INFORMATION TECHNOLOGY INDUSTRIES AND NATIONAL COMPETITIVENESS

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ABSTRACT

The global economy is being rapidly restructured under the impact of the information technology revolution, moving towards knowledge-intensive economic activities. There is now in the literature a range of theories that provide a rationale for a link between industrial structure and competitiveness. One implication of such theories is that there may be leading industrial sectors, particularly important in factors driving growth, such as innovation and the generation and diffusion of knowledge. Expansion of such sectors can change the trajectory of economic development and foster growth of national income and welfare.

The issue of the role of industrial structure, and of the computing and electronics industries, in growth and competitiveness are approached through the experience of particular industrialised and developing economies. Central attention is given to considering the role of computing and electronics industries in the growth and competitiveness of East Asian nations over the period 1970-1995. This empirical analysis is undertaken in three parts. Part B documents the changing pattern of industrial structure of manufacturing trade over the period 1970-96, and the increasing role of the computing and electronics industries in most economies over that period. Part C looks beneath the initial measures of industry structure, to examine the nature of the computing and electronic products produced and traded, and at the extent of segmentation across countries in the products produced. Part D provides an analysis of productive activities in the electronics and other industries in selected countries, focussing on productivity, labour costs and income generated, and hence on whether there is process segmentation across countries in the computing and electronics industries.

There are several main conclusions emerging from this research. One is that it is possible to identify the composition of an advanced industrial structure, conducive to income generation, at a particular time and stage of technological development. In the late 1980s and early 1990s, the computing and electronics industries played a central role in an advanced industrial structure. Over the 1970-1996 period there was a substantial shift towards an advanced industrial structure, which was especially pronounced in many East Asian countries. In most cases, the main reason for this shift was the increasing role of the computing and electronics industries.

Another conclusion is that a shift in industrial structure, towards the computing and electronics industries, did contribute to the rapid growth in East Asian over the 1970-1995 period. But for many such countries, particularly Malaysia, Thailand, the Philippines and Indonesia, little has yet been contributed to a broader national competitiveness. Here, the relevant characteristic of these industries was their rapid global growth rather their advanced technology status. For other countries, such as South Korea and Singapore, there was serious involvement with the advanced technology aspects of the industries. As a result, the effects of industrial structure linked to the advanced nature of these industries - direct, high value effects and spillovers to other industries - are likely to have become important in these countries.

A final overall conclusion is that an advanced industrial structure conducive to income generation is not a sufficient condition for achieving high levels of national competitiveness by international standards. Genuine participation in the advanced industries at an high level is also required, and is necessary for the high income generating potential of that industrial structure to be realised for this to be achieved.

OVERVIEW

The Information Industries, Industrial Structure and Competitiveness: Some Questions

The global economy is facing substantial restructuring, and is rapidly moving towards knowledge-intensive economic activities. At the heart of this process lies a profound technological change, the information technology revolution. It is widely argued that the prosperity of nations depends to a large extent upon their ability to make maximum use of the new conditions of the global environment. The strategic importance of high-technology industries for economic development in the current era of technological change, and in particular of the computing and information industries, has been stressed by many authors. These include, for example, Magaziner and Reich 1982; Lawrence 1984; Prestowitz 1988; Dertouzos, Lester and Solow 1989; Tyson 1992; Thurow 1992; Carnoy, Castells, Cohen and Cardoso 1993; OECD 1996 and 1999. Several observations relevant to the significance of the information technology industries for economic development can be drawn from the empirical record or the literature. Some of these are briefly outlined below.

First, the computing and electronics industries are among the most dynamic industries in overall economic terms. Through the 1970s and 1980s the computer industry was the fastest growing manufacturing industry in the United States, Japan, Germany, the United Kingdom and France in terms of constant price gross output growth (Vickery 1996, pp. 112, 115). Between 1996 and 2000 worldwide spending on personal single-user computer systems has been expected to grow from \$203 billion to \$300 billion (Council on Competitiveness 1998, p. 61). The trade-intensity (exports/production ratio) for the computer industry is more than double that for total manufacturing. Between 1980 and 1993 total world exports of computers grew from US\$12.5 to US\$85.6 billion, and exports of parts and components increased from US\$7.5 billion to US\$53 billion (Vickery 1996, p. 125), and that rapid growth has continued since 1993.

