial base. Only the second-generation NIEs seem to have avoided the effects of the slow-down. In that group the growth of output in several industries – food products, fabricated metal products and electrical machinery – actually accelerated after 1973.

Patterns of change and specialization

A survey of trends in manufacturing output can begin by posing several questions. First, are patterns of specialization similar across countries or, if not, are they becoming more similar over time? Second, is the pace of industrial change accelerating or slowing in relation to past experience? Third, can these patterns of change be related to broad industry characteristics such as relative factor intensity?

The expectation that industrial structures are becoming more similar is based on two broad lines of reasoning. First, international differences in tastes, preferences and other demand characteristics have narrowed over the past two decades. The technological revolutions in communications and transport are important reasons for closer agreement between demand patterns. Other contributing factors include the increasing international mobility of firms and the growth of foreign direct investment. Second, studies of the relative endowments of capital and skilled and unskilled labour in Japan, the USA, Western Europe and even some developing countries have found a tendency towards convergence (Bowen, 1983a, pp. 403–5; Aho and Bayard, 1982, p. 383; Cline, 1982, p. 39). A country's factor endowments are an important determinant of the inter-industry structure, and these supply-side changes should give rise to a greater degree of output similarity.

In order to test for greater similarity, the 28 industries that make up the manufacturing sector were first ranked by level of value added in each country. These rankings were then compared for all members of each country group using Kendall's coefficient of concordance. Table 2.5 shows the results. Agreement between industry rankings is closest for the DMEs. Rankings for the advanced developing countries are less similar, and disparity is even greater when the remaining developing countries are considered as a group. Since convergence in demand patterns and relative factor endowments is likely to have gone furthest in DMEs, these results are not surprising. However, intertemporal changes in coefficients were also negligible, giving no support to the expectation that structures converged during the period 1970–86. Only the more advanced developing countries report any noticeable increase in the agreement between industry rankings.

If the similarity in industrial structures is neither great nor rising, what are the specific industries in which countries specialize? An answer to this question

Table 2.5 Test of comparative industry rankings[a]

Country group (number of countries/areas)	Kendall's coefficient of concordance[b] 1970	1986
DMEs (22)	0.774	0.758
Advanced developing countries (21)[c]	0.507	0.542
Other developing countries (40)	0.481	0.485
All countries (83)	0.460	0.466

Source: UNIDO

a/ Industry rankings are based on value added in constant United States dollars.

b/ Kendall's coefficient (W) is defined as:

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

where S is the sum of the squares of the deviations of the total of the ranks obtained by each industry from the average of these totals, k is the number of countries and n is the number of industries.

c/ Includes six NIEs, eleven second generation NIEs, India, Pakistan, Turkey and Yugoslavia.

can be obtained by comparing each industry's unweighted share in the total MVA of a given country group with the corresponding world totals. An indicator having a value of unity would mean that the industry's importance in the country group exactly matches its global contribution to world MVA. Values substantially greater than unity indicate areas of specialization, while those substantially less than unity represent industries in which the country group has no specialization. For illustrative purposes, it is assumed that any indicator with a value below 0.50 (i.e. where the industry's contribution to the group's MVA is less than half of its global contribution to world MVA) represents an instance of underspecialization. The corresponding case of specialization is represented by values in excess of 1.50.

Calculations of the above type were carried out for DMEs, NIEs and second-generation NIEs and are shown in Table 2.6. Although the composition of output is most similar among the DMEs, that group's structure is also the most distinct in comparison with world averages. The DMEs specialize in eight of 28 industries, while in another three industries they are underspecialized. The pattern found for the NIEs is similar. These countries

Table 2.6 International patterns of specialization,[a] by industry, 1986 (industry and index of specialization)

Industry characterization[b]	DMEs	NIEs	NIEs, second generation
Under-specialization	beverages (0.453) tobacco (0.197) petroleum refineries (0.263)	beverages (0.394) tobacco (0.257) wood products (0.445)	non-electrical machinery (0.460)
Specialization	paper products (1.743) printing, publishing (1.628) plastic products (1.511) iron and steel (1.629) non-electrical machinery (2.454) electrical machinery (1.874) transport equipment (1.788) scientific equipment (2.258)	wearing apparel (1.644) plastic products (2.205) iron and steel (1.871) electrical machinery (2.483) transport equipment (1.605) scientific equipment (2.692)	tobacco (1.521) rubber products (2.011) other non-metallic mineral products (1.842)

Source: UNIDO

a/ The index of specialization (S) is the ratio between two shares defined as: $S = a_{ij}/a_{iw}$ where a_{ij} is the unweighted share of industry i in the MVA of country group j and a_{iw} is the corresponding share of industry i's worldwide output in world MVA.

b/ Underspecialization is defined by an index of 0.50 or less. Specialization refers to those industries having an index of 1.50 or more.

are specialized in six industries, only one of which (clothing) is not among the same list of DMEs. The second-generation NIEs are quite different. Figures for this group deviate very little from the corresponding world figures, meaning that there is no true pattern of specialization. Of the th.se industries that do qualify as areas of specialization, all rely heavily on inputs from mining or agriculture.

The results in Table 2.6 contrast with those of other studies of inter-industry specialization based on trade (not output) data. Trade-related studies have concluded that inter-industrial specialization among DMEs was never great and probably declined in the 1960s and early 1970s (see, e.g., Aquino, 1978, p. 294). The lack of any distinct pattern of specialization among second-generation NIEs offers another contrast. Some analysts have regarded the export gains of this group as evidence that they are gradually emerging as competitive suppliers of certain manufactures. For this interpretation to be true, numerous supply-side adjustments should have occurred. Without supporting evidence of specialization in output, a more likely explanation for the export achievements of second-generation NIEs may be the rapid growth of intra-industry trade. Such trade would require substantial imports of components and other inputs but may result in only modest additions to local value added.

The foregoing description relies upon the national economy as the reference for measuring inter-industry specialization. A more complete picture can be obtained if patterns of specialization are examined from an international perspective as well. Conventional bases for determining industrial change (for example, in relation to a country's GDP or total MVA) are not appropriate for such a purpose. Another reference, or norm, is needed for an international assessment. In the case of the DMEs, the norm chosen as a basis of comparison is the world. The norm adopted for developing countries, however, is different. Since the question is whether the industrial structure of the developing countries is becoming more similar to that of the DMEs, the latter group of countries is used as the norm.

An international measure of structural change can be based on differences between growth rates. First, the difference between an industry's growth of output in a country group and the same industry's growth in the appropriate reference group is taken. From this expression the difference between the growth of MVA in the country group and the reference group is subtracted. The resultant index would show the advance or decline of the industry, in relation to changes in the reference group.[4]

Table 2.7 identifies industries in DMEs and developing countries according to whether they are expanding or contracting in relation to the corresponding norm. There are few industries where the direction of change in the DMEs agrees with that of the developing countries. Of the 28 industries in the manufacturing sector, the DMEEs have ten that are expanding in relation to world trends. Eight of these were found to be contracting in the developing countries. Similarly, among the DMEs' 18 contracting

Table 2.7 An internationalized ranking[a] of industries by growth of output,[b] 1973–86

	DMEs	Developing countries[c]	
Expanding industries	Printing and publishing	Petroleum products	Expanding industries
	Non-electrical machinery	Scientific equipment	
	Transport equipment	Petroleum refining*	
	Plastics	Non-metal products	
	Electrical machinery	Iron and steel	
	Glass products*	Miscellaneous industries	
	Paper products	Industrial chemicals	
	Furniture, fixtures*	Tobacco*	
	Scientific equipment	Metal products	
	Leather products*	Wood products*	
Contracting industries	Non-ferrous metals*	Rubber products*	
	Non-industrial chemicals	Beverages	
	Pottery, china*	Wearing apparel*	
	Metal products*	Non-ferrous metals*	
	Food products	Footwear*	
	Wood products*	Pottery, china*	
	Iron and steel*	Furniture, fixtures*	
	Industrial chemicals	Paper products	Contracting industries
	Rubber products*	Textiles*	
	Wearing apparel*	Electrical machinery	
	Beverages	Food products*	
	Textiles*	Non-industrial chemicals	
	Footwear*	Glass products*	
	Miscellaneous industries	Leather products*	
	Non-metal products*	Plastic products*	
	Tobacco*	Non-electrical machinery	
	Petroleum refining*	Transport equipment*	
	Petroleum products*	Printing and publishing*	

Source: UNIDO

a/ Industries are ranked in declining order by their relative rate of international expansion/contraction. An asterisk indicates that the industry's share of MVA in the country group declined between 1973 and 1986.

b/ The measure (I) is defined in terms of rates of growth (r) where i is the industry, j is the country group, n is the reference group (world or DMEs) and M refers to the entire manufacturing sector. Thus, $I = (r_{ij} - r_{Mj}) - (r_{in} - r_{Mn})$. In calculating I, all growth rates for country groups were weighted by output.

c/ Data was available for 32 developing countries which accounted for 79 per cent of that group's MVA in the 1980 base weights.

industries, 15 appear in the list of expanding industries in the developing countries.

Table 2.7 also identifies contracting and expanding industries in more conventional terms (by each industry's weighted share in the MVA of the country group). In the DMEs, 16 industries are identified as contracting by this method, though three are found to be expanding relative to world norms. In the developing countries, nine of the 16 industries that are contracting relative to group averages are found to be expanding in comparison with international standards.

More insights regarding industrial patterns can be obtained by considering the pace of change rather than the extent of agreement. In order to address this question, indices of structural change have been calculated and are reported in Table 2.8. The pace of change has been greatest in the two groups of NIEs. Moreover, the pattern appears to differ depending on the size of the countries concerned. This fact can be seen by a comparison between the two sets of indices, since the weighted measures are dominated by trends in the larger economies while unweighted measures give equal importance to large and small ones. The distinction on the basis of market size applies mainly to the DMEs and second-generation NIEs. In both groups, the extent of structural change in the larger countries has exceeded that in smaller countries. The opposite relationship is found for the NIEs, although this group is not a representative one in terms of market size as it consists mainly of economies that are either extremely small or relatively large.

The structural indices used here can be unduly sensitive to cyclical events. For example, an industry reporting an increasing share of MVA over several years may contract in later years. In order to account for cyclical differences, an index of consistency has been calculated and reported in Table 2.8. The

Table 2.8 Indices of structural change, 1973–86 (percentages)

Country grouping (number of countries)	Index of structural change[a]		Index of consistency[b]	
	weighted[c]	unweighted	weighted[c]	unweighted
DMEs (23)	6.83	5.34	0.51	0.49
NIEs (6)	8.30	9.56	0.38	0.40
Second generation NIEs (12)	9.29	6.55	0.33	0.32
Other developing countries (51)	7.28	5.65	0.43	0.47

Source: UNIDO

a/ The index of structural change (C) is defined as: $C = 0.5 \sum_{i=1}^{28} |a_{iT} - a_{i0}|$

where a_{it} is a three-year average of the share of industrial branch i (i = 1,2,....,28) in MVA for the periods t = T (1984-86) and t = 0 (1973-75).

b/ The index of consistency (K) is defined as: $K = \dfrac{\sum_{i=1}^{28} |a_{iT} - a_{i0}|}{\sum_{i=1}^{28} \sum_{t=0}^{T-1} |a_{i,t+1} - a_{it}|}$

c/ Weighted shares were obtained by summing value added in constant United States dollars over each industry in the respective country group.

index takes a value of unity when there have been no reversals in movements of industry shares and a value of zero when year-to-year changes cancel out completely. The pattern of structural change is most consistent for the DMEs. Trends in NIEs and second-generation NIEs have been somewhat more erratic, as periods of rapid growth have often been preceded or followed by a relative contraction. The degree of consistency is little affected by the size of the economies concerned.

The last question raised at the beginning of this section concerned the extent to which patterns of change can be related to the input requirements of various industries. In order to study this aspect, several overlapping categories of industries were created. One consists of industries with a high growth potential. These are thought to require comparatively large outlays for R and D and to have rapid rates of technological innovation. A second category is composed of industries that are growing slowly and have relatively modest requirements for R and D. The two remaining categories are made up of industries generally regarded as being either labour-intensive or capital-intensive.

Table 2.9 reports the output shares of each category and the percentage change in these shares between 1973 and 1986. The increase of high-growth industries in the DMEs (20.74 per cent) was nearly equivalent to the relative decline in slower-growing industries (-25.47 per cent). The DMEs have also moved quickly out of the labour-intensive fields but have been far slower to boost the share of output in capital-intensive industries. The experience of individual countries varies, however. In Japan, the movement into high-growth industries and the exit from labour-intensive operations have proceeded at a torrid pace. The movement out of low-growth industries has also been rapid in the USA, but the relative contraction of labour-intensive activities was not large and was accompanied by a decline in the share of capital-intensive industries. Much of the change in the Federal Republic of Germany has been a withdrawal from low-growth industries and or labour-intensive industries.

For completeness, Table 2.9 also gives estimates for the developing countries. These figures, however, should be viewed with caution, since the industry classification is intended for DMEs and may not be suitable for developing countries. One reason is that an industry's factor intensity and production technologies can vary, depending on domestic availability of factors and relative prices. Subject to this qualification, the calculations tell an interesting story.

The developing countries have been relatively slow to withdraw from low-growth industries, but the expansion of high-growth industries has matched that in DMEs. Also remarkable is the expansion of capital-intensive industries (8.51 per cent), which has been proportionately greater than for the DMEs. Trends in several of the larger non-NIEs (India, Pakistan and Turkey) were the main reason for this shift.

The overall results of this survey have already been summarized in Chapter 1 and need not be repeated here. It is sufficient to note that the inter-industrial pattern of world production has changed substantially since the early 1970s but that the experiences of different country groups bear little resemblance.

Table 2.9 Change in output share in selected industry groups, 1973–86 (percentages and percentage changes[a])

	Industry categories[b]			
	High-growth industries	Low-growth industries	Labour-intensive industries	Capital-intensive industries
DMEs				
1973	30.96	18.14	13.53	49.50
1986	37.38	13.52	10.91	50.01
Percentage change	+20.74	-25.47	-19.36	+1.03
United States				
1973	32.00	17.55	12.21	53.30
1986	37.38	10.87	10.98	49.87
Percentage change	+16.81	-38.06	-10.07	-6.44
Japan				
1973	29.04	22.11	12.27	53.53
1986	45.65	15.38	6.91	60.99
Percentage change	+57.20	-30.44	-43.68	+13.94
Germany, Fed.Rep.of				
1973	38.26	17.32	10.87	55.13
1986	42.86	12.28	7.61	57.84
Percentage change	+12.02	-29.10	-29.99	+4.92
Developing countries[c]				
1973	17.94	24.11	21.92	31.01
1986	22.71	20.29	17.35	33.65
Percentage change	+26.59	-15.84	-20.85	+8.51
NIEs[d]				
1973	22.09	22.54	19.14	33.56
1986	29.19	20.25	16.04	35.49
Percentage change	+32.14	-10.16	-16.20	+5.75
Second-generation NIEs				
1973	13.17	18.14	19.94	27.31
1986	15.21	16.07	17.11	28.64
Percentage change	+15.49	-11.41	-14.19	+4.87
Other developing countries[e]				
1973	15.01	27.59	25.44	29.47
1986	19.07	21.88	18.73	33.67
Percentage change	+27.05	-20.70	-26.38	+14.25

Source: UNIDO.

a/ Percentage change was calculated as $[(S_2 - S_1)/S_1]100$ where $S_1(S_2)$ is the output share in 1973 (1986).

b/ Industry categories were adapted from Lawrence (1984, pp.33-35). The categories overlap and do not include all output of the manufacturing sector. For a listing of the industries included in each category, see table B.3 of the statistical appendix.

c/ Totals refer to 69 countries which, together, accounted for 95 per cent of the base weights for MVA in all developing countries in 1980.

d/ Figures exclude Taiwan Province.

e/ Figures refer to 51 developing countries.

The following chapter considers inter-industry patterns of specialization in world trade.

Notes: Chapter 2

1 For an early but incisive critique of the uses and abuses of structuralist terminology, see Machlup, 1958.
2 Lawrence, 1984, adopts this interpretation in his study of the US economy.
3 Included in this group are NIEs and second-generation NIEs.
4 Assume, for example, that the food products industry in the DMEs grew at a rate of 2.2 per cent in 1973–86 while the industry's worldwide growth rate was 2.7 per cent. The difference in growth rates (−0.5 per cent) must then be corrected for growth of total MVA in the DMEs and the world. If these two rates are 1.6 and 1.9 per cent respectively, the industry is identified as a contracting one:

$$(2.2 - 2.7) - (1.6 - 1.9) = -0.2$$

Note that the industry would be identified as an expanding one if the conventional practice of comparing industry growth (2.2 per cent) with growth of MVA (1.6 per cent) were used.

CHAPTER 3

Inter-industry trade in a global system

Trade in manufactures has always been subject to substantial fluctuations during the business cycle. More stable trends can be observed, however, when trading patterns are examined over longer periods of time. The chapter begins with an overview of long-term trends in inter-industry trade. The remainder of the chapter is devoted to a discussion of some of the main features of inter-industry trade among developed and developing countries.

Long-term trends in world trade

Table 3.1 shows growth in GDP, total exports, MVA and exports of manufactures in each of the three major economic groupings. The high rates of growth in total income during the 1960s and early 1970s reflect the exceptional nature of that period. The subsequent slow-down in world growth is also evident: the growth of income in developing and developed countries has fallen significantly since 1975. The pattern is similar in the case of exports (SITC 0–9), though rates of growth have generally been more volatile.

Neither MVA nor exports of manufactures were immune to the slow-down in the world economy. However, these activities were not so hard hit by the slow-down as other economic sectors. MVA has tended to grow at a more rapid pace than income. The difference between the two rates of growth was greatest in the 1960s, but even during the 1980s the gap remained. Manufactured exports, in turn, have expanded at a pace exceeding the growth of MVA. Other studies spanning even longer periods of time have also found a stable relationship between growth of manufacturing production and exports, the latter expanding more rapidly than production (e.g. Batchelor, Major and Morgan, 1980, pp. 16–17). The impression that emerges from these comparisons is that manufacturing has provided much of the impetus for overall growth and that exporting has been a major reason for this sector's prominence.

These features of the world economy are well-known, but they have received comparatively little attention in the work of most trade theories. The theoretical literature reveals only a passing interest in issues such as

Table 3.1 Growth rates for GDP, MVA and exports of manufactures,[a] 1960–86 (percentages)

Indicator[b]	1960–70	1970–75	1975–80	1980–86
Developing countries/areas				
GDP	5.6	6.1	5.1	3.0
Total exports	7.3	4.1	4.0	1.5
MVA	7.1	7.2	6.1	3.5
Manufactured exports[c]	...	11.6	14.0	10.4
DMEs				
GDP	5.1	3.2	3.4	2.5
Total exports	8.0	6.8	6.0	3.8
MVA	6.3	3.3	3.8	3.0
Manufactured exports[c]	10.0	6.6	6.5	3.4
CPEs				
NMP[d]	6.7	6.2	4.3	3.6
Total exports[e]	9.8	22.4	16.2	3.8
Index of industrial production	9.0	9.0	5.6	4.0
Manufactured exports[e]	10.0	20.6	14.2	3.8

Sources: GDP and data for total exports: UNIDO and United Nations, Yearbook of National Accounts Statistics, Vol. II, international tables, various issues. Index of industrial production, manufactured exports and exports in current dollars: United Nations, Monthly Bulletin of Statistics, various issues.

a/ SITC 5-8 less 68.
b/ Growth rates are derived from data expressed in constant dollars.
c/ Quantum index.
d/ Net material product.
e/ Growth rates are derived from data expressed in current dollars.

the level of trade between countries or changes in those levels over time. Empiricists and policy analysts have had more to say about these particular features. They suggest that the rate of growth in manufactured exports is tied to the rate of expansion in foreign markets, which in turn is tied to consumption patterns. In particular, since income elasticities of demand are higher for manufactured products than for non-manufactures, manufactured exports would grow more rapidly during periods when income is growing at normal or high rates. Conversely, when the rate of growth in income slows, manufactured exports will be adversely effected.

Those focusing on policy matters have stressed that the international arrangements in force during much of this period contributed to the rapid growth of trade. The removal of trade barriers on manufactures was one of the relevant policy features. However, the period was also marked by a relatively free movement of international capital and floating exchange rates.

Governments often preferred to manipulate capital flows and exchange rates to resolve balance of payments problems rather than use import restraints.

Table 3.2 provides a different view of world trade. The figures show manufactured exports both as a share of total exports and as a percentage of non-oil exports (i.e. excluding SITC 3). The share of manufactures in total exports has tended to rise throughout the world. By 1986, three-quarters of all exports from DMEs were manufactures. The proportion of manufactures in the exports of developing countries, though much lower, has also risen since 1970. Figures for the CPEs reflect a somewhat different trend. These countries are somewhat less dependent than the DMEs on manufactured exports. The share of manufactures in their total exports fell during the last ten years.

Dramatic changes in the price of oil are the major reason for the sometimes erratic movement in the share of manufactures. The effects of oil price increases in 1973 and again in 1978–9 can be seen from the year-to-year changes in the figures in Table 3.2. The importance of this commodity in the exports of developing countries (and, to a lesser extent, in CPEs) explains the sharp drop in the share of manufactures during these two periods. Owing to the significance and volatility of oil prices, a clearer indication of the manufacturing sector's contribution to world exports is obtained when trade in crude oil and refined petroleum (SITC 3) is excluded. The long-term rise in the share of manufactures in non-oil exports is readily apparent. Manufactures accounted for two-thirds of the world's non-oil exports in 1970, but by the mid-1980s more than three-quarters of the total was in this form.

The exclusion of oil reveals a modest rise in the share of manufactured exports of CPEs since 1970. The increase is much sharper, however, in the case of developing countries. By 1985 the share of manufactures in the non-oil exports of these countries was approaching that of industrialized countries. This result should dispel the notion that developing countries are dependent on exports of agricultural products. Furthermore, the rise in the share of fuel exports in the 1970s was due largely to price effects and did not reflect any shift in the underlying composition of the commodities being exported by developing countries. The same observation would not apply to manufactures. The rising share of manufactures in the exports of developing countries cannot be attributed primarily to price effects, but was the result of more fundamental changes in the structure of production.

Other features of world trade in manufactures are given in Table 3.3. The value of manufactured exports rose impressively throughout the 1970s. This is a continuation of a trend dating back to the 1950s. Growth faltered in the early 1980s but then resumed its upward movement, recovering dramatically in 1986. The predominance of DMEs is also clear from the table. These countries have accounted for 80–85 per cent of world trade in manufactures in almost every year since 1970. In contrast, the CPEs' share of world trade in manufactures has steadily declined. By the early 1980s, the value of this group's manufactured exports had fallen below that of the developing countries.

Table 3.2 Share of manufactures[a] in total exports, by economic group, 1970–86 (percentages)

Economic group	Basis[b]	1970	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World	A	60.9	57.4	57.0	57.5	60.4	57.5	54.2	55.1	56.3	57.8	59.3	61.4	66.6
	B	67.1	71.1	71.5	71.7	72.9	72.2	71.4	72.6	73.3	73.4	73.9	75.6	76.1
DMEs	A	71.9	73.1	73.5	74.1	74.8	72.8	70.9	71.1	71.5	71.5	71.9	73.5	75.6
	B	74.4	77.0	77.4	78.0	78.4	77.3	76.2	77.1	78.0	77.8	78.1	79.8	79.6
CPEs	A	58.2	55.2	54.5	53.9	54.9	52.5	49.8	49.1	47.5	47.1	47.0	47.2	51.2
	B	63.9	66.8	67.1	66.7	67.9	68.0	67.2	67.8	67.8	68.3	68.4	67.5	68.1
Developing countries	A	17.3	15.1	16.6	17.3	21.0	19.8	17.7	20.6	22.8	27.4	31.4	34.6	43.6
	B	25.9	37.0	40.3	40.3	44.5	46.1	47.1	51.9	53.0	55.4	58.4	61.2	63.7

Source: United Nations, Monthly Bulletin of Statistics, various issues.

a/ SITC 5 through 8 less 68.

b/ A = manufactures as percentage of total exports; B = manufactures as percentage of total exports excluding SITC 3, mineral fuels and related materials. All figures calculated from data expressed in current prices.

Table 3.3 World exports of manufactures[a] and the shares of the major economic groups (US$ billion and percentages)

Year	World exports of manufactures: Total US$ billions	World exports of manufactures: Percentage increase over preceding year	Developing countries/areas: Share in world exports	Developing countries/areas: Exports to DMEs	CPEs: Share in world exports	CPEs: Exports to DMEs	DMEs: Share in world exports	DMEs: Exports to DMEs
1970	189.9	15.2	5.0	3.1	10.0	1.5	85.0	63.9
1971	216.0	13.7	5.2	2.7	9.6	1.5	85.2	64.2
1972	258.9	19.9	5.7	3.6	9.9	1.5	84.4	64.1
1973	346.9	34.0	6.7	4.5	9.4	1.6	83.9	63.2
1974	458.4	32.2	6.8	4.3	8.5	1.7	84.7	60.6
1975	500.1	9.1	6.3	3.7	9.3	1.6	84.4	56.4
1976	564.4	12.8	7.5	4.8	8.9	1.6	83.6	57.2
1977	647.3	14.7	7.8	4.8	8.9	1.6	83.3	56.9
1978	784.0	21.1	8.1	5.1	8.7	1.5	83.2	57.1
1979	941.0	20.0	8.7	5.4	8.4	1.7	82.9	58.5
1980	1 085.9	15.4	9.1	5.3	8.1	1.5	82.8	57.2
1981	1 083.2	-0.3	10.3	5.8	8.2	1.5	81.5	54.1
1982	1 040.4	-4.0	10.7	6.2	8.5	1.6	80.8	54.3
1983	1 048.6	0.8	11.8	7.4	9.0	1.6	79.2	55.3
1984	1 132.1	8.0	13.1	8.5	8.4	1.5	78.5	56.5
1985	1 186.2	4.8	13.5	8.3	8.0	1.3	78.5	57.3
1986	1 411.4	19.0	13.1	8.5	8.1	1.4	78.8	59.9

Source: United Nations, Monthly Bulletin of Statistics, various issues.

a/ SITC 5 through 8 less 68.

Curiously, the export shares in the two groups of developed countries have evolved along lines that are different from the corresponding trends in world production of manufactures. In the case of MVA, CPEs have claimed a steadily growing proportion of the world total while the dominance of DMEs has waned (see Table 2.1). The situation is different in the developing countries. Their share of manufactured exports has grown modestly but steadily and roughly parallels movements in world MVA.

A third view of trading patterns is given in Table 3.3, which shows the direction of trade. Because the DMEs are the largest importers of manufactures, their share in each group's exports is shown separately. In every year since 1970, more than one-half of the world's exports of manufactures have been intra-trade between DMEs. In contrast, the proportion of CPEs' exports to DMEs is negligible and has remained so since 1970. The developing countries, too, are only minor suppliers of manufactures to DMEs. Their share, however, rose rapidly after 1975.

The disproportionately large amount of manufactured trade among DMEs is inconsistent with the most popular model to explain the commodity pattern of world trade. According to the H–O model, factor requirements differ across products and factor endowments differ across countries. Therefore, a country will have a comparative advantage in (and will export) those products that require the country's abundant factors of production. The theory would predict, for example, that China, a labour-abundant country, would export textiles and apparel, labour-intensive products, whereas the USA, a capital-abundant country, would export aircraft and heavy machinery or other capital-intensive products. A second prediction is that the bulk of world trade would be bilateral trade between countries with different factor endowments. A corollary is that there would be little trade between countries with similar factor endowments. Although the factor endowments of DMEs are similar, the share of world exports of manufactures accounted for by trade among DMEs has been invariably high.

Because the trends described in the foregoing tables are merely averages for groups of countries, they may conceal large shifts in individual economies. This introductory section concludes with a brief look at movements in the share of manufactured exports in selected countries. Table 3.4 shows that among the DMEs the rise in the share of manufactured trade was greatest for Japan, although substantial increases were also recorded in other countries. The lowest shares in 1986 are shown for the UK, which is an oil exporter, and the USA – a major exporter of agricultural products. In several developing countries the rise in the share of manufactures has been even more dramatic. The exports of Brazil, Malaysia and Thailand included very few manufactures in 1965, but by the mid-1980s these goods were an important source of foreign exchange. Progress was no less impressive in other countries (for example, Pakistan, the Republic of Korea and Singapore) which already had a significant base of manufactured exports.

Table 3.4 Share of manufactures[a] in total exports of selected countries and areas (percentages)

	1965	1970	1975	1980	1986
DMEs					
France	60.9	73.7	75.5	73.1	75.6
Germany, Federal Republic of	78.8	87.5	86.8	84.3	87.6
Italy	71.4	82.9	82.8	83.7	87.1
Japan	73.3	92.5	94.4	94.5	96.5
United Kingdom	76.0	80.1	80.6	71.5	72.8
United States	59.7	66.5	65.7	64.4	70.6
Developing countries and areas					
Brazil	5.0	13.4	25.3	37.2	35.1[b/]
Hong Kong	92.4	92.6	92.9	91.1	91.2
India	46.7	51.9	44.9	58.6	49.2[c/]
Malaysia	5.6[d/]	9.7	17.3	18.8	26.5[e/]
Pakistan	36.0	58.8	54.4	48.7	67.2[e/]
Republic of Korea	52.0	76.7	81.4	89.6	91.8
Singapore	28.9	27.5	41.5	43.1	58.8
Taiwan Province[f/]	...	84.8	83.6	90.8	93.3
Thailand	2.0	5.4	15.1	25.0	38.1[g/]

Sources: United Nations, Yearbook of International Trade Statistics, various issues.

a/ SITC 5 through 8 less 68
b/ 1983
c/ 1982
d/ 1968
e/ 1984
f/ Data are derived from the Statistical Yearbook of the Republic of China, various issues. Trade data follow the Chinese Commodity Classification which is not comparable to the SITC classification. Manufactured exports were regarded as being represented by section 3-4 after exclusion of processed food exports.
g/ 1985

In conclusion, the figures presented here represent only a brief survey of global trends in manufactured trade. It is clear, however, that the growth of world income and the internationalization of markets have contributed to a dramatic increase in manufactured exports. The growth of trade in manufactures was most rapid when the world economy itself was growing rapidly. Once that rate slowed, the pace of manufactured exports also subsided. But even during this later period, exports of manufactures continued to expand at rates exceeding those of non-manufactured exports or manufactured production.

The growing share of manufactures in total exports represents only part of the overall adjustment process. Of equal importance are the underlying shifts that must have occurred in order to accommodate a reorientation of this magnitude. Trade theory offers a natural point of departure for an examination of these issues. The following section considers trading patterns in terms of alternative trade theories.

The inter-industry structure of world trade in manufactures

Long-term patterns of trade in manufactures can be more easily linked with underlying determinants if traded goods are grouped in a relatively few categories which, in turn, can be associated with existing trade models. The Ricardian, H–O and product-cycle models were chosen for this purpose. When industries are arranged in such a manner, they represent a continuum of trade which reflects the importance of various factors of production. Although these factors can be identified only in generic terms, the results provide a rough indication of the types of industries in which countries specialize. The statistical classification used to construct these three trade categories draws upon previous studies (Hufbauer and Chilas, 1974; Hirsch, 1974; UNIDO, 1981) and is presented in the statistical appendix (Appendix B).

A Ricardian interpretation

Manufactures containing a high proportion of domestic natural resources are described as Ricardian goods. A country's ability to produce these goods and to compete in international markets is determined largely by the quality and amounts of its resource endowments. The direction of world trade in Ricardian goods is generally expected to be from developing to developed countries, because much of the world's supply of natural resources is found in developing countries. The existing distribution of natural resources is due primarily to chance, as in the case of oil, where the bulk of world reserves are located in the Middle East. In the case of some resources, the domestic supplies of developed countries provided the original impetus for industrialization and were subsequently depleted – for example, the oil reserves of the USA or coal and other minerals in Europe.

Although the world's distribution of resource endowments is usually pictured as being static, international patterns of comparative advantage in Ricardian goods may change over time. For example, the discovery of new resource deposits – particularly those that are easily extracted or of a superior quality – can shift the pattern of international trade. The development of new technologies for extraction, steady reductions in the cost of transport, and the emergence of substitutes will also affect various suppliers.

Broad shifts in the priorities of the state have also altered the global distribution of natural resources. Beginning in the 1970s, governments in several developing countries made the exploitation of their natural resources a high priority. Chile, for instance, is presently the world's largest producer of copper. Roughly 80 per cent of this production is controlled by Codelco, the state-owned mining corporation. Similarly, Brazil's state-owned Carajás mine is the world's largest supplier of iron. The mine, which contains 20 billion tonnes of high-quality iron ore, has an annual output nearly matching production of the entire US industry in 1983. In fact, developing countries that are rich in natural resources often find that this richness represents a disincentive in the choice of appropriate development policies and trade strategies. They will frequently encounter a natural resource bias (Ranis, 1981, pp. 215–20) and will fail to develop fully the exports of simple, labour-intensive manufactures (Bradford, 1987, pp. 302–5). Such a bias is not observed among the resource-poor countries of Asia, but it does seem to have occurred in Latin America.

An H–O interpretation

H–O goods lack the resource dependency associated with Ricardian goods. One distinguishing characteristic is that these goods are produced with production technologies that are everywhere the same. Economies of scale are assumed to be absent, while product specifications are simple or at least universally accepted. In other words, H–O goods represent a fairly orthodox set of manufactures where the ability to compete in international markets depends not on natural resource endowments but on the country's availability of labour and capital. The real marginal product of each factor depends on the ratio in which labour and capital are combined. Even though the relative prices of the two factors may differ between countries, a good whose production in one country is labour-intensive, for example, will be labour-intensive when produced elsewhere.

The likely direction of trade in H–O goods is not so clear-cut as in the case of Ricardian goods. Developing countries are expected to be relatively labour-abundant and therefore important exporters of labour-intensive goods. Developed countries, on the other hand, are usually well endowed with capital relative to labour and should excel in the export of capital-intensive goods.

A product-cycle interpretation

The characteristics of the third category, product-cycle goods, involve production technologies that are neither stable nor universally available. Instead, they are possessed by the firms that have designed and developed the product or the crucial production process. Access to this knowledge is limited through patent protection or because the research costs required for duplication are great. The prominent role accorded technology means that a third factor of production becomes an important determinant of competitive ability. In addition to unskilled labour and capital, a country's availability of skilled labour (managers, scientists and engineers) will determine export prospects.

Most versions of the product cycle assume that products systematically pass through several stages. Production in the first stage is characterized by the 'instability' of product design, a heavy dependence on skilled engineers and relatively large outlays for research and development. A second stage is entered once product characteristics are standardized. Input requirements then become more capital-intensive and long production runs are common.

Eventually, the product becomes a mature one with the labour-intensive parts of the production process (for example, the testing of parts and components and their assembly) being carried out in developing countries.

As products pass through these stages, a process of maturation occurs which alters the relative importance of the different factors of production. The technologies and know-how that generated economic rents for innovators and fast imitators become diffused as patents expire or as the knowledge is transferred to others in the form of licences, joint ventures or other types of inter-firm collaboration.

Once production is characterized by a series of standardized operations, the availability of skilled labour is less critical. As with H–O goods, the availability of unskilled labour and physical capital becomes the major determinant of comparative advantage. Not all phases of the production process – from conception to final assembly – are necessarily subject to this sort of evolution. Nevertheless, it is likely that specific production stages may be converted into mature, standardized operations.

The conception and development of new products and processes will continue to make considerable use of engineering skills and to require significant outlays for R and D. Later stages, such as the production of components and parts, often come to be characterized by much longer production runs. As the size of production facilities is expanded, the possibilities for automation grow and input requirements become more capital-intensive. Still other stages will consist in the testing of parts and components and their assembly into finished goods. After standardization, these operations will be relatively intensive in their use of unskilled labour. Developments such as these have had a profound effect on the selection of production sites. Various stages of production are located in countries that are endowed with specific factors.

The direction of trade will depend on the position of the product in the cycle. Mature goods, components and semi-finished products will conform to the trade predictions of the H–O model. Relative costs of labour and capital will determine comparative advantage. Developed countries should be the major suppliers of mature goods that have capital-intensive requirements, while developing countries are expected to export mature labour-intensive products. Expectations are different for product-cycle goods that are not mature. The ability to compete in international markets will depend not only on the availability of capital, skilled labour and unskilled labour, but also on access to the relevant technologies and related know-how. Some countries try to secure this information through foreign investment or by arranging joint ventures, licensing agreements and other forms of collaboration with technological leaders. However, because innovators are often reluctant to see their knowledge dispersed, they do not always supply the most vital technologies and related information.

The effects of these informal barriers are compounded by other difficulties inherent in the nature of the technology. Scientific knowledge, or know-how, may be transferred or taught. But mastery of the necessary scientific principles is not always sufficient for their application in manufacturing operations. There is also a 'know-why' component, which is required for adaptation and modification of products and processes in new locations and markets. This element is often locked in the experience of individuals and is less easily conveyed. The only alternative may then be to replicate the necessary know-how or to develop rival versions. This approach can be costly for countries having a shortage of scientists and engineers. The problems involved in the transfer of technology imply that products may not always move smoothly through the cycle described here. Countries that are the technological leaders in particular product lines may continue to be the major suppliers for long periods of time.

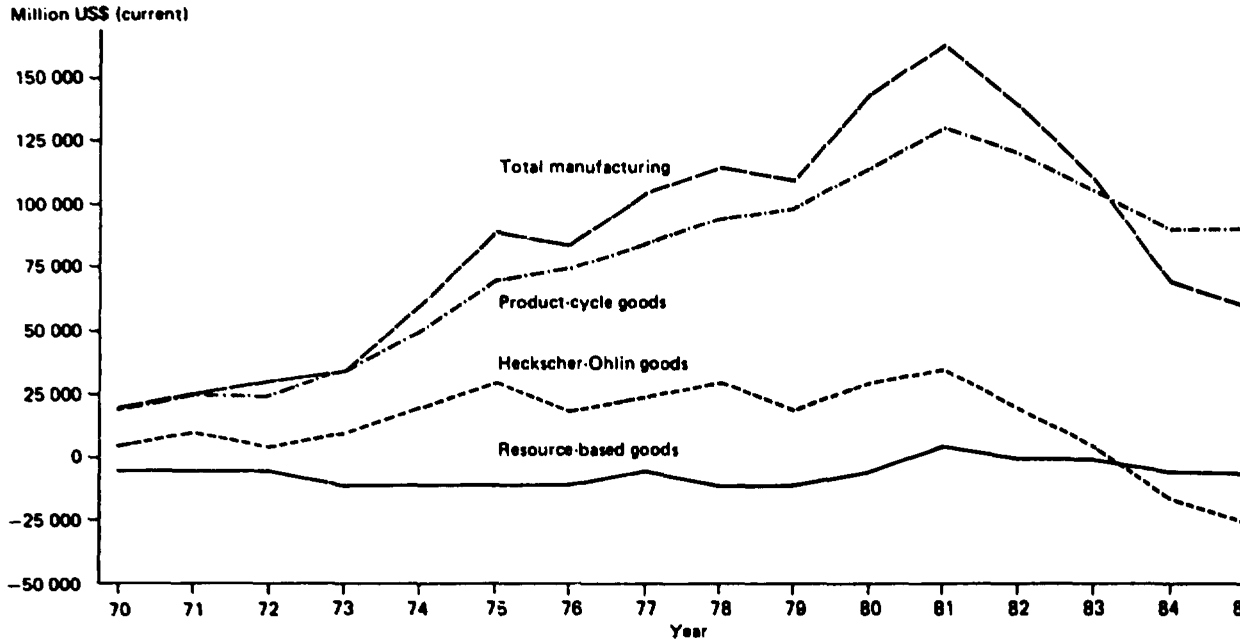
The foregoing description is merely a stylistic representation of the three trade models of interest here. The actual number of theoretical expositions and interpretations of each model are many. Each model is distinguishable in terms of those factors of production that will be the most important determinants of the composition of trade. Based on very general impressions of the international distribution of factors and factor requirements, the expected directions of trade have been hypothesized.[1]

Stylized evidence of trading patterns

A picture of international trading patterns in each of these product categories is assembled in this section. Conventional statistical definitions of trade in manufactures are not suitable for this purpose. Instead, an 'ISIC equivalent' of manufactured trade is used and can be found in the statistical appendix (Appendix B). Figures 3.1 and 3.2 refer to the trade of DMEs and developing countries, respectively. They show year-to-year changes in the composition of manufactured trade in each of the three product categories described above.

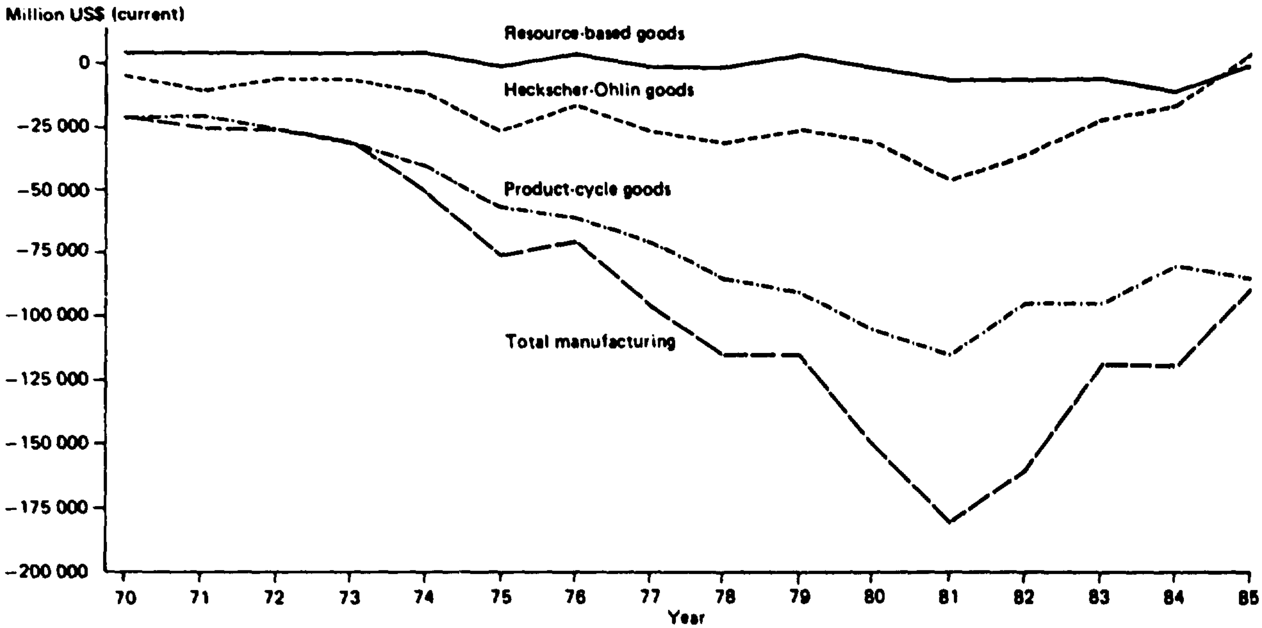
The two figures paint a very clear picture. In the case of Ricardian (resource-based) goods, comparative advantage did not change during the 1970–85 period. Developed countries are small net importers and developing countries are small net exporters. The experience for H–O goods is different. Net exports of developed countries increased steadily during the 1970s. However, there was a definite break in the trend in the early 1980s in favour of developing countries. By 1983 the developing countries were net exporters rather than net importers. A similar pattern exists for product-cycle goods, except that the developed countries remain significant net exporters.

These figures provide a basis for several general impressions. First, the data for Ricardian and product-cycle goods show that trade has been in the expected direction for both country groups. Although the H–O theory provides no explicit indication of the direction of trade, the results obtained are not surprising. Second, net trade in total manufactures in both groups of countries is determined primarily by performance in product-cycle goods



Source: UNIDO

Figure 3.1 Net exports of developed market economies, by product category, 1970–85



Source: UNIDO

Figure 3.2 Net exports of developing countries, by product category, 1970–85 and, to a lesser extent, by H–O goods. Ricardian goods play only a minor role. Third, a similar relationship applies when year-to-year changes in net exports of each trade category are considered. Ricardian goods exhibit a fairly stable trend. Curiously, perhaps, the wide swings in commodity prices that characterized much of the 1970s and 1980s are not reflected in the aggregate figure for trade in this category. Year-to-year movements in net exports of H–O goods have been more volatile, with even greater swings for product-cycle goods.

The evidence summarized in Figures 3.1 and 3.2 refers to a large number of diverse countries. More specific data are desirable in order to obtain a clear picture of trade performance in each of these categories. Table 3.5 provides figures on the net trade of individual countries. The comparative abundance of natural resources in several countries included among 'other DMEs' (e.g. Australia, Canada, New Zealand and Norway) is reflected by the favourable trade position of that sub-group with regard to Ricardian goods. The resource abundance of the USA, on the other hand, is negated by the large amounts of oil imports (SITC 331 and 332). CPEs are also net importers of Ricardian goods, although these results may be partly a statistical anomaly owing to the lack of data on trade between these countries.[2]

Trade patterns for H–O goods are of more interest. The increase in net exports during the 1970s can be attributed largely to Japan, with smaller increases being recorded by the Federal Republic of Germany and Italy. These developments were outweighed by a steady rise in net imports of the USA. The net trading position of the USA gradually deteriorated during the 1970s but net imports of H–O goods soared in the 1980s. By 1985 the country's imbalance in H–O trade exceeded the combined net exports of France, the Federal Republic of Germany, Italy and Japan.

Of the three categories, net trade in product-cycle goods has been the most volatile. Between 1970 and 1980, the DMEs' net exports rose almost sixfold. Later years brought further improvements in three of the six large countries. Surprisingly, the USA recorded a trade surplus of $44 billion in 1980 but had become a net importer of product-cycle goods by the middle of the decade. This turnaround, which occurred during a period of significant dollar appreciation, was very abrupt: by 1985 US net imports almost equalled the combined figure for all CPEs. Despite the US downturn, net exports of product-cycle goods by all DMEs were $91 billion, a total that was 47 per cent larger than net exports of all manufactures in 1985.

Swings of this magnitude would be due to multiple causes. The totals reported here for net exports in all product categories combined must reflect, and be influenced by, exchange rates, international capital flows and other determinants of the balance of trade. The relative importance of each respective trade category, however, depends on the underlying determinants of comparative advantage. These, in turn, are indicated by the data in Table 3.6. The percentages reveal little of the volatility typical of net exports. The decline in the share of Ricardian exports has been gradual

Table 3.5 New manufactured exports of developed countries, by trade category,[a] 1970–85 (US$ million)

Economic group/country	Ricardian goods				Heckscher Ohlin goods			
	1970	1975	1980	1985	1970	1975	1980	1985
DMEs total	-6 075	-7 883	-3 821	-6 071	7 287	29 369	30 366	-23 099
France	-1 110	-1 280	2 762	2 213	2 560	8 042	9 363	5 017
Germany, Fed. Rep. of	-3 787	-4 572	-7 525	-4 183	4 957	11 189	17 867	23 955
Italy	2 290	-4 397	-9 954	-7 522	3 570	11 699	17 536	18 593
Japan	-1 858	-4 884	-10 040	-9 041	7 419	21 904	45 138	56 280
United Kingdom	-4 641	-7 701	-11 069	-8 559	3 330	2 162	657	-8 763
United States	-1 348	-977	1 400	-10 240	-6 863	-10 637	37 400	108 872
Other	8 960	15 929	36 130	35 686	-7 685	-15 991	-22 794	-9 309
CPEs, total	442	-1 850	-5 031	62	-123	-2 041	2 962	6 548

Economic group/country	Product-cycle goods				Total manufactures			
	1970	1975	1980	1985	1970	1975	1980	1985
DMEs total	19 589	68 041	11 6871	90 856	20 801	89 507	143 416	61 687
France	-59	3 318	2 221	3 838	1 392	10 080	8 822	6 642
Germany, Fed. Rep. of	9 439	26 144	39 716	35 992	10 609	32 760	50 057	55 764
Italy	1 172	3 161	3 721	5 886	2 452	10 663	11 302	16 955
Japan	5 416	19 731	45 907	75 636	10 977	36 751	81 005	122 875
United Kingdom	3 486	7 693	13 504	3 557	2 174	3 135	3 092	-13 764
United States	10 495	26 858	44 597	-6 070	2 284	15 244	8 597	-125 182
Other	-10 361	-19 064	-32 794	-27 980	-9 086	-19 126	-19 459	-1 603
CPEs total	1 587	7 644	-8 315	-8 626	-1 244	-11 761	-10 386	-4 016

Source: UNIDO

a/ Trade categories and country groups are defined in the statistical appendix.

Table 3.6 Manufactured exports of developed market economies, by trade category, 1970–85 (percentages)

	Ricardian goods				Product-cycle goods				Heckscher-Ohlin goods			
	1970	1975	1980	1985	1970	1975	1980	1985	1970	1975	1980	1985
DMEs total	16.3	13.6	14.5	12.1	42.6	44.0	42.8	45.7	41.0	42.5	42.7	42.2
France	12.5	12.2	13.4	12.0	36.0	38.0	37.2	41.1	51.5	49.8	49.4	46.9
Germany, Federal Republic of	5.9	6.9	8.9	8.4	50.5	49.9	46.2	46.7	43.6	43.2	44.9	44.9
Italy	5.3	5.2	5.5	6.2	39.8	36.5	34.7	37.0	54.9	58.2	59.8	56.7
Japan	4.8	3.2	3.3	2.1	45.3	46.8	47.9	54.8	49.8	49.9	48.8	43.1
United Kingdom	9.6	8.8	10.5	8.5	47.6	51.3	51.6	55.3	42.8	39.9	37.9	36.2
United States	15.5	12.8	15.5	10.8	56.3	56.9	58.0	61.9	28.2	30.3	26.5	27.3
Other	30.9	24.9	25.1	22.0	31.2	34.5	32.3	33.4	37.9	40.7	42.7	44.6

Source: UNIDO.

and reflects the comparative scarcity of resources in West Europe and Japan. The share of product-cycle goods has tended to rise, while that of H–O exports has declined slightly in most developed countries. In 1985 product-cycle goods accounted for more than half of all manufactured exports by the USA, Japan and the UK. Changes in the composition of US exports are also noteworthy when considered in relation to the figures in Table 3.5. Despite a significant fall in net exports of product-cycle goods, the category's share in the country's total manufactured exports is large and growing. By 1985, nearly two-thirds of US manufactured exports were product-cycle goods. A similar pattern applied to trade in H–O goods. Although the US net exports of H–O goods declined by $102 billion between 1970 and 1985, their share in the country's total manufactured exports fell only marginally.

Table 3.7 provides evidence for the developing countries which is comparable to that in Table 3.5. Because trade performance in these countries varies so widely, selected sub-groups have been singled out for attention. Both first- and second-generation NIEs have consistently been modest net exporters of Ricardian goods. Few of these economies are particularly well endowed with natural resources, and some (e.g. Hong Kong and Singapore) have almost none. Instead, the favourable trade balances achieved by these countries result from the fact that they are efficient processors of imported materials from which higher-stage goods are then exported. The remainder of developing countries have an unfavourable balance of trade in Ricardian goods and this total has risen over time.

In the case of H–O goods, the model suggests that developing countries will be important exporters of labour-intensive goods. This expectation, which has been confirmed by other studies (e.g. Lary, 1968; Tuong and Yeats, 1980), should be consistent with the figures in Table 3.7. Although the classification used here does not distinguish between labour- and capital-intensive H–O products, a switch in the developing countries' trade position from a deficit of $32 billion in 1980 to a surplus of $4.5 billion in 1985 can be observed. The improvement was due predominantly to the gains of the NIEs. Other developing country groups were net importers, though the size of these deficits fell between 1980 and 1985.

Data for product-cycle goods show that net imports rose significantly in 1970–80 but declined slightly in later years. Imports are nevertheless substantial (more than $84 billion in 1985) and explain much of the overall trade deficit of developing countries. In 1970 net imports of product-cycle goods were equivalent to 86 per cent of the overall net trade deficit of developing countries, and by 1985 they amounted to 96 per cent of this total. Among the sub-groups of developing countries, only the NIEs appear to have managed a moderate improvement in their trade position, though they too are still net importers.

These trends may be re-examined in terms of the composition of manufactured exports from developing countries. Table 3.8 shows large changes in the export composition in comparison with those observed for DMEs

Table 3.7 Net manufactured exports of developing countries and areas, by trade category,[a] 1970–85 (US$ million)

Economic group/subgroup	Ricardian goods				Heckscher-Ohlin goods			
	1970	1975	1980	1985	1970	1975	1980	1985
Developing countries and areas								
Total	4 456	1 851	-1 474	-396	-7 354	-25 140	-32 130	4 510
NIEs	455	935	2 448	2 630	-424	543	12 456	31 552
Second-generation NIEs	1 225	1 904	4 487	5 412	-1 946	-5 781	-11 587	-3 742
Other developing countries	2 275	-989	-8 410	-8 439	-4 984	-19 902	-33 000	-23 300

Economic group/subgroup	Product-cycle goods				Total manufacturing			
	1970	1975	1980	1985	1970	1975	1980	1985
Developing countries and areas								
Total	-17 511	-53 223	-103 756	-84 333	-20 381	-75 755	-148 586	-87 721
NIEs	-5 367	-12 696	-23 438	-8 808	-4 989	-11 219	-8 534	25 374
Second generation NIEs	-2 523	-8 277	-16 893	-12 252	-3 110	-12 153	-23 992	-10 582
Other developing countries	-96 211	-32 250	-63 425	-63 273	-12 283	-52 383	-116 060	-102 512

Source: UNIDO

a/ Trade categories and economic groups of developing countries and areas are defined in the statistical appendix.

Table 3.8 Manufactured exports of developing countries and areas, by trade category, 1970–85 (percentages of total manufactured exports)

	Ricardian goods				Product-cycle goods				Heckscher-Ohlin goods			
	1970	1975	1980	1985	1970	1975	1980	1985	1970	1975	1980	1985
Developing countries/areas, total	46.8	36.7	25.6	13.3	11.6	13.3	16.6	20.2	43.3	48.4	57.7	66.5
NIEs	32.9	21.9	16.6	7.4	19.6	23.6	27.5	31.0	53.4	54.6	55.9	61.6
Second-generation NIEs	80.4	66.3	51.2	31.4	2.5	8.6	14.6	7.6	17.1	25.1	34.2	61.1
Other developing countries	47.1	38.8	28.7	20.0	9.6	9.9	10.9	16.4	43.4	51.3	60.4	63.6

Source: UNIDO

(see Table 3.6). The share of Ricardian goods in manufactured exports has declined significantly, and the average for all developing countries is now little more than the corresponding figure for DMEs. The decline was proportionately greatest among second-generation NIEs but also occurred in both other country groups. Among the NIEs, the decline in Ricardian exports was largely offset by a rise in the share of product-cycle goods. The same was not true of second-generation NIEs or other developing countries. In these countries, exports of H–O goods accounted for most of the shift away from Ricardian exports. The increase in the share of product-cycle goods was less impressive.

One feature that reappears throughout the evidence assembled in this chapter concerns the dynamic character of world trade. Before turning to more detailed aspects of trade and specialization, it would be helpful to obtain a comparative picture of the pace of change in the export composition of DMEs and developing countries. For this purpose, summary measures of structural change (expressed in percentage points) have been calculated and are shown in Table 3.9. Also given in the table are calculations showing the extent to which changes in export structure have been consistent over time. The latter index takes a value of unity when there have been no reversals in movements of industry shares (that is, when there has been total consistency over time) and of zero when year-to-year changes cancel out completely.

When group averages are compared, the results match casual expectations. The degree of change has been greatest for the second-generation NIEs, followed by first-generation NIEs and DMEs. Among individual countries, those experiencing a substantial degree of change also tend to have relatively high rates of export growth within the respective groups. Exceptions to this pattern can be noted, however. The composition of Argentina's exports, for example, has changed considerably, though the rate of export growth has been lowest of all NIEs. Similar comments apply to Australia, Colombia and Peru.

In conclusion, this survey has found a large measure of agreement between the interpretations offered by various trade models and the observed patterns of inter-industry trade. There was, however, a degree of unpredictability for both developing countries and DMEs. Changes in the composition of trade were sometimes substantial (whether measured in relative or absolute terms) and occurred over surprisingly brief time spans. The dynamic character of trade in manufactures may be more closely examined by restricting attention to the fastest-growing trade component.

Table 3.9 Structural change in manufactured exports 1970–2 to 1983–5 (DMEs and selected developing countries and areas)

Countries and areas[a]	Structural change indicator[b]	Indicator of consistency[c]
DMEs[d]	23.6	0.16
Ireland	44.6	0.25
Iceland	16.7	0.07
Israel	36.6	0.17
Spain	34.3	0.20
Greece	42.6	0.17
Japan	28.2	0.20
Finland	23.3	0.14
Portugal	30.9	0.17
Austria	16.2	0.14
Italy	13.0	0.10
Canada	16.6	0.12
Netherlands	20.4	0.16
United States	14.7	0.11
France	15.2	0.13
Germany, Federal Republic of	12.7	0.11
Switzerland	17.7	0.15
Denmark	20.0	0.16
Sweden	16.7	0.14
New Zealand	28.0	0.18
Belgium	22.6	0.18
United Kingdom	21.1	0.16
Australia	32.1	0.17
Norway	19.0	0.10
NIEs	36.2	0.17
Republic of Korea	48.1	0.23
Singapore	27.5	0.16
Mexico	42.2	0.14
Brazil	44.4	0.15
Taiwan Province	22.2	0.18
Hong Kong	25.3	0.18
Argentina	43.8	0.1
Second-generation NIEs[e]	51.3	0.16
Jordan	51.5	0.11
Indonesia	32.4	0.08
Cyprus	57.6	0.23
Thailand	48.6	0.22
Malaysia	49.9	0.21
Tunisia	62.7	0.12
Morocco	54.4	0.21
Philippines	47.1	0.19
Colombia	52.2	0.12
Sri Lanka	43.7	0.19
Peru	63.7	0.06

Table 3.9 continued

Countries and areas[a]	Structural change indicator[b]	Indicator of consistency[c]
Other significant exporters of manufactures	36.6	0.13
China	37.5	0.11
Yugoslavia	28.4	0.15
Turkey	62.6	0.21
Pakistan	25.7	0.11
India	28.9	0.08

Source: UNIDO.

a/ Countries are ranked within each group by the rate of growth of manufactured exports between 1970-1972 and 1983-1985.

b/ The indicator of structural change (C) is defined as

$$C = \frac{1}{2} \sum_{i=1}^{m} | a_{iT} - a_{i0} |$$

where m is the number of industries and a_{it} is the share of industry i in total manufactured exports in period t. Industries were defined at the three-digit level of the SITC and shares were calculated as three-year averages for 1970-72 (t = 0) and 1983-85 (t = T).

c/ The index of consistency (K) is defined as

$$K = \frac{\sum_{i=1}^{m} | a_{iT} - a_{i0} |}{\sum_{i=1}^{m} \sum_{t=0}^{T-1} | a_{i,t+1} - a_{it} |}$$

where t runs through all years between 1970 (t = 0) and 1984 (t = T-1).

d/ Group averages are unweighted means of the respective indicators.

e/ Uruguay was omitted owing to a lack of sufficiently detailed data.

Notes: Chapter 3

1 These insights, while useful, tell us nothing about the level of trade between countries. Such a lacuna is a serious one but is shared by all fundamental theories of international trade.
2 Because few CPEs provide detailed figures on their international trade, many of the data have been derived from partner-country statistics. Use of this method leads to an underestimation and does not take account of trade between CPEs.

CHAPTER 4

Two-way trade in similar products

The previous chapter portrayed world trade in terms of inter-industry exchanges. Although much world trade is of that form, a large and growing portion takes place within industries. Known as two-way or intra-industry trade (IIT), this is the fastest growing component of global trade in manufactures.

The portion of a country's trade that takes place within, rather than between, industries obviously depends on how industries are delineated. The statistical definition of an industry, however, seldom agrees with its theoretical counterpart. Putting aside this difficulty for the moment, IIT can be defined as the simultaneous import and export of products that are close substitutes, in terms of either factor inputs or consumption, or both. Because trade of this type can not be easily explained in terms of comparative advantages, IIT has played the role of an irritating but stimulating phenomenon for both theorists and empiricists.[1]

Formal models were initially developed in order to identify the circumstances under which IIT would occur. More recently, attention has turned to other aspects of IIT – the gains from trade, the consequences of trade intervention, and the implications for structural adjustment. The interest in IIT grew as its importance in world trade increased and as economists came to realize that certain theoretical and policy implications are different from those associated with inter-industry trade.

The empirical analysis of IIT is complicated by the fact that it occurs in many forms. A number of product categories are likely to exhibit IIT. They include the following:

(a) homogeneous products involved in border trade, entrepôt trade or seasonal trade;
(b) heterogeneous products made in the same industry at vertically adjacent or complementary stages of production;
(c) heterogeneous or differentiated products that are close substitutes in production, consumption or both.

The main determinants of IIT in category (a) are transport costs and seasonal differences in production. Labour cost differentials are the primary reason for the type of IIT described in category (b). This type of trade is sometimes referred to as 'vertical' or 'complementary' IIT, and tends to be of greatest significance in industries dominated by multinational corporations. Because intra-firm IIT depends partly on the complex objectives of multinationals, inferences with regard to its economic determinants are difficult.

The type of IIT described in category (c) can be further divided into the following sub-categories:

(i) products with different input requirements but high elasticities of substitution: examples are furniture made from different materials (steel, plastic, timber or cane), textile yarn from natural or man-made fibres, and footwear of leather or synthetic materials;
(ii) products being produced by industries that transform identical inputs into a range of outputs with different end-uses. For example, the basic iron and steel industry may supply both railway sleepers and heavy plates for shipbuilding; the petroleum industry may produce gasoline or tar but also supply a range of petrochemical products;
(iii) similar products made by similar processes from similar materials. Industries in which this type of IIT occurs are processed food, beverages, textiles, clothing, shoes, cars, furniture, tobacco products, appliances, hand tools, boats, electronic and mechanical data processing equipment and communications equipment.

It is mainly the types of IIT in sub-categories (ii) and (iii) that cannot be easily explained by conventional trade theory and most of its extensions. The basis for this trade seems to be the interaction between a variety of circumstances, many of which are insignificant when considered in isolation. Examples are small changes in production processes or special conditions surrounding the sale of the product. The resulting product differentiation often leads to a situation where plants in different countries produce product varieties that are close substitutes.

Such specialization is inevitable. The production of all varieties would be too costly because it would increase the down-time of machines, the size of inventories and the selling costs. If economies of scale are to be achieved, not all product varieties can be produced in every country. Simultaneous import and export of different product varieties is the result. The following section provides a survey of this type of trade.

An overview of two-way trade

An empirical indicator of IIT should measure 'trade overlap'. Although methods of measurement have been the subject of extensive debate in the literature, the only aspect of particular relevance to this discussion is the need to standardize the value of trade overlap in order to permit cross-country comparisons.

Trade overlap is best expressed as that portion of an industry's exports (imports) which is matched by imports (exports) of the same industry, depending on which of the two values is larger. In mathematical notation, the measure can be stated as

$$\min (X_{ij}, M_{ij})$$

where X_{ij} represents country j's exports of industry i and M_{ij} refers to the corresponding imports. The value chosen to represent two-way trade is then the lower of these two figures.

The popular share measure of IIT introduced by Grubel and Lloyd (1975) is easily derived from the above minimum expression. In the same way as the share of net exports in the sum of exports and imports is used to measure the relative size of 'one-way' trade, the share of IIT in the same total serves as an indicator of the relative size of two-way trade. After multiplying this ratio by 2, the upper bound becomes unity and the lower bound is zero. The expression, which is identical to the Grubel–Lloyd measure,[2] can be written as:

$$\frac{\min (X_{ij}, M_{ij})}{X_{ij} + M_{ij}} \times 2.$$

Much of the literature dealing with the measure concerns the advisability of adjustments to account for trade imbalances. In most applications, however, a correction for trade imbalance is not advisable. The present study will make use of an unadjusted measure of IIT shares, together with a corresponding unadjusted indicator of IIT levels.

Estimates of IIT shares in 1985 are given in Table 4.1. The table is organized as a matrix which shows the proportion of two-way trade between various country groups and among the members of each group. The share of IIT in world trade of the DMEs (42.8 per cent) is considerably higher than that among developing countries (16.3 per cent). Among the developing countries, the NIEs have the largest share of two-way trade. This type of trade is far less important for second-generation NIEs and other developing countries. However, these broad averages conceal substantial variations in the figures for individual countries and country groups. Particularly noteworthy is the case of Japan, which is the only one of the six largest DMEs that does not engage in a relatively large amount of IIT.

The aggregate figures suggest a positive relationship between the level of development and the share of IIT in manufactured trade. Whatever the actual determinants of IIT, the literature on the subject clearly demonstrates that some of them are country-specific or bilateral in nature. Accordingly, the most desirable means of assessing IIT is in terms of bilateral trade flows between countries or country groups. The types of predictions that would

Table 4.1 Average shares of IIT[a] in manufactured goods, by country group,[b] 1985 (percentages)

Economic group/country (number of countries)	Trade with: World	DMEs	Six major exporters	Other DMEs	CPEs	Developing countries	NIEs	Second-generation NIEs	Other developing countries
DMEs (22)	42.8	47.1	45.3	48.3	16.1	15.3	21.6	11.6	12.3
Six major exporters	47.8	54.4	52.8	55.6	20.8	19.9	30.8	19.1	14.3
France	60.1	70.2	69.6	71.3	33.5	13.7	28.2	13.5	10.8
Germany, Fed. Rep. of	56.0	63.9	63.9	62.9	23.4	17.0	27.6	17.9	13.6
Italy	48.0	55.1	55.7	54.0	23.4	19.1	35.7	12.3	16.5
Japan	17.8	22.4	24.0	16.3	6.6	10.3	22.0	7.0	4.2
United Kingdom	60.2	67.7	66.5	69.3	22.5	22.7	26.9	25.3	20.5
United States	44.6	47.6	37.3	59.6	15.2	36.5	44.3	38.7	20.0
Other DMEs (16)	40.9	44.4	42.5	45.5	14.4	13.3	18.2	8.7	11.5
Developing countries and areas (25)	16.3	14.9	15.3	12.5	2.5	16.7	15.8	14.0	18.8
NIEs (6)	29.3	29.8	30.4	26.4	2.7	29.6	32.7	29.0	24.0
Second-generation NIEs (9)	13.3	11.3	11.9	7.9	0.6	17.5	18.2	11.5	13.5
Other developing countries (10)	11.4	9.6	9.7	8.8	4.3	12.8	3.8	7.5	15.5

Source: UNIDO.

a/ In general, the averages of the Grubel-Lloyd measure used in this table are based on data at the four-digit level of the SITC. Determination of these averages consisted of three steps. First, for each of the 47 countries in the sample and for each of the six 'basic' subgroups of trading partners (identified in columns 3, 4, 5, 7, 8 and 9) the IIT share of all manufactures was calculated as a weighted average where the sum of exports and imports was used as the weight. Second, IIT-shares for the 'broad' partner country groups (DMEs, developing countries and world) were derived from the foregoing figures as the same type of weighted average. Third, figures for the groupings of the 47 countries were obtained as unweighted averages of the indices derived in steps one and/or two.

b/ The composition of country groups is given in table 5.1.

result from such an exercise are based on the premise that trading partners that are similar with regard to income levels and market size will tend to have larger shares of IIT in their bilateral trade than those that are not similar.

When trade between a heterogeneous sample of countries is analysed, the similarity hypothesis should lead to substantial variation in the IIT shares for many pairs of countries (or country groups). The results in Table 4.1 bear out this expectation. Looking first at the figures for DMEs, 47 per cent of their intra-trade was in the form of two-way trade. This compares with a share of 15 per cent in the same group's trade with developing countries. In contrast, the developing countries had a slightly higher IIT share in their intra-trade (16.7 per cent) than in their trade with DMEs (14.9 per cent).

Further support for the hypothesis is obtained from data for more narrowly defined groups of countries. Two-way trade between the six largest DMEs accounted for 53 per cent of the group's total intra-trade. With the exception of Japan, all these DMEs report large shares for IIT. The corresponding estimates for the major exporters among developing countries also conform to the hypothesis. The NIEs occupy a middle position between the DMEs and the second-generation NIEs. In terms of the country-similarity hypothesis, the group's shares with 'surrounding' partner groups should be of similar magnitudes, and this is exactly what the figures for the NIEs in Table 4.1 reflect.

Country data also provide evidence supporting the hypothesis. The two-way trade of France, the Federal Republic of Germany and the UK accounts for a substantial portion of all their trade with DMEs and with each other. Results for the USA are somewhat different. The proportion of IIT in that country's trade with developing countries (in particular, the NIEs and second-generation NIEs) is remarkably high. In this instance, country similarities may be of less importance than other economic and/or political factors. The same may apply to the IIT shares of Japan, which in general are far smaller than those of other DMEs.

Although there is wide variation in IIT shares, almost all countries have experienced a rapid increase in this type of trade. Table 4.2 documents the growth in IIT between 1970 and 1985. Increases in the IIT shares were of a similar magnitude for DMEs and developing countries. However, there are fairly wide differences between particular country groups and individual countries. Between 1970 and 1985 the share of IIT in Japan's trade with the world was unchanged, while its share of IIT in trade with other DMEs actually declined. At the other extreme is the UK, where the portion of IIT in world trade rose by nearly 15 percentage points.

Among the developing countries, the increase in the two-way trade of the NIEs was over 15 percentage points, another indication of this group's trade dynamism. The share for second-generation NIEs rose by slightly more than the average for all developing countries, while among the non-NIEs the increase was negligible. These figures suggest that many developing countries have yet to realize the potential for trade expansion that is inherent in two-way trade.

Table 4.2 Change in the average share of IIT in manufactured goods between 1970 and 1985, by country group[a] (differences in percentage points[b])

Economic group/country (number of countries)	Trade with: World	DMEs	Six major exporters	Other DMEs	CPEs	Developing countries	NIEs	Second-generation NIEs	Other developing countries
DMEs (22)	7.7	8.1	7.8	7.3	3.3	7.4	13.5	6.6	4.4
Six major exporters	6.7	5.7	1.8	10.2	3.8	10.9	18.7	15.7	5.9
France	8.2	9.2	8.4	10.4	11.2	7.8	17.3	9.7	5.4
Germany, Fed. Rep. of	5.0	5.4	0.3	9.9	0.1	8.5	20.0	16.1	3.6
Italy	3.7	2.9	0.2	9.5	5.5	10.9	26.7	8.3	8.0
Japan	0.1	-2.9	-3.8	-2.2	-2.7	6.1	15.5	5.1	0.5
United Kingdom	14.9	13.[illegible]	2.5	21.8	2.2	11.5	12.5	19.9	9.4
United States	8.6	6.1	3.0	11.9	6.8	20.5	20.0	34.7	8.4
Other DMEs (16)	8.1	9.0	10.1	6.2	3.1	6.1	11.6	3.3	3.8
Developing countries and areas (25)	8.2	8.9	9.2	6.8	0.5	3.7	4.4	8.0	2.0
NIEs (6)	15.4	18.1	18.2	18.5	1.7	8.0	7.6	17.3	5.5
Second-generation NIEs (9)	9.9	8.6	9.2	4.1	0.1	7.6	7.7	7.1	4.6
Other developing countries (10)	2.5	4.0	4.2	2.7	0.0	-2.5	0.1	3.8	-2.5

Source: UNIDO

a/ The composition of country groups is given in table 5.1.

b/ Figures represent absolute change in percentage points between the beginning and ending year. A minus indicates a decline in the share.

With regard to two-way trade between different country groups, the fastest growing component was the DMEs' trade with NIEs. This applies even to Japan, where the strong emphasis on inter-industry specialization leaves comparatively little room for IIT. A similarly high increase in IIT was observed for the NIEs' trade with second-generation NIEs, while the figures for trade between other groups of developing countries present a mixed picture.

The impression that emerges from this exercise is that the level of IIT is especially sensitive to the economic characteristics of the trading partners. Various economic attributes may be determinants of two-way trade, but the most obvious is the level of income. The estimates of IIT shares and their changes over time suggest a systematic relationship between these two variables. The more developed a country, the greater the portion of IIT in its manufactured trade.[3] Furthermore, when trading partners are similar, the share of IIT in bilateral trade tends to be higher. A more extensive investigation of these generalizations will be carried out in a later chapter.

An industry-specific view of IIT

The discussion in the previous section was concerned mainly with the direction of trade. An alternative line of investigation would focus on the product composition of trade. Much of the theory is concerned with the product structure of inter-industry trade, although the product pattern of IIT is also of interest. The present section provides a documentary account of this aspect.

Table 4.3 shows those industries reporting relatively large shares of IIT in 1985 and accounting for at least 1 per cent of the total in the respective country group. One point that is immediately apparent from this table is the re-emergence of country similarities as a determinant of IIT shares. The share of two-way trade in particular industries tended to be higher for trade within each country group than for trade between DMEs and developing countries. This was particularly true for developing countries, although, on average, this group engages in less two-way trade for all manufactures than DMEs.

From the description of IIT at the beginning of this chapter, it is clear that certain industries are more likely to figure prominently in two-way trade than others. Such industries are identified here on the basis of average shares of IIT calculated over all 47 countries in the sample. According to these global figures (which are not shown), eight industries, which accounted for at least 1 per cent of world trade in manufactures, had IIT shares in excess of 50 per cent. The largest shares were recorded for miscellaneous electrical machinery (SITC 729), plastic materials (SITC 581) and office machines (SITC 714).

When industries were grouped by end-use into capital goods, consumer goods and intermediate goods, high global shares of IIT were found in all three classes. This result is somewhat surprising. Given the variety of differentiated products in consumer-goods industries, the proportion of two-way trade in

Table 4.3 Industries[a] with high IIT shares[b] in trade of DMEs and developing countries and areas, 1985 (percentages)

Country group	SITC	Trade with DMEs	SITC	Trade with developing countries and areas
	581	Plastic materials (74.3)	714	Office machines (54.7)
	729	Other electrical machinery (66.2)	729	Other electric machinery (51.8)
	722	Electric power machinery (66.2)	512	Organic chemicals (41.7)
	734	Aircraft (64.8)	723	Equipment for distributing electricity (42.5)
	512	Organic chemicals (64.3)	722	Electric power machinery (32.3)
DMEs	711	Non-electric power generating machinery (64.0)	711	Power generating machinery (25.5)
	651	Textile yarn and thread (64.0	653	Woven textile fabrics (25.3)
	719	Non-electric machinery and appliances (63.0)	894	Perambulators, toys, games (22.4)
	714	Office machines (62.3)	891	Musical instruments, etc. (22.0)
	541	Medicinal and pharmaceutical products (62.3)	861	Scientific, medical and optical instruments (20.6)
			735	Ships and boats (74.3)
			864	Watches and clocks (69.1)
			894	Perambulators, toys, games (60.2)
Developing countries and areas[c]			729	Other electrical machinery (59.6)
			722	Electric power machinery (50.4)
			714	Office machines (39.3)
			724	Telecommunications apparatus (35.7)
			652	Cotton, fabrics, woven (33.0)
			541	Medicinal and pharmaceutical products (31.8)
			891	Musical instruments (31.0)

Source: UNIDO

a/ Only industries which accounted for at least one per cent of total trade between or within the respective country groups in 1985 are included.

b/ IIT shares, given in parentheses, are weighted averages of four-digit SITC subgroups within each given three-digit group.

c/ The figures in the lower right hand block refer to trade between the 25 developing countries included in the sample and all developing countries for which partner country data were available.

that group was expected to be greatest. Consumer goods, however, do not figure as prominently in two-way trade as expected. Among the top ten industries in the ranking by global IIT shares, only two – pharmaceutical products (SITC 541) and furniture (SITC 821) – fall in this category. By contrast, five out of the top ten were producers of capital goods. They include: non-electric power generating machinery (SITC 711), office machines (SITC 714), electric power machinery (SITC 722), miscellaneous electric machinery (SITC 729) and aircraft (SITC 734). The remaining three industries in this list – organic chemicals (SITC 712), plastic materials (SITC 581) and miscellaneous chemical products (SITC 599) – produce intermediate goods.

The data in Table 4.3 show that the large shares recorded for capital goods result from their prominence in the two-way trade of DMEs – in particular, the trade within that country group. In contrast, the role of consumer goods in two-way trade is positively associated with the developing countries' involvement in world trade. Only one consumer-goods industry (pharmaceutical products) figured prominently in IIT among DMEs. Three others (toys and games, musical instruments, and photographic equipment) had relatively high IIT shares in trade between DMEs and developing countries. And the number increased to five (pharmaceutical products, consumer electronics, watches and clocks, musical instruments, and toys and games) in the trade of developing countries among themselves.

As an indicator of IIT, the empirical measure of 'trade overlap' suffers from certain statistical shortcomings. Depending on the data used to calculate IIT shares, different types of two-way trade flows may sometimes be lumped together. Some of the reasons for the resulting statistical untidiness of measures of IIT have already been mentioned in the introduction to this chapter. The measurement difficulties arising from the fact that different types of IIT are statistically indistinguishable have led some researchers to conclude that an empirical assessment of IIT may be futile. Instead, it has been suggested that empiricists should investigate patterns of change in two-way trade rather than focus on the level or share of such trade (Deardorff, 1984). While the present study does not quite share the pessimism regarding measurement issues, the last part of this chapter considers changes in IIT over time.

Figure 4.1 shows those industries that accounted for at least a moderate portion of world trade in 1970 and experienced substantial increases in IIT shares by 1985. In the case of the aircraft industry (SITC 734), the global share of IIT rose more than 26 percentage points. Gains in the other industries shown in the figure ranged from 10 to 20 percentage points. The industries shown include representatives from all three end-user groups – capital goods, consumer goods and intermediates.

Overall, the trade composition of 90 industries was considered in drawing up Figure 4.1. Of these, 67 recorded an increase in IIT shares between 1970 and 1985. On average, the increases were of a much greater magnitude than decreases. Not only does two-way trade account for a significant portion of

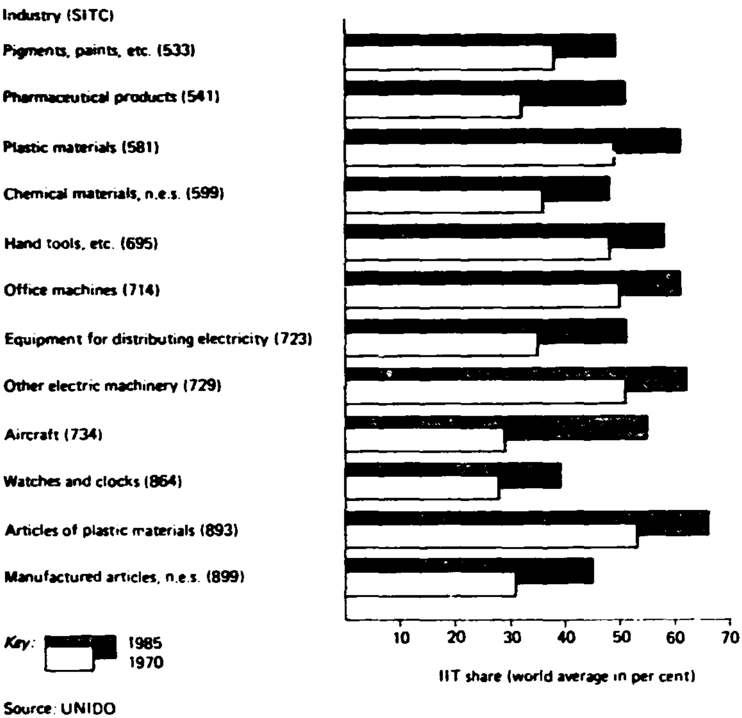


Figure 4.1 Industries with significant increases of IIT, 1970–85

world trade, but its effects are widespread and apply to most of the world's industries.

This chapter completes the 'survey' portion of the book. The evidence of IIT has been examined in a way that highlights particular features that are relevant to the discussion in later chapters. The relationships between country similarities and two-way trade are reconsidered in Chapters 7 and 9 where an empirical investigation of the economies-of-scale model is the focus of discussion. The intervening chapters return to the topics of inter-industrial specialization and inter-industry trade and rely primarily on an H–O framework.

Notes: Chapter 4

1 The subject owes its origins to the unexpected empirical finding that the formation of the Benelux Union and the consequent dismantling of trade obstacles led to greater amounts of intra-industry trade rather than to inter-industry specialization and trade among members; see Verdoorn, 1960. Previous work had acknowledged the role of preference similarities and the interaction between product differentiation and economies of scale as determinants of the composition

of trade in manufactures. However, the link between these hypotheses and IIT had yet to be made explicit.

2 In most studies the expression used is:

$$\frac{(X_{ij} + M_{ij}) - \quad X_{ij} - M_{ij}}{X_{ij} + M_{ij}}.$$

This version obscures the character of the trade overlap. It is useful in another sense, however; it highlights the complementarity between IIT and net trade, an aspect that is stressed in later parts of the book.

3 Japan is an exception. Its IIT share is far below that of other DMEs. One explanation may be that trade impediments restrict IIT more severely than inter-industry trade. The result could also simply reflect the fact that the country's immense export capacity in most industries tends to dwarf competing imports.

CHAPTER 5

International patterns of factor endowments

This chapter, together with the following one, turns from a discussion of the more readily observable features of specialization and trade to their underlying determinants. The chapter begins with an empirical analysis of the distribution of factor endowments and then moves on to the subject of factor abundance. The theoretical models which serve as a framework for the organization and interpretation of the evidence receive particular attention in the following discussion.

In order to explain the pattern of international trade, theorists have considered three broad sets of determinants. One set is technological. These determinants can be represented by inter-country variations in (relative) efficiencies and give rise to comparative advantages through differences in production functions. The Ricardian model of trade provides an example of this line of reasoning. Factor endowments are a second set of determinants. Their effects are highlighted by the factor abundance model, which provides much of the framework for the present study. The third group of determinants is demand-related forces. Although these phenomena have now claimed a place in the literature on trade, there is no equivalent demand-oriented theory of international trade, since the results it could produce are trivial (Dixit and Norman, 1980, p. 3).

Theorists have acknowledged that one deficiency of their work is the lack of a universal model of comparative advantage. In the absence of such a model, the usual practice is to explain comparative advantage in terms of only one set of determinants. The most striking example of this practice is found in the factor abundance approach. In order to highlight the role of inter-country differences in factor abundance, other determinants of comparative advantage are neutralized with the help of specific assumptions. The effects of technology are excluded by the assumption that all countries have access to the same pool of technological knowledge, i.e. share the same production functions which in additon exhibit constant returns to scale. The role of demand is neutralized by the assumption that consumers' tastes are similar, both between countries and across income levels. In theoretical parlance, the latter assumption is known as the postulate of 'identical homothetic preferences'.

Stringent assumptions like these have led to misunderstandings of the role that theory may play in empirical work on trade. Rigorous empirical testing of any trade theory is questionable if the crucial assumptions are far removed from reality. Refutation of such theories would come as no surprise, whereas support would mean little in view of the extreme and often unrealistic assumptions they embody. All this seems to suggest that the prospects for carrying out a convincing empirical application of a particular theory are not bright.

Concerns such as these are valid, but they also ignore one of the main functions of trade theory. The true purpose of most models is to highlight a particular characteristic of trade and not to represent the complete workings of the world trading system. So long as an 'application' is not regarded as a rigorous test of a theory's validity, theoretical propositions can play a constructive role in empirical investigations. The propositions – even if they depend on questionable assumptions – can serve as a guide for the organization and systematic presentation of empirical information. Furthermore, data that are organized and presented along the lines suggested by a given theory either lend themselves to interpretation in the spirit of that theory or reveal facts of real life that are at variance with the theory's predictions. Both outcomes are of interest to the analyst.

The present chapter represents an example of an empirical application which makes use of a particular trade model in the sense described here. In view of the dominant role that the factor abundance theory plays in this chapter, the first section considers some of its empirical implications. This is followed by an examination of empirical methods to measure countries' factor endowments and to assess factor abundance. The third section applies these methods to data for a large sample of countries. The chapter concludes with some documentary evidence on the relationship between factor abundance and the commodity structure of net trade.

The factor abundance theory in higher dimensions

The theory's central proposition is an unambiguous prediction of the direction of trade. In a world of two countries, two goods and two factors, each country will export that good which makes intensive use of its abundant factor. In order for trade to occur, the two countries must differ in factor abundance.

The direction of trade in this 2×2×2 model can be predicted unequivocally. What happens, however, if the trading world is more complex, involving a multitude of countries, goods and factors? This question had long puzzled both theorists and empirical researchers. Theorists must grapple with the fact that their basic model yields determinate solutions only for the 'laboratory case of twoness'. Empiricists are compelled to rely on a narrow, two-dimensional theoretical framework as a basis for analysis of a higher-dimensional world. It is only recently that refinements in the theory have promised a solution to some of these problems. The work of Dixit and Norman (1980) and Deardorff (1980, 1982) has produced a more general set of results on factor abundance trade, albeit at some cost in predictive power.[1] In a somewhat diluted form, the law of comparative advantage and the proposition of factor abundance are shown to be valid in a world populated by many countries, goods and factors.

The original, 'strong' version of the factor abundance proposition rests on the condition of twoness. The new, 'weak' version, however, is derived from a more general model. It asserts that comparative advantage (or, more specifically, factor abundance) determines trade patterns only in an 'on-average' sense. Countries have a tendency to export the goods they would produce relatively cheaply in autarky. And to the extent that comparative advantage is based on factor abundance, countries tend to export those goods that use abundant factors relatively intensively.

In more formal terms, these generalizations can be expressed as correlations between net exports and their determinants. A weak version of the law of comparative advantage implies a negative correlation between each country's autarky prices and net exports when trade is in equilibrium. Likewise, in an H–O setting with many countries, goods and factors, the factor abundance proposition implies a positive (correlation-like) association between net exports, factor intensities and factor abundance (Deardorff, 1982). It is important to note that these correlation results not only refer to the direction of trade (as the 'strong' version of the proposition) but also take into account the volume of trade in the various goods. This feature is especially useful in the interpretation of empirical results later in the book.[2]

A final point concerns the flexibility of the theoretical framework for any empirical study. Once a particular model has been selected as the conceptual basis of study, its theoretical content will usually require some modification in order to be accessible to empirical methods. In the present case the modification entails a compromise between the simplistic but 'strong' relationships that emerge from the 2×2×2 model and the complex but 'weak' relationships that characterize larger models. The reason for such a compromise is simple. Precise predictions regarding the structure of trade are not possible, owing to the indeterminacy of patterns of production and trade in models with more goods than factors. Moreover, the weak version of the factor abundance proposition yields hypotheses that are so complex that they prevent the direct application to real-world data. Because of these limitations the present study is modest in its methodological claims. The main objective is to portray patterns of international specialization and trade in such a way that some of the traits suggested by theory can be assessed approximately.

The measurement of factor abundance

A satisfactory method of determining factor endowments and factor abundance must deal with at least three issues. These relate to the selection and definition of the factors to be studied, the appropriate use of data to measure endowment levels, and the derivation of factor abundance indicators.

Capital and labour were the factors traditionally considered in applications of the classic two-dimensional model. However, the puzzling empirical results obtained with two-factor models eventually led economists to extend the framework.[3] One extension was to redefine capital to include both physical and human capital. The two types of capital endowments could then be compared with labour endowments in order to reassess the basis for comparative advantage.

The present exercise uses a similar approach, distinguishing between four broadly defined factors of production: physical capital, skilled labour, semi-skilled labour, and unskilled labour. In the case of physical capital, problems arise because capital stock is a heterogeneous collection of machinery and equipment, and not a primary input. The conceptual difficulties resulting from these circumstances have been extensively debated in the literature.[4] But a simplistic view of (physical) capital is still justified so long as it does not invalidate major propositions about the relationship between factor abundance and international specialization and trade (Ethier, 1979).

The second factor inherited from the original H–O model is unskilled or 'raw' labour. Unlike physical capital, this factor's services clearly meet the requirement of being a primary input. Unskilled labour also comes closest to fulfilling the theoretical postulate that factors are homogeneous and qualitatively alike across different countries. Hence many of the conceptual complications arising in connection with physical capital are absent. Unskilled labour, however, represents only a portion of the country's labour force. Human capital acquired through education and training is embodied in the labour force, and the unskilled or raw labour component is not directly observable.

The inclusion of human capital as a separate factor of production serves to distinguish between the original factor proportions model and its extensions. The basic notion is simple: human capital is formed through schooling, training and related forms of investment in workers. An early version of the extended model (Leontief, 1953) used the concept of 'labour efficiency' to distinguish between various types of labour. Later contributions, however, focused on skill differentials to represent different rates of human capital formation.

Prior to the development of a generalized factor abundance theory the inclusion of human and physical capital complicated the analysis by increasing the number of factors to three. In order to retain the 'twoness' of the original model, some analysts sought to merge human and physical capital into one broad aggregate of total capital. This method, however, had its own problems. It was necessary that the two types of capital be close substitutes. Moreover, the use of a composite measure of capital yielded results that were inferior to those obtained when human and physical capital were separately recognized as determinants of trade patterns (Branson and Monoyios, 1977). Finally, in order to determine the stock of the capital composite, estimates of aggregate investment in human as well as physical capital were needed. Such estimates are more difficult than a straightforward assessment of the size of various skill classes within the total labour force of a country.

In the present study the identification of skill classes forms the basis for treatment of human capital. The actual number of classes to be considered is primarily a matter of data availability.[5] The present exercise employs data for unskilled (or raw) labour, semi-skilled and skilled workers. These categories represent the entire labour force and together with physical capital serve as the conceptual framework for an extended factor proportions model.

Having determined the factors to be considered, attention turns to the method of assessing abundance (or scarcity). Factor abundance can be pictured in at least two ways. One is to define abundance (or scarcity) in terms of physical endowments of factors. Factor abundance could then be determined from cross-country comparisons of endowment levels. The alternative method employs an 'economic' definition of abundance based on factor prices. According to that approach, an abundant (scarce) factor will command a relatively low (high) price in an autarky state. The two views yield the same theoretical relationship between factor abundance and the composition of trade.

In empirical studies, the distinction between a physical and a price-based definition of abundance translates into the choice between a 'stock' measure of factor endowments and a measure based on the relative price of factor services. A preference for either has obvious data implications. The physical approach yields estimates that are appropriate for a country operating in an autarky state and for all conceivable trading equilibria. Most analysts shunned the use of price-based measures. They argued that such measures must reflect autarky relationships if they were to serve as predictors of patterns of specialization and trade. Recent theoretical work, however, has shown that factor prices observed in trading equilibria can perform the same function.[6] As a result, the empiricists have a real choice which is not constrained by the lack of data on autarky prices.[7]

For reasons of data availability, the present study relies on factor endowments and uses conventional methods of estimation. Following others (Balassa, 1979; Bowen, 1983a; Leamer, 1984; and Bowen, Leamer and Sveikauskas, 1987), the stock of physical capital is determined from accumulated gross domestic investment. An estimate of the net capital stock in current US dollars is derived by applying a depreciation factor to annual gross domestic investment (prior to accumulation) and assuming an asset life of 15 years. This method was employed to obtain estimates of physical capital stock in 47 countries for 1970 and 1985.[8]

An ideal complement to estimates for the stock of physical capital would be corresponding information on human capital. Such figures, however, would require economy-wide information on investment in human capital and are not available. Nor is it practical to estimate the returns on investment in human capital, as these cannot be defined in an empirically operational way. The only feasible alternative is to employ a stock-related measure which depends on the number of workers with certain labour skills. These figures serve as a proxy measure for human capital. They cannot be precise indicators, since they neglect differences between workers' 'personal' levels of human capital. And consequently, the count of skilled labourers leads to biases in inter-country comparisons of human capital endowments to the extent that the distribution of human capital among skilled workers differs between countries. Despite this potential measurement bias, it has become common practice to define skilled labour as the number of professional or technical workers. The same practice is followed in the present study. By contrast, the unskilled labour category is defined narrowly to consist of illiterate workers. The residual category of semi-skilled labour then becomes a fairly broad one comprising all literate, non-professional workers.

In the H–O framework, measurement of a country's total factor supplies is not suitable to indicate factor abundance. Due to the assumption of con.tant returns to scale, it is relative endowments which matter, so that absolute levels must be judged in relation to the country's overall size. In the simplest (2×2×2) model several alternative expressions for factor abundance are available. These include the endowment ratio between the two factors in a single country, the endowment ratio between country A and country B for a single factor, and the share of country A's endowment of one factor in corresponding world endowments. Measures based on any of these ratios will provide an unequivocal indication of factor abundance or scarcity. But complications emerge once the model is extended to include more than two factors. In that case, not all three of the above ratios will yield useful measures of abundance.

A 'naive' approach to the measurement of factor abundance in the extended model is to follow the practices used in the two-factor case. Accordingly, empiricists will often replace the capital-labour ratio of the original 'small' model with ratios between different types of capital and labour. Such measures, even if they are appropriately scaled, result in asymmetric treatment of factors and cannot be justified by rigorous derivation from the underlying formal model. By contrast, the last one of the above indicators can serve to compare the relative endowments of more than two factors for a single country. This indicator, which is expressed in terms of the country's share in world endowments, yields a measure that treats all factors symmetrically. Yet another measure is the ratio between a country's share in world supply of a given factor and its share in world expenditure (Leamer and Bowen, 1981). This expression can be used in an ordinal manner to determine a factor's relative abundance across countries. It may also be treated as a dichotomous indicator of factor abundance or scarcity in a country.

The changing basis for comparative advantage

The following analysis of the international distribution of factor supplies makes use of each of tne three measures described above. Information of this type is required if variations in resource availability are to be related to levels of trade. Leamer (1984), for example, has shown that in an H–O setting an industry's net exports can be expressed as a linear function of factor supplies. Such a relationship incorporates two effects, one relating to factor abundance and the other to country size. The information on international differences in factor endowments presented here will be used in the analysis of net trade in manufactures reported in Chapter 7.

Table 5.1 summarizes the endowment pattern in 1970 and 1985. The figures show the expected high concentration of physical capital in the DMEs. These countries also accounted for a large share of all skilled labour and a significant portion of semi-skilled labour in the country sample. The shifts during this period were not great but have clearly favoured the developing countries. The DMEs' share of physical capital declined slightly although by 1985 they still claimed 85 per cent of the total. Unskilled labour is the only factor for which these countries had a marginal share of total supply (2.5 per cent in 1985).

When absolute changes in factor shares are considered, the trend towards lesser concentration among the DMEs is reconfirmed. The DMEs' decline is most pronounced for semi-skilled labour with lesser – and roughly equal – shifts for skilled labour and physical capital. However, the wide disparity in the distribution of resources between DMEs and developing countries means that differences in factor abundance will continue to be a paramount source of trade between the two country groups for some time.

Differences in the endowment patterns of the developing countries are as interesting as the distinctions between the two major country groups. The NIEs have a fairly balanced resource structure with semi-skilled and skilled labour being relatively important. The pattern of change in NIEs is characterized by relative increases in the shares of physical capital, skilled and semi-skilled labour and a decline in the share of unskilled labour. A similar pattern is found among second-generation NIEs. These countries are relatively better endowed with unskilled and semi-skilled labour than are the NIEs, although increases in the share of physical capital matched that reported for the richer group. The remaining developing countries account for an overwhelming portion of unskilled labour in the sample and the share has risen since 1970. Physical capital is by far the scarcest factor among the non-NIEs, although its rate of increase between 1970 and 1985 was high. In general, the distribution of productive factors reveals substantial differences between the country groups. These variations seem to agree with casual impressions regarding levels of economic development.