Secondly, information and communication technologies are widely held to contribute to the productivity of industries across the economy (e.g. Houghton and Flaherty 1997, p. 135). Computers are claimed to be critical to firm and national competitiveness in numerous other sectors (Yoffie 1993, p. 79). The OECD has argued that "information and communication technologies are a pillar of the knowledge-based economy" (OECD 1999, p. 9). These effects of information and communication technologies relate to the diverse spillover and productivity effects, within a given economy, of the ability to design and produce computing and electronic products on other industries in that economy, and to the role of these technologies as enabling technologies for all industries.

Thirdly, a major geographical shift has taken place in global production of computing and electronic equipment, which has led to the emergence of East Asia as a new centre of production activities. This has been extensively documented in a number of studies, which include, for example, Wellenius, Miller, and Dahlman 1993, Kozmetsky and Yue 1997, Mathews and Cho 2000, Sheehan, Pappas, Tikhomirova and Sinclair 1995, and Sheehan and Tikhomirova 1996. By 1996 South Korea, Taiwan, Hong Kong, Singapore, Thailand, and Malaysia contributed 20.7 per cent of world computer production, and Singapore and Taiwan were among the largest producers of computing equipment, following the United States and Japan. Between 1980 and 1993 the exports generated in East Asia were the main source of growth in world computer exports, and over this period Japan increased its share of world exports from 4.3 per cent to 19.7 per cent. South Korea, Taiwan, Hong Kong, Singapore, Thailand, Malaysia, and China were exporting almost 23 per cent of the world total in 1993, while in 1980 as a group they had less than 1 per cent of world exports. Singapore's share increased from 0.1 per cent to 14 per cent over the same period. Taiwan's share increased from 0 to 5.8 per cent and the share of South Korea – from 0.05 to 3 per cent (Vickery 1996, pp. 115, 125).

Finally, as a result of some of these and other facts, it has been suggested that the rapid economic growth in East Asia and ASEAN has been substantially driven by "the ability of many of these countries to capture the production of, and trade in, the new goods emerging from the revolution in computing and communications" (Sheehan and Tikhomirova 1996, pp. 25-26). As has been observed by Mathews and Cho, the East Asian success is revealed through the technological achievements which "have penetrated deep into advanced technologies and industries such as electronics, information technology and semiconductors…" (2000, p. 2).

These various facts and opinions about the central role of the information technology industries, and of the computing and electronics manufacturing industries in particular, raise many important questions. One particular question concerns the importance of a high level of performance in these manufacturing industries (as distinct from competence in applying the technologies in other industries) for growth and competitiveness. More specifically, *in the emerging global economy, is a high level of production capability in computing and electronics either a necessary or a sufficient condition for the achievement of high levels of national competitiveness?* If it is neither a sufficient nor a necessary condition, in what terms is the apparent link between these industries and national competitiveness, suggested by the facts and opinions cited above, to be explained?

Underlying these more specific questions are more general ones concerning the link between industrial structure and competitiveness. In this thesis, the industrial structure of an economy, or of a sector of an economy, in terms of a particular variable, is the composition by industry of that economy or sector. Thus the industrial structure of a given manufacturing sector, which consists of twenty two industries, in terms of value added at a given time is shown by the distribution of total manufacturing value added across those industries at that time. In standard neoclassical theory there is no role for industrial structure in the theory of growth or in the determination of national competitiveness. The uninhibited, self-adjusting processes of the market generate the optimum level of output and/or growth, and the structure of a nation's economy emerges as a result of this process. But no particular industrial structure is privileged or essential for a high level of competitiveness. Nations can have strong levels of international competitiveness, and high levels of national income, with quite different industrial structures. But much of the discussion about the computing and communications industries, such as that cited above, implies that in a modern economy there are indeed preferred industrial structures, and that the computing and electronics industries play a key role in them. So the following questions arise: *at a given stage of technological development, is there a particular type of industrial structure that is more conducive for the achievement of high levels of national competitiveness and, if so, is such an industrial structure either a necessary or a sufficient condition for high levels of competitiveness?*

These questions – concerning the link between the manufacturing segment of the information technology industries and competitiveness and the role of industrial structure in national competitiveness – form the topic of this thesis. But they are not approached directly, in all their generality and complexity, but through the experience of particular industrialised and developing economies in particular industries. Central attention is given to considering the role of computing and electronics industries in the growth and competitiveness of East Asian nations over the period 1970-1995. Thus, the specific question being addressed below, in large part for its broader implications, is this: *to what* *extent, and in what ways, did increased activity in the computing and electronics manufacturing industries contribute to national competitiveness in different industrialised and developing economies and particularly in the rapidly developing countries of East Asia over the period 1970-95?* Even this question is not addressed in its full generality. Thus, for example, the thesis does not incorporate the macroeconomic analyses necessary to estimate the indirect effects of specialisation in the computing and electronics industries on improvements in national competitiveness. Rather, an industrial structure analysis is undertaken, with the intention of drawing whatever implications are possible from this analysis about issues concerning industrial structure and national competitiveness.

The Structure and Argument of the Thesis

Part A: Competitiveness, Industrial Structure and the Information Technology Industries

In seeking to address this specific question, and to throw light on the broader issues, the thesis is organised in four groups of chapters. Part A starts by reviewing the literature on the relevant issues, before considering the options for quantifying industrial structure and developing a new approach to assessing the industrial structure of the manufacturing sector. A working definition of competitiveness is developed (Chapter 1). National competitiveness is defined in terms of high levels of per capita income sustainable over time in open markets. This definition allows us to distinguish between economic growth and the development of national competitiveness, although in practice historically sustained levels of per capita GDP have to be used as indicators of competitiveness. A review of the relevant literature (Chapter 2) and of aspects of the development of the information technology industries (Chapter 3) leads to several findings. One is that there is now a range of models and theories that provide a rationale for a link between industrial structure and competitiveness, so that such a link can no longer be ruled out on the basis of theory. One particular implication of the theory, that is of particular relevance to the topic of this thesis, is the possibility that there are leading industrial sectors, which are particularly important in terms of factors driving growth, such as technological innovation and the generation, accumulation and diffusion of knowledge. In a number of new growth models, expansion of leading, strategic, sectors can change the trajectory of economic development and, thus, foster growth of national income and welfare. A finding of the review carried out in Chapter 3 is that the policies pursued in many countries have been based on the principle of the importance of industrial structure and of the strategic role of the information technology industries in a preferred industrial structure.

More specifically, the review of the literature suggests that there are four main types of reason why industrial structure may matter for growth and competitiveness. These are as follows:

- *direct effects*: some industries, and not others, generate high levels of value added per employee and wages per employee, and hence contribute directly to high levels of per capita GDP;
- *demand growth and increasing returns*: some industries, and not others, are associated with high rates of growth in demand (from either national or international sources) and also with increasing returns to scale, so that production within those industries will generate a virtuous cycle of rising demand, falling unit costs, further increases in demand and so on;
- *spillover effects on other industries*: some industries, and not others, generate high spillovers to other industries (in terms, for example, of technology, production knowledge, and design and product creation capabilities), and these spillovers spur the growth of the overall economy, and
- *balance of payments constraint effects*: export related growth in an industry growing rapidly in world markets may lift the balance of payments constraint on an economy, thereby allowing that economy to grow more rapidly than would otherwise have been the case.

As noted above, it is beyond the scope of this thesis to undertake a complete analysis of each of these effects. But, within the constraints of undertaking an analysis of industry structure rather than of broader macroeconomic and other factors, the thesis seeks to throw some light on the relevance of these effects to the specific question noted above. That is, to the question of the role of the computing and electronics industries in the competitiveness of different industrialised and developing economies, and particularly of the rapidly developing countries of East Asia, over the period 1970-95.

Given its objectives, a central requirement for the analysis is a method for analysing industrial structure in a quantitative form. Chapter 4 considers options for such a method, and develops a new approach to assessing the structure of manufacturing industries from the perspective of competitiveness. Five characteristics of industries relevant to competitiveness are identified, in three groups as follows:

- the level of value added and employee income in the industry, as measured by value added per employee and wages per employee;
- the scale and growth of the industry in global markets, as measured by the growth of world exports and the share of the industry in world exports, and
- the technology intensity of the industry, as measured by the ratio of R&D to production.

Using these five characteristics, a method for analysing industrial structure of the manufacturing sector on a comparative basis across countries and over time, referred to as the Index of Long Run Income Potential, is developed and applied throughout the study. The industry rankings used in the Index are derived from the experience of three leading developed nations - USA, Japan and Germany - and hence can be taken as representative of the highest level of industrial performance for the period considered. This new approach for analysing industrial structure, based on ranking industries and constructing a weighted index of industrial composition, has been developed for the manufacturing sector, given the topic of this thesis. However, it is worth mentioning that the suggested methodology can be extended to incorporate other sectors of the economy, on the condition of the availability of the relevant data.