Figures for individual countries reveal very few instances of extremely high concentration of factor endowments. The most striking example is that of India, whose share of unskilled labour accounted for over 62 per cent of the entire country sample in 1970, rising to 65 per cent in 1985. Although lower, India's shares of skilled and semi-skilled labour were also remarkable. Figures for the USA represent another instance of factor concentration. The country began the 1970s with large shares of physical capital, skilled labour

Table 5.1 Distribution of factor endowments, 1970 and 1985

Country group, country or area	Percentage in total country sample (country ranking in parentheses)							
	Physical capital[a]		Skilled labour[b]		Semi skilled labour[c]		Unskilled labour[d]	
	1970	1985	1970	1985	1970	1985	1970	1985
All DMEs	90.53	85.27	66.03	62.87	54.18	46.71	3.37	2.47
of which:								
Six largest DMEs	74.03	70.16	52.31	48.55	43.82	38.20	1.66	1.20
France	7.38 (4)	5.13 (4)	5.33 (6)	4.65 (7)	4.15 (7)	3.36 (9)	0.09(33)	0.09(32)
Germany, Fed. Rep. of	9.71 (3)	6.62 (3)	5.83 (5)	5.60 (6)	4.92 (6)	4.13 (6)	0.11(31)	0.11(30)
Italy	4.02 (6)	3.48 (6)	3.25 (8)	2.71 (9)	3.91 (9)	3.02(11)	0.54(13)	0.24(23)
Japan	11.17 (2)	17.62 (2)	6.59 (3)	7.08 (3)	10.74 (3)	8.48 (3)	0.23(27)	0.22(26)
United Kingdom	4.80 (5)	3.91 (5)	6.40 (4)	5.74 (5)	5.00 (5)	3.61 (7)	0.34(21)	0.10(31)
United States	36.95 (1)	33.40 (1)	24.91 (1)	22.77 (1)	15.10 (2)	15.60 (2)	0.35(20)	0.44(13)
Other DMEs	16.50	15.11	13.72	14.32	10.36	8.51	1.71	1.27
Australia[a]	1.79 (8)	1.72(12)	1.26(18)	1.34(17)	.	.	.	.
Austria	0.75(19)	0.78(19)	0.61(29)	0.58(31)	0.64(27)	0.46(32)	0.01(42)	0.01(43)
Belgium	1.19(13)	0.72(21)	0.90(21)	0.84(25)	0.72(22)	0.53(29)	0.02(38)	0.02(38)
Canada	3.75 (7)	3.29 (7)	2.38 (9)	2.61(10)	1.57(17)	1.54(16)	0.27(26)	0.33(19)
Denmark	0.65(21)	0.55(25)	0.63(26)	0.78(26)	0.45(33)	0.34(34)	0.01(42)	0.01(43)
Finland	0.60(23)	0.64(22)	0.56(30)	0.64(29)	0.42(34)	0.29(36)	0.01(42)	0.01(43)
Greece	0.48(24)	0.49(28)	0.47(32)	0.54(33)	0.65(26)	0.49(30)	0.30(24)	0.14(28)
Ireland	0.17(38)	0.21(40)	0.23(40)	0.23(40)	0.22(39)	0.17(41)	0.01(42)	0.01(43)
Israel	0.25(32)	0.24(38)	0.33(37)	0.43(35)	0.16(42)	0.16(42)	0.05(35)	0.04(34)
Netherlands	1.61 (9)	1.28(13)	1.44(17)	1.45(15)	0.94(20)	0.75(22)	0.02(38)	0.02(38)
New Zealand	0.32(26)	0.28(36)	0.29(38)	0.26(39)	0.22(39)	0.19(39)	0.00(46)	0.01(43)
Norway	0.66(20)	0.77(20)	0.40(34)	0.57(32)	0.29(36)	0.25(37)	0.01(42)	0.01(43)
Portugal	0.20(35)	0.29(35)	0.27(39)	0.38(37)	0.52(30)	0.58(26)	0.44(17)	0.28(22)
Spain	2.38(12)	1.82(11)	1.47(16)	1.26(18)	2.28(11)	1.81(15)	0.53(14)	0.35(17)
Sweden	1.55(11)	0.94(16)	1.67(11)	1.72(13)	0.69(24)	0.49(30)	0.02(38)	0.02(38)
Switzerland	1.15(16)	1.09(14)	0.81(23)	0.69(28)	0.59(28)	0.46(32)	0.01(42)	0.01(43)

Table 5.1 continued

Country group, country or area	Percentage in total country sample (country ranking in parentheses)							
	Physical capital[a]		Skilled labour[b]		Semi-skilled labour[c]		Unskilled labour[d]	
	1970	1985	1970	1985	1970	1985	1970	1985
Developing country or area	9.48	14.73	33.96	37.11	45.82	53.28	96.62	97.54
NIEs	3.68	6.46	8.54	10.87	9.95	12.12	7.01	5.71
Argentina	0.91(17)	0.52(26)	1.51(14)	1.06(22)	1.74(15)	1.50(17)	0.28(25)	0.24(23)
Brazil	1.16(14)	2.21 (9)	4.26 (7)	6.22 (4)	3.98 (8)	4.92 (5)	4.49 (4)	3.76 (4)
Hong Kong	0.10(40)	0.35(32)	0.18(42)	0.22(41)	0.27(37)	0.30(35)	0.16(28)	0.22(26)
Mexico	1.16(14)	2.02(10)	1.64(12)	2.07(11)	2.00(13)	3.16(10)	1.51 (8)	0.89 (9)
Republic of Korea	0.30(27)	1.02(15)	0.82(22)	1.14(20)	1.86(14)	2.10(14)	0.52(15)	0.52(12)
Singapore	0.05(43)	0.34(33)	0.13(43)	0.16(42)	0.10(44)	0.14(44)	0.10(32)	0.08(33)
Second-generation NIEs	1.49	3.00	6.42	7.91	13.28	16.22	13.50	12.53
Colombia	0.29(28)	0.32(34)	0.62(28)	0.92(24)	1.04(19)	1.32(19)	0.76(10)	0.59(11)
Indonesia	0.19(36)	0.92(17)	2.02(10)	2.83 (8)	5.14 (4)	6.2 (4)	8.30 (2)	7.83 (2)
Malaysia	0.12(39)	0.40(31)	0.34(36)	0.45(34)	0.42(34)	0.56(27)	0.65(12)	0.62(10)
Peru	0.19(36)	0.28(36)	0.64(25)	0.60(30)	0.56(29)	0.72(23)	0.48(16)	0.41(15)
Philippines	0.27(29)	0.45(29)	1.49(15)	1.54(14)	2.16(12)	2.69(12)	0.93 (9)	1.29 (7)
Sri Lanka	0.04(46)	0.08(44)	0.37(35)	0.36(38)	0.70(23)	0.78(21)	0.41(18)	0.29(21)
Thailand	0.26(30)	0.42(30)	0.63(26)	1.03(23)	2.95(10)	3.43 (8)	1.58 (7)	1.14 (8)
Tunisia	0.07(41)	0.11(42)	0.12(45)	0.05(47)	0.09(45)	0.14(44)	0.34(21)	0.33(19)
Uruguay	0.06(42)	0.03(47)	0.19(41)	0.13(44)	0.22(39)	0.16(42)	0.05(35)	0.03(35
Other developing countries	4.31	5.27	19.00	18.33	22.59	24.94	76.06	79.30
Chile	0.26(30)	0.13(41)	0.41(33)	0.40(36)	0.48(31)	0.56(27)	0.13(30)	0.14(28)
Dominican Republic	0.04(46)	0.04(46)	0.08(46)	0.09(45)	0.16(42)	0.19(39)	0.16(28)	0.22(26)
Egypt	0.22(34)	0.63(23	1.26(18)	1.81(12)	0.67(25)	0.63(25)	2.58 (6)	2.99 (5)
Guatemala	0.05(43)	0.09(43)	0.13(43)	0.16(42)	0.16(42)	0.20(38)	0.38(19)	0.42(14)
India	1.61 (9)	2.23 (8)	13.06 (2)	11.30 (2)	16.44 (1)	17.84 (1)	62.38 (1)	65.00 (1)

Table 5.1 continued

Countiy group, country or area	Physical capital[a] 1970	Physical capital[a] 1985	Skilled labour[b] 1970	Skilled labour[b] 1985	Semi-skilled labour[c] 1970	Semi-skilled labour[c] 1985	Unskilled labour[d] 1970	Unskilled labour[d] 1985
	Percentage in total country sample (country ranking in parentheses)							
Pakistan	0.24(33)	0.22(39)	0.78(24)	1.11(21)	0.86(21)	1.08(20)	5.90 (3)	7.74 (3)
Panama	0.04(46)	0.05(45)	0.07(47)	0.09(45)	0.08(46)	0.09(46)	0.05(35)	0.03(35)
Turkey	0.40(25)	0.51(27)	1.12(20)	1.21(19)	1.71(16)	2.31(13)	3.47 (5)	2.03 (6)
Venezuela	0.62(22)	0.57(24)	0.52(31)	0.77(27)	0.47(32)	0.69(24)	0.31(23)	0.33(19)
Yugoslavia	0.83(18)	0.80(18)	1.57(13)	1.39(16)	1.56(18)	1.35(18)	0.70(11)	0.60(16)

Source: UNIDO (based on supplementary data sources documented in the statistical appendix).

a/ Net capital stocks were computed by summing depreciated flows of annual real gross domestic investment. For technical details of the computation see the statistical appendix.

b/ Skilled labour is defined as the number of professional/technical workers (ISCO 0/1).

c/ Semi-skilled labour is the number of literate workers who do not belong to the professional/technical category.

d/ Uuskilled labour is the number of illiterate workers.

e/ Endowments of semi-skilled labour and unskilled labour could not be estimated due to a lack of information on literacy rates.

and semi-skilled labour. However, its shares of physical capital and skilled labour had declined somewhat by 1985. A third remarkable case is Japan's share of physical capital, which rose from over 11 per cent in 1970 to over 17 per cent in 1985. These three countries were the only cases where factor shares of more than 10 per cent were recorded.

Changes in the international distribution of factors can be judged on the basis of absolute differences in country shares. The largest shifts were in national endowments of physical capital, a result reflecting wide differences in rates of capital accumulation. Singapore's gains, which even surpassed those of Japan, were the most impressive: the country increased its share of physical capital almost sevenfold between 1970 and 1985. The share of physical capital at least tripled in five other developing economies (Egypt, Hong Kong, Indonesia, Malaysia, and Republic of Korea). Of the ten developing countries experiencing the largest increases in this factor, five were NIEs and three were second-generation NIEs. Among the DMEs, Japan was the only country where the share of physical capital increased by more than a half. The factor's share actually declined in 14 DMEs, with the steepest fall recorded for Belgium.

Changes in country shares for the three labour categories were not great. All NIEs other than Argentina increased their shares of skilled labour though only about half of the second-generation NIEs reported relative increases in this factor. Japan was the only large DME to report a higher share of skilled labour in 1985 than in 1970, although about two-thirds of the smaller DMEs met this criterion.[9] Relative endowments of semi-skilled labour declined in all DMEs except Portugal and the USA. Shifts were in the opposite direction in NIEs and second-generation NIEs (other than Argentina and Uruguay), while the distribution of unskilled labour changed very little in comparison with other factors. In a third of the countries, the share of unskilled labour was virtually unchanged between 1970 and 1985.[10]

Summary measures of the dispersion of resource endowments between the members of each country group are a useful supplement to the data in Table 5.1. Although country groups were drawn up to ensure a degree of homogeneity, intra-group dispersion of endowments was sometimes large. The figures in the first part of Table 5.2 illustrate this feature. Among the DMEs, the dispersion of physical capital is largest and appears to be associated with that of country size. The six largest DMEs are similar in their endowments of physical capital as are the 16 smaller economies, but coefficients of variation for the group as a whole are much larger. The figures for developing countries tell a quite different story. Physical capital, skilled labour and semi-skilled labour are comparatively equitably dispersed among the NIEs and between the second-generation NIEs. The same was not true for other developing countries. Unskilled labour was the most unevenly distributed resource of all the four factors, and its dispersion widened over time.

The types of data shown in Table 5.1 and the first part of Table 5.2 offer some preliminary evidence regarding the distribution of factor endowments.

Table 5.2 Dispersion of factor endowments[a] within broad country groups, 1970 and 1985

Country group	Physical capital 1970	Physical capital 1985	Skilled labour 1970	Skilled labour 1985	Semi-skilled labour 1970	Semi-skilled labour 1985	Unskilled labour 1970	Unskilled labour 1985
A. Variation of endowment levels (coefficients of variation in per cent)[b]								
DMEs	193.7	196.4	177.7	170.9	149.3	165.2	116.9	116.0
Six largest DMEs	100.2	101.4	92.0	90.7	62.8	77.8	61.2	67.0
Other DMEs	87.2	84.1	72.3	70.9	81.4	85.0	156.7	149.9
Developing countries and areas	112.3	110.0	191.5	162.6	180.2	171.0	319.9	330.8
NIEs	85.2	78.4	107.4	125.3	84.9	89.9	144.8	147.7
Second-generation NIEs	58.3	80.7	88.9	98.9	113.2	114.7	172.4	175.8
Other developing countries	113.3	124.8	208.2	184.4	222.0	217.8	254.3	254.6
B. Variation of endowment levels relative to variation in GNP (ratio of the respective coefficients of variation)								
DMEs	0.88	0.89	0.81	0.78	0.68	0.75	0.53	0.53
Six largest DMEs	0.84	0.87	0.77	0.78	0.53	0.67	0.51	0.58
Other DMEs	0.98	0.91	0.81	0.77	0.91	0.92	1.76	1.63
Developing countries and areas	0.94	0.96	1.61	1.43	1.51	1.50	2.69	2.90
NIEs	0.96	0.96	1.20	1.32	0.96	1.11	1.63	1.83
Second-generation NIEs	1.05	0.93	1.62	1.14	2.05	1.32	3.12	2.02
Other developing countries	0.89	1.01	1.63	1.49	1.74	1.76	1.99	2.06

Source: UNIDO (based on supplementary data sources documented in the statistical appendix).

a/ Underlying factor endowment data are those of table 5.1.

b/ Ratio between standard deviation and mean expressed in per cent.

However, they do not provide the explicit information on factor abundance which is needed to answer fundamental questions regarding the H–O pattern of trade. A first impression regarding the dispersion of factor abundance (rather than factor endowments) is obtained from the second part of Table 5.2. The indicators, which correct resource variation for differences in country size, show a much more equitable pattern of factor abundance in DMEs than in the developing countries. This result conforms with the impression that DMEs are relatively homogeneous in terms of their basic economic characteristics while developing countries are not.

At least three general observations can be made on the basis of the data presented in this section. First, because the diversity of factor endowments is great, a strong H–O component should be present among the determinants of the commodity composition of trade. Second, the variation in factor abundance differs among factors and H–O influences should reflect this fact. Third, the distribution of resources across countries is changing over time but the pace of change is different for each resource. Patterns of specialization and trade should be altered as a result of these shifts.

Factor abundance and the patterns of trade

National differences in factor abundance offer plausible partial explanations for international variations in patterns of specialization and trade. The point of empirical interest is whether these differences are mirrored in the structure of production and trade and, if they are, whether their role coincides with the predictions of the H–O theory. These questions are addressed in a later chapter with the help of more detailed data. The present section has a related, but more limited, objective – to consider how factor abundance may influence trade in broad groups of manufactures.

From the previous discussion, it is clear that any 'application' of the factor abundance hypothesis requires three types of data. Information on factor endowments, factor intensities and the structure of trade is needed to forge a link between factor abundance and trade patterns. In the present exercise, a classification of goods according to relative factor requirements is established. The classification yields three broad product categories. H–O trade is represented by two categories which consist of labour-intensive and capital-intensive goods, while the third refers to product-cycle goods. Countries were arranged in three groups based on this product classification. They include net exporters of product-cycle goods, net exporters of capital-intensive H–O goods that were importers of product-cycle goods, and net exporters of labour-intensive H–O goods that were also importers of both product-cycle and capital-intensive H–O goods.[11] Economic theory suggests a loose connection between factor abundance and trade in these country groups.

Table 5.3 shows the relationship between net trade and factor abundance, where an ordinal measure is used for the latter. Based on this measure a

Table 5.3 Factor abundance and net trade by country or area, 1970 and 1985

Net exporters by product class	Ranking of factors by abundance ratio[a/]							
	Physical capital		Skilled labour		Semi-skilled labour		Unskilled labour	
	1970	1985	1970	1985	1970	1985	1970	1985
A. Product-cycle goods[b]								
Denmark	1-	2+	2-	1+	3-	3-	4-	4-
France	1+	1+	2-	2-	3-	3-	4-	4-
Germany, Fed. Rep. of	1+	1+	2-	2-	3-	3-	4-	4-
Ireland	3+	2+	1+	1+	2+	3+	4-	4-
Italy	1-	1-	3-	3-	2-	2-	4-	4-
Japan	1+	1+	3-	3-	2+	2-	4-	4-
Netherlands	1+	2+	2+	1+	3-	3-	4-	4-
Sweden	2+	2-	1+	1+	3-	3-	4-	4-
Switzerland	1+	1+	2-	2-	3-	3-	4-	4-
United Kingdom	3-	2-	1+	1+	2-	3-	4-	4-
United States	1-	1-	2-	2-	3-	3-	4-	4-
Yugoslavia	3+	3+	1+	1+	2+	2+	4+	4-
B. Capital-intensive H-O goods								
Argentina	3+	3-	2+	2+	1+	1+	4-	4-
Belgium	1+	2-	2-	1+	3-	3-	4-	4-
Brazil	4-	4+	2+	1+	3+	2+	1+	3+
Canada	1+	1-	2-	2-	3-	3-	4-	4-
Indonesia	4-	4+	3+	3+	2+	2+	1+	1+
Peru	4-	4+	1+	2+	2+	1+	3+	3+
Republic of Korea	4-	3+	2+	2+	1+	1+	3+	4-
Singapore	4-	1+	1+	2-	2+	3-	3+	4-
Spain	3-	1+	2-	3-	1+	2+	4-	4-
Venezuela	1+	3+	2+	1+	3+	2+	4-	4-

Table 5.3 continued

Net exporters by product class	Ranking of factors by abundance ratio[a] Physical capital 1970	Physical capital 1985	Skilled labour 1970	Skilled labour 1985	Semi-skilled labour 1970	Semi-skilled labour 1985	Unskilled labour 1970	Unskilled labour 1985
C. Labour intensive H-O goods								
Austria	1+	1+	3+	2-	2+	3-	4-	4-
Colombia	4-	4-	3+	2+	1+	1+	2+	3+
Egypt	4	3+	2+	2+	3+	4+	1+	1+
Finland	1+	1+	2+	2+	3-	3-	4	4-
Greece	2+	2+	3+	1+	1+	3+	4	4
Hong Kong	4-	1+	2+	3-	1+	2-	3+	4-
India	4-	4+	3+	3+	2+	2+	1+	1+
Israel	2+	2+	1+	1+	3-	3-	4	4
Malaysia	4-	4+	3+	3+	2+	2+	1+	1+
Mexico	4	3+	2+	2+	1+	1+	3+	4
Pakistan	4-	4-	3+	2+	2+	3+	1+	1+
Philippines	4-	4+	2+	2+	1+	1+	3+	3+
Portugal	4-	3+	3+	2+	1+	1+	2+	4+
Sri Lanka	4-	4+	3+	2+	1+	1+	2+	3+
Thailand	4	4+	3+	3+	1+	1+	2+	2+
Tunisia	4+	3+	2+	4-	3+	2+	1+	1+
Turkey	4-	4-	3+	3+	2+	1+	1+	2+
Uruguay	3-	3-	2+	2+	1+	1+	4-	4

Sources: UNIDO and supplementary data sources documented in the statistical appendix.

a/ Ranks 1 or 2 indicate relative factor abundance. Ranks 3 or 4 denote relative scarcity. The sign accompanying each rank denotes absolute abundance (+) or scarcity (-). Both the ordinal and dichotomous measures used here are derived from normalized factor shares. These normalized shares are obtained as the ratio of a country's share in world supply of the given factor and its share in world GNP.

b/ Group A consists of all net exporters of product cycle goods, irrespective of trade in the other two types of goods. Group B is composed of net exporters of capital-intensive H-O goods that imported product cycle goods. Finally, group C is made up of net exporters of labour-intensive H-O goods that imported the other two types of goods. If a country's assignment to one of the three groups was different between 1970 and 1985, the more 'advanced' group was chosen for representation in the table. Countries that were net importers of all three types of goods are not shown.

ranking of 1 or 2 may be interpreted as an indication of relative abundance, while a ranking of 3 or 4 suggests relative scarcity. In addition, a plus or minus denotes factor abundance (+) or scarcity (−) measured in an absolute sense. When considered in relation to the type of trade, these factor abundance profiles provide the basis for a prima facie judgement of H–O forces.

The results provide some empirical support for the generalized version of the factor abundance proposition. That proposition suggests a tendency for countries to be net exporters of goods that use their abundant factors intensively. Similarly, countries will be net importers of goods that use their scarce factors intensively. The insistence that there is no more than 'a tendency' for this proposition to hold means that predictions of the trade pattern are not necessarily applicable to a specific country, good or factor. Bearing this qualification in mind, the theory's assertion concerning average factor characteristics of trade is confirmed by Table 5.3.

The generalized factor abundance hypothesis is broad enough to allow for differences in the 'contribution' of various factors to an overall H–O scheme. Such differences can be observed from comparisons between net exports and factor abundance. If the factor rankings in Table 5.3 are considered in conjunction with the indicators of absolute abundance, a broad pattern of differentiation emerges. The expectation that skilled labour conveys a competitive advantage in product-cycle goods is corroborated in ten out of the 12 countries. All such exporters of product-cycle goods (other than Yugoslavia) are DMEs and include the six largest countries in this group. Italy and Japan are the exceptions to this broad interpretation of the product-cycle hypothesis in the sense that skilled labour is relatively scarce in the two countries. The relative availability of semi-skilled labour,[12] however, is much greater than that of skilled labour. The results for these two countries may reflect the fact that the degree of international competitiveness in product-cycle goods depends on more than the availability of skilled labour. The innovative capacity of skilled labour is crucial for product development, but other labour skills which are even more closely tied to production processes can also convey a competitive advantage in product-cycle goods. Confirmation of the important role that is suggested for semi-skilled labour requires more evidence and is the subject of further analysis later in this book.

The results for net exporters of capital-intensive goods provide only modest support for a (partial) factor abundance hypothesis. There is limited evidence that capital exerts a substantial effect on net exports – mainly in the form of a positive sign of the dichotomous indicator. An unambiguous relationship between capital abundance and trade does not appear to be a general characteristic of the ten countries in this group. There can be at least two reasons for these poor results. First, an H–O outcome would be observed only in terms of an on-average relationship or tendency. A positive interaction between capital abundance and capital intensity will yield a comparative advantage, but there may still be numerous exceptions for countries, goods or factors. Second, the H–O model assumes that physical capital is not internationally mobile, though in reality, to a considerable extent, it is. For both reasons, the H–O link between capital abundance and product structure of net trade may be a rather weak one.[13]

International flows of capital and skilled labour violate the assumption of factor immobility between countries, but the same may not apply to semi-skilled or unskilled labour.[14] Certainly, the empirical relationship between these two factors and the net trade of labour-intensive products conforms to H–O predictions. This fact can be seen from the results for country group C in Table 5.3. The group consists of 18 countries which are both net exporters of labour-intensive goods and net importers of capital-intensive goods. With very few exceptions, the dichotomous indicator for semi-skilled labour had the expected sign. Most countries in this group can be distinguished according to whether semi-skilled labour, unskilled labour or both are important determinants of international competitiveness. Semi-skilled labour seems to dominate in Austria, Greece, Hong Kong, Mexico, the Philippines and Uruguay, while unskilled labour is important for Egypt. Other countries (India, Malaysia, Thailand and Turkey) appear to rely on both types of labour.

In strict terms, the modern version of the H–O theory says that factor abundance will also be an on-average determinant of the volume of net trade in the various product groups. As a final step in this preliminary analysis, Table 5.4 summarizes the evidence on this aspect. Countries are again divided into groups, this time according to 'factor dominance'. Countries characterized by a dominance of physical capital are all those for which this factor is ranked highest in Table 5.3. The same criterion is applied analogously to other factors. Net exports were then aggregated across each of the three product categories to determine whether the direction and volume of trade agree, on average, with an H–O pattern.

Only some of the estimates compiled in Table 5.4 support a factor abundance explanation. When the volume and direction of trade are considered simultaneously, the abundance of semi-skilled or unskilled labour is still the major determinant of trade. The importance of skilled labour is weakened in this set of comparisons. One reason may be the nature of trade in product-cycle goods. A country with ample innovative capacity will have high rates of product development in at least some of these industries, but it may simultaneously import other product-cycle goods where its innovative base is weak. On balance, the country is likely to be a net exporter of product-cycle goods, though perhaps not in large volumes. Finally, the relatively weak performance of physical capital as a determinant of the direction and volume of net trade may again be explained by its greater mobility among countries.

Though not a rigorous test, factor abundance effects of varying strengths can be observed in these results. The strength of these effects varies between the four factors. Labour other than the most skilled appears to be the prominent source of comparative advantages. By contrast, the extent to which physical capital endowments determine comparative advantage is ambiguous. The following chapter considers the role of factor intensities while Chapter 7

Table 5.4 Factor abundance and net trade, by country group, 1970 and 1985 (percentages)

Year	Countries/areas with dominant abundance of:[a]	Net exports ratio[b] H-O goods, capital intensive[c]	Net exports ratio[b] Product-cycle goods	Net exports ratio[b] H-O goods, labour intensive[c]
1970	Physical capital	7.8	17.6	0.6
	Skilled labour	10.7	6.9	-3.2
	Semi-skilled labour	-30.5	-71.3	21.3
	Unskilled labour	-54.4	-84.5	47.9
1985	Physical capital	1.3	12.1	-11.1
	Skilled labour	3.8	0.4	-5.1
	Semi-skilled labour	-12.5	-25.4	62.6
	Unskilled labour	-65.4	-55.9	37.8

Sources: UNIDO and supplementary data sources documented in the statistical appendix.

a/ A country or area is defined to have dominant abundance of that factor for which the country's share in world supply is relatively highest.

b/ The net exports ratio is defined as the ratio of exports minus imports over exports plus imports.

c/ The classification of H-O goods into capital intensive and labour intensive is based on United States data for 1982. For details see the statistical appendix.

draws together all these results for a more comprehensive application of the factor abundance hypothesis.

Annex: The specific factors model

In the preceding chapter, the analysis of international specialization and trade utilized the factor abundance approach. In general, the focus until now has been on how the relative abundance of various factors of production creates comparative advantage. The existence of diverse patterns of comparative advantage among countries or groups of countries lies at the basis of an explanation of international specialization and trade, where the H–O model provides the theoretical framework. In this section we will relax one of the major assumptions that was implicitly made in our analysis, in order to reconcile some of the predictions of the H–O model with real-world situations.

A crucial assumption of the H–O model demands that factors of production can be shifted costlessly from one industry to another in response to changes in domestic supplies of various factors. As factor supplies change, factor prices may change, leading to changes in specialization and patterns of trade. In this process reallocation of resources at little or no cost appears to be possible in the long run. Accordingly, the above assumption should not substantially affect results that are representative of a relatively long time period like that covered by the analysis of this chapter.

Over shorter periods of time, however, the assumption of costless reallocation may be less plausible. A short-run change in the relative price of commodities produces changes in the relative price of factors of production which induce an intersectoral reallocation of resources. Over short periods of time such reallocations may be difficult, as some factors may be immobile within the economy and/or specific to a particular use. Immobility may be due to geographic considerations. The expanding and contracting sectors of the economy may be in separate locations, making it difficult to reallocate labour and/or capital. In the case of labour, contracting industries may also lobby for legislation concerning plant closings and layoffs, which may hinder the movement of factors of production from one industry to another.

Aside from geographic or legal restraints on resource reallocation, a more fundamental problem lies in the specificity of various resources to particular industries or uses. Certain types of semi-skilled or skilled labour provide examples of such specificity. Thus, workers in a particular industry may develop forms of human capital that are specific to that industry. In general, human capital may be thought of as being composed of two components. First, workers may develop generic human capital such as basic literacy, which is easily transferable across industries. Other types of education, skills and training may be more sector-specific and difficult to transfer across industries. As a result, as economic circumstances change, labour may become 'trapped' in a particular industry in the short run even if no legal or geographic barriers to labour mobility exist. Over time, however, worker retraining and geographic mobility should overcome much of this type of labour immobility. In summary, this implies that even in the long run only half of the H–O assumption of intersectoral mobility of resources would seem plausible for the majority of the labour force.

The issue of factor specificity may be more important with respect to capital. It has long been recognized that various forms of capital may not be intersectorally mobile in the short run, for example, for geographic reasons similar to those outlined above. More importantly, capital may be specific to a particular kind of use such as producing food, and may be partially or totally unsuited to the production of another commodity such as textiles. In such cases it would be difficult to reallocate capital in the short run from one sector to another in response to a change in relative commodity prices. And again, the brisk reallocation of resources envisioned in the H–O model may be realistic only over the long run. As a practical matter, the actual speed of reallocation in response to changes in commodity prices may be related to the speed with which sector-specific capital is depreciated in the contracting industry. If, for instance, the relative price of food rises and that of textiles falls, then the medium-term response may be a faster rate of new investment in the food industry. Put another way, net investment (new investment minus depreciation) may be positive in the food industry. In the contracting textile industry, net investment may become negative. This process would continue until a new long-run equilibrium is reached in both industries. Thus, capital would not be 'released' from one sector to another in a strict sense, but the reallocation would be a dynamic process occurring over time.

There are obvious effects on the economy as a whole of such impediments to reallocation. Since capital cannot be reallocated over the short run, the economy will not be able to produce an optimal quantity of food and the supply of tradable goods will be suboptimal. Further, since capital allocation is temporarily suboptimal, the economy will operate inside its production possibility frontier, or in other words at less than full employment. These conditions are clearly at variance with those postulated for the H–O model.

In order to assess the effects of the presence of specific factors on the patterns of trade and the prices and returns to factors of production, the previous example has to be analysed in a more formal framework. Following most previous work on the subject, three factors of production will be considered. Labour is assumed to be intersectorally mobile between both the food and textile industries, even in the short run. However, instead of capital being homogeneous, the capital stock is divided between the two sectors and is assumed to be immobile between them in the short run. The model thus contains two countries, two products and three factors of production.

One of the main results of the H–O model used for the major part of the study was that it can predict trade patterns from the knowledge of factor endowments alone. Would the same be true in a specific factors model?

In an H–O world, where countries have identical factor endowments and preferences, no trade would take place. In such a situation trade is still possible, however, if in the short run capital has been allocated differently between the two industries in the two countries. Comparative advantage would then depend upon which industry in which country is better endowed with specific capital. The result is that in a specific factors model trade patterns cannot be predicted from knowledge of total factor endowments alone; one must also know how capital is allocated among industries.

To gain more insight into the working of the model, an increase in the supply of labour in one country will be assumed. Under H–O conditions, the result would be that this country would now be relatively well endowed with labour so that it would export the labour-intensive product. In the specific factors model, however, this result does not necessarily hold. All that can be said is that the labour-abundant country would produce more of both goods. Trading patterns depend on how the specific capital is allocated between industries, and are much less sensitive to the overall endowments of labour and capital in the two countries. If specific factors are present, one should not be too surprised to observe instances where a country is exporting a commodity that seems to run against the grain of its total factor endowments. This does not imply that the H–O model is incorrect; rather, it simply means that its predictions may not hold in every short-run situation, especially in the presence of specific factors.

As an extension, it can be shown that trade does not equalize factor prices across countries within the context of the specific factors model. It may be assumed, for instance, that countries A and B have identical endowments of labour, but that country A is relatively well endowed with capital specific to the production of food. Country A will then export food and import textiles. If trade continues unimpeded, commodity prices will be equalized across countries. Does this also imply that factor prices will be equalized across countries? Labour is now relatively productive in country A, which has more capital to work with than in country B. Trade would not equalize wages across the two countries in this case. However, it may be that trade would reduce factor price differences between countries relative to the factor price differences that prevail in autarky. This would seem to be consistent with the fact that, while trade does not equalize factor prices, it seems to move factor prices in that direction.

The above results are useful in order to sort out some anomalies in the patterns of international trade and specialization. As mentioned before, the presence of specific factors would help to explain, in many cases, instances where a country can be observed exporting a product that would seem to run counter to its comparative advantage. Even in a labour-abundant country, the presence of sector-specific capital could lead to the export of capital-intensive products. This does not mean that the H–O model is incorrect; it simply implies that there may be exceptions attributable to the presence of specific factors.

The existence of specific factors might help to explain some of the anomalies present in this chapter. Although the analysis uses more than just two factors of production, the data do not permit inferences concerning the allocation of the various types of labour and capital to the various industries. They allow for measuring the abundance of three separate classes of labour, but capital must, of necessity, be considered homogeneous. Some types of physical capital may be mobile across all classes of goods, but a reasonable assumption is that some forms of capital are not. Since capital was defined to be homogeneous, it was expected that it would confer comparative advantage most heavily to the production of capital-intensive H–O goods. While the results in Table 5.3 do not refute this proposition, the results for capital are weaker than those for the various classes of labour. Some countries that are abundant in capital may have a substantial portion of this capital allocated to the production of product-cycle goods. In this case the presence of capital may be conferring some comparative advantage that cannot be readily discerned owing to data limitations. Given the existence of sector-specific capital, it is not surprising that the H–O results with respect to undifferentiated capital are weaker than for various types of labour, which can be reasonably posited to contribute to comparative advantages in broadly defined sectors.

In the preceding chapter, the weaker results for physical capital were explained in terms of the international mobility of this factor. It may well be that capital mobility and the existence of sector-specific capital may be related. Sector-specific capital may be difficult to reallocate between two disparate industries in the same country. However, it is quite plausible that mobility could occur between countries for the same sector. Thus, the existence of capital mobility and sector-specific capital may both contribute in a complementary way to the relatively weaker results obtained for the H–O predictions for physical capital.

The specific factors model can serve to explain some of the deviations from the predictions of the H–O model. Further, it can help to explain how economies adapt to changing patterns of comparative advantage. Over longer periods of time it becomes a less useful device, as capital and labour are reallocated and become less 'specific'. In the long run, relative supplies of factors determine – at least in part – how international trade and specialization evolve.

Notes: Chapter 5

1 Dixit and Norman, 1980, provide a wealth of generally valid relationships which describe general equilibrium in an open-economy world with many factors and many goods. Deardorff, 1980, restates the law of comparative advantage for a fairly general model of world trade. Deardorff's later work (1982) is a logical extension of his general model, which provides a detailed account of the role of factor proportions in a high-dimensional world

2 The hypothesis discussed here is the 'commodity version' of the factor abundance proposition. The underlying model is used to predict the commodity

(or product) pattern of (net) trade on the basis of country attributes and characteristics of production processes. An alternative formulation, the 'factor content version', was suggested by Vanek, 1968. Vanek's interpretation also depends on a systematic relationship between factor abundance, factor intensities and trade; however, it lacks the intuitive appeal of the commodity version. The message of the factor content proposition is that a country's exports will embody the services of its abundant factors, while its imports will embody the services of scarce factors.

3 An often cited example of such surprising empirical results is the so-called Leontief paradox. Leontief, 1953, had carried out factor content calculations which apparently revealed the USA as labour- rather than capital-abundant.

4 Arguing from a neo-Ricardian point of view, Steedman, 1979, p. 64, has asserted 'that the existence of heterogeneous capital goods does lead to a breakdown of the logic of the Heckscher–Ohlin–Samuelson theory and hence to that of its major conclusions'. By contrast, Ethier, 1979 and 1981, demonstrated that if the factor abundance model's basic assumptions are not violated by the introduction of capital, the core theorems remain valid.

5 An early example of the distinction between unskilled and skilled labour is found in Hufbauer, 1970. The maximum number of seven labour categories appears in Bowen, Leamer and Sveikauskas, 1987.

6 Helpman, 1984, demonstrated 'that in the absence of factor price equalization the factor content of bilateral trade patterns can be predicted from post-trade data' (p. 93) on factor prices. These predictions are again of the weak (correlation) type and can easily be extended to a country's aggregate trade with the rest of the world. Their attractiveness is twofold: they state factor abundance attributes of bilateral trade flows, and their empirical validation can be performed in a direct manner.

7 It would have been interesting to compare the empirical performance of the physical-abundance hypothesis with that of the price-abundance hypothesis, if data availability had allowed to do so. However, such a comparison must be left for the research agenda of future studies.

8 These countries accounted for over 88 per cent of world exports of manufactures in 1979. More technical and statistical details on the compilation of capital stock estimates are provided in the statistical appendix (Appendix B).

9 Among individual countries, the largest increases were recorded by Thailand, followed by Colombia, Venezuela, Brazil and Egypt. Among the DMEs, Norway had the largest relative increase in skilled labour.

10 A major exception was the Philippines, which experienced a particularly large increase in the share of unskilled labour. Modest increases were observed for Canada, Hong Kong, Pakistan and the USA.

11 The classification can be loosely associated with stages of development where exporters of product-cycle goods are regarded as the most advanced and exporters of labour-intensive H–O goods as the least advanced. If a country's trade type changed between 1970 and 1985, it was assigned to the more advanced of the two groups. In setting up this country classification, trade in Ricardian (resource-based) goods was disregarded, as no indicator of natural resource endowments was used in the analysis.

12 Semi-skilled labour as defined here is an amalgamation of labour categories of differing skill levels. A plausible hypothesis may be to assume that this factor has a higher skill content in DMEs than in developing countries.

13 Recent general results on these points are found in Ethier and Svensson 1986.

14 There are exceptions e.g. Latin American and Asian immigration to the USA, or the European guest labour programme.

CHAPTER 6

Factor requirements, output and trade

The previous chapter was concerned with the role of factor endowments, but obviously more information is required for an empirical assessment of patterns of specialization and trade. In particular, the factor abundance theory assigns a big role to factor intensities.

The present chapter provides a detailed account of factor intensities in specific industries. The first section deals with the measurement of factor intensities and considers the extent to which intensities vary across industries and between countries. The second section examines the relationships between factor intensities on the one hand and output and trade on the other hand.

Factor intensities and empirical evidence

Previous discussion has made implicit use of the fact that the relative factor requirements of industries differ. Terms like 'resource-based', 'capital-intensive' or 'labour-intensive' are used to suggest systematic differences in the relative input requirements of industries. Such terms can be associated with quantifiable characteristics.

From the economist's point of view, factor intensities characterize a production technique rather than the underlying 'technology'. It is quite possible, for example, that two factories sited in different countries would have identical production functions but operate with different factor intensities, for the simple reason that factor prices in the two countries differ. Profit-maximizing producers would choose different production techniques even though they share the same technology.

In reality, both technological possibilities and factor returns are likely to vary across countries. The factor abundance model nevertheless makes use of certain restrictions on inter-country differences in production techniques in order to obtain predictions on trade patterns. One such restriction is that of identical techniques for all countries as a result of identical technologies and equalized factor prices. Another (weaker) restriction appears in the H-O model with two countries, two factors and two goods: it rules out the possibility that factor intensities are reversed between industries when factor prices change.

The absence of 'factor intensity reversals' ensures that the rankings of industries by factor intensities are everywhere the same.

Theoretical assumptions about production techniques raise several empirical questions. First, what is the extent of inter-country variations in factor intensities of particular industries? Second, is it sensible to construct an industry typology based on factor requirements that is not country-specific? That is, can industries be classified universally by their factor intensities?[1]

Measuring factor intensities

Before answers to the above questions can be attempted, some measurement issues must be clarified. Like the measurement of factor abundance, that of factor intensity is not a trivial matter. In the simplest case – that of a single industry – a knowledge of factor requirements per (physical) unit of output is sufficient to permit comparisons of factor intensities between countries. But when two or more industries are compared, input-output ratios stated in physical quantities are inappropriate for obvious reasons.

The basic two-factors, two-goods model provides a point of departure for discussion of measurement questions. Based on a comparison of factor-input ratios, the two industries can be identified as relatively labour-intensive and relatively capital-intensive. These ratios provide a precise characterization of factor intensity so long as only two factors are considered. A ranking of industries by a single factor-input ratio contains all the information required by the analyst.

When more than two factors of production are admitted, several types of factor-input ratios can be calculated and the measurement of factor intensities on the basis of such ratios becomes problematic. In this case the factor shares approach offers a way out of the dilemma. The value of a factor's input in relation to the value of the industry's output provides a measure of intensity which is free from the ambiguities associated with other expressions (Jones and Scheinkman, 1977). In general, the factor shares yield a measure of intensities which permits generalization and empirical application of the model's basic propositions.

Estimates of factor intensities can be used, for instance, to judge the extent to which reversals in industry rankings occur in the real world. Because such reversals would have significant repercussions for the basic model with two factors and two goods, they have received considerable attention in the literature. The importance of this phenomenon is diminished, however, in models with more than two goods. The possibility that industry rankings by factor intensities will differ between countries is then of less consequence to predictions about trade (Deardorff, 1986). A cross-country comparison of factor intensities is nevertheless of interest, as it provides a basis for developing a typology of industries.

The cross-country pattern of factor intensities

Table 6.1 presents industry rankings by average factor intensities for 43 countries. The methods of compilation are imperfect, however, and before examining the results, three qualifications should be noted. First, factor-input ratios rather than factor shares were the basis of calculations. This departure from the ideal was dictated by data availability; use of factor shares would have meant that a smaller number of factors could be studied. Instead, a more conventional approach which uses labour-based factor ratios as proxy measures of intensities was employed.[2] Non-wage value added per employee and wages per employee are taken as indicators of the relative intensities of physical capital and human capital, respectively. In addition, a simple, globally applicable indicator of labour intensity was calculated in the form of the reciprocal of total value added per employee.[3] All three factor-input ratios are proxies rather than actual measures of physical-capital, human-capital and labour intensities. Their limitations have been discussed repeatedly in the literature (Balassa, 1979, pp. 260–1; UNIDO, 1986, pp. 164–5; Bowden, 1983, pp. 218–19).

A second qualification is that the data underlying the present exercise are highly aggregated. Therefore, they can hardly serve to assess factor intensities of industries defined in a manner that would accord with theoretical models. Nevertheless, the attention that trade theorists have paid recently to the issues of aggregation (Neary, 1985; Deardorff, 1986) and of average relationships (Dixit and Norman, 1980; Deardorff, 1982) seems to justify also a discussion of averages of factor intensities.

A third qualification is that in Table 6.1 cross-country variations in factor intensities are disregarded. Instead, the estimates are expressed as world averages (both unweighted and weighted). Subsequent analysis of the cross-country variations will provide some means of assessing the validity of this step. A concession that is intended to address these departures from preferred practice is to focus attention on ordinal rather than cardinal expressions of factor intensities.

The unweighted estimates of physical capital intensity proved to be quite stable over time. The same six industries were the most intensive users of physical capital in both time periods. These industries, in decreasing order of capital intensity, were petroleum refining, petroleum, coal and related products, industrial chemicals, beverages, tobacco and 'other chemical products' (including pharmaceuticals). Additional industries appearing in the highest quarter of the distribution were non-ferrous metals (1970–7) and paper products (1978–85).

Steel products and transport equipment are still other industries that are widely regarded as heavy users of capital. The results, however, are ambiguous. Unweighted estimates indicate that neither of the two industries is a particularly large user of capital. When weighted estimates are considered, the results fit more closely with conventional expectations. This discrepancy

Table 6.1 Average factor intensities, by industry,[a] 1970–7 and 1978–85 (unweighted and weighted industry rankings)

Industry (ISIC)	Intensity in the use of: Physical capital[a] 1970-1977		Physical capital[a] 1978-1985		Human capital[a,c] 1970-1977		Human capital[a,c] 1978-1985		Labour[a,c] 1970-1977		Labour[a,c] 1978-1985	
Food products (311)	9	(11)	8	(12)	20	(26)	19	(24)	18	(9)	18	(10)
Beverages (313)	4	(4)	4	(4)	24	(24)	17	(21)	23	(23)	23	(24)
Tobacco etc. (314)	5	(12)	5	(20)	27	(28)	21	(28)	24	(4)	24	(4)
Textiles (321)	26	(28)	24	(28)	26	(27)	23	(27)	2	(1)	4	(1)
Wearing apparel (322)	28	(27)	28	(27)	28	(25)	28	(26)	1	(2)	1	(2)
Leather and fur products (323)	23	(23)	23	(25)	21	(18)	26	(23)	5	(7)	5	(5)
Footwear (324)	27	(26)	27	(26)	25	(23)	27	(25)	3	(3)	2	(3)
Wood and cork products (331)	17	(19)	22	(23)	18	(15)	22	(15)	10	(10)	7	(9)
Furniture fixtures excl. metal (332)	25	(17)	26	(18)	16	(8)	24	(8)	4	(16)	3	(15)
Paper (341)	11	(8)	7	(7)	9	(9)	7	(7)	19	(22)	22	(21)
Printing and publishing (342)	16	(14)	19	(13)	3	(6)	9	(11)	16	(18)	11	(16)
Industrial chemicals (351)	3	(3)	3	(3)	8	(11)	1	(5)	26	(25)	27	(27)
Other chemicals (352)	6	(6)	6	(5)	11	(20)	4	(16)	25	(21)	25	(22)
Petroleum refineries (353)	1	(1)	1	(1)	1	(1)	2	(2)	28	(28)	28	(28)
Products of petroleum and coal (354)	2	(2)	2	(2)	2	(7)	8	(17)	27	(27)	26	(26)
Rubber products (355)	14	(24)	14	(24)	22	(21)	12	(20)	12	(6)	16	(6)
Plastic products (356)	12	(20)	18	(19)	23	(22)	25	(19)	14	(8)	9	(8)
Pottery, china, earthenware (361)	24	(25)	25	(22)	14	(17)	20	(18)	8	(5)	6	(7)
Glass (362)	20	(18)	15	(15)	12	(16)	11	(12)	6	(12)	14	(14)
Other non-metallic min. products (369)	8	(9)	9	(16)	10	(19)	13	(22)	20	(15)	19	(11)
Iron and steel (371)	10	(7)	10	(8)	5	(3)	3	(3)	21	(24)	21	(23)
Non-ferrous metals (372)	7	(5)	11	(6)	7	(2)	6	(1)	22	(26)	20	(25)
Metal products (381)	22	(21)	21	(21)	13	(10)	18	(13)	7	(13)	8	(12)

Table 6.1 continued

Industry (ISIC)	Intensity in the use of: Physical capital[b] 1970-1977	1978-1985	Human capital[c] 1970-1977	1978-1985	Labour[d] 1970-1977	1978-1985
Non-electrical machinery (382)	15 (13)	17 (10)	6 (5)	10 (4)	17 (20)	12 (19)
Electrical machinery (383)	21 (22)	13 (11)	15 (13)	14 (9)	9 (11)	15 (18)
Transport equipment (384)	19 (15)	20 (17)	4 (4)	5 (6)	15 (19)	13 (17)
Professional scientific equipment (385)	18 (10)	16 (9)	17 (12)	16 (10)	11 (17)	10 (20)
Other manufactures (390)	13 (16)	12 (14)	19 (14)	15 (14)	13 (14)	17 (13)

Source: UNIDO

a/ Averages were taken over a sample of 43 developed and developing countries. To derive the unweighted measure, industries (i=1,2,...,m) were first ranked by factor intensity for each country (j=1,2,...,n) separately to obtain ranks r_{ij}. The average ranking of each industry over all countries in the sample was then calculated simply as the arithmetic mean:

$$\bar{r}_i = \frac{1}{n} \sum_{j=1}^{n} r_{ij}$$

Finally, industry rankings were based on the world averages $\bar{r}_i$. The ranks in terms of weighted averages of factor intensities are given in parentheses. These averages were derived from aggregate data on value added, wages and employment.

b/ Physical-capital intensity is measured by non-wage value added per employee.

c/ Human-capital intensity is measured by wages per employee.

d/ Labour intensity is measured by the reciprocal of total value added per employee.

between weighted and unweighted estimates points to the possibility of variations between countries in factor intensities.