One conclusion of this chapter is that manufacturing industries differ markedly according to the selected benchmarking indicators. It is also shown that in the ranking of industries, in terms of income generating potential, the computing and electronics industries occupy the highest place. This implies that, if in a particular economy the computing and electronics industries have the characteristics of the most advanced industries in comparison with other manufacturing industries (as in the case of the economies used to derive the benchmarking indicators), a higher proportion of the computing and electronics industries in the composition of manufacturing sector should inevitably lead to higher value added generated in this sector than would otherwise be the case. These two aspects, *the structural significance of the computing and electronics industries in the composition of the manufacturing sector* and *the characteristics of these industries in different economies, in terms of the three groups of variables relevant to competitiveness*, constitute the main substance of the empirical research of this thesis.

Part B: Changes in the Structure of Manufacturing Trade: The Role of the Computing and Electronics Industries

The second group of chapters (Chapters 5-7) considers the changing pattern of industrial structure of manufacturing trade in a selected group of developed and developing countries over the period 1970-96, and the increasing role of the computing and electronics industries in most economies over that period. Chapter 5 shows, inter alia, the pronounced rise in the share of manufactured exports in total merchandise exports for most countries, as well as the global shift in the structure of exports to industries with high income potential. In particular, it documents the extent of the shift in the structure of the exports of the rapidly growing East Asian countries to industries with high income potential. Chapter 6 documents two main points: that the global shift to export industries of high income potential is driven substantially by the rise of the computing and electronics industries, and that this shift was much more pronounced in the East Asian countries than in most other countries.

The analysis to this stage might be seen as supporting the central role of a change in industrial structure and, in particular, of a high degree of specialisation in computing and electronics production and trade, to rapid growth of East Asian economies. At least in terms of exports, the East Asian countries have led the global move to industries of high income potential, and it might be thought that this must surely be a central factor behind their rapid growth. However, a number of factors indicate that the situation is considerably more complex than this. One, which is explored in Chapter 7, is the high and increasing significance of computer and electronic products in the composition of manufactured imports of East Asian economies. This fact, suggestive of the possibility of processing of high value imports, indicates that further analysis of the composition of computing and electronic production and trade at a higher level of disaggregation is required.

Part C: Product Segmentation in the Global Electronics Industry

The third group of chapters (Chapters 8-9) looks beneath the measures of industry structure defined at the twenty two industry level, to examine the nature of the computing and electronic products produced and traded. Two types of data are used to explore product segmentation within the computing and electronic industries. One is data from the Yearbook of World Electronics, which gives detailed information on production and apparent consumption for fifty countries over the period 1985-1997. The other is detailed trade data from the national statistical agencies in US and Australia, which are used to undertake case study analyses of two products: video cassette recorders and pocket-sized cassette players. Clearly, the conclusions of this part of the analysis must be tempered by the limitations of the available data.

One persistent finding of this analysis is that extensive product segmentation across countries was a dominant feature of global electronic production over the period studied. Most East Asian countries were specialised in electronic data processing equipment and components, with a considerable emphasis also on consumer electronics. These product areas are each substantial and rapidly growing areas of world trade in electronic products. The non-Asian developed countries were mainly specialised in the production of complex electronic equipment related to control and instrumentation, industrial and medical processes, and communications. These product areas tend to be smaller and more slowly growing market segments. Within the two consumer product areas studied, the East Asian economies produced and exported electronic products characterised by low unit prices, which are likely to be indicative to a moderate degree of technical sophistication, and achieved high market shares. The developed countries produced and exported electronic equipment characterised by high unit prices, which is likely to involve professional functionally sophisticated equipment of high quality but moderate demand.

Given the data limitations, care must be taken in interpreting these findings. But it does seem clear that global product segmentation in the electronic industries was extensive, and that within this process the East Asian countries tended to specialise in less sophisticated products the global demand for which was high and growing rapidly. Developed countries tended to specialise in technically complex electronic products, for which global demand was more limited and growing more slowly. In terms of the three types of criteria of industries relevant to competitiveness, East Asian activities in these industries certainly met the test of high global demand. We now turn in Part D to examine the nature of the production processes involved, as opposed to the type of electronic goods produced.