Unweighted estimates for human capital showed consistently high factor intensities for industrial chemicals, petroleum refining, petroleum and coal products, iron and steel, non-ferrous metals and transport equipment. A high ranking was also obtained for non-electrical machinery (including computers), when weighted averages were calculated. Many of these same industries were also in the highest quarter of the ranking for physical capital. Spearman correlations between industry rankings by human- and physical-capital intensity were 0.41 for 1970–7 and 0.67 in 1978–85. These results suggest a positive association between the two factor intensities – at least when global averages are considered.

The industries that were found to be heavy users of labour closely matched with a priori expectations. Wearing apparel, footwear, furniture, textiles, leather and leather products, pottery and metal products all have large requirements for labour relative to total (i.e. physical and human) capital. Rankings changed only slightly when weighted averages were used.

International differences in factor intensities

Table 6.2 provides an indication of differences in factor intensities among country groups. Spearman correlations measure the agreement between the industry rankings of a reference group (the DMEs) and three groups of developing countries. The figures show that rankings of the latter countries differed, sometimes substantially, from the DME average. This result can partly be explained by differences in the basic economic attributes of the various developing countries. The greater the disparity in the relative factor abundance of countries, the more likely it is that there will be substantial differences in factor prices. Significant cross-country differences in factor intensities will be the result.

Cross-country variation in factor intensities can also be represented on an industry-by-industry basis. Table 6.3 documents this feature, showing for each of the 28 industries coefficients of variation of factor intensities across the 43 studied countries. Labour has the largest coefficients, with the maximum being reported for industrial chemicals in 1970–7. Wide differences in labour intensity can be observed even among the most labour-intensive industries such as wearing apparel, leather and leather products, footwear and pottery. These particular results indicate the need for caution when categorizing industries as 'labour-intensive'.

Variations in physical and human capital intensity were similar in magnitude and considerably lower than those for labour. Most industries that are extensive users of either factor reported a relatively narrow range for the corresponding intensities. This result would seem to imply that a general classification of industries in terms of human or physical capital requirements is more appropriate than one based on labour intensity.

Table 6.2 Correlations between factor intensity rankings of country groups, 1970–7 and 1978–85

Country group (no. of countries/areas)	Spearman correlations between country group[a] and DME average: Physical-capital intensity 1970-1977	Physical-capital intensity 1978-1985	Human-capital intensity 1970-1977	Human-capital intensity 1978-1985	Labour intensity 1970-1977	Labour intensity 1970-1985
Developed market economies (20)	1.00	1.00	1.00	1.00	1.00	1.00
NIEs (6)	0.79	0.84	0.64	0.84	0.70	0.86
Second-generation NIEs (7)	0.76	0.76	0.61	0.46	0.81	0.81
Other developing countries/areas (10)	0.60	0.73	0.27	0.57	0.53	0.69

Source: UNIDO

a/ The group averages of factor intensities underlying the above correlations are of the unweighted ordinal type. They were derived by first ranking industries (i = 1,2, ... m) by factor intensity separately for each country (j = 1,2, ..., n) to obtain ranks r_{ij}. The average ranking of each industry over all countries in the group was then calculated simply as the arithmetic mean:

$$\bar{r}_i = \frac{1}{n} \sum_{j=1}^{n} r_{ij}$$

Finally, industry rankings were based on the group averages $\bar{r}_i$.

Table 6.3 Coefficients of variation of factor intensities, by industry, 1970–7 and 1978–85

Industry (ISIC)	Physical capital 1970–1977	Physical capital 1978–1985	Human capital 1970–1977	Human capital 1978–1985	Labour 1970–1977	Labour 1978–1985
Food products (311)	66.0	68.5	71.7	76.5	111.6	112.0
Beverages (313)	59.7	61.7	76.2	80.1	118.0	117.6
Tobacco (314)	85.1	88.8	99.5	87.6	159.6	176.7
Textiles (321)	48.0	56.5	61.4	71.6	93.1	93.6
Wearing apparel (322)	100.2	73.3	101.7	92.7	131.7	127.2
Leather and fur products (323)	73.3	77.3	73.6	90.6	121.7	155.1
Footwear (324)	90.9	72.3	72.6	72.7	250.3	161.1
Wood and cork products (331)	87.8	105.3	88.7	100.5	80.0	128.0
Furniture fixtures excl. metal (332)	82.2	82.2	72.3	81.6	99.7	145.6
Paper (341)	70.6	72.4	74.1	76.7	82.0	108.8
Printing and publishing (342)	63.9	67.3	73.0	78.6	101.9	256.7
Industrial chemicals (351)	83.3	65.6	67.3	71.5	136.0	275.6
Other chemicals (352)	77.1	56.5	64.7	67.6	70.6	72.0
Petroleum refineries (353)	99.1	115.6	79.6	201.6	151.5	216.5
Products of petroleum and coal (354)	175.8	174.7	40.5	93.2	95.2	76.0
Rubber products (355)	62.1	59.5	69.8	73.9	90.8	78.0
Plastic products (356)	64.6	70.9	75.5	87.9	255.7	131.7
Pottery, china, earthenware (361)	68.9	81.9	73.5	80.6	126.2	115.6
Glass (362)	67.6	66.3	69.2	76.6	85.0	96.8
Other non-metallic min. products (369)	53.1	50.7	68.6	70.1	73.3	86.0
Iron and steel (371)	62.7	69.1	68.3	76.6	91.6	143.2
Non-ferrous metals (372)	116.7	145.9	69.9	82.2	185.5	163.1
Metal products (381)	56.9	59.7	71.0	77.6	91.1	102.3
Non-electrical machinery (382)	53.5	67.6	72.0	77.1	102.9	101.8
Electrical machinery (383)	58.6	51.3	76.3	79.1	90.6	126.1
Transport equipment (384)	78.3	57.0	72.5	72.0	81.5	74.6
Professional & scientific equipment (385)	95.8	63.6	80.1	73.3	77.5	72.5
Other manufactures (390)	113.8	101.5	160.3	113.5	89.6	112.2

Source: UNIDO

a Coefficients of variation (ratios between standard deviations and means) were calculated using the entire country sample of 43 countries and areas.

This assessment of factor intensities concludes with an examination of the consistency in industry rankings across countries. Measures of concordance were calculated for members of each country group and are reported in Table 6.4. They reveal a high degree of agreement in the industry rankings. The null hypothesis of no relationship between countries' industry rankings is rejected, as all coefficients are positive and statistically significant. Furthermore, the coefficients are stable over time and differ very little, either between factors or between country groups.

Although the concordance is strong, the coefficients for each country group do not support an extreme assumption of perfect agreement in industry rankings. Such an outcome would be indicated by a coefficient of unity, but the estimates in Table 6.4 are much lower. Unequal factor prices and technological differences may provide sufficient reasons for a diverse range of production techniques. Such diversity is likely to account for patterns of specialization and trade which are more complex than suggested by theoretical models.

The imperfect concordances in Table 6.4 indicate the existence of reversals between countries in the rankings of industries by factor intensities.[4] The extent of such reversals was examined with the help of clustering techniques. The most surprising result of the cluster analysis was the 'omnipresence' of reversals. There was no pair of countries throughout the entire sample where reversals did not occur for each factor. In other words, no two countries had identical industry rankings for at least one factor of production in either of the two time periods.[5]

Revealed comparative advantage and factor intensities

Factor intensities provide the theoretical link between endowments and patterns of output and trade. But in empirical work they have often played a more prominent role. In fact, most empirical studies of trade have been country-specific and have left aside any explicit assessment of factor abundance – the major characteristic in the underlying theory.[6] They have focused instead on the relationship between factor intensities and levels of output or trade in specific industries. Although the concept of factor intensities is by no means assigned a secondary role in the H–O literature, there are two reasons to regard this approach as an improper test of the theory. First, any test of the H–O proposition must explicitly incorporate data on trade, factor intensities and factor abundance. Second, when analysts focus exclusively on the interaction between factor intensities and trade, they obtain only indirect evidence on the operation of H–O forces. More specifically, factor abundance cannot usually be inferred with precision from the relationship between factor intensities and trade patterns (Leamer and Bowen, 1981; Aw, 1983).

Analysts may wish to study the technical characteristics of specific industries for other reasons, however. One is that factor intensities are useful in

Table 6.4 Concordance of factor intensity rankings within country groups, 1970–7 and 1978–85

Country group (number of countries/areas)	Kendall's coefficient of concordance[a] Physical capital 1970-1977	1978-1985	Human capital 1970-1977	1978-1985	Labour 1970-1977	1978-1985
Developed market economies (20)	0.65	0.65	0.73	0.74	0.69	0.68
NIEs (6)	0.74	0.74	0.68	0.66	0.67	0.68
Second-generation NIEs (7)	0.69	0.78	0.66	0.70	0.60	0.68
Other developing countries (10)	0.62	0.60	0.63	0.63	0.66	0.64

Source: UNIDO

a/ The (adjusted) coefficient of concordance (W) is defined as:

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

where S is the sum of squares of the deviations of the total of the ranks obtained by each industry from the average of these totals. The number of countries is n and m is the number of industries. For more details, see Maxwell (1967), pp. 117-121.
A coefficient of zero would indicate complete randomness while a coefficient of unity would signify complete agreement in the rankings.

describing a country's involvement in the international division of labour. Another is that the theory poses questions that are applicable mainly to single countries (for example, the types of commodities to be produced and exported), and factor intensities have an important role to play in this regard.[7]

Methodological considerations

The role of factor intensities is encapsulated in the expectation that the composition of national output will be weighted in favour of those industries that use the country's abundant factors most intensively. This relationship – which is usually associated with the work of Rybczynski (1955) – lies at the heart of the factor abundance theory. In the high-dimensional version of the theory it takes the form of a correlation or on-average result (Ethier, 1984). For such an on-average relationship to hold, it is sufficient that production be concentrated in a few industries which use an abundant factor intensively. Thus, the output structure in a relatively capital-abundant country is expected to be dominated by relatively capital-intensive industries and analogously for other countries and factors. Demand conditions permitting, the commodity patterns of exports are expected to reflect the interaction between factor intensity and factor abundance in a way similar to output.

The static framework which yields the sorts of relationships described here can be easily extended to a model expressed in comparative-static terms. An example is Krueger's (1977) model of complete global specialization with three factors and two sectors. By providing a theoretical framework to describe the changes in output and trade that occur as a consequence of factor growth, the model serves as a means for analysing shifts in factor intensities over time.[8] Krueger's model predicts that, as economic development continues, the absolute and relative amounts of accumuulated capital will increase. The share of capital-intensive industries will tend to rise (on average) as relative factor endowments change. Similar changes will occur in the structure of exports unless shifts in domestic demand offset this tendency.

Most of the arguments depend on the existence of an on-average rather than a determinate relationship between variables. A given set of factor intensities may impose only a weak restriction on the structure of output and trade, though the possibility of a much stronger association is not precluded. The strength of the hypotheses relating factor intensities to output and trade is then open to question. Three stylistic interpretations are possible. The strongest of these would be one postulating a monotonic relationship: the more intensively an industry uses an abundant factor, the higher are its values of output and exports. A second, and weaker, relationship can be stated as a 'bloc' hypothesis: depending on a country's factor abundance, comparative advantage is expected to be concentrated in the set (or bloc) of industries that use a given abundant factor most intensively. The third hypothesis is even weaker. It merely postulates the existence of an on-average association between factor intensity and the structure of output or trade. Empirically, this last hypothesis depends merely on a test of the sign of a correlation coefficient. The theory of high dimensional trade models implies that a monotonic hypothesis is inappropriate for an empirical study of this type. Tests of the third hypothesis are faced with serious problems of econometric specification (Anderson 1981). Consequently, the second version is chosen as the basis for analysis in this section.

Testing the 'bloc' hypothesis

An analysis of the output structure is a natural starting point for an investigation of the bloc hypothesis.[9] A set of 'commodity composites' which can be associated with each factor was first identified. The composites were made up of those industries in the highest quarter of each factor intensity ranking. Each composite consists of seven of the 28 industries included in the manufacturing sector. The second step was to calculate output-based measures of revealed comparative advantage (RCA) for the three 'factor-intensive' composites and for all countries in the sample.[10] The RCA indicator is defined as the ratio between a country's share in world output of the composite and the country's share in world GDP.[11] In countries where manufacturing output is relatively concentrated in industries that are intensive users of abundant factors, the H–O relationship between factor intensities and output should be borne out by the above indicator.

Table 6.5 summarizes the results, showing RCA indicators for the entire country sample in 1970–2 and 1983–5. At first glance the figures present a diffuse picture. Much of this diffuseness may be due to the shortcomings of the RCA indicator as an 'absolute' measure of comparative advantage. Nevertheless, simple ordinal comparisons between RCA values of the three commodity composites reveal some systematic relationships. In particular, if for each country the highest (lowest) of the three RCA values is taken as indicating comparative advantage (disadvantage) in the corresponding type of goods, the expected association between factor intensities and output is confirmed for almost all DMEs. The comparative disadvantage of these countries in production of labour-intensive manufactures was pronounced and pervasive. Shares in world output for the labour-intensive composite reveal that only a few DMEs (Belgium, Greece, Israel and New Zealand) had a comparative advantage in this type of goods and that, except for Israel, this was the case only in one time period. The competitive strengths of most DMEs are in industries that use large amounts of physical or human capital.

Of the two capital-intensive composites, one usually dominates over the other. Human capital was the major contributor to comparative advantage in one-half of the DMEs, while physical capital played this role in about one-quarter of these countries. In particular, comparative advantage in production was closely associated with human-capital intensity in nine DMEs (including most of the largest exporters of manufactures) in both time periods.

Although the results for DMEs agree with theoretical expectations, the situation was different for the developing countries. The expectation that comparative advantage would be associated with labour-intensive manufactures was only partly supported by empirical evidence. The most labour-intensive industries are not necessarily those in which the developing countries have the highest shares in world output. Only the results for Hong Kong, the Republic of Korea and several of the larger developing countries (India, Pakistan and Yugoslavia) in part conform with expectations, showing a substantial bias in favour of labour-intensive industries in the second time period. Among second-generation NIEs, only Indonesia had a significant comparative

Table 6.5 Output-based measures of RCA,[a] by industry groups, 1970–2 and 1983–5 (percentages)

Country group/ Country and area	Aggregate RCA (per cent) for 'commodity composites'[b] which are intensive users of: 1970-1972 Physical capital	Human capital	Labour	1983-1985 Physical capital	Human capital	Labour
DMEs						
Australia	77.9	113.0	59.6	70.4	90.1	41.6
Austria	127.1	147.2	121.8	158.6	151.3	114.0
Belgium	145.9	124.0	141.0	122.7	119.3	127.9
Canada	133.9	110.1	60.8	96.[illegible]	113.8	68.1
Denmark	111.3	98.5	44.7	59.1	69.9	25.1
Finland	218.0	175.9	36.8	160.5	159.9	70.2
Germany, Fed.Rep.of	83.5	140.5	75.2	95.1	153.9	100.4
Greece	65.3	55.2	113.1	121.2	109.4	61.2
Ireland	114.3	75.3	42.3	121.1	54.3	49.9
Israel	92.6	147.4	171.2	141.2	115.5	224.4
Italy	103.7	115.7	99.7	156.1	156.7	92.3
Japan	154.9	165.1	124.9	117.6	168.0	76.0
Netherlands	103.2	109.0	72.1	163.8	168.1	72.2
New Zealand[c]	65.4	138.2	114.9	50.1	80.7	94.5
Norway	135.5	104.2	72.6	112.8	448.5	55.5
Portugal[c]	59.2	65.9	58.1	141.6	197.6	69.5
Spain	172.2	134.2	98.2	115.9	159.8	88.8
Sweden	114.2	164.3	56.5	105.2	164.0	37.6
United Kingdom	140.8	146.4	91.6	107.5	105.8	69.4
United States	86.5	94.7	54.1	91.8	95.1	60.1
NIEs						
Argentina	98.9	116.8	77.3	[illegible]	86.7	56.0
Brazil[c]	144.9	103.6	67.5	127.8	113.7	87.[illegible]
Hong Kong[d]	38.3	198.5	37.4	[illegible]	109.0	164.[illegible]
Mexico	110.6	98.3	56.3	56.[illegible]	89.7	48.8
Republic of Korea	92.2	57.8	33.4	133.0	136.8	163.[illegible]
Singapore	274.3	241.5	136.3	221.5	223.7	53.3
Second-generation NIEs						
Colombia	196.[illegible]	158.1	25.8	200.7	141.3	30.8
Indonesia	26.2	[illegible]	20.4	27.6	[illegible]	[illegible]
Malaysia	266.8	[illegible]	115.2	[illegible]	[illegible]	[illegible]
Peru[c]	164.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Philippines	154.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Thailand	219.0	[illegible]	35.6	[illegible]	129.0	[illegible]
Tunisia	236.4	218.5	60.4	116.6	[illegible]	[illegible]

Table 6.5 continued

Country group/ Country and area	Aggregate RCA (per cent) for 'commodity composites'[a] which are intensive users of: 1970-1972 Physical capital	Human capital	Labour	1983-1985 Physical capital	Human capital	Labour
Other developing countries						
Chile	119.1	98.0	32.2	114.7	98.7	49.6
Dominican Republic[c]	51.4	21.1	190.2	71.8	60.7	106.7
Egypt	123.9	218.5	27.7	108.0	56.9	50.9
Guatemala[c]	151.1	181.5	31.5	108.8	142.9	22.6
India	204.3	183.1	96.5	196.1	212.0	162.6
Pakistan[c]	139.5	68.4	14.7	91.7	66.6	126.9
Panama	204.8	153.9	42.3	70.0	63.6	10.6
Turkey[c]	85.7	85.7	16.5	84.0	90.8	49.2
Venezuela[c]	189.0	111.2	27.7	122.1	111.3	24.8
Yugoslavia	128.6	137.3	116.4	213.1	175.3	295.8

Source: UNIDO

a/ The output-based indicator of RCA can be written as:

$$RCA^{Q}_{hj} = \frac{Q_{hj}}{Q_{hw}} \Big/ \frac{Y_j}{Y_w} \times 100$$

where Q is output, Y is GDP, h refers to a given factor, j represents a country and w refers to world totals. In particular, Q_{hj} is output in country j of those (seven) industries in the upper quartile of the distribution of industries by h-intensity in country j. Aggregate Q_{hw} is defined analogously for the whole sample w. For more details on the underlying data see the statistical appendix.

b/ For a description of the construction of each commodity composite, see the text.

c/ Data for the second time period are for 1980.

d/ Data for the first time period are for 1973.

advantage in the production of labour-intensive goods (and only for 1983–5). Aside from these instances of corroboration, evidence of a consistently high concentration of output in labour-intensive areas of manufacturing was noted for one developing country (the Dominican Republic). In summary, the structure of manufacturing output in developing countries only partially matched H–O expectations regarding the relationship between factor abundance and factor intensity. The strength of the association between the two variables was weakest in 1970–2 and particularly so among second-generation NIEs.

The same tests were repeated after replacing the output-based measure of RCA by indicators derived from export data.[17] The results are reported in Table 6.6. As far as the DMEs are concerned, the figures agree largely with the pattern that emerged from output-based measures. In particular, the data for 1983–5 support H–O propositions about labour intensity as a source of comparative disadvantage[13] and capital intensity as a source of comparative advantage of these countries.

Among the NIEs, the export-based measure of RCA produces marginally better evidence of H–O relationships than the output-based version in as much as physical capital and labour are more frequently identified as sources of comparative advantage. Furthermore, the figures for second-generation NIEs show that the rapid growth of manufactured exports of these countries during the 1970s was based on a comparative advantage in relatively labour-intensive industries. Unlike the results for output, those for exports indicate that at the beginning of the 1980s a number of second-generation NIEs (Indonesia,

Table 6.6 Export-based measures of RCA,[a] by industry groups, 1970–2 and 1983–5 (percentages)

Country group/ Country and area	Aggregate RCA (per cent) for 'commodity composites'[b] which are intensive users of: 1970–1972 Physical capital	Human capital	Labour	1983–1985 Physical capital	Human capital	Labour
DMEs						
Australia	50.5	49.6	24.7	99.3	74.3	14.6
Austria	208.7	226.9	196.1	160.3	164.0	136.4
Belgium	269.3	250.4	523.7	317.9	333.1	402.6
Canada	346.6	244.8	43.4	214.1	251.7	39.4
Denmark	290.9	137.0	79.6	239.3	102.5	87.5
Finland	352.1	245.6	99.7	331.1	203.3	[illegible]
Germany, Fed.Rep.of	69.9	168.9	87.5	89.3	184.8	129.0
Greece	78.6	41.2	43.8	77.5	79.1	36.7
Ireland	156.1	73.6	97.6	535.5	134.1	235.4
Israel	91.0	93.1	220.9	286.8	189.0	133.8
Italy	86.0	146.2	100.4	106.9	142.0	86.6
Japan	83.5	96.9	125.6	62.9	121.0	46.5
Netherlands	330.0	179.5	214.0	554.2	303.6	144.3
New Zealand[c]	26.4	19.9	111.4	41.1	68.9	23.2
Norway	282.1	180.7	45.9	165.5	125.0	22.5
Portugal[c]	114.8	138.3	367.2	152.6	106.0	92.4
Spain	34.0	29.1	95.7	82.1	82.7	69.2
Sweden	208.6	210.6	164.3	195.9	215.9	162.1
United Kingdom	136.6	131.2	126.1	134.8	109.7	83.1
United States	35.1	51.2	14.7	39.7	47.6	17.0
NIEs						
Argentina	10.9	6.1	13.1	26.7	15.4	16.4
Brazil[?]	187.7	17.9	16.2	93.7	28.5	38.8
Hong Kong[d]	51.3	536.9	293.2	69.2	34.6	754.7
Mexico[e]	26.0	24.4	24.7	12.3	12.2	9.9
Republic of Korea	18.1	24.0	116.7	153.5	156.4	690.6
Singapore	1134.3	959.0	687.5	1037.3	992.4	598.2
Second generation NIEs						
Colombia	272.1	277.2	14.8	203.0	279.3	8.1
Indonesia[c]	1.7	0.2	56.8	10.6	10.2	[illegible]
Malaysia	[illegible]75.2	220.3	224.1	295.1	56.9	[illegible]
Peru[c]	169.5	14[illegible]	1.0	121.[illegible]	233.1	[illegible]
Philippines	130.3	149.8	12.4	100.[illegible]	14.[illegible]	[illegible]
Thailand[?]	27.1	25.3	18.0	8.5	10.3	[illegible]
Tunisia	78.6	29.1	15.9	113.3	124.9	383.3

Table 6.6 continued

	Aggregate RCA (per cent) for 'commodity composites'[b] which are intensive users of:					
	1970–1972			1983–1985		
Country group/ Country and area	Physical capital	Human capital	Labour	Physical capital	Human capital	Labour
Other developing countries						
Chile	647.6	[illegible]	[illegible]	327.2	32.4	[illegible]
Dominican Republic	3.0	18.9	442.9	[illegible]	[illegible]	[illegible]
Egypt	6.9	32.8	[illegible]	30.4	[illegible]	[illegible]
Guatemala	273.9	[illegible]	63.8	[illegible]	[illegible]	[illegible]
India	19.4	[illegible]	27.3	[illegible]	21.7	[illegible]
Pakistan	55.3	7.2	[illegible]	[illegible]	[illegible]	[illegible]
Panama	157.7	64.2	3.3	[illegible]	37.6	[illegible]
Turkey	6.3	2.0	5.1	[illegible]	[illegible]	17.2
Venezuela	302.3	236.9	0.7	[illegible]	[illegible]	[illegible]
Yugoslavia	69.6	67.5	88.8	[illegible]	[illegible]	[illegible]

Source: UNIDO

a/ The export-RCA indicator can be written as:

$$RCA_{hj} = \frac{X_{hj}}{X_{hw}} \Big/ \frac{Y_j}{Y_w} \times 100$$

where X are exports, Y is GDP, h refers to a given factor, j to a country and w to the world. In particular X_{hj} are the exports by country j of those (seven) industries that appear in the upper quartile of the distribution of industries by h-intensity in country j. Variable X_{hw} is defined analogously for the whole sample w. For more details on the underlying data see the statistical appendix.

b/ For a description of the construction of each commodity composite, see the text.

c/ Data for the second time period are for 1982.

d/ Data for the first time period are for 1973.

e/ Data for the second time period are for 1979.

Malaysia, Philippines, Thailand and Tunisia had attained an international comparative advantage in labour-intensive goods. Similarly, export data of non-NIEs reveal more cases of this type of comparative advantage than do output data.

From the previous results it can be concluded that the bloc hypothesis performs well for the DMEs, irrespective of whether output or export data are the basis for determining RCA. For the developing countries, export figures provide relatively stronger support for the hypothesis than do output figures. Thus, an overall comparison between Tables 6.5 and 6.6 suggests that the H-O traits that characterize patterns of exchange (exports) are somewhat stronger than those for output. This distinction is of interest since the factor abundance theory maintains that national differences in factor endowments generate differences in output structure. Differences in output structure should translate directly into trading patterns if patterns of consumption are uniform. But in a world of differing consumption patterns, it would be no surprise if the vagaries of demand blurred the expected H–O relationship between output and trade. Such a possibility, however, is not observed. Instead, the structure of demand for manufactures seems to accentuate the H–O traits of trade as compared with those of output.

In summary, a moderately strong hypothesis of an H–O-like relationship between factor input requirements and comparative advantage receives partial support from the foregoing analysis. This support comes mainly from the relationship between labour inputs and comparative advantage. Whether such a partial concordance between theoretical expectations and empirical evidence warrants an endorsement of the H–O model of the trading world at large is considered in the following chapter.

Annex: Technology and trade

The H–O model of trade posits that a country will tend to specialize in and export products that intensively use its relatively abundant and thus relatively cheap factors of production. The reverse would also hold, as a country would tend to import a product that intensively utilizes its relatively scarce (expensive) factors of production. Among the assumptions from which these propositions are derived is that production functions are the same everywhere. Alternatively, the technology of production for a particular commodity is assumed to be known and fixed both domestically and internationally. Under such restrictive conditions, which seem at variance with casual observation, the only basis for trade is differences in the prices of the factors of production.

In this section the effects of relaxing the above assumption concerning technology will be discussed. A framework for this discussion is provided by models that incorporate changes in technology as well as technological differences between countries. In response to the Leontief paradox, a fairly large amount of work has been done regarding the effects of technological change in a standard H–O model. The common feature of these theories is an emphasis on such change and the resulting pattern of trade in new products. While the details of the process differ among theories, all are designed to explain the pattern of trade of the USA.

The first major theoretical effort to explain the observed patterns of trade in terms of technical progress was the technology gap model sketched by Posner (1961). The basic idea is that, as new products and processes are being developed, the country in which these innovations occur will temporarily possess a technological advantage over its trading partners in these products. This advantage will last only until the new technology is initiated in other countries. But before that happens, the innovating country may export the good even though it has no obvious basis for comparative advantage in terms of factor endowments. As time passes, each individual innovation is eventually diffused around the world and the initial advantage is lost. However, as progress continues, new products and processes are being discovered. This implies that there exists a constantly changing list of new products in which the innovating country has a competitive advantage.

A difficulty with the technology gap model is that it fails to explain why a new innovation is not produced immediately in the least cost-location. Put another way, new products and production processes are transferred to the developing countries only after a substantial amount of time has lapsed. In a world where firms operate only domestically, this would be understandable, as firms would be reluctant to share their knowledge with others. However, in a world of transnational corporations (TNCs), it is difficult to see why a firm would not go abroad immediately to produce in the lowest-cost location. In this way it could potentially reap an even larger reward from the innovation and prevent the diffusion of the knowledge because production would be internalized within the firm.

The most commonly used approach to technology and trade is that developed by Vernon (1966). Vernon departs from the strict theory of comparative advantage to construct the product-cycle hypothesis which was outlined in Chapter 3. While comparative costs are important for standardized (H–O) goods, for new and maturing (product-cycle) goods the patterns of trade are to some extent outside the traditional H–O model. Vernon's product-cycle theory might also provide an explanation of the Leontief paradox. If DMEs are heavy exporters of product-cycle goods, then their exports would embody labour and human capital rather than physical capital, as the theory predicts.

While these theories are intuitively appealing, it is necessary to attempt to test their validity empirically. Several empirical studies have included R and D as a factor explaining trade within a multi-factor proportions model. Stern (1976) found that R and D expenditures had a positive and significant effect on West Germany's exports. Similar results for the USA were obtained by Baldwin (1971, 1979) and by Stern and Maskus (1981). Maskus (1983) found that for the USA the importance of R and D as a determinant of trade may be growing over time. Based on a different methodology, the results obtained by Sveikauskas (1983) indicate that science and technology are what differentiates the US economy from that of the rest of the world.

The conclusion of this empirical work is that the technology gap and product-cycle explanations of trade flows seem to have some validity for DMEs. This conclusion is rather tentative, as most of the empirical work has been done only for the USA. A loose implication of the results is that new technology, products and processes have become important determinants of the patterns of trade. The gross quantities of labour and capital are still important, but other factors matter as well. It would thus seem likely that the transfer of technology to the developing countries would tend to improve their competitive advantage relative to the DMEs. A number of recent theoretical models of North-South trade also support this (Krugman, 1979b; Dollar, 1986).

The H–O assumption that technology is virtually identical across countries for a given industry may be appropriate for the technology necessary to produce labour-intensive or capital-intensive H–O goods. By contrast, for countries to develop competitive advantage in product-cycle goods, the transfer of proprietary technology may be essential. A general definition of such transfer is: the development by people in one country of the capacity on the part of nationals of another country to use, adapt, replicate, modify or further expand the knowledge and skills associated with a different method of manufacture of a product. Technology transfer is inherently difficult to measure as it is more a relationship or process rather than a simple economic exchange of quantities. One cannot define a standard unit of technology in the same fashion that one can define goods.

In more concrete terms, it is frequently useful to think of technology transfer as a package. A technology transfer package may contain one or more of the following components: (1) technology transferred via technical documents, blueprints, etc.; (2) permission to use various rights, knowledge, or assets; (3) use of capital, intermediate or final goods; (4) transfer of training, etc. Such transfers may be either proprietary or non-proprietary. In the former case the technology may be associated with some form of monopoly rent, which means that cost and price may be distorted. The technology package, or its components, may be transferred either via a foreign direct investment (FDI) 'bundle' or by means of some sort of contractual arrangement, i.e. 'unbundled'. Some of the components of a technology transfer bundle could be: export of hardware, licence, technical assistance contract, contract manufacturing, management contract, marketing agreement, training contract, consulting contract, architectural and engineering contract, research and development contract, construction supervision contract, construction contract, turnkey contract, production-sharing, and co-operation. The above list is of course not all-inclusive, but it serves to illustrate the variety of forms that technology transfer may take and to explain why the concept is difficult to define in a precise way. Additionally, one has to consider indirect technology transfer, which occurs through publicly accessible channels or through training in DMEs.

If the transfer of technology is potentially beneficial to developing countries, then it is appropriate to consider its cost. Theoretically, the price of technology should be an approximation of the present discounted value of the anticipated royalties or fees and other benefits derived from the technology, net of all costs. To the seller, the cost of technology would include all direct costs, overhead costs and the cost of forgone profits on exports or direct investment. Both the price and the cost are subject to much judgement because they contain implicit forecasts and include costs that are difficult to allocate in an accounting sense. All one can conclude is that the value of technology transfer is very difficult to calculate with any degree of precision. This fact alone constitutes a major impediment to technology transfer.

Since much of the technology transfer to developing countries occurs through TNCs, it is useful to look at technology transfer as an interaction between the two. Ultimately, developing countries would like to be able to generate their own technology. In the interim, such countries must be concerned primarily with the availability of technology. Using FDI as a proxy for 'bundled' technology transfer, it may appear that the rate of growth of access is slowing down. During the 1970s international direct investment in developing countries was growing at 29 per cent per year. The share of developing countries as recipients of international direct investment increased from an average level of about 20 per cent in the first half of the 1970s to a level above 32 per cent in the late 1970s. Since that time there has clearly been a reduction of significant proportions, with the 1984 level of international direct investment being only $9.5 billion as compared with $16.7 billion in 1981 (OECD, 1987).

The transfer of technology will almost always involve a contest between the desire of the TNC to maximize rents from technology and the desire of developing countries to obtain technology cheaply and/or on very favourable terms. The major issue here seems to be the 'unbundling' of FDI. TNCs would frequently prefer to exploit their monopoly power through FDI; on the other side, developing countries feel that this may be an expensive way to obtain technology and that it carries non-economic costs. However, attempts to unbundle FDI through licensing or joint ventures will probably slow technology transfers or restrict the availability of the newest technology. Furthermore, within the current institutional framework of world trade, increasing the amount of technology transfers may not be a simple policy task. However, given the current slow growth of world trade, this transfer is essential.

Notes: Chapter 6

1 In relation to empirical tests of the H-O proposition, the question is sometimes raised whether a matrix of factor intensities can be found that would be 'representative' of the world. Indications are that matrices pertaining to individual countries (e.g. the USA) usually cannot play this role (Anderson, 1987).

2 Factor shares of unskilled labour require data on wages paid to unskilled workers. These data are not available for a broad range of countries. The alternative of factor-input ratios has the disadvantages of treating factors asymmetrically and depends on factor price ratios, see Bowden, 1983.

3 Total value added per employee was introduced as a measure of total (physical and human) capital intensity by Lary, 1968. Its reciprocal can loosely be interpreted as an indicator of labour intensity in the underlying factor proportions model. On the other hand, non-wage value added and wages are usually taken broadly to represent the returns to physical capital and human capital, respectively. On these grounds, they serve as proxy measures of the input values of the two types of capital

4 Here the term 'reversal' is used in a desc[illegible] way. It doses not reflect properly the generalized definition of a factor intensity reversal in high dimensions (Ethier, 1984).

5 The final results of the clustering procedure were rather inconclusive as regards the formation of broad groups of countries with similar factor intensity attributes. This was particularly evident when an ordinal measure of factor intensity was employed. That measure yielded an 'atomistic' portrait of the whole country sample. Most steps in the process of hierarchical clustering merely linked one additional individual country to the existing single cluster. Additional details on the techniques applied can be found in the technical appendix (Appendix A).

6 Deardorff, 1984 provides a comprehensive overview of empirical studies on trade patterns. His article lays out the relationship between theoretical models and empirical work and summarizes the main results obtained by the latter. The priority placed on factor intensities in the empirical analyses of specific countries is evident from this summary.

7 Although a contrary view has sometimes been expressed (Leamer, 1974), both the structure and the methodology of trade theory emphasize a country-specific orientation. This applies in particular to results that have been obtained on the basis of the duality approach to general equilibrium analysis; see Dixit and Norman, 1980.

8 The model has a primary sector and a manufacturing sector producing many commodities. Land is a specific input to the primary sector, capital is a specific input to manufacturing, and labour is mobile between the two sectors. The basic propositions derived from the model concern the successive stages of output specialization that accompany capital accumulation. For details on this comparative-static approach, see Jones, 1971, and Krueger, 1977.

9 Another rationale for emphasizing the relationship between output and factor intensities concerns the choice of the factor intensity measure. The present study makes use of a measure of factor intensities that is based only on direct factor inputs to the production of a given industry. Hamilton and Svensson, 1983, argue that direct factor intensities are best suited to explain the structure of production.

10 Bowen, 1983a, suggests use of a composite commodity to indicate international comparative advantage. A recent theoretical application of the composite commodity (together with the composite factor) approach is found in Neary, 1985.

11 This particular version of an RCA indicator has been suggested by Bowen, 1983b. It is a straightforward generalization of Balassa's 1965 original indicator, and can be interpreted in at least three different ways. First, the measure can be assumed to indicate comparative advantage in an 'absolute' sense, where the value of 100 per cent represents the dividing line between comparative advantage and comparative disadvantage of a given country in a given industry. Second, it can serve to rank, for a given industry, countries in terms of comparative advantage. Third, it can provide, for a given country, a ranking of industries in terms of comparative advantage. The present discussion adopts the last (and least controversial) of the three views, where commodity composites are considered instead of industries.

12 Exports rather than net exports were chosen for the exercise on trade, since it was easier to calculate RCA indicators from the former data (Balassa, 1965).

13 Only Belgium (in both time periods) and Japan (in 1970–2) showed surprisingly high values for exports of labour-intensive industries. In the case of Japan, this is due mainly to exports of electrical machinery – an industry where value added per employee was relatively low in 1970–2.

CHAPTER 7

Country differences, country similarities and the structure of trade

Trade analysts have usually chosen to explain inter-industry patterns of specialization and trade in terms of differences in the economic characteristics of trading partners. Such an approach is found in the first section of this chapter, where the relationship between factor endowments and net trade is examined for a large number of countries. The results of that investigation are used in the second section to assess the extent to which a generalized version of the H–O theory provides an explanation for patterns of world trade.

The discussion in the third section takes up a different issue, intra-industrial specialization and trade. The rapid growth of IIT is an empirical fact for which conventional factor abundance theory does not offer a satisfactory explanation. In searching for an adequate explanation for IIT, theorists have concluded that similarities rather than differences between countries are conducive to intra-industry forms of specialization. This possibility seems paradoxical in light of the conclusions of the factor abundance theory. Nevertheless, it is quite plausible from the viewpoint of the new theories which emphasize the role of scale economies and product differentiation. The concluding section of the chapter is devoted to an empirical analysis of some of these issues.

The theoretical basis for this chapter draws upon both the H–O and the economies-of-scale models. Such an approach is in line with the observation made by Helpman and Krugman (1985, p. 262) that 'the pattern of trade is shaped by the underlying exchange of factors but with an overlay of additional specialization to realize economies of scale'. The pattern of trade referred to here is explained by the conventional H–O model, which depends on country differences, while the overlay of additional specialization is intra-industry in scope and its extent is dependent upon country similarities.

Factor abundance and net trade

The present empirical application of the factor abundance model rests upon two points of logic. First, if country differences in factor endowments are a major determinant of comparative advantage, they should be systematically related to the pattern of trade of the various industries. Second, some knowledge of an industry's factor input characteristics would permit inferences about the relationship between factor supplies and trade. The first half of this argument serves as the basic premise for analysis in this section, while the second half will be treated in the following section.

Both propositions are integral parts of the argument and are needed to reflect the full content of the basic H–O hypothesis. Consequently, the analysis in this section is partial in the sense that it focuses on industry-specific linkages between factor supplies and trading patterns but only casually attempts to explain these linkages in terms of the underlying industry characteristics. The view that emerges from this exercise should, nevertheless, lead to some impression of the extent to which factor abundance influences specialization and trade.

Methodological background

Evidence of industry-specific relationships between net exports and factor endowments can be obtained from cross-country regressions in the tradition of Leamer (1984).[1] The researcher can choose from several regression models in order to demonstrate that differences in relative factor supplies are systematically related to variations in trading patterns. The model used here follows Leamer (1984) in that it makes no explicit use of factor abundance indicators. Instead, it attempts to assess the impact of levels of factor supplies on the size of net exports for each particular industry. Such an assessment is expected to answer two basic questions: (a) Is the cross-country variation in a given industry's net exports systematically related to variations in the endowments of certain factors? (b) How do industries differ with respect to the factor endowments effects on trade?

In order to describe these relationships, use is made of the notion of 'factor orientation'.[2] The term is an illustrative label referring to the association between factor endowments and trade. Its meaning can best be defined in geometric terms. In a space where the dimensionality equals the number of countries, two types of vectors can be visualized. One represents the cross-country distribution of a given resource. The components of this vector are the countries' levels of endowment for that resource. The second vector provides an analogous representation of the cross-country pattern of trade for a particular industry. The generalized factor abundance theory will then suggest a statement about the way in which the directions of the two vectors are related. The statement will be an on-average one, referring to all industries and all factors. Alternatively, if the resource distribution vectors are given, the underlying theory permits the user to draw inferences about the 'orientation' of industries' trade vectors.

A narrow definition of factor orientation can be stated in terms of the angle between the net exports vector and the resource distribution vector. There is, however, a close relationship between this geometric definition and the more familiar usage of correlation and regression coefficients.[3] The generalized H–O theory employs covariances or correlations to assess its basic relationships

(Deardorff, 1982). These tools, however, are limited, as they do not permit the user to isolate the impact of each individual factor on trade. Accordingly, the present analysis makes use of regression techniques and depicts factor orientation as equivalent to a regression coefficient which associates net trade with levels of factor supply.

The factor orientation of an industry's net exports is expressed in terms of beta coefficients. These show the change in standard deviations of the trade variable that is induced by a change of one standard deviation of the respective factor endowment variable. The meaning of the coefficients is straightforward: they indicate both the direction and the strength of the abundance effect which a given factor exerts on the net exports in a particular industry. The abundance effects may be positive, negative or non-existent. In geometric parlance, the corresponding 'orientation' of the net export vector with respect to the factor endowments vector would be termed near-parallel, near-anti-parallel or virtually orthogonal.

Estimates of factor orientation

Table 7.1 presents industry data which have been compiled in accordance with this interpretation. The estimates are based on a sample of 46 countries and 90 industries. The table shows only those industries with beta coefficients that were statistically significant in at least one of the two years considered. The rationale for such a selection is that a coefficient with a sufficiently large *t*-value can confidently be assumed to carry the correct sign. If a statistically significant coefficient also has a large absolute value, the factor abundance impact on net exports is appreciable. Coefficients that meet both criteria would indicate that the industry's net trade has a marked factor orientation.

A first glance at the figures of Table 7.1 suggests that the factor abundance impact on net trade is not overwhelming. Of the 90 industries considered, 41 had a marked factor orientation in 1970 and the number dropped to 35 in 1985. A total of 54 industries exhibited a significant factor orientation in at least one of the two years, but only 22 revealed such a relationship in both 1970 and 1985.

The impression conveyed by these statistics is not complete, however. The sheer number of categories (or industries) having a marked factor orientation is not a good indication of the role played by factor abundance. A more accurate picture is obtained by considering the share of world trade accounted for by products with a marked factor orientation. This share was found to be 54 per cent of total net trade in 1970 and 63 per cent in 1985. In other words, differences in factor abundance exerted some influence on more than one-half of the value of the net trade of the sample countries, and the significance rose over time.