Part D: The Nature and Economic Benefits of Production in the Global Electronics Industry

The three chapters of Part D provide an analysis of productive activities in the electronics industries, and other industries, in selected countries, focussing on productivity, labour costs and income generated. The objective is to analyse the character of national activities in these regards, with the purpose of finding out to what degree the high income generating potential of the computing and electronics industries was actually realised in different countries, and hence to throw light on the contribution these industries to the development of national competitiveness of different economies, in particular those of East Asia.

Chapter 10 undertakes a cross-country analysis of labour productivity, value added, the structure of production and the output of R&D activities (patents) in the computing and electronics industries. Again, data limitations restrict the coverage of the analysis, both in time and in terms of countries covered. A starting point of the analysis is that in developed countries structural change in manufacturing production (towards a higher proportion of industries of high income generating potential) is positively correlated with the growth of value added and productivity in manufacturing, although it is negatively correlated with employment growth, but these correlations are not confirmed for East Asia. These results provide a rationale for examining these variables in the context of the overall objectives of the thesis.

There are five main conclusions from this empirical analysis. First, in many East Asian economies (notably Malaysia, the Philippines and Indonesia) productivity in the computing and electronics industries remained at very low levels. In South Korea, Singapore and Hong Kong, however, the growth of productivity in these industries was quite pronounced, and productivity levels approached those achieved in some developed economies. Nevertheless, they were still at levels only about half of that achieved in the leading developed countries.

Second, in most developed countries in 1985-1995 productivity in the computing and electronics industries exceeded overall manufacturing productivity, while in East Asian economies the situation was rather diverse. Prior to 1990, productivity in the computing and electronics in South Korea and Singapore was below or equal to the level achieved in total manufacturing, and only in the 1990s did it exceed overall manufacturing productivity. In some other East Asian countries productivity in the computing and electronics industries was below overall manufacturing productivity.

Third, while the share of value added in gross output in the electronics industries varied markedly across countries, it was generally much lower in most East Asian countries than in the leading countries. In the USA, for example, the share of value added was about 55% in 1995, while for Germany it was 69% in 1993. By contrast, the value added share was only 38% in Japan (1995), 26% in Singapore (1994), 21% in Malaysia (1993) and 30% in Indonesia (1994), although it was noticeably higher at 47% in South Korea (1995).

Fourth, in the USA and Germany, and in many other but not all developed countries for which data are available, the electronics industries have a higher value added share than an industry such as textiles and clothing. While the value added shares in the two industries were similar in South Korea and the Philippines, they were higher in textiles and clothing than in electronics in Japan, Singapore, Hong Kong and Malaysia.

Fifth, an analysis of patent data by industry and country (using patents granted by the US Patent Office) shows quite high levels of patent activity in computers and electronics in Japan, South Korea and Taiwan, but otherwise very low levels of patenting in other East Asian countries in these industries. In Singapore, where the number of patents granted was still quite low in 1995, there was nevertheless evidence of strong growth in the 1990s. Thus the results of domestic R&D have played little part in productive activities in the computer and electronic industries in the countries of East Asia, other than for the three cited.

In addition to highlighting the differences within the East Asian group, the results of this chapter indicate a general tendency for production activities in the computing and electronic industries in East Asian countries to involve low levels of productivity and value added, and not to be supported to a significant degree by the results of domestic R&D. These results indicate that high income generating potential of the computing and electronics industries was not fully utilised in East Asian economies, and for many of these countries there is a close parallel between the computing and electronics industries and more traditional industries, such as textiles and clothing. These issues are investigated further in the following chapters.

Chapter 11 starts from the finding that in developed countries structural change in domestic manufacturing production (towards a higher proportion of industries of high income generating potential) was positively correlated with the growth of wages and wages per employee and negatively correlated with employment growth. There is also clear evidence that, for all developed countries studied and for the limited period for which data are available, wages per employee were growing more rapidly in industries characterised by high income generating potential than in other industries. These findings are again not replicated for the East Asian countries, but do provide a further reason for examining the structural change issue from the perspective of the employee earnings generated. One question here is whether the computing and electronics industries generated strong economic returns to employees in the form of wages or whether production activities continued to be mainly based on low labour costs.