A comparison between the four factors reveals pronounced differences in factor orientation. The contribution to comparative advantage/disadvantage can be determined by ranking each factor according to absolute values of beta

Table 7.1 Factor orientations[a] in selected industries, 1970 and 1985

Industry (SITC)	Physical capital[a] 1970	Physical capital[a] 1985	Skilled labour[b] 1970	Skilled labour[b] 1985	Semi-skilled labour[a,c] 1970	Semi-skilled labour[a,c] 1985	Unskilled labour[a] 1970	Unskilled labour[a] 1985	Adjusted[d] R^2 1970	Adjusted[d] R^2 1985
Organic chemicals (512)	1.976*	0.346	-1.146*	0.411	-0.291	-0.744***	0.581	0.193	0.478	0.013
Other inorganic chemicals (514)	1.797*	0.430	-0.934	0.510	-0.150	-0.403	0.432	0.022	0.196	0.109
Radioactive and associated materials (515)	-1.064	-0.387	2.215**	0.055	-0.685***	0.019	2.143	-0.027	0.511	-
Mineral tar and crude chemical (521)	2.582*	-0.272	-2.099**	0.438	-0.556	-0.330	1.267*	0.065	0.345	-
Pigments, paints, varnishes and related materials (533)	0.527	0.405	0.200	0.264	-0.350***	-0.286	0.128	0.024	0.008	-
Essential oils, perfume and flavour materials (551)	-0.513	-0.532	1.854***	1.406	-1.377**	-0.844	0.156	0.053	0.026	-
Fertilizers, manufactured (561)	1.998***	0.912	-1.673	-0.126	-0.292	-0.495	0.380	0.029	0.058	0.152
Plastic materials, regenerated (581)	1.404*	0.277	-0.878	0.126	0.258	-0.178	0.198	-0.008	0.375	-
Chemical materials and products (599)	0.905***	0.128	-0.127	0.982**	-0.354	-0.583***	0.201	-0.053	0.102	0.252
Leather (611)	-0.467	-0.134	0.385	0.140	-0.063	-0.224	0.628**	0.559	0.443	0.068
Manufactures of leather or reconstitutes (612)	-0.474	-0.535	-0.258	-0.237	0.938**	0.508***	-0.461	-0.021	0.059	0.149
Articles of rubber (629)	-0.320	0.546	-0.501	-0.674***	1.367*	0.443***	-0.653**	-0.055	0.224	0.046
Veneers, plywood boards, reconstituted wood (631)	0.424	-0.870	-1.534***	-0.590	0.480	1.044*	0.347	-0.403	0.220	0.173
Wood manufactures (632)	0.329	-0.758***	-2.069*	-0.130	1.524*	0.393	-0.106	-0.194	0.393	0.219
Cotton fabrics, woven (652)	1.134	0.150	-2.061**	-0.453	0.995**	0.192	0.630	0.311	0.227	0.013
Textile fabrics, woven other than cotton (653)	0.286	0.591	-2.052*	-0.716	2.232*	0.645	-0.368	-0.124	0.504	-
Made-up articles, chiefly of textiles (656)	1.177	-0.515***	-1.754***	-0.923**	0.601	0.828**	1.087*	-0.087	0.396	0.655
Lime, cement, building materials excluding glass and clay (661)	0.528	0.040	-0.852	-1.132***	0.511	1.067**	0.067	-0.313	-	0.065
Clay and refractory construction materials (662)	0.670	0.408	-1.253	-0.276	1.235*	0.270	-0.296	-0.110	0.214	-
Mineral manufactures (663)	0.679	1.051**	-0.342	-0.179	0.002	-0.135	0.129	0.110	-	0.099
Pottery (666)	0.113	-0.051	-1.058***	-0.381	1.107*	0.334	-0.261	-0.072	0.286	-
Pig iron, spiegeleisen, sponge (671)	0.143	-1.469**	0.703	0.947	-1.510*	-0.161	0.828**	-0.226	0.283	0.095

Table 7.1 continued

Industry (SITC)	Physical capital[a] 1970	Physical capital[a] 1985	Skilled labour[b] 1970	Skilled labour[b] 1985	Semi-skilled labour[c] 1970	Semi-skilled labour[c] 1985	Unskilled labour[d] 1970	Unskilled labour[d] 1985	Adjusted[e] R^2 1970	Adjusted[e] R^2 1985
Ingots and forms of iron or steel (672)	1.340***	-0.193	-0.607	1.103	-0.718	-0.776	0.734**	0.055	0.095	0.003
Universals, plates and sheets (674)	0.959***	0.690	-1.059	-0.695	0.537	0.161	0.070	0.076	0.053	-
Tubes, pipes and fittings of iron or steel (678)	1.101**	0.919**	-0.704	-0.709***	0.317	0.325	0.078	-0.024	0.166	0.170
Iron and steel castings, forgings, unworked (679)	-0.125	0.223	1.047***	-0.322	-0.218	0.731	-0.390***	-0.450	0.452	0.023
Nails, screws, nuts, bolts, rivets, etc. (694)	0.556	0.309	-1.598	-0.852**	1.151*	0.438	-0.056	0.042	0.218	0.077
Cutlery (696)	0.312	0.278	-0.743	-0.745***	0.707**	0.484***	-0.137	-0.033	0.096	0.003
Household equipment of base metals (697)	0.205	-0.030	-0.060	-0.829***	0.180	0.600***	-0.049	-0.019	-	0.110
Office machines (714)	1.100*	1.677*	-0.396	-1.559*	-0.287	0.462	0.352***	0.255	0.322	0.459
Metalworking machinery (715)	0.604	0.982**	-0.535	-0.679	-0.053	0.089	0.215	0.131	-	0.067
Textile and leather machinery (717)	1.381***	0.854	-0.211	-0.341	-0.480	-0.040	0.293	0.078	0.063	0.023
Machines for special industry (718)	1.015**	0.761	-0.050	0.013	-0.233	-0.157	0.124	-0.028	0.314	0.051
Machines and appliances (excl. electric.) parts (719)	0.856***	0.859***	-0.395	-0.138	-0.162	-0.107	0.206	0.034	0.052	0.050
Electric power machinery, switchgear (722)	1.597*	1.210*	-0.725	-0.708***	-0.212	0.120	0.376	0.094	0.191	0.163
Telecommunications apparatus (724)	1.089**	0.824**	-2.017*	-0.804**	1.381*	0.211	-0.052	0.129	0.369	0.091
Domestic electrical equipment (725)	0.193	0.871**	-0.259	-1.241*	0.500	0.500***	-0.202	0.122	-	0.109
Electric apparatus for medical purposes (726)	1.374**	0.799	-0.436	0.081	-0.464	-0.310	0.421	0.101	0.072	0.057
Other electrical machinery and apparatus (729)	1.113*	-1.010	-0.075	0.257	-0.264	0.006	0.175	-0.090	0.693	-
Railway vehicles (731)	2.044*	1.188**	-1.104***	0.324	-0.096	-0.012	0.442	0.056	0.316	0.145
Road motor vehicles (732)	0.801	0.656**	-0.284	-0.689***	0.043	0.253	0.078	0.078	0.030	0.030
Road vehicles other than motor vehicles (733)	-0.162	0.684***	0.464	-0.428	0.224	0.129	-0.285	0.027	0.027	0.014
Aircraft (734)	0.538***	0.196	0.934*	0.664**	-0.984*	-0.349***	0.229	-0.044	0.788	0.463
Ships and boats (735)	0.968	1.439*	-1.942**	-1.620*	1.641*	0.768***	-0.255	0.020	0.358	0.326
Travel goods, handbags and similar articles (831)	-0.201	-0.559***	-0.827	-0.680***	0.820**	0.713**	0.167	0.172	0.051	0.436
Clothing, except fur clothing (841)	-0.370	-0.410	-0.872	-0.900**	0.895	0.736**	-0.197	-0.095	0.007	0.420

Table 7.1 continued

Industry (SITC)	Physical capital[b] 1970	Physical capital[b] 1985	Skilled labour[c] 1970	Skilled labour[c] 1985	Semi-skilled labour[d] 1970	Semi-skilled labour[d] 1985	Unskilled labour[e] 1970	Unskilled labour[e] 1985	Adjusted R^2 [f] 1970	Adjusted R^2 [f] 1985
Fur clothing and articles made of fur skins (842)	-0.874	-0.732*	0.418	0.065	0.367	-0.187	-0.264	0.082	-	0.917
Footwear (851)	-0.128	-0.667***	-0.098	-0.511	0.253	0.759**	-0.105	-0.299	-	0.307
Scientific, medical, optical measuring instruments (861)	1.250**	1.020*	-1.129***	-0.762**	0.639***	0.150	0.067	0.146	0.414	0.126
Watches and clocks (864)	0.585	0.931***	-1.140	-1.310**	0.414	0.344	0.196	0.245	-	0.018
Musical instruments, sound recorders and reproducers (891)	0.938***	0.942*	-2.273*	-1.086*	1.588*	0.358***	-0.055	0.161	0.419	0.179
Perambulators, toys, games, sporting goods (894)	0.217	-0.068	-0.730	-0.998*	0.392	0.531***	0.042	0.036	-	0.392
Office and stationery supplies (895)	0.958	0.848***	-0.750	-0.490	0.519	0.135	0.002	0.076	0.279	0.019
Manufactured articles (899)	-0.073	-0.559***	-1.626**	-0.394	1.452*	0.613*	-0.251	-0.246	0.473	0.224

Source: UNIDO

a/ Factor orientation coefficients are regression coefficients estimated from a sample of 46 countries. The regression equation used is

$$T_{ij} = a_i + b_i K_{ij} + c_i H_{ij} + d_i S_{ij} + e_i U_{ij} + u_{ij}$$

where T_{ij} are net exports of industry i by country j, K, H, S and U are stock measures of physical capital, skilled labour, semi-skilled labour and unskilled labour, respectively, and u is the disturbance term. Both the dependent and the independent variables are standardized to unit variance, so that regression coefficents are beta coefficients. Asterisks indicate statistical significance at the 1(*), 5(**) or 10(***) per cent level. Only those industries are shown for which at least one statistically significant coefficient obtained in at least one year.

b/ Net capital stocks are aggregated depreciated flows of real gross domestic investment.

c/ Skilled labour is the number of professional/technical workers (ISCO 0/1).

d/ Semi-skilled labour is the number of literate workers who do not belong to the professional/technical category.

e/ Unskilled labour is the number of illiterate workers.

f/ In several cases the values of R^2 were low and, after adjustment, were negative. These observations are indicated by a dash (-).

coefficients. On this basis, physical capital was the most important in 1970. Coefficients for physical capital were dominant; that is, they had the highest absolute value in 47 of the 90 industries in 1970. In almost all these cases (43) the beta coefficients were positive, indicating that physical capital made a significant contribution to comparative advantage. The factor's significance had diminished somewhat by 1985. Physical capital had the highest ranking in only 35 industries, of which 28 coefficients were positive.

Skilled labour was second in importance to physical capital in 1970. But in 20 of the 32 industries where this factor was dominant, its influence was negative, meaning that abundance of skilled labour resulted in a comparative disadvantage.[4] By 1985 skilled labour had replaced physical capital as the most important determinant of net trade. In 26 out of the 40 industries where net exports were influenced by endowments of skilled labour, the factor was a source of comparative disadvantage. The impact of the two remaining factors on net trade was less important. The beta coefficients for semi-skilled labour revealed only ten industries (in both years) with a visible factor orientation. Unskilled labour played a minor role: the factor was dominant in only one industry in 1970 and five industries in 1985.

The pattern of industry rankings summarized here includes no test to determine whether the beta coefficients are significantly different from zero. Inclusion of this criterion leaves the picture virtually unchanged. The number of occurrences of both dominant and significantly positive (negative) beta coefficients for each of the factors were as follows: for physical capital, 17 (0) in 1970 and 11 (3) in 1985; for skilled labour, 3 (8) in 1970 and 2 (13) in 1985; for semi-skilled labour, 4 (2) in 1970 and 4 (1) in 1985; and for unskilled labour, 1 (0) in 1970 and none in 1985.

The relatively important role of physical capital is reconfirmed by the results for broad groups of industries. The factor is an important source of comparative advantage in industries producing chemicals (SITC 5) and machinery and transport equipment (SITC 7). It is of less significance for basic manufactures (SITC 6) and miscellaneous manufactured goods (SITC 8). This broad pattern fits with the casual impression that chemicals and machinery and transport equipment tend to be relatively large users of physical capital. In the case of machinery and transport equipment, the relationship between physical capital and net trade was unchanged between 1970 and 1985. The same was not true for chemicals, where the factor's significance has declined over time.

The contribution of each factor to comparative advantage can be assessed when the trade shares of various industries are considered. The largest shares of net trade are in motor vehicles and non-electrical machinery. The fact that the abundance of physical capital exerts a strong influence on the trade patterns of these two industries fits comfortably with a conventional H–O model. Similar observations apply to other widely traded manufactures such as universals, plates and sheets of iron or steel, and ships and boats. In contrast, the finding that physical-capital abundance is the prime source of comparative advantage in certain engineering industries is surprising. Many types of the engineering activities are thought to depend heavily on the availability of human capital and are regarded as product-cycle industries. Nevertheless, two engineering industries – machines for special industries and telecommunications apparatus – had large volumes of net trade and their trading patterns had a close positive association with the distribution of physical capital.

The results are even more ambiguous among industries with low to moderate levels of net trade. In some (for example, plastics, steel tubes and pipes, paints and fertilizers), the expected relationship between physical-capital intensity and factor supplies is obtained. In others, elements of the product-cycle model might be expected to operate although the availability of physical capital again exerted a strong positive influence on net exports. Examples are organic chemicals, office machinery, electric power machinery and scientific instruments.

In the case of skilled labour, the negative effects of resource abundance were observed most frequently among industries producing basic manufactures (SITC 6). In other words, the factor had an anti-parallel orientation which might have to do with specific use of skilled labour in other industries. A similar, though less pronounced, result was observed for industries producing miscellaneous manufactured goods (SITC 8). Among the industries with an anti-parallel orientation for skilled labour, those classified as basic manufactures generally reflect features of the H–O model. This is true for various textile industries like woven cotton fabrics, textile fabrics and made-up articles of textiles as well as for cement and pottery.

Gauged in terms of the volume of trade, the aircraft industry was the most significant instance where skilled labour made a positive contribution to net trade performance. Other industries where this factor was a source of comparative advantage included some of the smaller chemical industries: inorganic chemicals, radioactive materials, essential oils, and miscellaneous chemical materials and products. Results such as these support H–O premises, but evidence for other industries is counter to expectations. The most striking contradiction occurs in engineering industries. The competitive abilities of these industries are thought to depend mainly on the availability of skilled labour. Most coefficients, however, were negative (and often statistically significant). Examples include telecommunications apparatus, office machines, electric power machinery and domestic electrical equipment.

Judging from the size of orientation coefficients, semi-skilled labour appears to be a less important source of comparative advantage than either physical capital or skilled labour. Clothing was the most important industry for which semi-skilled labour was a prominent source of comparative advantage. Other industries with modest amounts of net trade and a parallel orientation for semi-skilled labour were musical instruments, footwear, ships and boats, and domestic electrical equipment. Also included in this category were several industries that are widely regarded as being labour-intensive – cotton fabrics, textile fabrics and made-up articles of textiles. One impression that emerges from this set of coefficients is that much of the comparative advantage usually attributed to an abundance of 'raw' labour actually depends on the availability of labour with some degree of skills.[5]

The fact that unskilled labour had little impact on comparative advantage is not explained by an examination of the detailed regression results. In some instances the relationship was expected; for example, unskilled labour was a source of comparative advantage for producers of leather or made-up articles of textiles. In other instances the factor's positive contribution to comparative advantage is puzzling in terms of the H–O model. Examples are organic chemicals, mineral tar, some iron and steel industries, and even office machines.

An even more detailed analysis of factor orientation could yield further insights with regard to industry-specific relationships. However, the overall impression of the role that factor abundance plays as a determinant of trade patterns would probably not change significantly. This role can be summed up in terms of a few statements. First, the factor abundance impact on net trade in manufactures is of moderate strength. This can be attributed to the fact that the relationships identified in the factor abundance theory are of an on-average nature. Consequently, no more than a portion of net trade in manufactures is likely to be subject to factor abundance effects. That portion, however, was relatively large in terms of the total value of trade considered.

Second, the strength of the abundance effect varies depending on the factor considered. From a sector-wide perspective, the results reported here suggest that physical-capital abundance is a source of comparative advantage in manufactures at large,[6] while the role played by skilled labour in this respect is ambiguous. Semi-skilled and unskilled labour are of less significance when the manufacturing sector as a whole is the focus of discussion.[7] These impressions are altered somewhat by the results reported in the following section, where the role of factor intensities is incorporated. They are not sufficient to judge which factors best accord with the H–O prediction of the product composition of manufactured trade. A more definitive statement requires information on factor intensities as well as factor orientation. The following section incorporates data on factor intensities, with the result that impressions regarding the relative importance of various factors are altered.

An empirical assessment of the factor abundance proposition

Empirical investigations of the factor abundance hypothesis require data on factor endowments, factor intensities and trade. Such a comprehensive application of the H–O model raises at least two problems. First, it has to be decided how the full, complex hypothesis should be evaluated on the basis of available data. Second, the correct interpretation of outcomes is not straightforward when the application of the model is less than complete.

In view of these points, the objective of the following exercise is a modest, descriptive one. It is to determine whether a particular kind of systematic overall relationship exists between empirical measures of factor abundance, factor intensity and net trade, and if so whether the sign of the relationship agrees with H–O predictions. A mosaic of data on factor abundance, factor intensity and net trade is first assembled. The evidence is then examined to determine the extent of agreement with one of the model's general predictions. Credible results will require the researcher to follow a precise set of rules when assembling the H–O 'mosaic'. Consequently, some thought must be given to the method of validation.

The general theory of comparative advantage can be stated in the form of correlations between the variables involved. All correlations that relate directly to the law of comparative advantage apply to pairs of variables (for example, autarky prices and net exports). In order to extend this method to a complete H–O framework, the analyst must be able to assess the relationship between the three variables, factor intensity, factor abundance and trade.

The association between factor abundance and trade was established in the previous section on the basis of the factor orientation concept. If factor orientation is also related systematically to factor intensity, the basic requirements of an application of the H–O proposition are met. As shown in the technical appendix (Appendix A), a correlation between factor orientation and factor intensity – extended over all factors and goods – serves to establish such a comprehensive relationship. The correlation is expected to be positive if the factor abundance proposition holds in its generalized form. In addition, the same type of correlation – if restricted to one particular factor – enables the analyst to assess the factor's contribution to an H–O version of the trading world.

The immediate requirement is to find appropriate data for factor intensities. Common practice was followed by employing US data. Direct factor shares were derived from US data for 1982 and used as a measure of relative factor intensities in each industry. The shares were calculated to reflect, as accurately as possible, the factor definitions used in the compilation of data on endowments.[8] Altogether, the data on factor intensities represent the technical characteristics for a large portion of the 90 industries treated in the present study.[9]

Table 7.2 summarizes the results of what can be termed a broad application of the factor abundance theory.[10] The first four rows and columns of the table show correlations between factor orientation and factor intensity for 1985. The entry in the last row and column of the table represents the weak global H–O proposition outlined in the technical appendix. The simple correlation coefficient carries a positive sign as predicted by the generalized factor abundance hypothesis and is significantly different from zero. This result is regarded as an indication that the pattern of net trade in manufactures carries features that conform with a weak prediction of the factor abundance model. Even in a complex trading world of many factors, goods and countries, net trade appears to be influenced (in an on-average sense) by the interaction between factor intensities and factor endowments. More generally, not only

Table 7.2 Correlations[a] between factor orientation and factor intensity, 1985[b] (Pearson correlation coefficients)

	Factor orientation				
	Physical capital	Skilled labour	Semi-skilled labour	Unskilled labour	All factors[c]
Factor intensity					
Physical capital	-0.009	0.250**	-0.340*	0.063	
Skilled labour	0.194***	0.020	-0.094	0.017	
Semi-skilled labour	-0.005	-0.215***	0.284**	-0.048	
Unskilled labour	-0.248**	-0.381*	0.618*	-0.127	
All factors[c]					0.246*

Sources: Table 7.1 and United States, Bureau of the Census (1984).

a/ Asterisks indicate statistical significance at the 1(*), 5(**) or 10(***) per cent level.

b/ Estimates of factor orientation are for 1985. All factor intensities were calculated from United States data for 1982. The measurement concept is that of shares of factor rewards in value added. The proxy measures of factor rewards used in this exercise are imputed factor incomes. The income imputed to capital is estimated by the non-wage portion of value added. The income of semi-skilled labour is proxied by wages of production workers, that of skilled labour by the difference between the total payroll and these wages. Both types of wages have been corrected for the income of unskilled labour embodied in the corresponding categories of employees. This correction is based on an estimate of the wage rate for unskilled labour which has also been used to calculate the income of that factor at large. More details on the underlying data and on estimation procedures can be found in note 6/ and in the statistical appendix.

c/ The correlation for all factors simultaneously was obtained by pooling the observations on all four types of factor intensity/factor orientation.

does factor abundance exert a visible effect on a substantial portion of net trade, but its overall impact is of a form predicted by the generalized H–O theory.

At least two remarks on the above results seem to be in place. First, its support for a general H–O proposition contrasts sharply with the rejections reported for recent tests of the factor abundance theory.[11] However, this is not surprising, if differences in concepts as well as in data are taken into account. While in other empirical contributions exact relationships (between supply of factors and indirect factor trade) were usually tested, the present exercise attempts to validate a prediction about the sign of a correlation-like expression. Furthermore, there are differences in the data underlying the various studies. Second, the present validation of a weak H–O proposition is partial in character in that it comprises only forty-six countries, only four broad factors of production, and only manufactured goods.

The other diagonal entries of the correlation matrix of Table 7.2 serve to assess the role of the studied four factors individually. The result for semi-skilled labour conformed most closely to the H–O model. The correlation tests for other factors were much less convincing. A tentative judgement of the relative significance of the four factors within an H–O world would be that basically all H–O regularity of the commodity composition of net trade relates to semi-skilled labour. Yet this regularity is strong enough to produce an overall relationship of the H–O type between factor endowments, factor intensities and trade flows.

A result that suggests that the H–O model can be closely associated with only one factor of production is surprising. However, the fact that this particular resource is semi-skilled labour does not appear to be counter-intuitive, for at least two reasons. First, of the factors considered here, semi-skilled labour comes closest to fulfilling the assumption of immobility between countries and is therefore most likely to impact trade patterns in an H–O manner.[12] The movement of highly skilled labour from developing to developed countries (i.e. the 'brain drain'), as well as the large amounts of unskilled labour moving (both legally and illegally) to North America, West Europe and now Japan, make the immobility assumption questionable for those two factors. Second, semi-skilled labour represents a broad category of workers whose abilities are closely related to production processes so that this type of labour is a vital input in many industries. A large reservoir of workers with production-oriented skills should provide a solid basis for comparative advantage. For these reasons, a strong relationship between net trade and abundance of this factor can be expected.

The results obtained for physical capital are nevertheless disappointing – despite the fact that the factor's high degree of international mobility violates a basic assumption of the model. The orientation coefficients of Table 7.1 showed that physical-capital abundance played a prominent role in sector-wide patterns of comparative advantage. This raised expectations about the factor's significance for the inter-industry composition of trade. The expectations, however, were not fulfilled by the correlation results in Table 7.2.

Country similarities and manufactured trade

The factor abundance model yields the proposition that differences in factor endowments are the basis for trade. However, similarities in factor endowments are also relevant. The role of endowment similarities is observed, for example, in the factor content version of the H–O model. One of the main features of this version is that under certain conditions international trade will lead to the international equalization not only of prices for goods but also of factor rewards. The necessary conditions for such an outcome include a minimum degree of similarity in relative factor endowments of countries.[13] In this sense, the factor content version embraces two paradoxical features. Countries must differ in terms of their factor abundance if the main motive for international trade is to be preserved. The differences, however, cannot be too large, or international equalization of factor rewards will not be guaranteed.

New theories of international trade

The above line of reasoning is quite different from the theoretical approaches lumped together under what is sometimes called the 'new theories of international trade'. An obvious contrast between these theories and the orthodox H–O approach lies in the fact that different types of specialization and trade are explained. While the factor abundance model is concerned with the inter-industry pattern of trade, the new models focus on intra-industrial forms of specialization and IIT.

The forerunner to much of the new theorizing is Linder's preference-similarity theory. A central tenet of this theory is that the type and quality of the manufactures consumed within a country reflect its level of development and structure of production. Per capita income is a useful proxy for both these characteristics, since a close correspondence is expected between this measure and the domestic pattern of consumption of manufactures. With regard to trade, the composition and quality of manufactured exports (which is a close correlate to domestic production) reflect the characteristic tastes of the majority of the country's consumers. Imports, on the other hand, are viewed as catering to slightly different sets of preferences for a consumer minority.

The link between Linder's ideas and the more formal theoretical work in recent years is the concept of 'international trade in manufactures . . . as an extension of the internal market' (Hufbauer, 1970, p. 197). Among other hypotheses relationships between country similarities and trade can be developed from this literature. One is that similarity in levels of per capita income should foster bilateral trade, given that other determinants (for example, geographical distance) remain constant. A second is that the composition of one country's exports will more closely resemble the composition of another's imports if the two countries have similar levels of per capita income and production structures. A logical consequence of the latter hypothesis is that the composition of a country's exports and imports are quite similar. On the whole, Linder's theory gives rise to the expectation that much of the trade between similar countries will be in similar goods.

Linder's arguments suggest that consumer preferences are an important determinant of the intensity and composition of international trade. It was not until more recent contributions to trade theory accorded a similar role to consumer tastes that the link between Linder's ideas and the new theories of trade became evident. Another element that figures prominently in the new theories is monopolistic competition, which to some extent was also reflected in the Linder model. What distinguishes the newer models from Linder's original work is their formal rigour, a feature that they have in common with the conventional factor abundance theory.

The literature on the new trade theories is broad in scope. For the present study one of its aspects – the relationship between country similarities and trading patterns – has been chosen as the subject of analysis. The underlying theoretical model assumes monopolistic competition and describes an interaction between economies of scale on the supply side and preference diversity on the demand side. Krugman's version of such a model (1979a) is one of the more concise and was outlined in Chapter 1. Its simplicity, and the fact that it focuses on trade between similar countries, illustrates clearly the main points of interest for the present study.

The main purpose of Krugman's model is to analyse the effects of scale economies, preference diversity and product differentiation on international trade. However, it also provides insights regarding the role of country similarities. The outcome is that the share of total trade (which is entirely IIT) in world income will be greatest when the two countries are of equal size and possess equal endowments of labour, the only factor of production that is recognized in the Krugman model.

Krugman's results have been criticized for their simplicity, particularly with regard to consumer preferences. But other models which take a more sophisticated view of demand yield similar results. Helpman (1981), for example, has shown that, when IIT occurs in differentiated products, the source of trade is economies of scale in production. This analysis also leads to the conclusion that in industries with increasing returns the share of IIT in bilateral trade will be higher when the factor endowments or per capita incomes of trading partners become more similar.

The growing importance of IIT is increasingly matched by a new appreciation of the country similarities that foster this form of trade. While large 'distances' between the H–O attributes of countries will create inter-industry trade, small distances are conducive to relatively high volumes of IIT. The first aspect was the subject of the previous section. The remainder of this section focuses on the second aspect.

Empirical evidence

The identification of empirically testable relationships in the generalized factor abundance theory is difficult owing to the complexity of the subject. That task becomes even more problematic in the case of the new trade theories. The major reason for added complications is that the new approaches concern very narrow aspects of international trade. And sometimes, the choice of a particular model to analyse trade is motivated by the desire for theoretical tractability rather than empirical relevance. The empiricist who chooses to work with the new theories must then consider the empirical 'applicability' of a given hypothesis rather than attempting a more wide-ranging analysis.

The recent empirical literature is full of attempts to explain IIT in terms of the concepts of the new trade theories. The most successful among these attempts had as their objective an explanation of the intra-industry component of bilateral trade, mainly in terms of country attributes.[14] This line of reasoning has a parallel in recent empirical work conducted in a factor abundance framework. In that case, investigations of partial relationships between country attributes and trade patterns (similar to those presented in the previous section) have produced interesting and stimulating results.

Building on such analogy, the present exercise introduces two novel features. One is the examination of relationships between country attributes and IIT in an industry-specific context. This approach contrasts with previous empirical studies which considered the whole of manufacturing, either by aggregating the measure of IIT across all industries or by pooling industry-specific observations into one huge sample. Although no model provides a rigorous framework for an industry-specific investigation, theoretical work seems to suggest that such a distinction can be helpful in identifying the influence of country attributes on IIT. Helpman (1981), for example, distinguishes between two sectors where only one produces differentiated manufactures with increasing returns to scale. The trade of this sector is likely to be influenced by the types of country attributes stressed by the new theories. Trade of the other (constant-returns) sector would follow H–O rules. More generally, the eclectic character of the new theoretical framework suggests that the distinctive features of any model will be more visible in some industries than in others. Visibility would also depend on the extent of agreement between theoretical assumptions and industrial realities.

A second distinctive feature of the following exercise is in the way trade flows are measured. Previous studies have dealt almost exclusively with the IIT component's share in total trade. The practice is due partly to the nature of theoretical results and partly to the fact that analysts were usually interested in the relative size of the inter-industry and intra-industry components in exports or imports. Nevertheless for descriptive purposes the absolute amount of intra-industry exchange for a given product category is of interest too. The present exercise adopts the second approach, examining levels of IIT under the hypothesis that, other things being equal, greater country similarities yield larger absolute levels of bilateral IIT. Such a premise seems plausible in light of the Linder theory and the central message contained in later attempts to explain IIT.[15]

Because country similarities are the primary concern of this section, bilateral comparisons between countries are employed. The level of the intra-industry component in bilateral trade (IITL) can be measured by the extent of trade overlap (see Chapter 4) as

$$\text{IITL} = \min(X, M)$$

where X (M) are exports (imports) by country 1 to (from) country 2 and trade flows pertain to a given product group or industry.

A comparison of trading partners in terms of the attributes that determine IIT is less straightforward. First, selection of relevant attributes suggested by theory would include relative factor endowments and country size. In order to streamline statistical procedures, the choice is usually narrowed to two country characteristics: per capita GDP, and market size measured by total GDP. Per capita GDP is employed because similarities in both factor endowments and demand patterns are normally mirrored by similarities in per capita income. Total GDP is used as a proxy for market size because it reflects economic size differences between countries while other alternatives such as population represent an indication of demographic size. Similarities are measured by the negative of the absolute difference between countries in each of the two variables.

Two other possible determinants of IIT are included in the regression analysis. These are average per capita GDP and average total GDP of the two countries involved in each bilateral comparison. The former variable reflects the expectation that demand for differentiated products is great in the trade between countries with high levels of income (Linder, 1961). The corresponding empirical hypothesis is that higher levels of income will result in larger amounts of IIT. The latter variable, average total GDP of trading partners, is expected to capture the size effect. In addition, it may be hypothesized that large countries tend to have a greater IIT component in their trade. This outcome can be attributed to the possibility that, with increasing returns to scale, large countries will be able to produce a wider variety of differentiated products than smaller countries (Lancaster, 1980).[16]

Construction of appropriate statistical tests is hindered because the new theories have little to say about the possible algebraic relationship between trade variables and country attributes. While the general impact of country similarities on new forms of trade is clear, an equation that would reflect this relationship in a cross-country framework can be formulated only in an ad hoc manner. The present exercise makes no attempt to fit complicated equational forms which may have little or no theoretical foundation. Instead, partial correlations of the data are examined to determine whether they show the expected signs.

Table 7.3 presents a summary of partial correlations between IITL and the four variables described above. The results are in almost perfect agreement with theoretical expectations. When country similarities are expressed in terms of income levels and market size, their impact is overwhelmingly positive. In fact, there is no industry where country similarities had a significantly negative influence on the level of bilateral IIT. Coefficients relating bilateral IIT to similarities in per capita GDP were significantly positive for 70 of the

Table 7.3 Partial correlations[a] between levels of bilateral intra-industry trade and country attributes, 1985 (number of significant coefficients)

Level of significance (percentage)	Partial correlation between IITL[b] and:							
	Income similarity[c]		Size similarity[d]		Average income[e]		Average size[f]	
	+	-	+	-	+	-	+	-
1	37	0	81	0	44	2	95	0
5	20	0	5	0	13	2	2	0
10	13	0	0	0	6	0	1	0
Total	70	0	86	0	63	4	98	0

Source: UNIDO

a/ Partial correlation coefficients were calculated for a total of 90 industries (SITC three-digit groups). For each industry bilateral IIT between all pairs formed out of the 47 countries in the sample was analyzed. The coefficients underlying the present summary table are shown in the statistical appendix (table B.9).

b/ IITL = min (X,M)
where X(M) are bilateral exports (imports).

c/ Income similarity is measured by the negative of the absolute difference in per capita GDP between the two trading partners.

d/ Size similarity is measured by the negative of the absolute difference in GDP between trading partners.

e/ Average income is the arithmetic mean of per capita GDP of trading partners.

f/ Average size is the arithmetic mean of GDP of trading partners.

90 industries tested, while those referring to similarities in market size were significantly positive for all but four industries.

The strongly positive correlations between IIT and average market size may be due to nothing more than a scale effect, but the positive coefficients associated with average per capita GDP lend direct support to a general hypothesis on intra-industry specialization. Linder, for example, argues that demand for (horizontally) differentiated products rises as per capita income grows. Consequently, the intra-industry exchange of (differentiated) products should increase as the per capita incomes of trading partners rise. This expectation is corroborated by the results in Table 7.3, which shows that 63 of the partial correlations are significantly positive.

In summary, the effects of country similarities on levels of IIT are pervasive. Similarities in income levels or market size breed intra-industry specialization and trade, irrespective of trends in inter-industry trade. However, this is only one aspect of the IIT phenomenon. Theory proposes that in addition to country attributes there are also quantifiable industry characteristics that have a significant impact on two-way trade. The following chapter considers this latter point by examining some of the industry characteristics that may act as determinants of the (relative) extent of IIT.

Annex: Trade flows and factor movements

In this chapter the impact of country differences and similarities on patterns of trade was considered. As is usual, it was assumed that the factors of production were mobile between industries but immobile internationally. Thus, countries export goods that intensively utilize their relatively cheap factors of production. If factors are allowed to move internationally, then capital and labour would migrate from those areas where their returns are low to areas where their returns are higher. To the extent that this is not possible, trade in goods becomes a substitute for the migration of factors. In reality, factors of production are not perfectly immobile internationally. The increasing mobility of capital and to a lesser extent labour needs to be considered to gain a more realistic picture of the structure of world trade. As was pointed out in the preceding chapter, the weak results obtained for physical capital and skilled labour (Table 7.2) may reflect the relatively high mobility of these factors. Furthermore, the migration of factors would tend to reduce differences in the endowment of factors across countries over time. This lessening of differences in endowments may partially account for the increasing importance of intra-industry trade over time.

The study of international trade has been traditionally concerned with cross-border transactions of goods and to a much lesser extent of services. Further, the way in which these cross-border transactions affect an economy's production structure and factor markets is usually examined. The monetary side of international economics deals with the way cross-border financial transactions affect an economy's interest rate, exchange rate and financial markets. In practice, the real and the monetary sides of international economics have developed almost independently of one another.

On the real side, exchange rates, interest rates and capital movements are generally considered irrelevant. Exchange rates are ignored because they are assumed to be the relative price of two monies, both of which are 'veils' which have no real effects. Interest rates do not matter, as it is assumed that they represent the long-run price of money with only negligible effects on intersectoral prices and relative factor prices. Financial capital movements may matter over a period that is long enough for them to influence an economy's endowment of productive capital. However, if this endowment is assumed to be initially large, then changes arising from financial flows can likewise be ignored. More generally, international trade in productive capital may also be ignored if commodity trade eliminates the factor-price differentials which stimulate the migration of factors across borders. Thus, for a variety of reasons, the study of international trade has been able comfortably to ignore international movements of capital.

Over the last twenty years, this split between the real and monetary sides of international economics has become increasingly less realistic. Since the advent of generalized exchange rate floating in the early 1970s, it has become more difficult to ignore changes in exchange rates. Recognizing this difficulty, theoretical and empirical research is now progressing on the issue of real and financial linkages among open economies. In this annex, the determinants of short-run flows of financial capital are considered. We shall also examine how these flows and other factors influence changes in exchange rates. Such changes in turn affect short- to medium-run trade flows in ways that may differ from predictions generated by a more long-run H–O model.

The current account balance can be defined as the difference between total imports and total exports. Using simple GNP accounting terms, the current account (CA) can be expressed as

$$CA = Y - (C + I + G),$$

where Y is national income, C is consumption by the public, I is investment spending and G is government spending. Another way of stating the same definitional identity is to set CA equal to the difference between national income (Y) and domestic residents' spending ($C + I + G$). If income is larger (smaller) than spending, a CA surplus (deficit) is created. Saving (S) is equal to $Y - C - G$. In a closed economy, it would be true that saving (S) must equal investment (I). For an open economy, only the following identity must hold:

$$S = I + CA.$$

If S is smaller (larger) than I in an open economy, a capital account surplus (deficit) occurs. Since in an open economy total outflows must equal total inflows, a current account surplus (deficit) creates a capital account deficit (surplus). A capital account surplus indicates that inflows of capital are larger than outflows; the reverse is true for a capital account deficit. Thus, in an economy where domestic saving is larger than investment, a current account surplus occurs. To balance overall inflows and outflows, the country exports capital (a capital account deficit).

Since governments rarely run balanced budgets, the above identity can be modified to reflect the influence of the government budget on the current and capital accounts. If we assume that the difference between government spending (G) and tax revenue (T) is borrowed by the government, then the current account (CA) can be written as

$$CA = S - I - (G - T).$$

The current account, or alternatively the capital account, thus becomes directly related to saving, investment, government spending and taxation.

Obviously, a current account deficit (surplus) must be financed by a capital account surplus (deficit). These capital movements necessary to offset imbalances in the current account may take several forms. In the older, fixed exchange rate system capital movements were primarily official. CA surpluses meant an accumulation of official reserves, while a CA deficit meant a loss of reserves. Increasingly, capital movements are non-official in nature. Among these movements, short-term capital flows involve assets with maturities of less than a year while long-term capital flows involve assets with maturities greater than a year. If the purchaser of the asset has operating control over the issuer of the asset, then the capital movement is direct. If not, the investment is referred to as portfolio investment, which may be either short-term or long-term.

Inflows and outflows of short-term and long-term capital obviously create capital account surpluses and deficits. In the case of a capital inflow, foreign investors must purchase the domestic currency in order to transfer the capital. The short-run effect is to increase the supply of foreign exchange and to cause the domestic currency to appreciate. The resulting appreciation of the currency reduces exports and increases imports. As exports contract and imports expand, the widening current account deficit mirrors the capital account surplus. For a capital account deficit (outflows larger than inflows), the buying of foreign exchange causes the capital-exporting country's currency to depreciate. This depreciation increases exports and reduces imports, creating a current account surplus.

The above scenario concerning capital flows and the current account balance represents the 'conventional wisdom' about how capital flows impact imports, exports and the current account balance. In an economy with a flexible exchange rate and open capital markets, changes in the exchange rate and the current account balance reflect changes in capital flows. This chain of causation is admittedly complex. Empirical evidence on the subject is limited, but one recent test seems to support the view that in the short run changes in capital flows determine the exchange rate and the current account (Hutchinson and Piggott, 1985). In the short run, monetary and fiscal policies that influence interest rates will tend to impact capital flows, the exchange rate and the current account balance.

These policy-induced changes in trade flows can in turn have a major impact on industrial structure and the ability of domestic industries to compete in international markets. Large exchange rate depreciations (appreciations) can enlarge (reduce) the size of the tradable goods sector of the economy (Dornbusch, 1973). Essentially the older form of 'crowding out' has moved. In a closed economy, policies that influence interest rates impact primarily on the interest-rate-sensitive sectors of the economy. However, in an open economy interest rate changes influence the exchange rate, and the structure of the economy changes as the relative prices of tradable and nontradable goods change.

Recent changes in the world capital markets have led to a worldwide increase in the mobility of short-run portfolio capital (Obstfeld, 1986). While these changes improved the worldwide efficiency of capital markets, the cost has been an increase in exchange rate volatility. These effects can be offset only to the extent that flows of capital not involving traded goods are restricted (i.e. by exchange controls). This insulation may be more apparent than real if the exchange rate is pegged to another country's currency which is floating. Variations in this latter exchange rate lead to implicit changes in the exchange rate and the value of reserves of the country.

One of the most important questions in the present context is whether or not the increased mobility of capital and the associated exchange rate changes have had a measurable impact on international specialization. Increased exchange rate variability could adversely impact investment in the tradable goods sector and distort patterns of comparative advantage. Although the proposition is inherently difficult to test, the available evidence appears to be that it does not (IMF, 1984a). However, it would be desirable if capital could flow freely internationally *and* exchange rates would fluctuate less. Such a change would require a new type of exchange rate system (IMF, 1984b). This change from official to unofficial capital flows may also influence the H–O results presented in the previous chapter. With fixed exchange rates, changes in a country's current account would change the level of private investment *and* official reserves. In a floating-rate system, virtually all of the changes in the current account would lead to changes in private investment. This would affect H–O-type empirical results because the new exchange rate system would lead to relatively large movements of the world's productive capital.

Another example of international factor mobility – besides capital movements – is the migration of labour. Unlike international flows of capital, labour migration involves the movement of both the factor of production and the owner of the factor, so that the source country loses both. In the standard H–O model of international trade, it is normally assumed that labour can be costlessly reallocated among industries domestically but that it is immobile internationally. In a modern economy labour is not typically homogeneous, and occupational classifications frequently define separate labour markets. The extent of international labour mobility also varies from occupation to occupation. Some skills form an almost world market as opposed to a purely domestic labour market, while other skills (or lack thereof) are characterized by almost H–O-like labour immobility. In occupations containing a large investment in education or training, significant migration from countries where such skills are poorly rewarded to countries where the remuneration is higher may be significant. In many cases, well trained migrants easily assimilate into their chosen countries, and social and cultural problems may be minimal. Most countries have notably more lenient immigration laws for such individuals. This may not be accidental for developed countries. A developed country may have a comparative advantage in the production of goods that contain relatively large amounts of human capital and/or have a large research and development component. The immigration of labour containing a large amount of human capital might thus augment the country's comparative advantage. The issue is far from trivial, as the USA alone admits nearly 50,000 professional immigrants per year.

The movements of labour may account for some of the results shown in Table 7.2. As pointed out, skilled labour is now quite mobile in the world economy, and this mobility may be partially responsible for the relatively poor results obtained for that factor in the previous chapter. The same seems to be true for unskilled labour. Both legal and illegal migration of this factor may be distorting the H–O results.

The empirical research on this issue tends to confirm that relative wage differentials affect labour migration. The key variable is the wage differential rather than just the relative income differential between countries. Furthermore, the relative wage elasticity seems to be greater than one implying a high degree of responsiveness of professional immigration to changes in relative wages (Agarwal and Winkler, 1984). However, non-economic variables in the home country also seem to have a significant impact on the migration of professionals (Huang, 1987).

A final point shall be made about the general relationship between trade and factor movements. The H–O model is based on the view that factor movements and (inter-industry) trade in goods are substitutes. If over time labour and/or capital is allowed to migrate between countries, then the differences in relative factor prices will decrease and the amount of inter-industry trade will diminish. Trade between the two countries will increasingly become intra-industry trade as the basis for trade moves from factor-price differentials to economies of scale, product differentiation or differences in product technology. If labour can migrate to countries whose exporting industries derive their comparative advantage from something other than differences in factor endowments, such migration could increase output and exports. In such a circumstance, migration would be trade-expanding. This result seems to hold for a wide variety of models where the basis of trade is something other than differences in factor endowments (Markusen, 1983). Thus, if trade is intra-industry rather than inter-industry, trade and factor movements may be complements rather than substitutes.

Notes: Chapter 7

1 For the case of more goods than factors – which seems to be representative of the real world – the underlying regression equations cannot be derived rigorously from the formal H–O model (Anderson, 1987). Nevertheless, the regressions can be useful to describe certain features of the trading world in the spirit of the H–O theory.

2 This terminology is inspired by the recent general formulations of the factor abundance theory which can be stated as geometric relationships between vectors in a high dimensional Euclidean space.

3 In the case of correlation coefficients, the relationship is straightforward. The cosine of the angle between the net exports and the factor endowments vectors is formally equivalent to the Pearson correlation coefficient, once net exports and factor endowment measures have been standardized to zero means.

4 A negative impact of a factor on an industry's comparative advantage is most likely the consequence of the factor's specificity of use in other industries (see Leamer, 1984, pp. 32–3 and the Annex to Chapter 5).

5 Semi-skilled labour could unambiguously be identified as a source of comparative disadvantage in very few industries, among them certain chemical industries, pig iron and the aircraft industry. The results for this last industry illustrate how two

different categories of labour – skilled and semi-skilled labour – can significantly influence net trade patterns in opposite ways.

6 Tamor, 1987, in a critical appraisal of the regression approach used here, maintains that endowment levels merely explain the level of total manufacturing activity (and thus sectoral comparative advantage), but not the industry composition of such activity (or inter-industry comparative advantage).

7 The sector-wide interpretation of comparative advantage in manufacturing largely agrees with the findings reported in Leamer, 1984, pp. 170–4. There it is shown that physical capital was the major source of comparative advantage in manufacturing in the 1970s, while skilled labour was more often associated with a comparative disadvantage. The latter feature seems to have become even more striking in the 1980s.

8 The major difficulties arose in connection with input requirements of the various skill categories of labour. Factor income of unskilled labour was estimated as the product of employment and a proxy for the unskilled wage rate, of which several alternatives were tested. Income of semi-skilled labour was defined as the wage sum of production workers with a minimum degree of labour skills. Finally, income of skilled labour was crudely proxied by the difference between total payroll and wages of production workers, with a correction for income of unskilled workers covered by this residual income value. Accordingly, the correlations relating to skilled labour are the least reliable part of the exercise.

9 For statistical details on this factor intensity matrix see the statistical appendix (Appendix B).

10 Only one of several tested alternatives of a correlation matrix is shown in the Table. The alternatives differ in terms of the minimum wage rate used to estimate the income of unskilled labour. Sector-wide, the wage rate of unskilled labour was assumed to be a fraction of the minimum (across all four-digit SIC categories) of the wage rates of production workers. By choosing alternative values for this fraction ranging between 0 and 1, the sensitivity of correlation results was tested. The outcome of this testing was that the correlation results remained qualitatively unchanged for all versions of the definiton of the return to unskilled labour.

11 An overview of such tests and their major results is given in Bowen, Leamer and Sveikauskas, 1987.

12 The basic results on patterns of trade in the presence of factor mobility are found in Ethier and Svensson, 1986. There it is shown, for example, that a weak form of the H–O theorem continues to hold in that 'a country will on average export those goods that make relatively intensive use of the country's relatively abundant non-traded factors' (p. 38).

13 In technical-theoretical parlance, countries are required to have factor endowments in the same 'cone of diversification'.

14 A recent example of an empirical analysis of this type is found in Balassa and Bauwens, 1987, where a huge sample of observations on bilateral IIT flows was related to a fairly long list of explanatory variables. And among these variables, country attributes yielded plausible results in terms of the signs and significance levels of their coefficients.

15 The present approach can also be seen as being motivated by symmetry considerations, since it mirrors the 'Leamer regressions' of the first section of the present chapter.

16 The present formulations of 'explanatory' variables are basically those used by Loertscher and Wolter, 1980. Some later studies adopted more complicated approaches to the measurement issue, but with little improvement in empirical results.

CHAPTER 8

Economies of scale and market structure

A factor abundance interpretation of international specialization and trade has served as the primary source of theoretical guidance throughout previous chapters. This chapter and the following one explore a different set of issues which are drawn from the new theories of trade. Though the discussion moves outside an H–O world, reference to that model is not discarded.

It has been suggested that the H–O model is most accurately pictured as an attempt to isolate the effects of factor abundance on patterns of specialization. To do so, it employs several assumptions which neutralize the effects of other determinants. The approach and rationale behind the new theories of trade are quite different. To appreciate better the distinction between the two approaches, several of the more stringent assumptions of the H–O model can be briefly recalled. One is the requirement that industry production functions exhibit constant returns to scale. A second is the stipulation that each good is homogeneous and that the consumer encounters no product diversity. Finally, perfect competition is assumed to prevail in all markets. The distinction between the factor proportions model and the new models is highlighted by the latter's treatment of these assumptions. By allowing for increasing returns to scale, product differentiation and various forms of imperfect competition, the new models recognize types of trade that depend on determinants other than factor endowments.

In contrasting these two approaches, the present chapter serves a dual purpose. One is to consider the degree to which the H–O view must be tempered and its predictions qualified if it is to approximate better the microeconomic realities of world industry. The second is to assemble some fragmentary evidence regarding the extent to which conditions in various industries depart from the H–O postulates. Such evidence can be helpful in determining the relevance of alternative trade models. A thorough empirical assessment of non-H–O determinants of specialization and trade would be valuable. However, the difficulties of measurement, data availability and comparability are severe, and the evidence assembled here is mainly inferential. The approach of this chapter is best described as an empirical excursion into a non-H–O world rather than an attempt to explain new forms of international trade.

The first section of this chapter summarizes some of the main hypotheses about the relationships between increasing returns, market structure and trade. The second section reviews the subjects of scale economies, industrial concentration and product differentiation as they are set out in the literature on industrial organization. It also describes the methods of measurement and discusses their strengths and weaknesses. The third section presents industry-specific estimates for each of the three characteristics mentioned above. The concluding section looks at the relationship between industrial concentration and export concentration.

Hypotheses on increasing returns, market structure and trade

The theoretical alternatives to an H–O world are many. In principle, there can be as many models of specialization and trade as there are models of imperfect competition. Faced with this multitude of alternatives, Dixit and Norman concluded that 'to arrive at a general theory of trade with imperfect competition is . . . impossible; the most one can hope for is a catalogue of special models' (1980, p. 265). The common features of these special models include production with increasing returns, various types of market structure, and product differentiation.

Recognition of the importance of increasing returns to scale for international trade long precedes the new models of trade. Adam Smith's familiar dictum that the division of labour is limited by the extent of the market points to the potential gains from trade which can be associated with scale economies. Smith's observation was extended by Ohlin (1933) and Drèze (1960), who noted that economies of scale may influence the pattern of trade. Other things being equal, industries that can benefit from scale economies will tend to have lower autarky prices in countries with large markets than in countries with small ones.

These ideas have been carried still further by economists who constructed formal models which relate economies of scale to imperfect competition (e.g. Negishi, 1972, or Dixit and Norman, 1980). Their work has led to more explicit statements regarding trade under increasing returns. Krugman (1980), for example, has put forward a 'larger domestic market hypothesis'. He suggests that a country will tend to be a net exporter of products that have relatively large domestic markets. Large countries are expected to have a competitive advantage in industries where scale economies are prominent. Conversely, countries with small domestic markets are at a disadvantage unless they produce standardized goods and then realize scale economies by exporting.

The relationship between scale economies and trade assumes other characteristics when attention focuses on the individual firm. There is empirical evidence to indicate that, on average, large firms tend to export a greater portion of their output than small firms and that the percentage of exporters in the industry tends to rise as firm size increases (e.g. Gleijser, Jacquemin and Petit, 1980; Auquier, 1980). This finding is often regarded as a confirmation that the export efficiency of large firms derives from cost advantages obtained through their involvement in international markets. Such evidence is used to justify the government's support for large firms or to show the benefits of mergers among directly competing firms.

The degree of industrial concentration will also affect the export capabilities of firms. Large firms operating in a highly concentrated domestic market will have considerable market power. The degree of market power will depend not only on the number of firms in the domestic market but also on the industry's size distribution. Firms with domestic market power enjoy several advantages over their weaker domestic rivals. They may engage in price discrimination because they are better able to segment domestic and international markets than are small firms operating in a highly competitive domestic market. They will also have better access to the sources of credit which are needed to finance export operations. These are only some of the reasons to expect industrial concentration to influence an industry's export performance.

However, the line of causation does not run in only one direction – from industrial concentration to export performance. The extent to which firms depend on exports will also affect the pattern of industrial concentration. For example, as an industry becomes more dependent on exports, the number of firms competing – not only in the domestic market but also in export markets – will rise. Trade ultimately will lead to a larger equilibrium number of firms and to greater competition (Dixit and Norman, 1980, pp. 267–72), and both characteristics imply a reduction of industrial concentration.

Observations such as these apply to markets where entry is relatively easy. But an industry may consist of only a few firms characterized by entry regulations, large investment to achieve minimum efficient scale (MES), or other entry-limiting practices. If factor supplies and production functions are otherwise comparable, increasing returns to scale in such industries can mean that higher concentration is associated with a greater comparative advantage (Das, 1982).[1]

Aside from scale economies and market structure, the possibility of product differentiation is relevant. The new theories of trade usually deal with products that are horizontally differentiated in terms of actual or perceived characteristics and assume a market structure of monopolistic competition. Each firm will produce one version of a differentiated product (with increasing returns) and face a downward-sloping demand curve. The firm may have some degree of market power, although this is limited by the existence of imperfect substitutes – real or potential. Entry usually depends not on the imitation of an existing product but on the development of a new product variant. Firms compete, then, not just on the basis of price but also in terms of consumer preferences[2] – that is, with regard to design, quality, presentation, and other features that make their products distinguishable from those of rivals.