The main conclusion of this analysis, which is again heavily constrained by data limitations, is that wages per employee in the computing and electronics industry in East Asia relate much more closely to wages in other industries within a given country than to wage rates in that industry across countries. Indeed, in 1992 average wages in the computer and electronics industries were more closely related to wages in other manufacturing industries in East Asian countries than in the developed countries. Wages per employee in computers and electronics were 11.5% higher than in manufacturing in the eight developed countries, while in the seven East Asian countries (including Japan) they were 0.6% lower. Even in South Korea and Singapore, the economies for which the trend of convergence of labour costs with the levels of the developed countries has been observed, wages per employee in the computing and electronics industries were below the level of wages in overall manufacturing sector. At least up to 1992, wages per employee in the computer and electronics industry in East Asian countries (excluding Japan) were still much lower than in developed countries. Indeed, in 1992 even for South Korea, Singapore, and Hong Kong these wage levels were only about 28-36% of those in Germany and USA, while for Malaysia the figure was about 10% and for Indonesia approximately 3%.

The findings of this chapter imply that low wage rates remained an important element in the expansion of the computing and electronics industries in East Asian up to the 1990s and, thus, provide confirmation that the high income generating potential of the computing and electronics industries was not fully utilised in East Asian economies.

Conclusions

The main conclusions emerging from this research are outlined in Chapter 12, and are summarised briefly below.

Identifying an Advanced Industrial Structure

One conclusion of the thesis, on the basis of the analysis of the manufacturing sector, is that it is possible, using economic criteria, to identify the composition of an advanced industrial structure at a particular time and stage of technological development, and to develop methods to compare industrial structure across countries and over time. Such an advanced industrial structure will be one which, other things being equal, will tend to generate high levels of valued added and wages per employee in a context of rapid innovation and adjustment to global markets.

The Diversity of Manufacturing Industries and the Centrality of the Computing and Electronics Industries

Another important finding is the diversity of industries in terms of the economic criteria developed. The analysis also shows that, in the late 1980s and early 1990s, the computing and electronics industries played a central role in an advanced industrial structure, being ranked the highest among all manufacturing industries in terms of the five criteria as a whole. In terms of this composite ranking textiles and clothing and wood and furniture occupied the lowest places.

The Shift to an Advanced Industrial Structure

The thesis also demonstrates, especially in terms of the structure of exports, that there was a substantial shift towards an advanced industrial structure in most countries over the period 1970-1996. This shift was especially pronounced in many East Asian countries, but is notable in some other countries as well, particularly Ireland, while Indonesia is a country in which a shift to a more advanced structure of exports did not occur. It is also shown that, in most cases, the main reason for the shift to a more advanced structure of exports was the increasing role of the computing and electronics industries.

Differences in the Utilisation of the Income Generating Potential of an Advanced Industrial Structure - Product Segmentation and Production Process Differentials

As noted above, the income generating potential of an advanced industrial structure identified in this way may in fact not be realised in a particular country, in one or both of two related ways. One is that the products produced within a given industry may be less complex than those produced in the leading countries, for example because the country specialises in relatively simple final or intermediate goods. The other is that the processes of production used within a given country may be less advanced than in the leading countries. These may, of course, both come together in a particular country, which produces low price electronic products by simple assembly processes based on imported components.

The empirical analysis undertaken in the thesis has revealed that a marked segmentation existed across developed and East Asian economies over the period studied, both in terms of the types of electronic goods produced and of the production processes used.

Regarding product segmentation, the East Asian countries tended to specialise in less sophisticated electronic products, the global demand for which was high and growing rapidly, mostly in the areas of electronic data processing equipment, components, and consumer electronics. Developed countries tended to specialise in technically complex electronic products, for which global demand was more limited and growing more slowly, such as control and instrumentation, industrial and medical processes, and communications electronic equipment.

Concerning the nature of the production processes involved, there was a general tendency for production activities in the computing and electronic industries in East Asian economies to involve relatively low levels of productivity, value added and labour costs. This was by comparison with the situation prevailing generally in the developed countries. With the exception of South Korea, Taiwan and to a certain extent Singapore, production activities in these industries in the East Asian countries were not supported to a significant degree by the results of domestic R&D.

The Computing and Electronics Industries and National Competitiveness in East Asia

The analysis of industry structure and the characteristics of the industries, undertaken in this thesis, enables some answers to be inferred to the questions posed in the first section of this Overview. In terms of the impact of increased activity in these industries on growth and improved competitiveness in the East Asian countries, some conclusions can be reached by considering the four potential effects of industrial structure distinguished above.