Concepts and measurement

The literature on industrial organization suggests a number of possible measures for economies of scale, market concentration and product differentiation. Most international data, however, are ill-suited for such purposes. The statistics are based on industry definitions which are stated in very broad terms (for example, the three-digit level of the ISIC). This characteristic is hardly compatible with the models which assume that products are either homogeneous or highly substitutable. A related problem is that the researcher is often forced to work with product classes that represent different types of production processes, multiple stages of production, and a variety of inputs. A third troublesome characteristic is that indicators based on a broad definition of an industry are sensitive to the composition of products and activities in a particular country. As a result, the empirical evidence considered here is subject to many qualifications. The results are still useful so long as systematic differences in the indicators for various industries can be identified with reasonable statistical certainty.

Economies of scale

Increased specialization is the source of economies of scale within a plant or firm. The larger the firm, the greater are the opportunities to achieve worker specialization or to utilize productive, special-purpose machinery to its maximum potential. Long production runs and mass production techniques are therefore common methods of reducing unit costs. In industries where fixed costs are a large portion of the total, the unit costs of batch production will be high. Long production runs will yield even greater reductions in unit costs if the variable cost component is not especially sensitive to an increase in the firm's output (that is, if there is a substantial degree of competition in markets for labour and other inputs).

The fact that a firm's production function does not exhibit constant returns to scale throughout is usually depicted by the familiar U-shaped average cost curve. The curve implies that economies of scale will eventually be contained by diminishing returns, since the opportunity to realize additional reductions in unit costs will eventually be exhausted. In a perfectly competitive market, firms operating on such cost curves will expand output until marginal costs rise to the point where they equal marginal revenue. The outcome is different, however, if marginal costs carry on falling as output is increased. It then makes sense for the firm to expand output indefinitely. The only check on the firm's growth would be the size of the market. In these circumstances, a rational firm would raise output until it was the only producer in the industry.

At least two features of the U-shaped average cost curve seem to conflict with reality. First, empirical estimates of long-run average cost curves generally suggest that many cost curves are L-shaped rather than U-shaped (Schmalensee, 1988, p. 653). Average costs will fall as small producers raise output but will remain approximately constant for levels of output above some MES. Second, the theoretical concept of single-product firms fits awkwardly with the reality of product differentiation and multiple-product plants. These circumstances give rise to another concept, that of economies of scope. If scale economies are realized in the provision of inputs used in more than one product, economies of scope are possible. More generally, the cost function of a multiple-product firm appears to be sensitive to the composition as well as the scale of output (Bailey and Friedlander, 1982, p. 1032).

Neither the shape of the cost curve nor the prevalence of multi-product firms can be separated from underlying patterns of technological development. Indeed, the types of technologies developed during the past two decades may have had the result (intended or otherwise) of enlarging the range of output for which increasing returns are applicable or at least postponing the onset of diminishing returns. Some support for this impression can be found in both industry-specific studies (e.g. McGee, 1973; Ayler, 1981) and more general investigations (Griliches and Ringstad, 1971). Certainly, improvements in information technology are intended to remove many of the managerial diseconomies of scale associated with communications and control in large organizations. It is these types of diseconomies that were traditionally thought to be the main cause of diminishing returns at higher levels of output.

A clear picture of the relationships between cost curves and concepts such as economies of scale, economies of scope and technological change cannot be assembled. However, there seem to be grounds to make the (comparatively weak) assertion that the incidence of decreasing returns within the manufacturing sector has been reduced. As a result, the economies-of-scale model poses a serious challenge to the assumption of non-increasing returns which is so firmly embedded in the H-O theory. Such a possibility makes it important to obtain some impression about cross-country patterns of scale economies, however crudely derived.

The extent of scale economies can be measured by various methods. Estimates of the MES may be obtained by interviewing engineers or executives, by studying the variation of costs with scale, by relating profitability to the size of plants or firms, or by assuming that some fraction of an industry's output is produced in efficient plants in a given country. Answers given in interviews may be speculative when the information required goes beyond design decisions, while evidence gathered from real data is subject to competitive conditions and historical circumstances. All these problems are magnified in the case of a cross-country study.

Following Hufbauer (1970, pp. 178–9), the present study uses size elasticities of output per person engaged as a proxy for scale economies. Once firms are classified by size, variations in value added per person engaged are regarded as an inverse measure of variations in average unit costs (Caves, Khalizadeh-Shirazi and Porter, 1975, p. 133). Estimates of these elasticities are obtained from the following regression equation:

$$v_i = kn_i^a$$

where v_i is value added per person engaged in a given size class i, n_i is the average number of persons engaged per establishment in size class i, k is a constant, and a is the size elasticity parameter for the industry which is assumed to be constant.

Estimates of size elasticity are subject to certain biases. The products and production technologies associated with a given 'industry' category will inevitably vary. Large establishments will tend to have relatively capital-intensive and/or skill-intensive methods of production, while small establishments rely more heavily on inputs of unskilled labour. The distinction will distort industry-wide estimates of size elasticity, exaggerating the significance of scale economies among large firms but underestimating their role for small firms. A related difficulty is that establishments classified as members of a given industry will differ with regard to age, product mix, quality of labour and other factors, all of which may be associated with firm size. The assumption that size elasticity is constant for a given industry can also be violated. For example, because market power is often related to establishment size, estimates of the parameter may reflect an element of monopoly profit. Considerations such as these obviously call for cautious treatment of the results.

Industrial concentration

Industrial concentration refers to the number and size distribution of firms supplying a particular product or a group of highly substitutable products. Concentration may be related to both the market power and growth performance of firms in an industry and is often treated as an indicator of the former.

Most industries are neither perfectly competitive nor monopolies and the distribution of firm size is frequently skewed. Typically, the number of establishments falls off abruptly for the larger size categories (that is, the distribution is log-normal with respect to firm size). This result contradicts the natural expectation that firms would be clustered around an optimal size or that a majority would operate at or above the industry MES owing to competitive forces. Such expectations might be confirmed only if the investigation is narrow in scope (e.g. at the level of products rather than an industry). So long as the focus of discussion is industry-wide, factors other than scale are important and a log-normal distribution is not surprising. Numerous firms, for example, may have secured a market niche through the production of high quality products – a strategy that would allow them to operate with small plants although at relatively high costs (Müller and Owen, 1985, p. 45). Whatever the industry's actual distribution of firm size, this feature, along with the number of firms in the industry, provides a means of determining industrial concentration.

There are various country-specific factors (the size of domestic and foreign markets, the level of industrialization and government policies) which may influence concentration. In addition to these, the growth of an industry will itself alter concentration patterns over time. Over the medium term, rapid growth may reduce concentration if large firms are unable to take advantage of all opportunities for expansion. Rapid growth will also induce new entry, particularly in industries producing differentiated products. Finally, in the long run, changes in production technologies emerge as a determinant of concentration (Curry and George, 1983, pp. 217–27).

A measure of industrial concentration is therefore a summary statistic which would take into account both the number of firms and the inequalities in the firm distribution of market shares. When the number of firms is small and inequality in market shares is large, the market power exerted by a group of firms is great and the concentration measure would be large. Several alternative measures of concentration can be constructed from these facts. Differences between the measures result mainly from the choice of relative weights assigned to the two variables.[3] All measures nevertheless display similar patterns, which means that a choice can usually be made dependent on data availability. The current study makes use of employment statistics for establishments rather than firms or enterprises. This decision, which was due to data limitations, has some potential drawbacks.[4] Establishment data, for example, may best capture the effects of scale economies at the plant level. Alternative measures based on data for firms or enterprises will include multiple plants producing different products with different technologies.

The actual expression used here is the employment entropy measure.[5] Computation requires information on the total number of establishments and the number of persons engaged by size class. The expression, which indicates the shape of the frequency distribution of establishments by size, is an inverse measure of relative concentration. Each establishment's share in the industry's total employment is weighted by the logarithm of its reciprocal. In its simplest form, the entropy measure (E) is defined as

$$E = \sum_{i=1}^{n} x_i \ln \frac{1}{x_i} = - \sum_{i=1}^{n} x_i \ln x_i$$

where x_i is the share of establishment i in the industry's total number of persons engaged and n is the number of establishments in the industry. The higher the value of E, the lower the degree of concentration. The measure takes its maximum value ($\ln n$) when the shares of all establishments are equal, and it is zero when there is only one establishment in the industry.

With the help of size distribution data, the measure for each industry can be decomposed into two additive components representing between-group and within-group entropy. In its decomposed form, the measure is defined as:

$$E = - \sum_{j=1}^{m} s_j \ln s_j + \sum_{j=1}^{m} s_j E_j$$

where s_j is the share of size class j in the industry's total number of persons engaged, m is the number of size classes, and E_j is the entropy of size class *j*. The first term represents between-class entropy, while the second refers to within-class entropy.[6]

Several remarks should be made with respect to the measurement of concentration. First, industries and markets are often defined differently. Industries are described in terms of their production processes or raw material requirements. Markets, however, are usually identified from the standpoint of the consumer, meaning that they consist of goods that are close substitutes in consumption. For example, metal products and plastic items may compete in the same market although they are supplied by different industries. It follows that industry data are not the preferred source of information to assess or interpret market characteristics. They are used because no other form of information is readily available. Second, because entropy typically refers to domestic production and ignores imports, evidence of concentration can be misleading. Accordingly, the measure employed here is regarded as an indicator of industrial concentration rather than market concentration. Third, measures of concentration are sensitive to the level of industry aggregation. Estimates derived from highly aggregated data will have a downward bias as they incorporate not only the effects of economies of scale and entry barriers but also the degree of product diversification. Finally, establishments may be separated according to regional rather than national markets. The degree of competition between geographically scattered establishments is sometimes modest, and the market power of these establishments could be large.

Product differentiation

Many (but not all) manufactured products become differentiated over time. Because of its nature, product differentiation is generally greater among consumer goods than among either capital goods or intermediate goods. Ready-to-eat food products, consumer electrical equipment, cosmetics and passenger cars are just a few examples of highly differentiated products. Such products are no longer perfect substitutes in consumption, although producers compete among themselves in the same market.

In order to compete on characteristics other than price, firms will try to differentiate their products in terms of design, quality and presentation. These efforts serve to lower the price elasticity of demand, to shift demand curves to the right, and to increase the firm's market share. With a greater degree of differentiation, rival products become poorer substitutes and the price elasticity of demand for a given product is reduced. Thus, product differentiation represents a departure from perfect competition (see e.g. Sherman, 1974, pp. 227–9; Howe, 1978, pp. 57–9; and Caves and Williamson, 1985).

It is customary to distinguish between horizontal, vertical and technological forms of differentiation. Horizontal differentiation refers to a combination of 'core' attributes found in all products within a given group. A particular product variety is determined by the way in which these attributes are combined. Vertical differentiation reflects differences in quality and can usually be attributed to absolute differences between the core attributes of product varieties. Finally, technological differentiation is the result of innovation. Products in a given group have distinct technical attributes or are produced by technologically different processes to combine attributes. Technological differentiation leads to product improvements across the entire quality range.

Product differentiation is easy to observe but difficult to measure. In theoretical terms, elasticities of substitution with respect to prices reveal the extent of product differentiation in a specific market. In practice, the multitude of markets and product varieties to be considered demands a much simpler approach. The current study makes use of data on the unit values of exports (stated at f.o.b. prices) as a proxy for the extent of product differentiation. With the assumption that unit values of non-differentiated exports are similar, coefficients of variation are calculated across export destinations.[7] The nature of this approach means that it focuses mainly on the extent of vertical product differentiation. The resultant measure depends largely on the number of export destinations and absolute differences in the unit values. Because market power and discriminatory export practices may influence the variation in unit values, the measure's use as an indicator of product differentiation may involve some distortion.

International comparisons between industries

The measures described above are employed to gain some impression of the extent to which industries deviate from the H–O assumptions of constant returns, perfect competition and product homogeneity. Attention focuses on inter-industry comparisons, as these can help to identify those industries for which a particular assumption may be especially inappropriate.

Industries' size elasticities

Evidence for scale economies is presented in the form of size elasticities of value added per person. These were calculated for 24 industries in selected DMEs and developing countries. The results, which relate to information for years around 1985, are shown in Table 8.1.

Industries with relatively large size elasticities in both country groups are non-industrial chemicals, petroleum and coal products, and glass. Those with consistently low elasticities include textiles, wearing apparel, and rubber products. In many cases, however, the relative values of the elasticity estimates differed between the two groups of countries. Electrical machinery proved to have a high elasticity in DMEs though not in developing countries, while the reverse was true for non-metallic minerals and basic metals. Footwear, plastics and non-metallic minerals reported relatively

Table 8.1 Size elasticities[a] and industry rankings for years around 1985

Industry (ISIC code)	Developed market economies: Number of countries	Developed market economies: Average size elasticity[b]	Developed market economies: Industry ranking	Developing countries and areas: Number of countries	Developing countries and areas: Average size elasticity[b]	Developing countries and areas: Industry ranking	All countries: Number of countries	All countries: Average size elasticity[b]	All countries: Industry ranking
Food products (311/2)	6	0.089	14	11	0.144	15	17	0.101	17
Beverages and tobacco (313/4)	4	0.137	6	11	0.391	3	15	0.322	1
Textiles (321)	6	0.031	24	12	0.097	22	18	0.059	24
Wearing apparel (322)	6	0.077	18	10	0.139	17	16	0.091	22
Leather and fur products (323)	5	0.085	15	11	0.157	13	16	0.126	8
Footwear (324)	5	0.056	23	9	0.212	8	14	0.111	13
Wood and cork products (331)	6	0.120	8	11	0.097	23	17	0.116	10
Furniture, excl. metal (332)	6	0.085	16	12	0.198	10	18	0.103	16
Pulp and paper (341)	7	0.157	3	12	0.279	5	19	0.172	4
Printing and publishing (342)	6	0.126	7	12	0.123	19	18	0.125	9
Industrial chemicals (351)	3	0.076	19	8	0.219	7	11	0.112	12
Other chemicals (352)	4	0.139	5	8	0.205	9	12	0.160	5
Petroleum and coal products (353/4)	6	0.234	1	6	0.409	1	12	0.255	2
Rubber products (355)	6	0.071	21	12	0.100	21	18	0.083	23
Plastic products (356)	5	0.070	22	11	0.176	12	16	0.098	19
Pottery, china, earthenware (361)	4	0.103	10	6	0.151	14	10	0.111	14
Glass (362)	5	0.191	2	5	0.392	2	10	0.226	3
Other non-metal. min. products (369)	5	0.072	20	9	0.391	4	14	0.133	7

Table 8.1 continued

Industry (ISIC code)	Developed market economies: Number of countries	Average size elasticity[a]	Industry ranking	Developing countries and areas: Number of countries	Average size elasticity[a]	Industry ranking	All countries: Number of countries	Average size elasticity[a]	Industry ranking
Basic metals (371/2)	7	0.084	17	11	0.233	6	18	0.110	15
Metal products (381)	6	0.095	12	11	0.141	16	17	0.100	18
Non-electrical machinery (382)	7	0.091	13	12	0.119	20	19	0.094	21
Electrical machinery (383)	7	0.155	4	12	0.180	11	19	0.158	6
Transport equipment (384)	7	0.111	9	11	0.129	18	18	0.112	11
Prof. and scient. equipment (385)	7	0.100	11	9	0.079	24	16	0.097	20

Source: UNIDO

a Estimates of size elasticities were obtained on the basis of the regression equation

$$v_i = k\, n_i^a$$

where v_i is value added per person engaged for establishment size class i, n_i is the corresponding average number of persons engaged, k is a constant and a is the size elasticity which is assumed to be constant.

b Individual countries' data were weighted by the number of persons engaged in the industry in question.

low elasticities in the DMEs but comparatively high values in developing countries.

In general, size elasticities tend to be significantly higher in developing countries than in DMEs. This contrast reflects the greater disparities between small and large establishments in the former countries. Scale economies could be one reason for the marked difference between large and small establishments in the two country groups. Another is that larger establishments in developing countries tend to have more highly protected markets. In comparison with their smaller competitors, they are able to generate relatively greater monopoly profits. Large firms operating in DMEs may not receive the same, relatively generous, levels of protection.

Indirect evidence on entry barriers

Scale economies are often regarded as a natural barrier to entry. But there are artificial entry barriers as well, some of which have already been mentioned. A rough impression of the effects of entry barriers can be obtained by considering the increase in the number of firms/establishments in an industry in relation to its growth of output. Increases in output can be attributed to the expansion of existing establishments and/or new entrants, while the relative contribution to growth from either source will be subject to the effectiveness of entry barriers. A low ratio would imply that entry barriers are restrictive. Slow growth in the number of establishments relative to growth of output can also reflect an increase in the average value added per establishment. In either case, industries experiencing this type of growth pattern are expected to be relatively concentrated.

In order to examine inter-industry differences, the relationship between growth of output and growth in the number of establishments was estimated for 24 industries during the period 1977–82. The results are reported in Table 8.2 for 15 DMEs and 18 developing countries. In the developing countries, the industries with the highest entry barriers are relatively intensive users of physical capital and/or they depend on scale economies. They include: food processing, beverages and tobacco, petroleum and coal products, and basic metals.

A somewhat different picture emerges in the DMEs. Stagnating growth is a major entry barrier, particularly for industries that are resource-based or labour-intensive. In many of these industries the number of establishments did not decrease in proportion to production cuts. And in some cases the number of establishments actually rose, implying a fall in output per establishment. Such trends suggest the emergence of excess capacity in some firms along with the rationalization of existing capacity in others. The DMEs reported a decline in the number of establishments in 11 of the 24 industries shown in Table 8.2. In four of these industries – furniture, pulp and paper, non-industrial chemicals, and glass – an increase in output was associated with the fall in number of establishments. Apart from the possible effects of the slow market

Table 8.2 Growth of the number of establishments and production, by industry, selected countries,[a] 1977–82

Industry (ISIC code)	Selected developed market economies			Selected developing countries and areas		
	Growth of the number of establishments[b]	Growth of production[b,c]	Growth of the number of establishments relative to production growth[d]	Growth of the number of establishments[b,c]	Growth of production[b,c]	Growth of the number of establishments relative to production growth[d]
Food products (311/2)	1.370	1.100	1.246	1.072	1.478	0.726
Beverages and tobacco (313/4)	1.169	1.097	1.066	1.055	1.406	0.750
Textiles (321)	0.925	0.940	0.984	1.119	1.066	1.049
Wearing apparel (322)	0.936	0.861	1.086	1.002	1.140	0.879
Leather and fur products (323)	0.776	0.895	0.867	1.209	1.191	1.016
Footwear (324)	0.825	0.948	0.870	1.212	1.075	1.127
Wood and cork products (331)	1.381	0.871	1.586	1.068	1.117	0.956
Furniture, excl. metal (332)	0.670	1.020	0.657	1.176	1.057	1.112
Pulp and paper (341)	0.936	1.089	0.859	1.276	1.288	0.991
Printing and publishing (342)	1.043	1.105	0.943	1.182	1.332	0.888
Industrial chemicals (351)	0.966	0.983	0.982	1.225	1.352	0.906
Other chemicals (352)	0.935	1.107	0.845	1.179	1.340	0.880
Petroleum and coal products (353/4)	1.062	0.865	1.227	1.024	1.395	0.735
Rubber products (355)	1.031	0.873	1.181	1.373	1.411	0.973
Plastic products (356)	1.110	1.130	0.983	1.391	1.281	1.085
Pottery, china and earthenware (361)	0.631	0.882	0.716	1.107	1.196	0.925
Glass (362)	0.932	1.002	0.930	1.258	1.377	0.914
Other non-metallic mineral products (369)	0.995	0.905	1.100	1.238	1.343	0.921
Basic metals (371/2)	1.113	0.799	1.393	1.177	1.355	0.869

Table 8.2 continued

Industry (ISIC code)	Selected developed market economies: Growth of the number of establishments[a]	Growth of production[b]	Growth of the number of establishments relative to production growth[d]	Selected developing countries and areas: Growth of the number of establishments[a]	Growth of production[b]	Growth of the number of establishments relative to production growth[d]
Metal products, excl. machinery (381)	1,148	0,928	1,238	1,215	1,431	0,848
Non-electrical machinery (382)	1,052	1,024	1,028	1,332	1,417	0,940
Electrical machinery (383)	1,125	1,107	1,017	1,500	1,328	1,130
Transport equipment (384)	1,011	0,957	1,056	1,248	1,235	1,011
Professional and scientific equipment (385)	1,033	1,016	1,017	1,820	1,911	0,952

Source: UNIDO.

a The countries included are as follows: 14 DMEs - Australia, Austria, Belgium, Denmark, Finland, Federal Republic of Germany, Iceland, Ireland, Italy, Norway, Spain, Sweden, United Kingdom and the United States; and 18 developing countries - Chile, Colombia, Cyprus, Ethiopia, Ghana, Haiti, Hong Kong, India, Indonesia, Kenya, Malta, Peru, the Philippines, Republic of Korea, Singapore, Turkey, Venezuela and Yugoslavia. However, the number of countries included differs slightly from industry to industry.

b In symbols,

$$g^E = \sum_{j=1}^{n} E82_j \Big/ \sum_{j=1}^{n} E77_j$$

where $E82_j$ and $E77_j$ are, respectively, the number of establishments in 1982 and in 1977 in country j, and n is the number of countries included.

c In symbols,

$$g^V = \sum_{j=1}^{n} V82_j \Big/ \sum_{j=1}^{n} V77_j$$

where $V82_j$ and $V77_j$ are, respectively, value added in constant 1980 United States dollars in 1982 and in 1977.

d In symbols, g^E/g^V.

growth, these shifts can be attributed to entry barriers such as heavy initial capital requirements and economies of scale.

Industrial concentration

Barriers to entry affect the degree of industrial concentration. The latter can be measured by the employment entropy index. Indices of this type were calculated for the individual industries in all DMEs and developing countries for which data were available. The results, which are given in Table 8.3, reveal a more consistent pattern for concentration than was found for size elasticities. The weighted averages show that the most highly concentrated industries are beverages and tobacco, footwear, industrial chemicals, petroleum and coal, rubber, and glass. Those that are not highly concentrated include food products, wearing apparel, wood, printing and publishing, metal products, and non-electrical machinery.

When industries are ranked by industrial concentration, the coefficients of concordance between DMEs, between developing countries and for the total sample were 0.850, 0.722 and 0.753, respectively. In other words, industries that are highly concentrated in one country tend to be highly concentrated in others, although absolute degrees of concentration differ.[8] The relationship between industrial concentration and size elasticities is also of interest. Correlation coefficients between the two indicators were positive but weak. The rank correlation for DMEs was statistically insignificant, while that for developing countries was significant at the 5 per cent level. This result may indicate that economies of scale are a somewhat more significant entry barrier in developing countries than in the DMEs.

Another distinctive feature of Table 8.3 is that industries in DMEs are less concentrated than those in developing countries. This result may be due partly to systematic differences in the market size of the two country groups. Industrial concentration, for example, may be less pronounced in large countries than in small ones owing to the interaction between economies of scale and the size of the domestic market. A simple cross-country regression analysis was conducted to determine the effects on industrial concentration of the level of industrial development and country size. The following equation was used for the test:

$$- \ln E_{ij} = a_i + b_i \ln V_j + c_i \ln N_j + u_{ij}$$

where i stands for an industry, j for a country, E is the employment entropy index, V is per capita MVA (a proxy of the level of industrial development), N is population (country size), and u is the disturbance term.

Regression results are summarized in Table 8.4. The two explanatory variables have a strong negative effect on industrial concentration. They also explain more than half of the variation in the entropy index for all industries other than footwear and petroleum and coal products. High absolute values of elasticities of industrial concentration with respect to both independent

Table 8.3 International comparison of employment entropy indices[a] in manufacturing industries, around 1985

Industry (ISIC code)	Developed market economies: Number of countries	Developed market economies: Average entropy index	Developed market economies: Industry ranking	Developing countries/areas: Number of countries	Developing countries/areas: Average entropy index	Developing countries/areas: Industry ranking	All countries: Number of countries	All countries: Average entropy index	All countries: Industry ranking
Food products (311/2)	9	8.16	22	10	6.00	21	19	7.87	22
Beverages and tobacco (313/4)	7	5.44	7	10	4.38	9	17	4.90	4
Textiles (321)	8	7.58	18	10	6.19	23	18	7.14	17
Wearing apparel (322)	8	8.57	24	10	6.96	24	18	8.21	24
Leather and fur products (323)	8	5.59	10	10	4.74	10	18	5.33	9
Footwear (324)	8	5.38	6	10	3.97	4	18	4.96	5
Wood and cork products (331)	8	8.13	21	10	5.16	15	18	7.86	21
Furniture, excl. metal (332)	8	7.48	17	10	4.92	12	18	7.28	18
Pulp and paper (341)	9	6.84	13	10	4.96	13	19	6.72	13
Printing and publishing (342)	9	7.84	20	10	5.29	16	19	7.66	20
Industrial chemicals (351)	7	5.20	5	9	4.21	8	16	5.03	6
Other chemicals (352)	7	5.82	11	9	4.80	11	16	5.55	11
Petroleum and coal products (353/4)	9	4.55	2	8	3.22	2	17	4.41	2
Rubber products (355)	8	4.67	3	10	4.06	6	18	4.45	3
Plastic products (356)	8	7.24	15	10	6.02	22	18	6.97	15
Pottery, china, earthenware (361)	7	5.48	8	8	3.20	1	15	5.23	8
Glass (362)	7	4.41	1	8	3.53	3	15	4.25	1
Other non-metal. min. products (369)	7	7.32	16	9	5.60	17	16	6.98	16
Basic metals (371/2)	9	5.55	9	10	4.14	7	19	5.47	10
Metal products (381)	9	8.20	23	10	5.97	20	19	8.02	23
Non-electrical machinery (382)	9	7.61	19	10	5.65	19	19	7.54	19
Electrical machinery (383)	9	6.87	14	10	5.62	18	19	6.77	14
Transport equipment (384)	9	5.12	4	10	4.05	5	19	5.06	7
Prof. and scient. equipment (385)	9	6.30	12	10	5.07	14	19	6.22	12

Source: UNIDO

a Industry averages for country groups were obtained by weighting values by the number of persons engaged in each country in the particular industry. Details of the computational procedure are given in the text.

Table 8.4 Relationship between industrial concentration, the level of industrial development and country size,[a] by industry, around 1985

Industry (ISIC)	Estimated regression coefficient[b] of: ln V	ln N	Number of countries in the sample	Adjusted R^2
Food products (311/2)	-0.1384	-0.1473	42	0.841
Beverages and tobacco (313/4)	-0.1565	-0.1733	43	0.605
Textiles (321)	-0.2016	-0.1943	42	0.706
Wearing apparel (322)	-0.2173	-0.0889	41	0.653
Leather and fur products (323)	-0.2453	-0.2223	40	0.715
Footwear (324)	-0.3159	-0.1647	38	0.481
Wood and cork products (331)	-0.2358	-0.2510	42	0.577
Furniture, excl. metal (332)	-0.1613	-0.1121	41	0.664
Pulp and paper (341)	-0.2833	-0.2233	45	0.765
Printing and publishing (342)	-0.1713	-0.1747	44	0.822
Industrial chemicals (351)	-0.2718	-0.3215	35	0.663
Other chemicals (352)	-0.1520	-0.1708	34	0.730
Petroleum and coal products (353/4)	-0.2058	-0.2363	25	0.222
Rubber products (355)	-0.1987	-0.1878	42	0.566
Plastic products (356)	-0.2550	-0.1661	42	0.774
Pottery, china, earthenware (361)	-0.1474	-0.3027	24	0.542
Glass (362)	-0.3110	-0.3122	29	0.665
Other non-metal. min. products (369)	-0.1813	-0.1493	36	0.758
Basic metals (371/2)	-0.2558	-0.2393	41	0.649
Metal products (381)	-0.1832	-0.1572	44	0.839
Non-electrical machinery (382)	-0.1968	-0.2091	43	0.703
Electrical machinery (383)	-0.2842	-0.1814	45	0.664
Transport equipment (384)	-0.1430	-0.1912	44	0.517
Prof. and scient. equipment (385)	-0.3246	-0.3294	33	0.645

Source: UNIDO

a/ The regression equation used here is

$$-\ln E_{ij} = a_i + b_i \ln V_j + c_i \ln N_j + u_{ij}$$

where i stands for an industry, j for a country, E is the employment entropy index, V is per capita MVA, N is population and u is the disturbance term.

b/ All coefficients were statistically significant at the ten per cent level. Out of the 48 estimates 44 were significantly different from zero even at the one per cent level.

variables are observed for industrial chemicals, glass, and professional and scientific equipment. Industries where concentration can be explained mainly on the basis of the level of industrial development include wearing apparel, footwear, pulp and paper, plastic and electrical machinery. Country size was the more important explanatory variable for industrial concentration of wood and pottery, china and earthenware.

The relationship between concentration and the level of industrial development may depend on the fact that skill and technology requirements sometimes act as a barrier to entry. In the case of country size, an analogous role would be played by economies of scale. The assumptions underlying these interpretations are that skill and technology requirements act as an important barrier in developing countries, whereas a domestic market of limited size has a similar effect in small countries.[9]

US industry characteristics

The empirical evidence assembled here is based on very broad definitions of industries. This fact obscures much of the effects of product differentiation. It also results in substantial variation in the cross-industry estimates for scale economies and industrial concentration. Ideally, the boundaries of each industry would be determined in such a way that all varieties would be produced with similar technologies and products were close substitutes. The first stipulation would permit a more accurate assessment of scale economies, while the second would yield greater precision in the determination of patterns of industrial concentration.

Although any single-country assessment has obvious drawbacks, this approach is necessary if precise industry definitions are to be obtained. The similarity in rankings for concentration and (to a lesser extent) scale economies which were obtained from the cross-country analysis described above provides a partial justification of this approach. The following paragraphs are based on an analysis of detailed industry data for the USA. This data source offers several technical advantages such as a good coverage of establishments, ample detail, and consistency between size categories as well as a minimum of data suppression.

Information on 439 US industries provided the basis for estimates of size elasticities (economies of scale), employment entropy indices (industrial concentration) and total capital intensity. A proxy for product differentiation was derived from coefficients of variation in unit values of US exports.[10]

The results are summarized in Table 8.5, which shows rank correlation coefficients between pairs of industry measures. The positive association of industrial concentration with both scale economies and capital intensity is the major finding of the exercise. This result provides additional empirical support for the view that increasing returns and high (initial) capital requirements can be effective entry barriers and important determinants of market structure. By contrast, the association between product differentiation and other industry characteristics is weak. This may be due partly to the fact that the measure used here is most appropriately interpreted as an indicator of vertical differentiation, although horizontal differentiation is thought to be more common. Vertical differentiation may nevertheless have a role to play, and this possibility is explored in the following chapter.

Export concentration and industrial concentration

The foregoing discussion was concerned with particular features of the scale economies model. The relevance of some of these features for patterns of

Table 8.5 Rank correlations between industry characteristics[a]

	Spearman correlation coefficients[b]		
	Total capital[c] intensity	Industrial[d] concentration	Product[e] differentiation
Economies of scale[f]	0.410*	0.219**	-0.182***
Total capital intensity		0.325*	0.012
Industrial concentration			0.052

Sources: UNIDO and United States, Bureau of the Census (1984)

a/ Correlations are based on United States data for 1982, aggregated into SITC three-digit groups.

b/ Asterisks denote statistical significance at the 1(*), 5(**), or 10(***) per cent level.

c/ Value added per employee.

d/ Employment entropy index.

e/ Coefficient of variation of unit values of exports to different destinations.

f/ Size elasticity.

IIT will be assessed in the following chapter. The present section considers a narrow issue – the possible relationship between export concentration and industrial concentration in domestic markets.

Since large firms in oligopolistic industries often rely on foreign sales to realize economies of scale, the degree of concentration may be high in domestic and export markets. It can also be the case that major exporting countries (particularly large ones) have a substantial degree of hegemonic power in certain international markets, or that international collaboration is great and borders on cartel-like behaviour. Typically, a few existing internationally oligopolistic producers (and exporters) compete under a regime established to maintain profits, stability or other goals.[11]

There will be other industries, of course, where domestic markets are not concentrated although exporters are limited to a very few suppliers. In these industries, the major exporting countries will often dominate international markets through economies of scale which are external to the firms but internal to domestic industries. Marketing and trade operations can be the responsibility of a few large companies even though the industry is not concentrated in its domestic market. In such cases, trade assumes oligopolistic characteristics which are not observed in production (Dixit, 1984).

Entropy indices are used to examine the relationship between domestic industrial concentration and export concentration. Employment entropy indices based on US data for 1982 (discussed in the previous section) represent the first element in this comparison. The second is an export entropy index of the form

$$-\sum_{j=1}^{n} x_{ij} \log x_{ij}$$

where x_{ij} is the share of country j in the value of world exports of industry i and n is the total number of exporting countries. United Nations trade statistics for 91 countries and 113 industries (SITC three-digit groups) in 1983 were the data source for this measure.

The two concentration measures revealed a significantly positive correlation (a Spearman correlation coefficient of 0.381) across industries. That result seems to support Dixit's observation (1984, p. 2) that entry barriers in international markets are closely associated with economies of scale – just as in domestic markets – and that a few large multinational firms dominate both markets. A more detailed picture of the association between industrial concentration and export concentration is obtained from Table 8.6, which is based on a two-way classification of the data taken from the source described above. The industry ranking by type of concentration was first condensed into five categories where each category represents one-fifth of the entire industry distribution. Industries were also arranged by product category – Ricardian, H–O and product-cycle – using a classification scheme described in earlier chapters.

Whatever the reasons for the similarities between export and industrial concentration, the data summarized in Table 8.6[12] reveal some interesting features. Both industrial and export concentration are high in resource-based industries but low among H–O industries.[13] Export concentration was generally high among product-cycle industries, whereas the degree of industrial concentration seems to depend on the importance of R and D and the extent of plant scale economies. Some product-cycle industries (for example, aircraft, photographic and cinematographic supplies, sound recorders and reproducers) are highly concentrated in both domestic and international markets; others, such as mineral manufactures, tools for use in the hand or in machines, and wire products, are not.[14]

The results outlined here yield some support for the assertion that external economies of scale, R and D capabilities relating to product development or differentiation, and natural resource endowments are more important for successful entry in international markets than for domestic market entry. In general, neither the extent of product differentiation nor plant economies of scale can fully explain the export concentration among countries. Their effects on trade patterns depend largely on technologies and skills used in the development of products and processes, all of which are subject to external economies of scale. These elements, then, should be considered

Table 8.6 Distribution of industries,[a] by industrial concentration and by export concentration (number of industries[b])

		Export concentration[d]					Type of industry[e]		
		High	Medium high	Medium	Medium low	Low	R	H-O	PC
Industrial concentration[c]									
high		10	6	3	3	1	11	6	6
medium high		6	3	7	2	4	5	12	5
medium		4	4	3	4	8	5	12	6
medium low		2	6	6	5	3	5	10	7
low		1	3	4	8	7	4	15	4
Type	R	12	4	3	3	8			
of	H-O	4	10	14	14	13			
industry	PC	7	8	6	5	2			

Sources: UNIDO and United States, Bureau of the Census (1984).

a/ A total of 113 industries defined as SITC three-digit categories, is covered.
b/ Each cell of the two-way classification table gives the number of industries falling in the respective categories. Each of the categories 'high', 'medium high', etc. comprises 20 per cent of the total number of industries. The detailed categorical data are shown in the statistical appendix (table B.10).
c/ Industrial concentration is measured by the employment entropy index and refers to data for the United States, 1982.
d/ Export concentration is measured by the export entropy index, which has been derived from data of 91 countries for 1983.
e/ The types of industries are designated by R (Ricardian), H-O and PC (product-cycle), where the definitions are those given in the statistical appendix.

as determinants of location of export capacities in conjunction with factor proportions and R and D intensity.

Notes: Chapter 8

1 These points refer to economies of scale that are internal to a firm or plant. But economies of scale that are external to the firm (though internal to the domestic industry) are also important. A relatively large industry may have more opportunities for within-industry specialization and easy access to public inputs. The sources of such scale economies include various types of industry-specific infrastructure (physical and institutional), industry-wide R and D activities, and accumulation of industry-wide technological information. It follows that firms in relatively large industries have more potential for cost savings than those in a smaller industry. In general, the size of the domestic industry is expected to determine the extent of external economies of scale.

2 The treatment of consumer preferences varies. In neo-Chamberlinian models (e.g. Krugman, 1979a, 1980, 1981; Dixit and Norman, 1980, pp. 281–93) consumers are assumed to demand all available varieties. All product varieties then enter the utility function symmetrically. In neo-Hotelling models (e.g. Lancaster, 1980; Helpman, 1981) consumers are assumed to demand a single variety; that is, varieties enter the utility function asymmetrically.

3 For various concentration measures and their characteristics, see e.g. Davies, 1979, and Curry and George, 1983, pp. 204–17.

4 The use of employment data may underestimate the relative importance of large establishments since these firms tend to use less labour and more capital than small establishments. However, this bias can be assumed to be insignificant since employment data are also highly correlated with other statistics such as sales or output.

5 Entropy is a concept of information theory that can be used to measure the degree of uncertainty. For a thorough review of the entropy concept and its application in economics, see Theil, 1967, ch. 8; 1971, pp. 636–46.

6 For details on the mathematical procedure of decomposition, see Jacquemin and Kumps, 1971, p. 61. In order to obtain the industry-wide estimate (E), it was necessary to calculate entropy (E_i) for each size class. The computation of E_i was based on the extreme values for entropy within size class i as suggested by Meller, 1978, pp. 46–7.

7 This approach is taken from Hufbauer, 1970, pp. 190–3. An alternative measure of product differentiation makes use of the relative amount spent on advertising. The underlying assumption for the latter proxy is that inherent product complexities characteristics and diverse tastes of consumers require producers to provide information on their varieties in order to promote sales.

8 At the four-digit level of ISIC, rankings of the 80 industries in different large countries are also similar. Spearman rank correlation coefficients between Japan and the USA, Japan and the Republic of Korea and the Republic of Korea and the USA are 0.751, 0.779 and 0.660 respectively. These calculations were based on data provided in Ministry of International Trade and Industry, Japan, 1986; Economic Planning Board, Republic of Korea, 1987; and a magnetic tape with data of the *US Census of Manufactures 1982* provided by the US Department of Commerce, 1984.

9 It should be noted that this argument refers to domestic markets only; i.e. it does not take into account the size of export markets.

10 All four measures of industry characteristics were aggregated to the SITC three-digit level. Partial evidence at this level of detail is found in the statistical appendix, which shows categorical measures of industry characteristics.

11 Such a regime usually concerns 'stability', 'basically co-operative arrangements', and 'specific roles and norms': Cowhey and Long, 1983, p. 158. Examples are the iron and steel industry or the automobile industry.

12 Details on industry coverage of each of the five categories of industrial concentration and export concentration can be obtained from Table B10 of the statistical appendix (Appendix B).

13 Food-processing industries were one exception. These are resource-based but are close to H–O operations. H–O industries that did not fit the general pattern were either partially dependent on natural resources (construction materials, pottery, ingots of iron or steel) or characterized by large economies of scale (perfumery and cosmetics, road vehicles, finished steel products).

14 These product-cycle industries also reflect various H–O characteristics, a fact that may be related to the result.

CHAPTER 9

Intra-industry trade revisited

The role played by industry-specific characteristics is quite different in the new theories of trade from their function in the factor abundance theory. In the H–O model, industries' factor intensities provide a precise link between endowments and trade patterns. By contrast, the new theories do not build on an interaction between industry characteristics and country attributes to explain trade. Instead, the presence of some combination of industry characteristics is shown to be sufficient to establish two-way trade. Such an outcome is possible even in the case where the economic attributes of trading partners are not distinguishable in any significant way (Krugman, 1979a). More generally, the new theories assign a more important role to industry characteristics as determinants of trading patterns.

The shift in emphasis complicates empirical analyses based on the new theories. One problem is to construct measures of the variables that are thought to determine patterns of trade. A second is that certain hypotheses regarding the relationship between industry characteristics and trade cannot be readily expressed in the form of algebraic relationships. Examples are the impact of product differentiation or of increasing returns on trade. The present chapter addresses these problems. The scope of discussion, however, is limited to a set of issues where the theory is fairly precise and the empirical difficulties are manageable. Such an approach is not comprehensive but is still helpful in obtaining an impression of the extent to which economies of scale and product differentiation may affect the relative extent of IIT. The first section of the chapter presents the test results for several broad hypotheses. The second section looks at the industry-specific determinants of IIT in DMEs, while the third section focuses on the role of vertical product differentiation in two-way trade between DMEs and developing countries.

Intra-industry trade versus inter-industry trade

The tendency for analysts to focus on the share of IIT in total trade (exports plus imports) was noted in Chapter 4. The most popular measure of IIT shares was proposed by Grubel and Lloyd (1975). Though not intended for such a purpose, the Grubel-Lloyd index shows the breakdown of total trade into its inter-industry (H–O) and intra-industry (non H–O) components. By indicating which of the two components dominates, the measure can be useful in identifying the types of determinants that are likely to influence trade in a specific industry.

The underlying question concerns the type of trade (inter-industry or intra-industry) that can be associated with a particular industry. One limiting case is described by the factor abundance model, which depends on assumptions that exclude the possibility of IIT. The other, represented for instance by the Krugman model, describes a world where all trade is IIT. In reality, both types of trade will co-exist, and this outcome, too, has been anticipated by several theoretical models. Rather than attempting to distinguish between inter-industry and intra-industry trade in a dichotomous manner, the following discussion focuses on the degree to which either component is present in the trade of various countries.

The methodological problem that arises in this context concerns the appropriateness of trade-overlap measures. In describing IIT as 'an untidy phenomenon', Gray (1988) called attention to an issue that is often neglected. Overlapping exports and imports within narrowly defined product categories represent the 'classical' case of two-way trade in horizontally differentiated products. However, the high level of aggregation in trade statistics, along with other statistical anomalies, means that the available data do not match the concepts of industry or product used in new trade theories. These discrepancies give rise to 'impure forms' of IIT; for example, the exchange of products at different stages of processing.

Most empiricists play down the statistical difficulties associated with the measurement of IIT and regard their measures as compatible with the theoretical concept. This pragmatic approach concedes that little can be done to reconcile the information demands of theory with the available data. Nevertheless, it is difficult to ignore the occurrence of impure forms of IIT, particularly since some of the reasons for the overlap are integral parts of non-H–O models. An eclectic approach is adopted here – one that attempts to assess the ability of various theoretical hypotheses to explain an intrinsically 'untidy' statistical phenomenon.

One such hypothesis concerns the interaction between scale economies and product differentiation. The mere fact that firms produce differentiated versions of a product with increasing returns to scale can result in two-way trade. Ideally, the analyst would wish to relate the presence or absence of scale economies or product differentiation to evidence of the presence or absence of IIT. Such a test could best be expressed as a relationship between dichotomous variables. The available evidence, however, can be stated only in terms of continuous (not dichotomous) measures. An empirically operational version of such a hypothesis would postulate that the cross-industry pattern of IIT is positively related to the extent of scale economies and the degree of product differentiation. Such a proposition – though it cannot be rigorously concluded from the underlying model – would reflect the spirit of the foregoing discussion.

A second hypothesis concerns the role of industrial concentration. Theories of IIT do not usually posit a direct link between industrial concentration and two-way trade. Product differentiation may nevertheless be related to industrial concentration in a systematic manner. Product differentiation is likely to be high in industries whose market structure approximates monopolistic competition, leading to a low degree of industrial concentration. Ample opportunities for product differentiation, on the other hand, are likely to reduce the extent of concentration. Accordingly, a measure of industrial concentration is expected to be negatively related to IIT (Greenaway and Milner, 1984).

These hypotheses were tested using data for 80 SITC three-digit categories. Measures of industry characteristics were computed from US information for 1982, while IIT shares are weighted averages for country groups drawn from a sample of 47 countries. The coefficients of linear regressions presented in Table 9.1 show how each industry characteristic impacts on IIT shares. Only a small portion of the variation in IIT shares across industries is explained by the three industry characteristics. The poor results may reflect the untidiness of IIT as well as the limited applicability of any particular theoretical account.

Given the eclectic approach that is adopted here, the individual coefficients are of more interest than the overall fit of the regression equation. Theory suggests that economies of scale are the major source of non-comparative-advantage trade. However, there is only a weak positive relationship between size elasticities and the share of IIT, and even this result seems to apply only to the DMEs. Findings of this type are common in the empirical literature. In some cases they have led researchers to recast the measure of plant scale economies as another indicator of product standardization – an extreme form of redressing unexpected results. More plausible is the suggestion that the scale economies being measured by size elasticities are not those stressed by the relevant theory. IIT may depend on economies of scale obtained from long production runs rather than a large scale of operations (Toh, 1982).

In the case of product differentiation, the weak (and mainly positive) association with IIT is not surprising. The interpretation, however, is clouded by the same types of problems that arise with the economies-of-scale variable. The measure used here represents vertical rather than horizontal forms of differentiation. Thus, it is not ideally suited to explain the 'classic' type of IIT which occurs between similar countries in a Chamberlinian setting. The expression used here may be a more appropriate indicator of H–O forms of IIT which occur when products are differentiated in terms of quality. It is this type of IIT in which developing countries are expected to engage. The positive coefficients for second-generation NIEs and for other developing countries are compatible with this interpretation, and this point is considered further in the last section of the chapter.

While Table 9.1 shows only weak support for the role of scale economies and product differentiation, the expected negative relationship between the share of IIT and industrial concentration emerges clearly from the estimates.

Table 9.1 Impact of industry characteristics on the share of IIT,[a] by country group, 1985 (beta coefficients)

Country sample (number of countries and areas)	Independent variables[b]			Adjusted R^2	F-value
	Scale economies	Product differentiation	Industrial concentration		
A. All industries[c]					
All countries (47)	0.158	0.022	-0.374*	0.08	3.46**
DMEs (22)	0.152	-0.088	-0.359*	0.14	5.24*
NIEs (6)	-0.024	0.006	-0.267**	0.04	2.24***
Second-generation NIEs (9)	-0.021	0.207***	-0.130	0.21	1.45
Other developing countries (10)	0.150	0.144	-0.271**	0.04	2.11
B. Low-concentration industries[d]					
All countries (47)	0.278	-0.030	-	0.02	1.35
DMEs (22)	0.358**	-0.003	-	0.09	2.95***

Sources: UNIDO and United States, Bureau of the Census (1984).

a/ The dependent variable in the underlying linear regressions was the unweighted average of the IIT share for each country group in 1985. Scale economies are measured by size elasticities of per person value added, product differentiation by coefficients of variation of export unit values, industry concentration by employment entropy indices. All measures of industry characteristics are as defined in the text and based on 1982 United States data.

b/ Variables have been standardized to unit variance so that parameter estimates are beta coefficents. The sign of the coefficient of the entropy index was reversed, in order to reflect the impact of concentration. Asterisks denote statistical significance at the 1(*), 5(**) and 10(***) per cent levels.

c/ Estimates of part A were obtained on the basis of data for 50 industries defined in terms of SITC three-digit groups.

d/ Estimates of part B were derived from data on those 41 industries whose employment entropy indices exceeded the arithmetic mean of all 50 industries. Results for subsets of developing countries are not shown, as they were not statistically significant.

Such a relationship appears in all five regressions of Table 9.1, with four out of five coefficients being statistically significant. The negative impact of industrial concentration on IIT is strongest for the DMEs.