Direct Effects. In terms of the direct effects of increased activity in the computing and electronics industries on growth, the analysis (Chapter 12) shows that, while they were substantial in some, but not in all, East Asian countries they were certainly not large enough to be a dominant reason for growth in most of these countries. For most East Asian countries, the overall conclusion is that the direct effects are substantial but do not alone provide sufficient evidence to support the hypothesis that these industries were the dominant factor in their rapid economic growth.

Demand Growth and Increasing Returns. As detailed in Chapter 6, the extent to which the countries of East Asia captured increasing market share in rapidly expanding global markets in these industries was quite remarkable, and the markets captured were very large relative to the scale of the economy. This means that the induced demand effects, and the increasing returns to scale that they generated, may well have been important factors in East Asian growth. It has not been possible, within the scope of the thesis, to explore in detail either the demand linkages arising from export driven expansion of these industries or the returns to scale within the industries, but our analysis suggests that these may well have been important factors.

Spillover Effects on Other Industries. With some exceptions, the products made, and the processes by which they were made, in the East Asian economies were far from the most advanced level internationally, and in many cases were on a par with those of other industries in these countries. Spillover effects from leading industries on other industries, widely discussed in the literature, are typically held to arise from factors such as advanced technology, production knowledge, and design and product creation capabilities. Given the nature of the products made, and the processes by which they were made in most East Asian countries, it seems likely that the growth effects through such spillovers to other industries were limited. Again, it has not been possible, within the scope of the thesis, to explore in detail the reality of spillover effects from these industries in East Asia, but given the structural characteristics of the industries documented here, it is unlikely that their impact on overall growth and competitiveness was substantial.

Balance of Payments Constraint Effects. Finally, given the strong export led expansion of the computing and electronics industries in East Asia, and in spite of their heavy reliance on imported capital and intermediate goods, these industries generated substantial trade surpluses. These surpluses could in turn facilitate rapid growth in other, deficit industries without generating a national balance of payments constraint. While our conclusion is qualified by the lack of a detailed analysis of balance of payments constraints on growth in individual countries, it does seem likely that the rapid expansion of the computing and electronics industries in the developing countries of East Asia facilitated rapid growth in many of those countries by lifting the balance of payments constraint.

Our overall conclusion here is that the fact that many countries in East Asia experienced a pronounced shift in industrial structure towards a higher proportion of the computing and electronics industries did indeed contribute to their rapid growth over the 1970-1995 period. But for many of these countries, particularly Malaysia, Thailand, the Philippines and Indonesia, the relevant characteristic of these industries was their rapid global growth rather their advanced technology status. Catching a wave of growth in the global economy in terms of exports was the key, rather than participating in a technological revolution. Other than the stimulus to demand and to the balance of payments, little has yet been contributed to a broader national competitiveness that would allow these countries to approach and sustain the living standards of the developed countries. As a result these East Asian economies remain vulnerable to shifts in the pattern of global sourcing of computing and electronics products.

For other countries – such as South Korea and Singapore – the situation is somewhat different. While the nature of their products and production processes did remain limited by the standards of the developed countries over the period studied, there was serious involvement with the advanced technology aspects of the computer and electronics industries. In these industries, the output of R&D was relatively strong, and production activities were increasingly focused on high quality products and high value added processes. As a result, those effects of industrial structure on growth and competitiveness linked to the advanced nature of these industries - direct, high value effects and spillovers to other industries - are likely to have become increasingly important in these countries.

The Computer and Electronics Industries and Competitiveness

These conclusions allow us to give partial answers to the two more general questions with which we began. The first of these concerned whether, at the current stage of technological development, a high level of production capability in the computing and electronics industries is either a necessary or a sufficient condition for a high level of national competitiveness. In terms of the sufficiency condition, our answer is clear. Possession of an advanced industrial structure, characterised by a large role for the computing and electronics industries in terms of output or exports, is not sufficient for high levels of competitiveness. Genuine participation in these industries at an advanced level is also required. The issue of the necessity condition for a particular economy should be considered in relation to the existing competitive strengths of this economy, in terms of both natural and created comparative advantages. Thus, to derive an exact answer to the question of which industrial structure is the most conducive to economic growth in a particular economy, extensive country-specific research is required. This would investigate, inter alia, to what degree the income generating potential of advanced industries can be utilised in given national conditions. Such country-specific analyses are beyond the scope of this thesis. However, the conclusions reached in this study indicate that such research is worth pursuing.