As mentioned before, industrial concentration has to do with a particular feature of the underlying model of monopolistic competition. This model specifies a market structure of numerous suppliers and a low degree of industrial concentration. Industries of this type are likely candidates for two-way trade in horizontally differentiated products. A modified hypothesis which would reflect this view focuses on industries where concentration is low. In these industries, scale economies and product differentiation may exert a positive influence on IIT which is not detected when the entire sample of industries is considered. The second half of Table 9.1 presents empirical evidence which provides partial support for this modified proposition. In DMEs, the two-way trade of industries with low concentration is significantly and positively influenced by the extent of economies of scale. An analogous, though weaker, effect was observed for the NIEs, while the IIT of other developing countries reveals no similar evidence.[1]

Determinants of IIT intensity in DMEs

Since the DMEs account for the bulk of two-way trade, most analyses focus on these countries. The present section adds to these studies by considering patterns of IIT in individual DMEs. In doing so, a measurement novelty is introduced. Rather than dealing with the level or share of IIT in total trade, an attempt is made to measure and analyse the intensity of IIT in various industries.

Intensity measures have become familiar tools in the study of (gross) exports and net trade. There, the term 'revealed comparative advantage' (RCA) is often used to refer to measures that require a normalization of trade flows with respect to country size and industry size. An analogous (RCA-like) approach is adopted here to derive a measure of IIT intensity which is both country and industry-specific. The resulting indicator has the following form:

$$IITI = \frac{\min(X_{ij}, M_{ij})}{(X_{mj} + M_{mj})\,(X_{iw} + M_{iw})}$$

where X is exports, M represents imports, i is an industry, j is a country, m refers to total manufactures and w stands for world totals.[2]

The present analysis differs from that of the previous section by offering an analysis of individual countries. Hence, the relative weight of each potential determinant of IIT intensity is assessed for each DME. The resulting picture of two-way trade of the DMEs supplements the (more aggregated) country-specific analysis of specialization and trade in comparative-advantage goods in Chapter 6.

To the extent that measures of the intensity of net trade can be regarded as indicators of comparative advantage, they represent the potential of a country to succeed as a net exporter of particular product groups. This interpretation must be altered somewhat in order to examine trade in non-comparative-advantage goods. However, the intensity of IIT in a given product group can be loosely regarded as an indication of the country's potential to engage in non-comparative-advantage trade. Although the determinants of IIT carry no labels as concise and informative as the classic trade determinants, they play a role similar to that of factor intensities in the study of comparative advantage.

Table 9.2 presents the results of country-specific regressions of IIT intensity on the set of potential determinants analysed in the previous section. A

Table 9.2 Determinants of IIT intensity[a] of selected DMEs, by country, 1985 (beta coefficients)

Country[b]	All industries[c]: Independent variables[e]: Scale economies	Product differentiation	Industrial concentration	Adjusted R^2	Low-concentration industries[d]: Independent variables[e]: Scale economies	Product differentiation	Adjusted R^2
Australia					0.494**	0.031	0.11
Austria	-0.016	-0.057	-0.341*	0.09	-	-	-
Belgium	0.009	0.022	-0.172*	0.05	-	-	-
Denmark	0.185	0.048	-0.504*	0.21	-	-	-
Finland	0.235**	-0.096	-0.379*	0.15	0.520**	-0.028	0.09
France	-	-	-	-	0.302***	0.011	0.03
Ireland	-0.112	-0.102	-0.188***	0.04	-	-	-
Italy	-0.130	-0.215***	0.028	0.02	-	-	-
Netherlands	0.124	0.055	-0.247*	0.09	0.280***	0.132	0.03
New Zealand	0.147***	-0.049	-0.211*	0.11	0.363**	-0.031	0.13
Norway	-	-	-	0.00	0.376**	0.152	0.10
Portugal	0.123	-0.218***	0.071	0.00	-	-	-
Sweden	0.083	-0.005	-0.290**	0.05	-	-	-
Switzerland	0.034	-0.090	-0.212*	0.20	-	-	-
United Kingdom		-	-	-	0.278**	-0.132	0.15
United States	0.243***	-0.125	-0.055	0.04	0.391***	-0.134	0.10

Sources: UNIDO and United States, Bureau of the Census (1984).

a/ For a definition of IIT intensity, see the text. All other measures are as defined in the text and based on 1982 United States data.
b/ Only those regressions are shown which yielded at least one significant coefficient estimate. This rule led to the exclusion of Canada, the Federal Republic of Germany, Greece, Israel, Japan and Spain.
c/ Estimates for 'all industries' were obtained on the basis of data for 80 SITC three-digit groups.
d/ Estimates for 'low-concentration industries' were derived from data for those 41 industries whose entropy indices exceeded the arithmetic mean of all 80 industries.
e/ Variables have been standardized to unit variance so that parameter estimates are beta coefficients. The sign of the coefficient of the employment entropy index was reversed, in order to reflect the impact of concentration. Asterisks denote statistical significance at the 1(*), 5(**) and 10(***) per cent levels.

remarkable variation in the strength of the impact of the various industry characteristics on IIT intensity is observed. In particular, for six out of the 22 DME countries considered here (Canada, the Federal Republic of Germany, Greece, Israel, Japan and Spain) the independent variables had no significant impact on competitiveness in non-comparative-advantage forms of trade.

On the whole, the results in Table 9.2 corroborate and extend those of Table 9.1. Like the earlier regressions, the present ones clearly bear out the hypothesis of a negative impact of industrial concentration on IIT. This impact was most evident among the smaller DMEs. A possible explanation for the distinction between large and small DMEs can be based on the argument that a large home market offers more opportunities to increase product variety. A large country could be expected to have a greater demand for imports of differentiated products because of its extended preference diversity. And the high potential for IIT may be spread more evenly across the entire range of manufactures than is true for a small country, where competitiveness in IIT appears to depend more strongly on the type of industry.

A significantly positive coefficient for scale economies was frequently obtained and usually associated with low-concentration industries. Even in those countries (Finland, New Zealand and the USA) where statistical significance of the scale-economies coefficient applied to all industries, the strongest results applied to the restricted sample of low-concentration industries. Moreover, the prominence of scale economies in low-concentration industries was not confined to the smaller DMEs but can be observed for France, the UK and the USA.

In summary, there is empirical evidence that the intensity of two-way trade of DMEs is subject to the types of determinants employed in a model of IIT under monopolistic competition. The degree of international competitiveness in two-way trade – particularly in small DMEs – appears to be greatest in industries where concentration is low and the scope for product differentiation is high. The degree of competitiveness in the two-way trade of these industries is often positively influenced by economies of scale.

The role of vertical product differentiation in IIT

The foregoing analysis suggests that both product differentiation and scale economies influence IIT. The first part of this conclusion, however, must be qualified since a precise measure of the degree of horizontal differentiation in an industry is not available. In fact, the extent to which product differentiation influences IIT depends upon the variable's assumed relationship with industrial concentration. Further ambiguity arises from the fact that the measure of vertical (not horizontal) differentiation introduced in Chapter 8 was of little importance as a determinant of IIT shares in broad groups of countries.

This state of empirical affairs is unsatisfactory. Despite indirect evidence that product differentiation seems to influence IIT, there is a lacuna as far as measures of differentiation and their relation to trade are concerned. No quantitative indicator that would permit a comprehensive assessment of the impact of horizontal differentiation on patterns of trade is available. Nevertheless, there is scope for a more detailed analysis of the way in which vertical differentiation affects two-way trade, in particular the trade between DMEs and developing countries.

A 'factor abundance' model of IIT developed by Falvey (1981) can serve as the backdrop for this tentative analysis. The model focuses attention on a particular industry operating in a two-country world. The industry is assumed to use a given stock of (industry-specific) capital in combination with labour, and product differentiation over a whole range of qualities is possible. Different product specifications (quality levels) are distinguished by the capital–labour ratios used in production. As a general rule, it is assumed that higher quality requires a higher capital–labour ratio.

When the endowments of the two countries differ, the capital-abundant country will have a comparative advantage in high-quality products and the labour-abundant country in low-quality products. This creates a potential for intra-industry specialization based on factor abundance. If demand conditions permit, the two-way trade of the countries will reflect this pattern of specialization. Such a model is best suited to the analysis of IIT between DMEs and developing countries where differences in factor abundance are substantial. The concept of vertical differentiation then provides an explanatory device to bridge the gap between conventional and modern views of international specialization and trade.

Additional insight into the sources of IIT between DMEs and developing countries can be gained from a second model developed by Flam and Helpman (1987). Their simplified approach to trade in vertically differentiated products differs from Falvey's by assuming that labour is the only factor of production. The Flam–Helpman model recognizes two countries, both producing the same product but with different levels of efficiency. International specialization takes the form of product differentiation by quality types. Such specialization is assumed to be Ricardian, or technology-based. The comparative advantage of one country (the 'North') is in high-quality versions of the differentiated product, while that of the other country (the 'South') is in low-quality versions. Two-way trade will occur if the quality range being produced in each country does not match the product versions that are demanded.

Flam and Helpman go on to assume that higher quality versions of the product require larger labour inputs per unit of output than do lower-quality versions. In a competitive equilibrium, the higher-quality versions of the differentiated product command a higher price. Based on the assumed pattern of specialization and IIT, it follows that the South will export products of low quality and low price to the North and will import versions of high quality and high price.

Testable hypotheses about IIT between a DME and a developing country can be developed on the basis of the latter model. As in previous instances, such hypotheses are only formulated 'in the spirit' of the underlying theory and not rigorously derived from a formal model. The theory implies that the probability of bilateral IIT in a particular industry will be larger if there are substantial opportunities for vertical differentiation between North and South. More specifically, there will be a difference between the quality of the DME's exports to the developing country and the quality of its imports, and this difference can be related to the extent of bilateral IIT.

The role of quality differences as a determinant of bilateral IIT can be described in terms of two alternative propositions. One concerns the 'direction' of quality differences. If the quality of the DME's exports to the developing country is superior to that of its imports from the latter, a relatively high share of IIT in bilateral trade obtains. In this sense, the mere direction of a quality difference is expected to impact on the share of IIT between pairs of trading partners. Second, not only the direction but also the extent of differences in quality may have a predictable impact on bilateral IIT. The wider the gap in quality between the two trade flows, the higher will be the portion of IIT in bilateral trade (provided that qualities of the DME's exports and imports differ in the way described).

Empirical tests of these hypotheses are carried out by linear regression. The dependent variable is the share of IIT in bilateral trade of a given product group between a DME and a developing country. The independent variable, reflecting the impact of quality difference, is defined in accordance with the arguments of Flam and Helpman (1987). Price differences are used as a proxy for differences in quality where, for reasons of data availability, prices are expressed as trade unit values. For a given pair of countries (one DME and one developing country) and a given product group, quality differences are proxied by the ratio between the unit value of the DME's exports to the developing country and the unit value of its imports from the developing country.[3] Corresponding to the two versions of the quality difference hypothesis, the independent variable is expressed in two alternative forms. First, the direction of quality differences is represented by a dummy variable which takes the value of 1 if the ratio of unit values exceeds unity and assumes a value of 0 otherwise. Second, the extent of quality differences is measured by that ratio itself.

Other independent variables used in the present regressions are those introduced in the last section of Chapter 7. They include: the negative of the absolute difference between trading partners in per capita GDP (a measure of income similarity), the negative of the absolute difference in total GDP (a measure of similarity in size), the arithmetic mean of per capita GDP of the two trading partners (a measure of the average income level), and the arithmetic mean of total GDP (a measure of average size).

The data set underlying the estimation of regression coefficients is very large. Individual observations relate to the bilateral trade of a DME and a developing country where each trade flow is expressed at the four-digit sub-group of the SITC. All trade in manufactures is considered, and the country pairings are exhaustive (22 DMEs and 25 developing countries). Thus, the analysis provides a comprehensive documentation of IIT in manufactures between North and South in 1985.

The results obtained from this sample of over 20,000 observations are summarized in Table 9.3. They show very clearly that 'conventional' forces such as country similarity in terms of income and market size, average income and average market size influence two-way trade between North and South in much the same way as they affect IIT in general. All four coefficients are highly significant and carry the expected signs.

The role of quality difference is also apparent from the regression coefficients of Table 9.3. The direction of quality difference is seen to have a significant impact on the share of IIT between DMEs and developing countries. When the extent of quality differences is taken into account, the overall impact is weaker though the regression coefficient is still statistically significant.

The results of Table 9.3 provide a general impression of the way determinants (and, particularly, quality differences) influence the IIT between DMEs and developing countries. Because the extent of vertical differentiation varies widely among industries, a more detailed examination of the results is desirable. That step would help to identify the industries where vertical differentiation makes the most important positive contribution to two-way trade. Such industries might be promising fields for developing countries that hope to build new trade relationships with DMEs.

This question can be addressed by breaking up the present sample into industries defined at the three-digit level of the SITC and re-estimating the first of the two relationships shown in Table 9.3 for each industry. The regression coefficients of the direction of quality difference (shown in Table B9 of the statistical appendix) yield interesting evidence on IIT of individual industries. The quality difference variable performed contrary to expectations (that is, it carried a negative sign) for less than one-third of the 87 industries considered. However, the negative coefficients were statistically significant in only four of these cases. For another one-third of the industry observations, the quality difference coefficient was significantly positive. Not all the industries in this subset accounted for large portions of the total value of two-way trade between DMEs and developing countries. The following discussion focuses on those industries where two-way trade between DMEs and developing countries exceeded the mean value for the entire sample of industries.

Because the models dealing with quality differentiation as a source of IIT recognize only final goods, it is appropriate to begin this summary by considering the results for consumer-goods industries. Trade in telecommunications apparatus – which includes most consumer electronics products – accounts for the largest portion of IIT between DMEs and developing countries in final products. The significantly positive coefficient for the quality difference variable indicates a distinct division of labour between DMEs and developing countries. This result is especially important in view of the industry's prominence in the total IIT between the two country groups. The balance of trade in

Table 9.3 Impact of quality differences on two-way trade between DMEs and developing countries and areas,[a] 1985

Dependent variable[c]	Independent variables[b]						
	Income[d] similarity	Size[e] similarity	Average[f] income	Average[g] size	Direction of quality difference[h]	Extent of quality difference[i]	F-value
IIT-share	0.026*	0.096*	0.016*	0.109*	0.028*	-	44.73*
	0.026*	0.106*	0.016*	0.120*	-	0.003***	36.02*

Source: UNIDO

a/ The number of bilateral trade flows (21904) considered in the two linear regressions is much less than the theoretical maximum which would apply for trade in all four-digit SITC categories involving 22 DME countries and 25 developing countries. The reason is that only non-zero values of IIT could be considered due to the definition of the quality-difference variables.

b/ Independent variables (other than the dummy variable indicating the direction of quality difference) have been standardized to unit variance. Asterisks denote statistical significance at the 1(*), 5(**) and 10(***) per cent levels.

c/ IIT-share in bilateral trade of a four-digit SITC category between a DME and a developing country.

d/ Negative of the absolute difference in per capita GDP of trading partners.

e/ Negative of the absoulte difference in total GDP.

f/ Arithmetic mean of per capita GDP of trading partner countries.

g/ Arithmetic mean of total GDP.

h/ The dummy variable used to indicate the direction of quality difference assumes a value of 1 if the unit value ratio (exports/imports) of the DME's trade with the developing country exceeds unity and the value of 0 otherwise.

i/ Ratio between the unit value of the DME's exports to the developing country and that of its imports from the latter.

telecommunications apparatus was slightly in favour of developing countries, and the industry appears as a quite promising area of trade expansion for this group.

Similar results were obtained for trade in domestic electrical equipment. Although the total value of IIT is substantially less than for telecommunications apparatus, the developing countries are net exporters and quality differences exert the expected influence. Other types of consumer goods where vertical differentiation is an important determinant of two-way trade are rubber articles and plastic articles.

The most striking exception among consumer goods was the clothing industry. The quality difference variable had a significantly negative impact on the share of North–South IIT. This means that, in cases where the quality of a DME's exports to a developing country is superior to that of the reverse trade flow, the share of IIT tends to be low. Viewed from a different angle, the net exports of developing countries are higher if the relative quality of their gross exports is low. An explanation for this negative (positive) impact of quality difference on IIT (net exports) can be stated in terms of price differentials. As the developing countries' gross exports become cheaper in relation to those of the DMEs, their net exports rise.

Other instances of a statistically significant impact of quality difference on the share of IIT were detected among capital goods or industrial intermediates. Although they are not truly represented in the formal model outlined previously, the intuitive reasoning is similar to that for consumer goods. It is best expressed in the words of Flam and Helpman (1987, p. 821), who state that IIT in vertically differentiated products (of all types) is bound to arise 'because in a given country the range of produced qualities does not correspond precisely to the demanded range of qualities'. If demand for intermediate and capital goods as well as demand for final goods is considered, the same basis for IIT in vertically differentiated products still applies. And quality difference plays the same role in the two-way trade of these goods as it does in consumer products.

The results of industry-specific regressions seem to support this view. The category with the largest value of IIT between North and South is electrical machinery and apparatus. These products consist mainly of capital equipment and related equipment components. Similarly, the sixth-largest trade category by value of IIT ('other non-electrical machinery') is also a capital-goods industry. The quality difference variable for both industries was positive and statistically significant. Three other capital-goods industries with significantly positive coefficients have lower trade levels, though these are by no means negligible; they include textile and leather machinery, machines for special industries, and ships and boats.

The occurrence of significantly positive coefficients was greatest among producers of intermediate goods, and many of these industries accounted for substantial amounts of IIT. Examples include organic chemicals, plastic materials, paper and paperboard, glass, and two steel categories (universals, plates and sheets and tubes, pipes and fittings). Other instances of quality differentiation in the IIT of industries producing intermediate goods were noted for metal manufactures and for equipment for distributing electricity. From such results, evidence of quality differentiation on the basis of technological differences may be inferred.

The role of quality difference in IIT could be discussed at greater length but would probably reinforce the general impression that the effects are not uniform across a broad spectrum of manufacturing industries. More detailed industry-specific studies would shed light on the particular characteristics of IIT. However, such an approach would go far beyond the scope of the present study, and the industry-specific regressions reported previously mark the end point of this exercise. Though not comprehensive and highly tentative, the foregoing results reveal several insights regarding the relationship between vertical differentiation and IIT. The most important is that, on average, quality difference has the expected impact on North–South IIT. Moreover, this impact is not restricted to consumer goods – as theoretical models might suggest – but holds also for industries producing intermediates and capital goods.

Annex: Foreign direct investment versus trade

In this chapter statistical tests were performed to ascertain whether or not the variables that have been theoretically linked to intra-industry trade influence this type of trade. As pointed out above, the empirical results obtained are not particularly strong. If the role of scale economies and product differentiation appears somewhat ambiguous, then are there other factors that might at least partially account for IIT?

In a standard H–O model, differences in factor endowments produce differences in factor prices and product prices. If resources are immobile, trade in goods takes place. If factors are allowed to move between countries, factors (in particular capital) will move in response to international differences in factor prices until all differences in factor rewards are arbitraged away. And inter-industry trade and FDI, for instance, act as substitutes for each other. As was mentioned earlier, the international movement of physical capital may have accounted for the weaker results obtained for this factor in attempting to explain inter-industry trade.

The situation is much more ambiguous with respect to intra-industry trade and specialization. Since this type of trade can occur where no significant differences in factor rewards exist, FDI can also occur in a similar environment. In this case, does FDI act as a substitute for trade or as a complement? At this point even the theoretical work on this question is not clear. On the one hand, Agmon (1979) argues that FDI and intra-industry trade are strong complements. The reasoning behind his conclusion is that the same factors that have led to the growth of TNCs are also the factors that stimulate intra-industry trade. This would seem intuitively plausible as the volume of world trade and the volume of FDI have both been expanding in the postwar era. On the other hand, Norman and Dunning (1984) in a recent survey reach no firm conclusion on the issue. In some cases FDI is a substitute for trade and in other cases it is complementary to it. The result depends on the type of product being traded, the size of transaction costs, and the extent of scale economies. A similar result can be obtained within the standard H–O framework. Markusen (1983) has recently found that a suitably modified H–O model can yield a variety of circumstances where FDI and trade are either substitutes or complements. He also shows that differences in production technology between countries and a variety of product and factor market distortions can lead to situations where FDI and intra-industry trade are complements rather than substitutes.

Empirical studies on this issue are at this point scarce. Norman and Dunning (1984) find that intra-industry FDI tends to be greatest in technology-intensive industries such as chemicals and allied products, engineering products, and electrical and electronic products. In a recent survey on intra-industry FDI, Rugman (1985) concludes that this type of FDI would be most common among high-income countries. The primary industry characteristics would be a high-income elasticity and a high level of technology. Intra-industry FDI would seem to be determined by the same factors that determine intra-industry trade.

Over the last thirty years, the H–O model has been refined to deal with the international mobility of capital. This development has been part of a more general line of research aimed at investigating the effects on predicted patterns of trade of relaxing some of the more restrictive assumptions of the H–O model. The advantage of starting with the H–O model is that it concentrates on the relationship between a country's pattern of international trade and specialization and its endowment of factors of production, such as capital. The international movement of capital, such as FDI, can be treated in a manner similar to changes in the factor endowments of the sending and receiving countries. Thus, the relationship between international trade and foreign investment can be analysed in an integrated fashion rather than treated as separate and relatively unrelated phenomena. From these propositions it can be established how FDI flows affect patterns of trade.

In an H–O framework, trade and FDI are potential substitutes. The greater the volume of trade, the lower the volume of FDI and vice versa. It can also be anticipated that FDI flows from relatively capital-abundant countries to relatively capital-scarce countries. FDI, like trade, also affects the relative prices of factors of production. As seen above, international capital movements tend to equalize factor prices across countries. Like trade, FDI would tend to raise the return to the relatively abundant factor in both countries.

The H–O framework also yields testable hypotheses concerning the flows of FDI. From the model one would assume that FDI would tend to originate in capital-abundant countries and flow to capital-scarce countries. The empirical evidence on FDI seems broadly consistent with this hypothesis. Gross inflows and outflows of FDI on a per capita basis seem to vary systematically with income per capita. Gross outflows are high for the highest-income countries, but then fall off sharply as a country's per capita income declines. Gross inflows also decline systematically with per capita income, but not as rapidly as outflows. As a result, only the richest countries have net outflows, and the middle-income countries tend to have the highest net inflows (Dunning, 1981). Further Baldwin (1979) has shown that FDI of the USA tends to be highest in labour-intensive industries, which generally conforms to the predictions of the H–O model. It was also hypothesized that tariffs (and other barriers to trade) would tend to stimulate FDI. Empirically this seems to be the case, as tariff and non-tariff barriers have been found to promote FDI, at least in developing countries.

The familiar model thus provides a simple explanation of FDI as a process of arbitrage where firms move capital from a location where its return is low to a location where its return is higher. As a consequence, the explanation for FDI can be tied to the existing and well developed theory of international trade. This explanation, however, may be somewhat too neat. Several obvious anomalies appear with respect to the international movement of capital.

It has been observed that the USA tends to have net outflows of FDI and net imports of portfolio capital. This poses the question of whether it is possible for equity capital to be cheap (abundant) and portfolio capital to be expensive (scarce) simultaneously. Furthermore, many developed countries simultaneously attract FDI and export capital abroad. Such behaviour does not seem to be consistent with the export of capital from capital-abundant countries to capital-scarce countries. The existence of such anomalies has led to a considerable amount of theoretical work concerning non-traditional explanations of FDI. As a starting point, most of this work assumes that the major vehicle for FDI is the TNC. Since it has been shown that the existence of TNCs is incompatible with the assumption of perfect competition, it is not surprising that at least some observed FDI flows are inconsistent with the results obtained from the H–O model. For example, if perfect competition prevails in capital markets, any differentials between the returns to capital engaged in various activities would be briskly competed away. If this is not the case, capital may not earn a homogeneous rate of return within a country, and thus capital flows may become difficult to predict.

Moving away from the assumption of perfect competition has yielded several other explanations of FDI which focus on the operation of the TNC. One of the earliest explanations of FDI is the product-cycle hypothesis. According to this hypothesis, new products are initially produced in the developed countries owing to the availability of research and development facilities and the locational advantages of being close to the expected market. As the production process becomes standardized and the domestic market becomes saturated, firms begin to export the product. If successful, firms may start to invest in plant and equipment abroad where costs may be lower. The final stage of the process may involve FDI flows into developing countries with the production being exported to the market where the product was originally produced. According to the product-cycle hypothesis, FDI could occur either as a result of the interpenetration of developed countries' markets or the development of lower-cost production sites. The former would involve FDI among capital-abundant countries and thus would not be easily explainable in a more traditional capital-arbitrage framework.

The idea of a cycle can also be found in Kojima (1978). In Kojima's model FDI flows from developed countries into developing countries on the basis of comparative advantage. This type of FDI is 'trade-oriented', in the sense that it allows previously unexploited resources to be used. Therefore flows of FDI in this model result mainly from the evolution of the international division of labour. This is an 'industry-cycle' approach as opposed to Vernon's 'product-cycle' approach. The model, while appealing, is not particularly general as much FDI does not fit this pattern. However, it was developed to explain Japanese FDI and explicitly recognizes that other forms of FDI may call for other explanations.

The product-cycle and industry-cycle hypotheses, while seemingly capable of explaining some forms of FDI, are not particularly useful. Most recent work has built on the explanations provided by Hymer (1976) and Kindleberger (1969). The starting point of these explanations is that firms undertake FDI in order to capture larger profits from a monopoly over rent-yielding assets. Some of these advantages may include patents, access to technology, managerial skills, marketing skills, or a recognizable brand name. In this situation, rent is defined as a rate of return greater than that which would occur in a perfectly competitive market. If capturing the rents available from such rent-yielding assets outweighs the disadvantages of operating in a foreign market, FDI may occur. A weakness of this explanation lies in the question of why firms would bother with FDI when these rents could theoretically be captured via selling or leasing intangible assets. However, if markets for these assets are imperfect, rents can be received by the owners of the assets. Market imperfections generally occur because of the special characteristics of intangible assets which make arms-length transactions difficult. Many of these assets, especially technology, have public-goods characteristics in the sense that their use does not diminish their stock. Also, once developed, technology may be reproduced at little cost. If such assets were sold in the open market, their availability would quickly become such that the innovating firm could gain little by selling them. A second problem is that if prospective buyers are fully informed about the product, the firm's market power might vanish. Thus, exporting or FDI flows become more attractive alternatives.

Another quite popular explanation of FDI is the internalization theory formulated by Buckley and Casson (1976). This model emphasizes the aforementioned market failures for technology and intermediate inputs. The corresponding markets are considered imperfect in the sense that they are difficult to organize, pose serious problems of uncertainty, and often make it difficult to exploit fully the value of intangible assets. In order to bypass these imperfections, firms internalize their operations. This involves the familiar forward and/or backward integration of production activities. The internalization of markets, if it occurs across national boundaries, results in FDI flows. In the market for various types of knowledge, the incentive to internalize is particularly strong. The creation of innovative production processes or products involves lengthy time lags, considerable investment, and sometimes a high degree of uncertainty. Under these circumstances, the firm may well be able to reduce its outlays by internalizing its operations rather than using external markets. A further possible benefit of international internalization is that the firm may be able to set intra-firm prices in such a way as to avoid certain types of government intervention (i.e. transfer pricing).

The most recent approach to FDI involves pulling together various explanations of such investment in order to attempt to formulate a more unified explanation. This eclectic theory of FDI, which is also sometimes referred to as the OLI (ownership location internalization) paradigm, has been developed by Dunning (1977, 1981). In this model, three essential conditions must be met for FDI to occur. First, the firms should possess ownership advantages associated with intangible assets mentioned earlier. Second, locational considerations such as tariffs and transportation costs should dictate whether a firm pursues FDI rather than exports the product. In engaging in FDI, the firm must consider whether it can overcome the locational disadvantages of operating in a foreign location. Dunning also emphasizes the opportunities of combining ownership advantages with the favourable factor endowment advantages of foreign countries; while factor endowments are considered, they enter the model in a different way from in the H–O model. Finally, internalization must be considerably more beneficial to the firm than selling the advantages it possesses on the open market through licensing.

What seems clear is that many of the difficulties associated with explaining the patterns of FDI are associated with intra-industry trade. This type of trade is difficult to reconcile with the standard H–O model, as it clearly implies that a country has a simultaneous competitive advantage and disadvantage in the same product category. Intra-industry trade can occur in a world where there are no differences in factor endowments and thus no differences in factor prices between countries.

At this point it should be clear that the knowledge concerning the determinants of FDI is incomplete at best. In the most general terms, it seems that the H–O prediction that FDI will flow from capital-abundant countries to capital-scarce countries seems to be correct in the long run. Since in the book the focus has been on long-run changes in specialization and trade, the H–O model may not be totally inaccurate. However, a simple H–O story of FDI may be less well suited to explain the flow of FDI among capital-abundant countries, where there seems to be more going on than simple capital arbitrage. Many of these flows may be intra-industry FDI, which is more difficult to explain. Attempts at an explanation usually rely on some form of internalization of intangible assets. However, at this point the literature lacks an overall theory of FDI. Progress in this area is further hampered by data limitations which constrain the possibilities to test various theories empirically.

Notes: Chapter 9

1 The role of vertical differentiation for low-concentration industries cannot be accurately assessed on the basis of the results of Table 9.1.

2 This measure of IIT intensity is analogous to the RCA indicator introduced in UNIDO, 1986. The definition also reflects Deardorff's 1984 suggestions on the preferred way to design dependent variables in regression analyses of international trade.

3 In order to correct partially for differences between f.o.b. and c.i.f. reported data, the unit values of bilateral exports/imports are first divided by those of the corresponding trade flows between the DME country and all its trading partners. Thus, the ratio actually takes the form of a pair of 'normalized' unit values.

CHAPTER 10

A retrospective view

Previous chapters have reported on a wide range of findings. An empirical examination of mainstream models suggests the existence of a set of 'core' determinants which govern patterns of specialization and trade. The strength of these determinants varies depending on whether inter-industry or intra-industry aspects are being considered and on the degree of similarity between trading partners. National differences in relative factor abundance have a perceptible impact on net trade and inter-industry specialization which partly conforms with the spirit of the factor abundance theory. Similarities between countries impact specialization and trade when intra-industry trends are examined.

The description and analysis of these relationships leads to several generalizations which can be condensed into a three-part thesis. The thesis consists of the following statements on patterns of output and trade at three different levels of aggregation:

(a) At the level of the manufacturing sector, comparative advantage is positively influenced by abundance of physical capital; the role of highly skilled labour is ambiguous.
(b) At the level of particular industries, inter-industry patterns of comparative advantage on average follow H–O predictions where the 'human factor' of semi-skilled labour plays an important part.
(c) The degree of intra-industrial specialization tends to be greatest among countries that are similar in their economic characteristics. Intra-industrial specialization is also positively associated with higher levels of income, with greater economies of scale and with low levels of industrial concentration.

The structure of this empirical thesis is clear. It starts from the broadest level of aggregation – the pattern of specialization distinguishing between manufacturing and other sectors of the economy. Having identified the determinants at this level, attention turns to the inter-industry structure and isolates the major forces that determine the composition of the manufacturing sector. Finally, the thesis considers the intra-industrial pattern of specialization and the relevant determinants. Each of the three components of the thesis is briefly considered below.

Sectoral comparative advantage

The assertion that abundance of capital is a source of sectoral comparative advantage is supported by several pieces of evidence. The DMEs' overwhelming shares in global production and exports are matched by an equally large proportion of the world's supply of physical capital. The abundance of physical capital is a general characteristic of the pattern of factor endowments which applies to all DMEs.

The results of the cross-country analyses of net trade in various industries lend further support to this view. Physical capital and highly skilled labour are both important determinants of net exports: the former usually has a positive impact, while the latter generally has a negative impact. As there are a number of reasons to interpret these cross-country results as a reflection of sector-wide determinants, physical capital stands out as the major source of comparative advantage in manufactures. In fact, of the four factors considered in this study, physical capital was the one that was mainly responsible for significant differences in the cross-country pattern of factor abundance.

Inter-industry comparative advantage

The statement that the inter-industry pattern of comparative advantage on average follows factor abundance rules receives support from several parts of the study. A comprehensive test was conducted for 46 countries, 90 industries and four factors. On average, net trade and factor endowments were found to be related as predicted by the generalized H–O theory.

The factor abundance proposition appears to enjoy a considerable degree of empirical support despite the unrealistic nature of some of the assumptions required for its formal derivation. In fact, at least one of the assumptions usually made to derive H–O results is grossly violated in the real world. The postulate that factor intensities of industries are the same in all countries (even in the weak sense of an ordinal equivalence) is clearly refuted by the evidence compiled here.

Further support for this interpretation is derived from the country-specific results on inter-industry patterns of output and trade. Because the H–O theory in higher dimensions is country-oriented rather than industry-oriented (Deardorff, 1980, 1982), the results for individual countries are especially relevant. There is a distinction, however, between patterns of specialization in output and trade: the evidence pertaining to exports exhibits slightly stronger H–O traits than patterns of output.

The analysis of inter-industry patterns of comparative advantage reveals other, more detailed, features. Among the four factors of production studied, only semi-skilled labour behaves in a typical H–O fashion. The basis for this assertion is found in the general test of the factor abundance proposition in Chapter 7. Additional support is obtained from the country-specific results (mentioned above) which assign an important role to a broad class of labour as a source of inter-industry comparative advantage.

Two other remarks on the role of semi-skilled labour in an H–O context are useful to bear in mind. One is that the dominant role of this particular factor may partly depend on its low degree of international mobility – a characteristic that conforms to H–O standards. A second, and somewhat contradictory, characteristic is that the factor is probably not perfectly mobile between domestic industries, and that to the extent that it is not, another H–O assumption seems to be violated.

Intra-industry specialization and trade

The intra-industry picture is a detailed mosaic of specialization and trade in differentiated products. Except for special cases – for example, two-way trade between DMEs and developing countries – the precise pattern of intra-industrial specialization (which country produces and exports which product) is arbitrary. The extent of such specialization and trade is nevertheless influenced by several forces, some of which are country-specific while others are industry-specific.

Country-specific factors were shown to exert a strong influence on the level of IIT. Income levels are positively associated with IIT in almost all industries. Similarities between trading partners (with regard to both income and market size) also have a strong positive impact on levels of bilateral IIT. In addition, industry-specific factors influence the intra-industry share in the whole of an industry's exports and imports. The intensity of IIT is systematically higher in industries that are relatively less concentrated (particularly among the DMEs). And within this class of industries, IIT intensity is sensitive to economies of scale. This pattern of 'nested' effects on the share of IIT is largely in the spirit of the major models of intra-industrial specialization.

Finally, the analysis of two-way trade between the DMEs and developing countries provides results that represent a point of tangency between the theory of comparative advantage and its alternatives. Differences in specialization are influenced by quality difference between versions of an industry's products. This result may well have its roots in factor abundance which may affect patterns of specialization even at the most detailed level.

In conclusion, the focus of this book has been on the presentation of empirical data and on the interface between empirical and theoretical aspects of specialization and trade. The need to bring these two lines of research more closely together offers a rich agenda for further work. Because the scope of the study has been rather broad, no particular aspect could be treated in the depth that a more narrowly focused study would afford. Therefore one objective of further work along the lines of the present book would be to deepen the analysis of certain subjects.

Further progress on the methodological tools of trade analysis is also desirable – and most likely. There are opportunities to improve on the empirical measurement of a number of concepts, for example. Measures that would better reflect the underlying theoretical concepts are expected to provide a clearer understanding of the forces driving today's world economy and serve as a much stronger bridge between theory and empirical work. Examples relate to the assessment of countries' resource bases, the measurement of industries' factor requirements and, in particular, the measurement of industry characteristics from the realm of new trade theories. Progress in the area of country analyses is also important, as the underlying factor abundance theory is country-oriented. The types of results that can be expected might be more relevant to policy issues than the sweeping conclusions usually drawn from cross-country studies.

As far as the results on factor abundance and trade are concerned, the major point of interest concerns the role of semi-skilled labour. Much of the evidence analysed here was based on a very broad concept of this type of labour. Future research could be directed towards examining the relationship between trade and semi-skilled labour in a more detailed fashion. Refinements in the measurement of labour categories that embody skills closely related to the production process would be desirable. In this connection a more extensive analysis of the relationship between trade and semi-skilled labour from both an industry-specific and a country-specific view should be attempted.

Among the many possibilities to improve on the analysis of IIT, two can be mentioned. First, new insights could be expected from more extensive investigations of industry-specific IIT. Case studies might be particularly useful in order to get a grasp on the precise type of two-way trade under study. Second, the role of vertical differentiation in IIT deserves more attention than it has sometimes received. More evidence is needed on intra-industrial variations in factor intensities, on ranges of product quality, and on the ensuing potential for developing countries to participate in two-way trade in manufactures. With these new tools, the two bodies of theory considered here can be fitted more closely with empirical accounts of trade and specialization.

Appendix A (Technical)

A procedure for validating the H–O proposition

The propositions of the generalized version of the theory of comparative advantage can be expressed in terms of covariances or correlations. The simplest correlation result is that of a non-positive relationship between the autarky prices and net exports of each country. The corresponding inequality reads

$$\mathbf{p}_j^{a\prime}\mathbf{t}_j \leq 0 \qquad (j = 1, 2, \ldots, n) \tag{1}$$

where $\mathbf{p}_j^a$ and $\mathbf{t}_j$ are two column vectors and $'$ designates the transpose. The first of these vectors represents the autarky prices of m goods. The second refers to the net exports of country j, which has been chosen arbitrarily from among the n countries of the model. In order to obtain a relationship that simultaneously embraces all m goods and n countries, two matrices can be formed, namely

$$\mathbf{P}^a = [\mathbf{p}_1^a\ \mathbf{p}_2^a \ldots \mathbf{p}_n^a] \tag{2}$$

and

$$\mathbf{T} = [\mathbf{t}_1\ \mathbf{t}_2 \ldots \mathbf{t}_n]. \tag{3}$$

The two matrices combine the autarky prices and the net exports of all countries.

A statement of comparative advantage which holds under fairly general assumptions can then be written as a matrix inequality of the following form:

$$\mathbf{u}_m' (\mathbf{P}^a \# \mathbf{T})\, \mathbf{u}_n \leq 0 \tag{4}$$

where $\mathbf{u}_m$ and $\mathbf{u}_n$ are vectors containing only 1s and of lengths m and n, respectively. Multiplication of the two matrices $\mathbf{P}^a$ and $\mathbf{T}$ is carried out in an element-by-element fashion, giving rise to the Schur product specified by #. In the literature, (4) is usually presented in the form of an inner product between two expanded vectors so as to retain the correlation character of the hypothesis (Deardorff, 1980). The equivalence between such extended correlations and the present reformulation as a matrix inequality is easily established.

Starting from (4), the basic H–O relationship for higher dimensions can be easily stated. The generalized H–O proposition must be of the same form as the generalized law of comparative advantage. In other words, a linkage is required between a trade matrix (**T** in the above example) and another matrix representing the determinants of this trade ($\mathbf{P}^a$ in the case of the law of comparative advantage). The statement of H-O relationships must incorporate variables representing factor abundance and factor intensities as well as trade. In order to simplify the exposition and to retain a close link with the empirical results of Chapter 7, factor intensities are assumed to be the same for all countries. In that case, such intensities can be represented by a matrix

$$\mathbf{A} = [a_{hi}] \tag{5}$$

where a_{hi} is the share of factor h in the value of output of good i, and h runs from 1 to k. The abundance of factor h in country j is measured by the variable v_{hj} and is summarized in the matrix

$$\mathbf{V} = [v_{hj}]. \tag{6}$$

The factor abundance proposition can then be stated as

$$\mathbf{u}_k' \; (\mathbf{V} \; \# \; \mathbf{AT}) \; \mathbf{u}_n \geq 0, \tag{7}$$

in close analogy to (4). From (7) it can be seen that the generalized H–O proposition can be expressed in the same 'correlation-like' form as the law of comparative advantage (4).

The major differences between the hypotheses represented by equations (4) and (7) can be easily summarized. First, in the H–O framework the matrix of determinants is represented by the factor abundance matrix **V** rather than p^a, the autarky price matrix. Second, the impact of factor abundance on trade is 'filtered' by factor intensities. This yields the familiar relationship between factor abundance (**V**) and net exports of factor services embodied in traded goods (**AT**). Third, because conditions of factor abundance convey comparative advantage and trade is expressed as net exports, the sign of the inequality in (7) is reversed as compared with (4).

The relationship between the basic law of comparative advantage and the H–O hypothesis is apparent from a comparison between the inequalities in (4) and (7). The hypothesis employs the law of comparative advantage to explain trade in terms of a 'primitive' set of characterisitics such as factor endowments. One of the essential methodological steps for the factor abundance theory to be operative is to move from the space of direct goods trade (represented by **T**) to the space of indirect trade in factor services (represented by **AT**). Following that step, it is a simple matter to show that relative factor endowments determine indirect trade in factor services and (somewhat less precisely) trade in goods. The change in space of the 'dependent variable' is suggested by the Heckscher–Ohlin–Vanek (H–O–V) or factor content version of the factor abundance hypothesis as the 'natural' formulation of a generalized proposition. The present discussion builds on a commodity version for the reason that a commodity version seems to have more intuitive appeal than a factor content version, even if the stated hypothesis is expressed in a weak (or average) form.

The generalized H–O proposition in (7) suggests an empirical procedure to assess the relationship between factor abundance and the factor content of traded goods. However, the empirical results in the first section of Chapter 7 concern the relationship between factor endowments and international trade in goods. In order to make use of the earlier results when equation (7) is the basis for a proximate validation of the H–O proposition, the inequality can be rewritten in the following way:

$$\mathbf{u}_k' \ (\mathbf{VT}' \ \# \ \mathbf{A}) \ \mathbf{u}_m \geq 0. \tag{8}$$

T is the transposed matrix of trade flows and $\mathbf{u}_m$ is a vector of length m consisting only of 1s. The elements of the $(k \times m)$ matrix $\mathbf{VT}'$ in this equation (where k represents the number of factors and m is the number of goods) are closely related to the concept of factor orientation on which Table 7.1 is based. Hence (8) can loosely be interpreted as an H–O restriction on the (generalized) correlation between factor orientation and factor intensity when all factors and all goods are considered simultaneously.

Finally, the form of (8) suggests a way to assess each factor's contribution to the overall H–O correlation. The k elements in the vector $(\mathbf{VT}' \ \# \ \mathbf{A})\mathbf{u}_m$, which shall be named $\mathbf{C}_h$, $(h = 1, 2, \ldots, k)$, reflect each individual factor's role in this regard.

Econometric methods

The following paragraphs present the technicalities behind some of the results reported in the book. Together with the details given in the text, they provide a complete description of the statistical/econometric procedures that were applied to the data.

An application of clustering techniques

Chapter 6 reports an attempt at grouping countries according to similarity of their factor intensity profiles. The method employed is that of clustering the 43 countries in the sample by ordinal factor intensity variables, where for each of the three factors 28 variables are used simultaneously. In the case of clustering by labour intensity, for instance, the *i*th variable is the rank of the *i*th industrial branch in terms of labour intensity, determined for a given country. Application of hierarchical clustering with the centroid method for measuring distance is expected to identify groups of countries that have similar rankings of industrial branches by labour intensity. In particular, the initial steps in the clustering procedure would by necessity identify countries that have identical rankings of industrial branches by factor intensity.

As was mentioned in Chapter 6, no pair of countries could be found for which the rankings of the 28 industrial branches were identical at least in terms of one type of factor intensity. In technical parlance, each hierarchical clustering exercise started with combining two countries that were somewhat apart in terms of factor intensity rankings.

Regression techniques

Tables 7.1, 7.3, 8.1, 8.4, 9.1, 9.2, 9.3 and B9 report results of regression analyses. The purpose of these analyses – which generally used linear regression equations – was to test hypotheses about determinants of specialization and trade but not to predict such patterns. As a consequence, economic theory served as the sole guide for specifying the underlying relationships, and no particular emphasis was laid on goodness of fit of the tested equations. Given the complexity and eclectic nature of the relevant theories, the analysis almost by necessity is plagued by the problem of omitted variables. In this respect, the usual assumption was made that the omitted variables are virtually uncorrelated with the included ones.

A special feature of the presentation of regression results in the book is that of writing coefficient estimates in the form of beta coefficients. Accordingly, the coefficients indicate the number of standard deviation changes in the dependent variable induced by a change of one standard deviation of the corresponding independent variable. Since the tests usually cover a large number of countries and industries as well as several factors, beta coefficients appear as the appropriate analytical tool that permits – owing to its inherent standardization – meaningful comparisons.

Most of the reported regression coefficients were obtained (sometimes after appropriate transformations of variables) on the basis of the ordinary-least-squares (OLS) estimation technique. However, in one case weighted-least-squares estimation was applied in order to correct for potential biases arising from systematic heteroscedasticity.

In the regression of an industry's net trade on factor endowments, the problem of heteroscedasticity is likely to arise. One reason is that large countries must be expected to have large amounts of unmeasured factor endowments and therefore high residual variances. Therefore, it may be assumed that a country's residual variance is systematically related to its size. More specifically, the assumption of 'multiplicative heteroscedasticity' can be made and the variance of residual j (var_j) modelled as

$$\mathrm{var}_j = a \cdot Y_j^b$$

with Y_j being GDP of country j and a and b unknown parameters.

In order to obtain weighted-least-squares estimates of the regression coefficients of Table 7.1, a three-step procedure (suggested by Leamer, 1984, p. 122) has been applied. As a first step in this procedure, the logarithms of the squared OLS residuals were regressed against the logarithms of GDP to obtain estimates for a and b in the above equation. In a second step, these estimates were used to derive predicted values of residual variances.

Finally, these predicted values were used as weights in the re-estimation of the regression of net trade on factor endowments.

Finally, it should be noted that all regression exercises reported in the book left one methodological problem – coefficient estimation in the presence of measurement errors – unresolved. The broad coverage of countries, factors and industries meant that elaborate treatment of errors in variables was precluded by the dimension of the exercise. It must be left for the agenda of future research to take up some of the approaches outlined in the study and to apply more sophisticated econometric techniques to possibly more reliable data.

Appendix B (Statistical)

Data sources

The data used in this study can be divided into primary and secondary sources. Primary sources are all data available in the UNIDO data base (UDB) and in related computer data sets maintained by the UNIDO Secretariat. Secondary data sources – for example, various national and international statistical publications – were used to supplement the main body of information. For information on how to acquire the general industry statistics used in the study, readers may write to: Head, Industrial Statistics and Sector Surveys Branch, UNIDO, Box 300, A-1400 Vienna, Austria.

Primary sources

The UDB contains statistics on national accounts, trade, employment and population as well as industrial statistics. In the case of industry data, the information is collected by the Statistical Office of the United Nations in collaboration with UNIDO and with estimates by the UNIDO Secretariat. In the course of the present study, the following variables have been used:

(a) GNP and GDP, exports and imports of goods and services in current US dollars (Chapters 5, 6 and 7);
(b) MVA in constant US dollars at 1980 prices (Chapters 2 and 8);
(c) population in thousands (Chapters 7 and 8);
(d) total labour force in thousands (Chapter 5);
(e) information at the level of industrial branches (three-digit ISIC) on gross output, value added and wages in constant US dollars (1980 prices), as well as on the number of employees (Chapters 2 and 6).

As regards gross output and value added, valuation for some countries is in producers' prices while others are at factor values. The main criterion for using either valuation concept has been to assure maximum consistency within a country both between variables and over time. In the case of employment data, the preferred indicator is the average number of employees, although the number of persons engaged is accepted if it is the only data available. More detail on concepts and data coverage is given in UNIDO (1989).

All information on international trade flows is taken from the UN trade data tapes. This vast data collection contains information on the current value of annual imports (c.i.f.) and exports (f.o.b.) in thousands of US dollars as well as on the physical quantities of such trade. The level of detail reaches the five-digit (item) level of SITC. In cases where reported country data were not available, gaps were filled by information from trading partner countries. The coverage of countries and years treated in the present study can be obtained from the tables in the text. Trade data for Belgium cover the Belgium–Luxembourg Economic Union, while those for the USA also cover Puerto Rico.

For part of the analysis in Chapter 6, trade flows had to be aggregated into ISIC three-digit categories. To achieve this goal, a concordance was established between the ISIC and the SITC, Revised. The concordance was based on a correspondence table provided by OECD. The table, which is a modified version of a concordance scheme developed by the World Bank, assigns to each four-digit ISIC category those categories of the SITC whose products fall, either entirely or partly, in the range of outputs of the ISIC category under consideration. In cases where only part of the SITC category is to be included in the ISIC category, an estimate of this part in percentage terms is provided. Aggregation of trade flows according to this scheme has been carried out by the UNIDO Secretariat on the basis of the UN trade data tapes.

A third primary source of information used in the present context is a UNIDO data set of industrial statistics containing additional details on the distribution of variables by size of establishments. This data set formed the basis of much of the analysis of Chapter 8.

Finally, compilation of factor endowments data (Chapter 5) was based on three primary data sources. The basic data for computing stocks of physical capital came from World Bank (1976, 1987). The underlying computer tapes contain information in national currency on countries' annual gross domestic investment both in current and in constant terms for the period 1955–85. They also provide a time series of exchange rates between national currencies and US dollars, so that capital stocks in current US dollars can be estimated by the method described below. The same tapes provide country data on the percentage of literate population which was used as supplementary information in the computation of unskilled-labour endowments.

Information on numbers of workers refers to the three skill categories (skilled, semi-skilled and unskilled) and was based on data taken from ILO, *Yearbook of Labour Statistics*, various issues. These data cover most of the countries studied in Chapter 5. Where data were not available for the two years under consideration, information on neighbouring years was substituted or figures were estimated. Table B1 reflects the availability of occupational data for the country sample of Chapter 5. Literacy rates were needed to compute the number of illiterate workers. These were taken from UNESCO, *Statistical Yearbook*, various issues, supplemented by information from World Bank (1976, 1987).

Table B1 Availability of data on skilled labour[a] by country and year

Country or area	Years[b]
Argentina	1970
Australia	1970, 1985
Austria	1971, 1985
Belgium	1970, 1981
Brazil	1970
Canada	1971, 1985
Chile	1970, 1985
Colombia	1973, 1981
Denmark	1970, 1985
Dominican Republic	1970, 1981
Egypt	1975, 1983
Finland	1970, 1986
France	1968, 1982
Federal Republic of Germany	1970, 1984
Greece	1971, 1985
Guatemala	1973, 1981
Hong Kong	1971, 1985
India	1971, 1981
Indonesia	1971, 1985
Ireland	1971, 1985
Israel	1970, 1985
Italy	1971, 1981
Japan	1970, 1985
Malaysia	1970, 1980
Mexico	1970, 1980
Netherlands	1971, 1985
New Zealand	1971, 1981
Norway	1970, 1985
Pakistan	1972, 1985
Panama	1970, 1985
Peru	1972, 1981
Portugal	1970, 1985
Philippines	1970, 1985
Republic of Korea	1970, 1985
Singapore	1970, 1985
Spain	1970, 1985
Sri Lanka	1971, 1985
Sweden	1970, 1985
Switzerland	1970, 1980
Thailand	1970, 1984
Tunisia	1975, 1980
Turkey	1970, 1980
United Kingdom	1971, 1981
United States	1970, 1985
Uruguay	1975, 1985
Venezuela	1971, 1985
Yugoslavia	1971, 1981

a/ Data availability refers to ILO, Yearbook of Labour Statistics, various issues.

b/ The years indicated are those required in the study or neighbouring years which were used as a basis for estimation.

Secondary sources

To supplement the data sources listed above, a number of international and national sources have been used. International sources included United Nations, *Monthly Bulletin of Statistics*, various issues, United Nations, *Yearbook of National Accounts*, vol. II, various issues, and United Nations, *Yearbook of International Trade Statistics*, various issues, all of which have been used to provide data for Chapter 3. Among the supplementary national data sources, the computer tape containing the Geographic Area and Industry File of the US *Census of Manufactures, 1982* was the most extensively used. In particular, the following variables were of interest: number of employees (total and by size class of establishments), number of production workers, payroll, wages for production workers, and value added. The above variables served to calculate proxy measures of scale economies, industrial concentration and factor intensities for US industries.

The compilation of measures of industrial concentration also made use of census data: Ministry of International Trade and Industry, Japan, *Census of Manufactures 1984, Report by Industries*, (1986), and Economic Planning Board, Republic of Korea, *Report on Mining and Manufacturing Survey 1985* (1987). To supplement the data in Table 3.4 on trade in manufactures, information from the *Statistical Yearbook of the Republic of China, 1986* was employed.

Estimation methods

The following sections describe the methods used to derive estimates of countries' factor endowments and industries' factor input requirements.

Physical capital endowment

For each country in the sample, two estimates (1970 and 1985) of the net stock of capital were derived by summing depreciated annual gross domestic investment. The average asset life was assumed to be 15 years with a depreciation rate of 13.3 per cent. As the objective was to express capital stocks in current US dollars, the real value of the capital stock was first computed in national currency by accumulating depreciated real values of gross domestic investment in that currency. Second, the current value in national currency of the capital stock was obtained by applying the implicit deflator for gross domestic investment to the real figure described above. Third, the current US dollar value was derived by use of the exchange rate of that year for which the stock of capital was to be computed.

Time series on gross domestic investment for 13 countries were incomplete for the first time period. After inspection of data plots, missing values for seven of these countries (Egypt, Indonesia, Malaysia, Pakistan, Singapore, Thailand and Tunisia) were estimated on the basis of a semi-logarithmic regression of real domestic investment on time. For the remaining six countries (Chile, Hong Kong, Mexico, Peru, Sweden and Venezuela), data gaps were filled by use of annual average growth rates.

Skill categories of labour

As outlined in Chapter 5, the total labour force of each country was subdivided into three categories of skilled workers, semi-skilled workers and unskilled workers. The basis of this categorization was occupational and demographic data.

'Skilled labour' was defined in a narrow way as that portion of the labour force with the relatively highest skill content. As the statistical equivalent of this high-skill category, the number of economically active people in major labour force group 0/1 (professional, technical and related workers) in the International Standard Classification of Occupations (ISCO) was chosen, following the practice of similar empirical studies. Whenever data for the required year (1970 or 1985) were not available, the share of skilled labour in the total labour force was calculated for the year closest to the missing one. This share was then applied to total labour force data (taken from the UDB) for the year in question. Missing data for Argentina and Brazil for the year 1985 were estimated on the basis of cross-country regressions. These regressions were log-linear relationships between relative capital endowments (measured by capital stock per worker) and relative skill endowments (measured by the share of skilled workers in total labour force).

'Unskilled labour' was defined as the number of illiterate workers. It was obtained by subtracting from total labour force the portion of literate workers (derived on the basis of the country-wide literacy rate). Finally, the category of 'semi-skilled labour' was defined as that portion of workers who are literate, but do not belong to the professional/technical group. Accordingly, their number was obtained by subtracting the numbers of professional workers and illiterate workers from the total labour force.

Factor input requirements

In order to derive measures of factor input requirements and factor intensities at the three-digit level of the ISIC (Chapter 6), data on value added and wages were used. To facilitate comparison as well as render possible aggregation across countries and over time, constant dollar figures were needed both for value added and wages (used to compute factor inputs). Data on value added in 1980 dollars were taken directly from the UDB, while corresponding figures for wages had to be estimated. In this estimation the implicit deflator for value added (derived from current-price and constant-price data in national currency) was first applied to national currency data on wages; the resultant real values in national currency were then converted to US dollars by use of the exchange rate for 1980.

For the test of the H–O proposition in Chapter 7, US census information of 1982 was used to obtain estimates of factor input requirements at the SITC three-digit level in the form of imputed factor incomes. For physical capital, the flow measure of non-wage value added was used. To indicate factor input requirements of the three skill classes of labour for which factor endowments had been measured, proxy variables had to be employed, as there was no exact correspondence between those three classes and the census data used.

The first step in the estimation of income for the various labour categories was to choose a proxy for the wage of unskilled labour. This proxy was taken to be the minimum (across all US Standard Industrial Classification (USSIC) four-digit categories) of the wage rates of production workers. In tests of the sensitivity of results to the choice of this proxy, fractions of the above minimum were also used. Imputed income of unskilled labour was obtained by multiplying the unskilled wage rate by employment of each industry. The basic data for imputed income of semi-skilled labour were wages for production workers. These wages were adjusted for the income accruing to unskilled workers by subtracting the product of the unskilled wage rate (as defined previously) and the number of production workers.

With regard to skilled labour, the data situation was most difficult, as the US census data contain no information that would approximately reflect the narrow definition of this type of labour used in the compilation of endowment figures. For want of more appropriate information, the difference between total payroll and wages for production workers was taken as a starting point to estimate income of skilled labour for each industry. This broad income aggregate was corrected for income of unskilled labour by the same method that was applied to semi-skilled labour. Still, the income estimate for skilled labour must be expected to be strongly upward-biased. Thus, the data on skilled labour requirements appear to be the most fragile part of the information on factor input requirements underlying the results of Table 7.2.

In order to aggregate data on value added, wages and employment to the three-digit level of the SITC, the concordance between the USSIC and the SITC given in Hufbauer (1970) was used.

Classifications

Tables B2–B4 give classifications of countries on the one hand, and of industries on the other hand, which have been used recurrently throughout the book. Together with details specified in the tables included in the text, these appendix tables provide the full background of typologies used in the analyses.

Table B2 gives the universe of countries from which samples for the various parts of the analysis were selected mainly on the basis of data availability. For

Chapter 5, the selection criterion was availability of resource endowment and trade data for the years studied. To ensure maximum comparability of results, the same criterion was applied in Chapters 4, 7 and 9. A slighly narrower selection of countries for Chapter 6 resulted from the availability constraints regarding detailed industrial statistics. The country samples analysed in Chapter 8 were designed on the basis of availability of data on the size distribution of establishments.

Table B2 Composition of country groups

Developing Countries and Areas		
Africa		
Algeria	Gambia	Réunion
Angola	Ghana	Rwanda
Benin	Guinea	Sao Tome and Principe
Botswana	Guinea-Bissau	Senegal
Burkina Faso	Kenya	Seychelles
Burundi	Lesotho	Sierra Leone
Cameroon	Liberia	Somalia
Cape Verde	Libyan Arab Jamahiriya	Sudan
Central African Republic	Madagascar	Swaziland
Chad	Malawi	Togo
Comoros	Mali	Tunisia[a]
Congo	Mauritania	Uganda
Côte d'Ivoire	Mauritius	United Republic of Tanzania
Djibouti	Morocco[a]	Zaire
Egypt	Mozambique	Zambia
Equatorial Guinea	Namibia	Zimbabwe
Ethiopia	Niger	
Gabon	Nigeria	
West Asia		
Bahrain	Kuwait	Syrian Arab Republic
Cyprus[a]	Lebanon	Turkey
Democratic Yemen	Oman	United Arab Emirates
Iraq	Qatar	Yemen
Jordan[a]	Saudi Arabia	
South and East Asia		
Afghanistan	Indonesia[a]	Philippines[a]
Bangladesh	Iran (Islamic Rep. of)	Republic of Korea[a]
Bhutan	Malaysia[a]	Singapore[a]
Brunei Darussalam	Maldives	Sri Lanka[a]
Burma	Mongolia	China (Taiwan Province)[a]
China	Nepal	Thailand[a]
Democratic Kampuchea	New Caledonia	Tonga
Fiji	Pakistan	Vanuatu
French Polynesia	Papua New Guinea	
Hong Kong[a]		
India		

Table B2 continued

Developing Countries and Areas

Latin America

Anguilla	Dominican Republic	Netherlands Antilles
Antigua and Barbuda	Ecuador	Nicaragua
Argentina[a]	El Salvador	Panama
Barbados	French Guyana	Paraguay
Belize	Grenada	Peru[b]
Bermuda	Guadeloupe	Puerto Rico
Bolivia	Guatemala	Saint Lucia
Brazil[a]	Guyana	St. Vincent-Grenadines
British Virgin Islands	Haiti	St. Kitts-Nevis
Chile	Honduras	Suriname
Colombia[b]	Jamaica	Trinidad and Tobago
Costa Rica	Martinique	Uruguay[b]
Cuba	Mexico[a]	United States Virgin Islands
Dominica	Montserrat	Venezuela

Europe

Malta
Yugoslavia

Developed countries

CPEs	DMEs	
Albania	Australia	Japan
Bulgaria	Austria	Luxembourg
Czechoslovakia	Belgium	Netherlands
German Democratic Republic	Canada	New Zealand
Hungary	Denmark	Norway
Poland	Finland	Portugal
Romania	France	South Africa
Union of Soviet Socialist Republics	Germany, Federal Republic of	Spain
	Greece	Sweden
	Iceland	Switzerland
	Ireland	United Kingdom
	Israel	United States
	Italy	

a/ Included among the NIEs. As there is no clear-cut quantitative criterion to define this country/area group, common practice was followed (see e.g., UNIDO, 1985, p. 116).

b/ Included among second generation NIEs. The definition adopted for this group is that of the 'new exporting countries' of Havrylyshyn and Alikhani (1982).

Table B3 Broad classification of industrial branches, by growth performance and factor intensity

Industry class	ISIC
High-growth:	351, 352, 356, 382, 383, 385
Low-growth:	321, 322, 323, 324, 371, 372
Labour-intensive:	321, 322, 323, 324, 331, 332
Capital-intensive:	353, 371, 372, 381, 382, 383, 384

In addition to listing those countries whose data have been used at least for part of the study, groupings that provided the framework of large parts of the discussion are specified in Table B2. Table B3 presents a broad classification of industries by growth performance and factor intensity. This classification has been used to summarize some of the results of Chapter 2. Finally, Table B4 provides the details of a classification of SITC three-digit industries into Ricardian, H–O and product-cycle industries. In addition, the second of the above industry groups is subdivided into a capital-intensive and a labour-intensive group.

Supplemental tables

Tables B5–B10 present background information to some of the results discussed in the main text. Tables B5-B8 give actual measures of physical capital intensity and human capital intensity for the 28 industrial branches studied in Chapter 6. The figures are weighted averages representative of four country groups (DMEs, NIEs, second-generation NIEs, and a sample of ten non-NIEs). Table B9 presents in detail the partial correlations between bilateral IIT and country characteristics (summarized in Table 7.3) as well as industry-specific regression coefficients indicating the influence of vertical differentiation on bilateral IIT (discussed also in connection with the results of Table 9.3). Finally, Table B10 gives the details of a classification of industries in terms of scale economies, industrial concentration, product differentiation and export concentration discussed in Chapter 8.

Table B4 Broad classes of manufactured goods

Class of goods[a]	SITC codes[b]				
Ricardian goods	011,	012,	013,	022,	023,
	024,	025,	032,	0422,	046,
	047,	048,	052,	053,	055,
	061,	062,	0713,	0722,	0723,
	073,	074,	081,	091,	099,
	122,	2219,	2312,	2313,	2314,
	243,	251,	2626,	2627,	2628,
	2629,	263,	267,	411,	421,
	422,	431,	633,	641,	681,
	682,	683,	684,	685,	686,
	687,	688,	689,		
Heckscher-Ohlin goods	111,	112,	332,	533,	551,
	553,	554,	561,	581,	611*,
	612*,	613*,	621*,	629,	631*
	632*,	642,	651* (less 6516 and 6517),		
	652*,	653*,	654*,	655*,	656*,
	657*,	661,	662*,	664,	665,
	666*,	671,	672,	673,	674,
	675,	676,	677,	678,	679,
	691*,	692*,	694*,	696,	698,
	[illegible]	732,	733*,	812*,	821*,
	[illegible]	841*,	842*,	851*,	892,
	[illegible]	894*,	895*,	897*,	899*,
Product-cycle goods	266,	512,	513,	514,	515,
	521,	531,	532,	541,	571,
	599,	6516,	6517,	663,	693,
	695,	697,	711,	712,	714,
	715,	717,	718,	719,	722,
	723,	724,	725,	726,	729,
	734,	735,	861,	862,	864,
	891.				

a/ The major source for the classification in Ricardian (resource-based), H-O and product-cycle goods was UNIDO (1981, pp. 103-108). The partitioning of H-O goods into a capital intensive and a labour intensive class was mainly based on data on value added per employee from United States, Bureau of the Census (1984). The resultant sub-classes were finally reconciled with the classification given in UNIDO (1981).

b/ An asterisk indicates a product group pertaining to a labour-intensive H-O industry.

Table B5 DMEs' average factor intensities,[a] 1970-7 and 1978-85 (thousands of 1980 US dollars)

Industry (ISIC)	Non-wage value added per employee[a] 1970-1977	Non-wage value added per employee[a] 1978-1985	Wages per employee[c] 1970-1977	Wages per employee[c] 1978-1985
Food products (311)	15.3	19.0	8.8	10.4
Beverages (313)	21.7	29.0	9.2	12.0
Tobacco etc. (314)	24.8	32.0	9.6	11.1
Textiles (321)	7.1	9.6	7.1	9.1
Wearing apparel (322)	6.1	7.6	7.0	7.6
Leather and fur products (323)	11.5	13.8	10.2	11.8
Footwear (324)	7.5	9.2	8.9	9.4
Wood and cork products (331)	11.9	13.5	10.7	12.5
Furniture fixtures excl. metal (332)	11.7	14.1	11.7	13.6
Paper (341)	14.5	19.7	11.3	14.2
Printing and publishing (342)	12.0	15.0	11.8	12.4
Industrial chemicals (351)	20.9	28.4	10.8	15.4
Other chemicals (352)	18.1	26.5	9.4	12.6
Petroleum refineries (353)	93.6	94.0	20.6	18.0
Products of petroleum and coal (354)[d]	37.8	35.3	13.8	13.0
Rubber products (355)	9.5	12.8	9.5	12.1
Plastic products (356)	11.1	13.1	8.6	10.4
Pottery, china, earthenware (361)	8.5	13.9	9.5	11.8
Glass (362)	11.8	16.4	10.1	13.6
Other non-metallic min. products (369)	15.0	17.7	10.2	11.4
Iron and steel (371)	16.6	21.1	15.5	18.1
Non-ferrous metals (372)	18.9	22.6	15.5	19.7
Metal products (381)	10.4	12.8	10.9	12.5

Table B5 continued

Industry (ISIC)	Non-wage value added per employee[a] 1970-1977	Non-wage value added per employee[a] 1978-1985	Wages per employee[a] 1970-1977	Wages per employee[a] 1978-1985
Non-electrical machinery (382)	12.1	16.0	12.3	14.7
Electrical machinery (383)	9.9	15.7	10.4	13.3
Transport equipment (384)	11.9	14.7	12.9	14.6
Professional scientific equipment (385)	12.7	17.0	10.1	12.2
Other manufactures (390)	11.5	14.8	9.8	11.1

Source: UNIDO

a/ The figures in the present table are weighted averages over the 20 DMEs shown in tables 6.5 to 6.7 and over the years within each time period for which data were available, with the weights being numbers of employees. For more details on country coverage and methods of computation see the text of the present appendix.

b/ Non-wage value added per employee is taken to be a proxy for physical-capital intensity.

c/ Wages per employee are taken to be a proxy for human-capital intensity.

d/ Group averages exclude Ireland and Portugal.

Table B6 NIEs' average factor intensities,[a] 1970–7 and 1978–85 (thousands of 1980 US dollars)

Industry (ISIC)	Non-wage value added per employee[b] 1970-1977	Non-wage value added per employee[b] 1978-1985	Wages per employee[c] 1970-1977	Wages per employee[c] 1978-1985
Food products (311)	11.2	12.8	3.6	3.2
Beverages (313)	9.1	11.4	2.8	2.6
Tobacco etc. (314)	14.9	16.6	4.4	4.1
Textiles (321)	6.2	6.5	2.8	2.5
Wearing apparel (322)	3.7	3.5	2.4	2.3
Leather and fur products (323)	5.4	5.1	4.8	2.7
Footwear (324)	4.0	3.5	3.6	2.5
Wood and cork products (331)	5.6	5.5	2.4	2.4
Furniture fixtures excl. metal (332)	5.3	7.2	3.1	2.7
Paper (341)	9.8	11.2	4.0	3.7
Printing and publishing (342)	11.4	9.6	6.9	4.7
Industrial chemicals (351)	16.6	25.8	5.6	6.0
Other chemicals (352)	13.7	18.9	5.0	5.1
Petroleum refineries (353)[d]	42.1	51.4	6.0	5.5
Products of petroleum and coal (354)[e]	13.1	21.3	3.8	4.4
Rubber products (355)	10.2	9.2	2.9	2.9
Plastic products (356)	7.5	6.5	3.3	2.7
Pottery, china, earthenware (361)	7.0	7.3	3.6	2.9
Glass (362)	10.9	11.1	6.0	4.5
Other non-metallic min. products (369)	7.8	8.8	3.1	2.8
Iron and steel (371)	15.9	17.8	5.1	4.7
Non-ferrous metals (372)	12.5	12.4	7.1	4.0
Metal products (381)	6.5	6.9	3.5	3.0

Table B6 continued

Industry (ISIC)	Non-wage value added per employee[b] 1970-1977	1978-1985	Wages per employee[c] 1970-1977	1978-1985
Non-electrical machinery (382)	8.9	7.2	4.7	3.8
Electrical machinery (383)	5.9	7.4	3.5	3.1
Transport equipment (384)	7.6	8.5	5.0	4.2
Professional scientific equipment (385)	4.4	6.2	3.2	3.6
Other manufactures (390)	4.7	6.7	3.1	2.9

Source: UNIDO

a/ The figures in the present table are weighted averages over the six NIEs shown in tables 6.5 to 6.7 and over the years within each time period for which data were available, with the weights being numbers of employees. For more details on country coverage and methods of computation see the text of the present appendix.

b/ Non-wage value added per employee is taken to be a proxy for physical-capital intensity.

c/ Wages per employee are taken to be a proxy for human-capital intensity.

d/ Group averages exclude Hong Kong.

e/ Group averages exclude Hong Kong and Singapore.

Table B7 Second-generation NIEs' average factor intensities,[a] 1970–7 and 1978–85 (thousands of 1980 US dollars)

Industry (ISIC)	Non-wage value added per employee[b] 1970-1977	Non-wage value added per employee[b] 1978-1985	Wages per employee[c] 1970-1977	Wages per employee[c] 1978-1985
Food products (311)	5.1	7.2	1.4	2.0
Beverages (313)	12.4	18.4	1.9	2.8
Tobacco etc. (314)	4.5	7.4	0.8	1.0
Textiles (321)	2.4	3.2	1.1	1.4
Wearing apparel (322)	3.5	2.5	2.2	2.0
Leather and fur products (323)	3.2	4.4	1.5	2.1
Footwear (324)	1.8	2.6	1.4	1.7
Wood and cork products (331)	2.7	3.6	1.7	1.8
Furniture fixtures excl. metal (332)	2.4	2.0	1.9	1.6
Paper (341)	4.7	5.9	1.6	1.8
Printing and publishing (342)	4.2	4.7	2.4	2.7
Industrial chemicals (351)	7.2	10.4	1.7	2.3
Other chemicals (352)	6.5	7.9	2.3	2.6
Petroleum refineries (353)[a]	164.1	115.9	13.6	8.6
Products of petroleum and coal (354)[a]	145.9	101.8	13.8	9.6
Rubber products (355)	4.8	4.9	1.6	1.8
Plastic products (356)	2.3	3.9	1.1	1.5
Pottery, china, earthenware (361)	3.9	3.8	1.9	1.9
Glass (362)	4.0	5.2	1.8	2.2
Other non-metallic min. products (369)	6.7	9.1	2.4	3.2
Iron and steel (371)	6.0	8.6	2.3	2.6
Non-ferrous metals (372)[a]	6.3	17.0	1.5	1.5
Metal products (381)	3.3	4.7	1.6	2.1

Table B7 continued

Industry (ISIC)	Non-wage value added per employee[b] 1970-1977	Non-wage value added per employee[b] 1978-1985	Wages per employee[c] 1970-1977	Wages per employee[c] 1978-1985
Non-electrical machinery (382)	3.2	4.6	1.7	2.1
Electrical machinery (383)	4.9	5.2	1.9	2.2
Transport equipment (384)	5.1	5.5	2.2	2.2
Professional scientific equipment (385)	8.6	6.9	4.0	3.2
Other manufactures (390)	4.0	4.6	1.3	2.3

Source: UNIDO

a/ The figures in the present table are weighted averages over the seven second-generation NIEs shown in tables 6.5 to 6.7 and over the years within each time period for which data were available, with the weights being numbers of employees. For more details on country coverage and methods of computation see the text of the present appendix.

b/ Non-wage value added per employee is taken to be a proxy for physical-capital intensity.

c/ Wages per employee are taken to be a proxy for human-capital intensity.

d/ Group averages exclude Indonesia.

e/ Group averages exclude Indonesia and Tunisia.

Table B8 Selected developing countries' average factor intensities,[a] 1970–7 and 1978–85 (thousands of 1980 US dollars)

Industry (ISIC)	Non-wage value added per employee[b] 1970-1977	Non-wage value added per employee[b] 1978-1985	Wages per employee[c] 1970-1977	Wages per employee[c] 1978-1985
Food products (311)	3.4	4.0	1.7	2.0
Beverages (313)	9.0	12.0	2.5	3.4
Tobacco etc. (314)	3.4	2.3	0.9	1.1
Textiles (321)	2.4	2.2	2.3	2.2
Wearing apparel (322)	9.7	5.7	9.0	6.0
Leather and fur products (323)	4.6	4.1	2.3	2.1
Footwear (324)	6.3	4.2	5.9	4.1
Wood and cork products (331)	5.0	6.3	3.8	4.1
Furniture fixtures excl. metal (332)	3.7	4.2	2.9	3.3
Paper (341)	5.7	6.5	2.7	3.7
Printing and publishing (342)	3.1	4.0	2.8	3.1
Industrial chemicals (351)	7.1	9.1	2.8	3.7
Other chemicals (352)	5.4	6.2	2.4	2.8
Petroleum refineries (353)	52.8	67.2	7.2	5.5
Products of petroleum and coal (354)[d]	12.5	11.0	4.8	3.1
Rubber products (355)	4.3	5.3	2.7	2.9
Plastic products (356)[e]	3.7	5.3	2.0	2.6
Pottery, china, earthenware (361)[f]	3.7	3.4	3.3	2.6
Glass (362)	2.3	3.6	1.9	2.6
Other non-metallic min. products (369)	3.8	4.3	2.5	2.5
Iron and steel (371)	3.6	3.7	2.6	2.7
Non-ferrous metals (372)	9.9	11.8	3.1	4.0
Metal products (381)	3.9	5.0	2.7	3.1

Table B8 continued

Industry (ISIC)	Non-wage value added per employee[b] 1970-1977	1978-1985	Wages per employee[c] 1970-1977	1978-1985
Non-electrical machinery (382)	2.8	3.6	2.5	2.7
Electrical machinery (383)	3.6	4.9	2.6	2.9
Transport equipment (384)[a]	2.9	3.5	2.7	3.0
Professional scientific equipment (385)	2.0	2.8	1.9	2.1
Other manufactures (390)	13.2	22.7	15.1	21.7

Source: UNIDO

a/ The figures in the present table are weighted averages over the ten non-NIEs shown in tables 6.5 to 6.7 and over the years within each time period for which data were available, with the weights being numbers of employees. For more details on country coverage and methods of computation see the present appendix.

b/ Non-wage value added per employee is taken to be a proxy for physical-capital intensity.

c/ Wages per employee are taken to be a proxy for human-capital intensity.

d/ Group averages exclude the Dominican Republic and Guatemala.

e/ Group averages exclude Pakistan.

f/ Group averages exclude the Dominican Republic and Panama.

g/ Group averages exclude the Dominican Republic.

Table B9 Determinants of bilateral intra-industry trade,[a] 1985

Industry (SITC)	Partial correlations[a] between the level of bilateral IIT and: Income[c] similarity	Size[c] similarity	Average income[a]	Average size[a]	Impact of quality difference on the share of bilateral IIT between DMEs and developing countries/areas[a]
Organic chemicals (512)	0.100*	0.435*	0.115*	0.487*	0.068**
Inorganic chemicals: elements, oxides & halides (513)	0.120*	0.333*	0.101*	0.392*	-0.083
Other inorganic chemicals (514)	0.102*	0.232*	0.053***	0.316*	0.000
Radioactive and associated materials (515)	0.071***	0.289*	0.041	0.340*	.
Mineral tar and crude chemical (521)	0.102**	0.119**	0.040	0.163*	-0.089
Synthetic organic dyestuffs (531)	0.064***	0.260*	0.171*	0.287*	0.122**
Dyeing & tanning extracts and materials (532)	0.005	0.193*	-0.051	0.223*	0.010
Pigments, paints varnishes and related materials (533)	0.140*	0.354*	0.164*	0.390*	0.034
Medical and pharmaceutical products (541)	0.161*	0.393*	0.241*	0.451*	-0.031
Essential oils, perfume and flavour materials (551)	0.066***	0.424*	0.027	0.501*	-0.136*
Perfumery and cosmetics except soaps (553)	0.096**	0.416*	0.107*	0.443*	0.059
Soaps, cleansing and polishing preparations (554)	0.150*	0.279*	0.172*	0.307*	0.109**
Fertilizers, manufactured (561)	0.073***	-0.013	0.120*	0.025	0.055
Explosives and pyrotechnic products (571)	0.088**	0.114**	0.064***	0.187*	0.206**
Plastic materials, regenerated (581)	0.122*	0.359*	0.110*	0.404*	0.091*
Chemical materials and products (599)	0.116*	0.404*	0.087**	0.462*	0.076*
Leather (611)	0.095**	0.773*	0.025	0.420*	0.061
Manufactures of leather or reconstitutes (612)	-0.005	0.340*	0.010	0.181*	0.037

Table B9 continued

Industry (SITC)	Partial correlations[a] between the level of bilateral IIT and: Income[c] similarity	Size[c] similarity	Average income[d]	Average size[d]	Impact of quality difference on the share of bilateral IIT between DMEs and developing countries/areas[e]
Fur skins, tanned or dressed (613)	-0.043	0.446*	0.016	0.235*	0.033
Materials of rubber (621)	0.099*	0.361*	0.102*	0.404*	0.141**
Articles of rubber (629)	0.101*	0.357*	0.089*	0.397*	0.058***
Veneers, plywood boards, reconstituted wood (631)	0.100**	0.140*	0.079**	0.187*	-0.036
Wood manufactures (632)	0.123*	0.114*	0.141*	0.153*	-0.039
Cork manufactures (633)	0.016	0.146*	-0.007	0.158*	-0.165**
Paper and paperboard (641)	0.084**	0.249*	0.100*	0.290*	0.132*
Articles of pulp, paper or paperboard (642)	0.168*	0.218*	[illegible]	0.245*	-0.028
Textile, yarn & thread (651)	0.106*	0.340*	0.149*	0.360*	0.052
Cotton fabrics, woven (652)	0.072**	0.290*	0.111*	0.306*	-0.037
Textile fabrics, woven other than cotton (653)	0.109*	0.272*	0.133*	0.305*	0.037
Tulle, lace, embroidery, ribbons, etc. (654)	0.075**	0.258*	0.132*	0.293*	-0.030
Special textile fabrics and related products (655)	0.110*	0.388*	0.135*	0.436*	0.031
Made-up articles, chiefly of textiles (656)	0.157*	0.186*	0.171*	0.226*	-0.084*
Floor coverings, tapestries etc. (657)	0.079**	0.108*	0.116*	0.154*	-0.012
Lime, cement, building materials excluding glass and clay (661)	0.117*	0.082**	0.100**	0.111*	-0.033
Clay and refractory construction materials (662)	0.056***	0.303*	0.093**	0.321*	0.048
Mineral manufactures (663)	0.109*	0.427*	0.132*	0.471*	-0.014
Glass (664)	0.084**	0.225*	0.044	0.278*	0.110**
Glassware (665)	0.115*	0.285*	0.099*	0.329*	0.019
Pottery (666)	-0.051	0.510*	-0.143*	0.559*	0.059
Pig iron, spiegeleisen, sponge (671)	0.078***	0.289*	0.152*	0.308*	0.049

Table B9 continued

Industry (SITC)	Partial correlations[a] between the level of bilateral IIT and: Income[b] similarity	Size[c] similarity	Average income[d]	Average size[d]	Impact of quality difference on the share of bilateral IIT between DMEs and developing countries/areas[e]
Office machines (714)	0.051***	0.433*	-0.017	0.507*	-0.021
Metalworking machinery (715)	0.060***	0.332*	0.094**	0.391*	0.071
Textile & leather machinery (717)	0.043	0.370*	0.093**	0.421*	0.075**
Machines for special industries (718)	0.092*	0.352*	0.068**	0.432*	0.069*
Machines, appliances (excl. electric.) parts (719)	0.106*	0.453*	0.083**	0.522*	0.015*
Electric power machinery, switchgear (722)	0.077**	0.443*	0.059***	0.522*	0.026
Equipment for distributing electricity (723)	0.079**	0.232*	0.069**	0.290*	0.136*
Telecommunications apparatus (724)	0.085**	0.277*	0.056***	0.356*	0.059**
Domestic electr. equipment (725)	0.112*	0.343*	0.164*	0.381*	0.063**
Electric apparatus for medical purposes (726)	0.019	0.570*	-0.032	0.533*	-0.004
Other electrical machinery and apparatus (729)	0.017	0.497*	-0.062**	0.578*	0.033***
Railway vehicles (731)	0.001	0.044	-0.001	0.106**	-0.090
Road motor vehicles (732)	0.054***	0.077**	0.024	0.118*	0.020
Road vehicles other than motor vehicles (733)	0.135*	0.221*	0.154*	0.247*	0.124**
Aircraft (734)	0.027	0.259*	0.001	0.307*	-0.125**
Ships and boats (735)	0.040	0.082**	-0.165*	0.098**	0.172**
Sanitary, plumbing, heating and lighting fixtures (812)	0.129*	0.219*	0.154*	0.254*	0.055
Furniture (821)	0.167*	0.185*	0.203*	0.221*	0.023
Railway vehicles (831)	0.145*	0.275*	0.152*	0.307*	-0.061
Clothing, excl. fur clothing (841)	0.145*	0.195*	0.166*	0.213*	-0.067*
Fur clothing and articles made of fur skins (842)	0.033	0.183*	0.088**	0.241*	0.051

Table B9 continued

Industry (SITC)	Partial correlations[a] between the level of bilateral IIT and: Income[b/c] similarity	Size[b/c] similarity	Average income[d]	Average size[d]	Impact of quality difference on the share of bilateral IIT between DMEs and developing countries/areas[e]
Footwear (851)	0.117*	0.237*	0.137*	0.262*	0.047
Scientific, medical, optical measuring instruments (861)	0.042	0.662*	-0.031	0.707*	0.002
Photographic and cinematographic supplies (862)	0.046	0.637*	-0.039	0.685*	-0.066
Watches and clocks (864)	0.028	0.029	0.125*	0.055***	.
Musical instruments, sound recorders & reproducers (891)	0.076**	0.549*	0.028	0.600*	0.013
Printed matter (892)	0.125*	0.223*	0.088*	0.286*	-0.003
Articles of artificial plastic materials (893)	0.149*	0.338*	0.156*	0.388*	0.125*
Perambulators, toys, games, sporting goods (894)	0.107*	0.455*	0.060***	0.519*	-0.027
Office & stationery supplies(895)	0.077**	0.556*	0.072**	0.605*	0.080**
Jewellery, gold and silverwares (897)	0.063***	0.171*	0.165*	0.223*	.
Manufactured articles (899)	0.170*	0.476*	0.167*	0.549*	0.033

Source: UNIDO

a/ Results were derived from observations on trade between all pairs of members of a sample of 22 DMEs and 25 developing countries and areas.
b/ Asterisks indicate statistical significance at the 1(*), 5(**) or 10(***) per cent level.
c/ Similarity between countries in terms of income (size) was measured by the negative of the absolute difference in GDP per capita (total GDP).
d/ Average income (size) was indicated by the arithmetic mean of GDP per capita (total GDP).
e/ The figures shown in this column are coefficient estimates obtained from a linear regression of IIT shares on income similarity, size similarity, average income, average size and the direction of quality difference. Only the coefficients of the last independent variable are presented in this table. This variable took the form of a dummy variable which assumed the value of 1 if the unit value of the DME's exports to the developing country exceeded that of its imports from the latter and the value of 0 otherwise.

Table B9 continued

Industry (SITC)	Partial correlations[a] between the level of bilateral IIT and: Income[c] similarity	Size[c] similarity	Average income[d]	Average size[d]	Impact of quality difference on the share of bilateral IIT between DMEs and developing countries/areas[e]
Ingots and forms of iron or steel (672)	0.052	0.130*	0.007	0.150*	0.040
Iron and steel bars, rods, angles, etc. (673)	0.092**	0.262*	0.159*	0.273*	0.064
Universals, plates & sheets (674)	-0.009	0.529*	-0.093**	0.594*	0.243*
Hoop & strip/iron or steel (675)	0.069***	0.259*	0.122*	0.273*	0.030
Rails and railway track construction materials (676)	0.057	-0.043	-0.064	-0.015	0.042
Iron and steel wire (677)	0.088**	0.239*	0.129*	0.256*	0.091
Tubes, pipes and fittings of iron or steel (678)	0.124*	0.248*	0.174*	0.289*	0.175*
Iron and steel castings, forgings, unworked (679)	0.089***	0.129*	0.065	0.186*	0.200
Finished structures and structural parts (691)	0.094**	0.120*	0.156*	0.148*	0.086
Metal containers for storage and transport (692)	0.125*	0.167*	0.125*	0.210*	0.070
Wire products (excluding electric), fencing grills (693)	0.109*	0.256*	0.098**	0.291*	0.100
Nails, screws, nuts, bolts, rivets, etc. (694)	-0.034	0.433*	-0.088**	0.488*	0.125**
Tools for use in the hand or in machines (695)	0.128*	0.387*	0.172*	0.454*	0.147*
Cutlery (696)	-0.004	0.580*	-0.013	0.618*	-0.032
Household equipment of base metals (697)	0.081**	0.416*	0.058***	0.457*	0.007
Manufacture of metals (698)	0.112*	0.271*	0.111*	0.328*	0.064*
Power generating machinery, excl. electric (711)	0.059***	0.227*	0.004	0.299*	-0.003
Agricultural machinery and implements (712)	0.070**	0.122*	0.038	0.170*	0.121**

Table B10 Categorization of industries by economies of scale, industrial concentration, product differentiation and export concentration

Industry (SITC)	Scale[b,c] economies	Categorical measure of[a] Industrial[b] concentration	Product[c] differentiation	Export[d] concentration
Meat, fresh, chilled or frozen (011)	5	4	4	4
Meat in airtight containers, n.e.s. (013)	1	5	5	2
Milk and cream (022)	3	5	1	1
Butter (023)	1	1	5	1
Cheese and curd (024)	2	4	5	1
Fish preparations (032)	5	4	1	5
Rice, glazed or polished (0422)	5	1	.	1
Meal and flour of wheat or of meslin (046)	4	2	1	1
Cereal preparations and starch (048)	1	5	4	5
Fruit, preserved and fruit preparations (053)	5	4	1	5
Vegetables, roots and tubers, preserved or prepared (055)	1	2	2	5
Sugar and honey (061)	1	1	1	5
Sugar preparations (062)	1	4	4	5
Chocolate (073)	1	1	5	4
Feeding-stuff for animals (081)	2	5	1	3
Margarine and shortening (091)	1	2	3	2
Food preparations, n.e.s. (099)	2	5	2	5
Non-alcoholic beverages, n.e.s. (111)	3	5	4	3
Alcoholic beverages (112)	1	1	5	1
Tobacco manufactures (122)	1	1	5	1
Synthetic and reclaimed rubber and substitutes (231)	1	1	5	2
Wood shaped or simply worked (243)	3	5	3	1
Pulp and waste paper (251)	2	1	2	1
Synthetic and regenerated fibres (266)	2	1	4	3
Petroleum products (332)	1	3	2	5
Animal oils and fats (411)	2	4	2	1
Fixed vegetable oils and fats (421)	5	2	5	3
Other fixed vegetable oils (422)	5	1	2	1
Inorganic chemicals: elements, oxides and halides (513)	5	2	.	5
Other inorganic chemicals (514)	5	3	1	3
Pigments, paints, varnishes and related materials (533)	2	5	4	3

Table B10 continued

Industry (SITC)	Categorical measure of[a]			
	Scale[b] economies	Industrial[b] concentration	Product[c] differentiation	Export[d] concentration
Medicinal and pharmaceutical products (541)	2	3	3	4
Essential oil, perfume and flavour materials (551)	5	2	1	3
Perfumery and cosmetics, except soaps (553)	2	3	4	1
Soaps, cleansing and polishing preparations (554)	2	5	4	3
Fertilizers, manufactured (561)	1	2	1	5
Explosives and pyrotechnic products (571)	4	1	1	4
Plastic materials, regenerated cellulose, etc. (581)	4	3	3	3
Chemical materials and products, n.e.s. (599)	5	4	1	3
Leather (611)	2	3	5	5
Manufactures of leather or reconstituted (612)	1	2	4	5
Articles of rubber, n.e.s. (629)	4	3	5	3
Veneers, plywood boards, reconstitituted wood (631)	4	5	2	5
Wood manufactures, n.e.s. (632)	4	5	2	5
Paper and paperboard (641)	2	3	3	3
Articles of pulp, paper or paperboard (642)	3	4	2	4
Textile yarn & thread (excl.synthetic or regenerated) (651)	5	3	4	5
Cotton fabrics, woven (652)	5	2	4	5
Textile fabrics, woven other than cotton (653)	5	3	5	4
Tulle, lace, embroidery, ribbons, etc. (654)	4	3	2	3
Special textile fabrics and related products (655)	1	2	4	4
Made-up articles, chiefly of textiles (656)	4	4	3	5
Floor coverings, tapestries, etc. (657)	3	3	4	4
Lime, cement, building materials, excl. glass & clay (661)	5	4	1	5
Clay and refractory construction materials (662)	3	2	3	2
Mineral manufactures, n.e.s. (663)	4	5	1	4
Glass (664)	1	2	1	3
Glassware (665)	5	3	1	4
Pottery (666)	1	1	2	2
Pig iron, spiegeleisen, sponge iron, etc. (671)	4	2	3	5
Ingots and forms of iron or steel (672)	4	2	5	2
Iron and steel bars, rods, angles, etc. (673)	1	2	1	4
Universals, plates and sheets of iron or steel (674)	1	1	4	2
Hoop and strip of iron or steel (675)	5	2	4	1
Rails and railway track construction materials (676)	[illegible]	1	4	2
Iron and steel wire (677)	3	3	1	3
Tubes, pipes and fittings of iron or steel (678)	2	3		2

Table B10 continued

Industry (SITC)	Categorical measure of[a] Scale[b] economies	Industrial[c] concentration	Product[d] differentiation	Export[e] concentration
Iron and steel castings, forgings, unworked (679)	4	4	1	3
Copper (682)	5	2	4	4
Nickel (683)	2	1	3	1
Aluminium (684)	1	1	3	5
Zinc (686)	3	2	1	2
Tin (687)	2	1	5	1
Finished structures and structural parts, n.e.s. (691)	4	5	2	4
Metal containers for storage and transport (692)	4	5	3	4
Wire products (excl. electric), fencing grills (693)	2	4	2	5
Nails, screws, nuts, bolts, etc. (694)	5	5	3	3
Tools for use in the hand or in machines (695)	3	4	4	4
Cutlery (696)	2	2	4	3
Manufacture of metals, n.e.s. (698)	3	5	3	4
Power generating machinery, excl. electric (711)	2	1	3	2
Agricultural machinery and implements (712)	1	4	5	2
Office machines (714)	4	4	2	1
Metalworking machinery (715)	3	5	4	2
Textile and leather machinery (717)	5	4	4	1
Machines for special industries (718)	3	4	2	2
Machines, appliances (excl. electric.), parts (719)	3	5	4	3
Electric power machinery, switchgear (722)	3	3	4	3
Equipment for distributing electricity (723)	4	3	2	4
Telecommunications apparatus (724)	4	4	3	2
Domestic electrical equipment (725)	3	1	4	3
Electric apparatus for medical purposes (726)	2	2	5	1
Other electrical machinery and apparatus (729)	4	3	2	2
Railway vehicles (731)	4	1	1	3
Road motor vehicles (732)	2	3	5	1
Road vehicles other than motor vehicles (733)	2	4	4	2
Aircraft (734)	3	1	2	1
Ships and boats (735)	4	2	2	2
Sanitary, plumbing, heating and lighting fixtures (812)	3	4	1	4
Furniture (821)	5	5	3	4

Table B10 continued

Industry (SITC)	Categorical measure of a/: Scale b/ economies	Industrial b/ concentration	Product c/ differentiation	Export d/ concentration
Travel goods, handbags and similar articles (831)	5	3	3	3
Clothing, except fur clothing (841)	5	5	5	5
Footwear (851)	5	3	5	2
Scientific, medical, optical, measuring instruments (861)	4	3	.	2
Photographic and cinematographic supplies (862)	3	1	5	1
Watches and clocks (864)	4	2	.	1
Musical instruments, sound recorders & reproducers (891)	4	3	1	1
Printed matter (892)	3	5	3	4
Articles of artificial plastic materials, n.e.s. (893)	3	5	5	4
Perambulators, toys, games, sporting goods (894)	2	4	3	4
Office and stationery supplies, n.e.s. (895)	3	2	3	2
Jewellery, gold and silver wares (897)	3	4	.	2
Manufactured articles, n.e.s. (899)	2	5	2	5

Sources: UNIDO and United States, Bureau of the Census (1984).

a/ Each variable takes values, 1, 2, 3, 4 or 5, indicating the magnitude for the respective industrial characteristic, where 1=high, 2=medium high, 3=medium, 4=medium low and 5=low. Each category is made up of 20 per cent of the distribution of industries by the respective variable.

b/ The measures of scale economies (size elasticity) and of industrial concentration (employment entropy index) were derived from United States census data for 1982. These measures were first calculated at the most detailed level of industry classification. Results were then aggregated to the three-digit level of the SITC using the concordance with the USSIC given in Hufbauer (1970). The proxies for scale economies and industrial concentration were expressed as weighted averages, where the weights were the total number of persons engaged in each four-digit category of the USSIC which fell within a three-digit SITC category.

c/ (Vertical) product differentiation was proxied by the coefficient of variation of unit values of United States exports to various destinations for 1982. Such coefficients were first calculated at the five-digit SITC level and then aggregated to the three-digit SITC level in the form of weighted averages, where export values were used as weights.

d/ The proxy variable for export concentration was the export entropy index, calculated on the basis of three digit SITC data for 91 countries and areas in 1983.

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Global patterns of production and trade in manufactures have changed tremendously over the past two decades. The growth of world trade has been accompanied by a rapid increase in the number of products, suppliers and buyers involved in international markets. At the same time, the means by which manufacturers compete and collaborate have been changing. The great challenges that these developments pose for policy makers and practitioners provide the basic motive for this comprehensive assessment of the underlying forces and determinants that are reshaping the world's industrial map.

Based upon an empirical approach, the analysis is closely interwoven with key elements of economic theory. The Heckscher-Ohlin model provides the framework for most of the book's interpretation, but less formal models focusing on economies of scale, product differentiation and other aspects of imperfect competition also figure prominently. The extensive research – with access to UNIDO's vast body of unpublished information – and contributions from specialists, has resulted in a blend of theoretical and empirical material which yields new insights into the way firms and industries compete in international markets.

Essential reading for researchers and students in the areas of industrial economics and international trade, this book will provide an invaluable reference for courses in international business and economics.

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Cover design by Wheeler and Porter
ISBN 0 04 445613 0 hb