The Relevance of Industrial Structure for National Competitiveness

In relation to the more general question of the link between advanced industrial structure and national competitiveness, we can conclude that specialisation in economic activities characterised by high income generating potential, or in other words, an industrial structure conducive to income generation, is not a sufficient condition for improving substantially the living standards of the population and for achieving high levels of national competitiveness by international standards. As the experience of many East Asian countries has demonstrated, it is possible to move rapidly to an apparently advanced structure, without either the products made, or the processes by which they are made, reflecting the advanced nature of these industries. While there are good reasons to believe that an advanced industrial structure, with its potential fully realised, will contribute greatly to national competitiveness, it is necessary for the high income generating potential of that industrial structure to be realised for this to be achieved.

PART A

COMPETITIVENESS, INDUSTRIAL STRUCTURE AND THE INFORMATION TECHNOLOGY INDUSTRIES

The first part of the thesis provides an overview of issues related to national competitiveness and the effects of industrial restructuring on economic growth, with particular emphasis on the strategic significance of the information technology industries. Part A consists of four chapters.

In Chapter 1 we discuss some of the controversies involved in the debate about defining the competitiveness of a nation, by comparison with that of a firm, and specify criteria for national competitiveness. Issues related to measuring national competitiveness, defined in terms of living standards that can be sustained in open markets, are considered. Further, in this chapter, some findings of recent empirical tests of long-term convergence in living standards across different economies are outlined. The conclusion of this analysis is that persistent polarisation in per capita income levels across countries as a whole is the prevailing situation, although there is evidence of convergence within particular groups of countries.

A review of selected literature that can provide theoretical basis for analysing factors affecting long-term economic growth and, thus, can help in explaining the persistent pattern of uneven economic growth across countries, is presented in Chapter 2. Special attention is given to growth theories which consider the effects of factors that are gaining significance at the current stage of technological development, such as changes in industrial structure, innovation, accumulation and diffusion of knowledge. This chapter shows that, by contrast to earlier theories, several models in the recent theoretical literature envisage a role for industrial structure in long-term growth and competitiveness, and for identification of strategic industries that have economy-wide benefits.

A brief overview of the development of information technology industries and of the industrial policies implemented in different economies is presented in Chapter 3. While not assessing the degree of success of industrial policies targeting the development of the computing and electronics industries, this chapter does demonstrate that, in a wide range of advanced countries and in many East Asian countries, these industries have been viewed as strategic industries and have been actively supported by industrial policies.

Chapter 4 considers options for quantifying the industrial structure of the manufacturing sector and sets out to develop a new approach to assessing manufacturing structure from the perspective of income generation. A process of benchmarking of manufacturing industries according to the characteristics germane to income generation is undertaken, and similarities and differences between industries are analysed. On this basis, criteria are developed for classifying industries in terms of 'income generating potential'. One of the findings is that, according to the selected benchmarking indicators, computers and electronics are classified as industries of the highest income potential among the manufacturing industries. Further, in this chapter, we introduce a weighted index of industrial composition, the Index of the Long Run Income Potential, developed on the basis of using the benchmarking characteristics as industry-specific weights. A number of applications of the index for analysing the significance of a particular industry or a number of industries in the composition of the manufacturing sector are considered. In subsequent chapters this approach will be used to assess the significance of the computing and electronics industries in the composition of the manufacturing trade and production of different regions and countries.

CHAPTER 1

NATIONAL COMPETITIVENESS AND CONVERGENCE

1.1 Debates about National Competitiveness

National competitiveness is one of the economic concepts that has recently gained particular significance in economic debate around the world. As the process of globalisation gathers pace and the very existence of effective nation-states becomes a subject of debate (see, for example, Ohmae 1996) the question of national competitiveness is undoubtedly a crucial one. As has been stressed by Hatzichronoglou, "rarely has an economic concept been as central to decision-makers' concerns as competitiveness has over the last ten years" (1996, p. 17).

1.1.1 Definition of National Competitiveness

In spite of the importance of the issue there is no consensus about the definition of competitiveness. "The term competitiveness may be used with contradictory meanings in various passages of the same article or report" (Hatzichronoglou 1996, p. 17). One of the reasons for this is that the term "competitiveness" is being applied to entities at different levels of economic activity. At the microeconomic level, in other words at the level of the firm, the term is well defined. There is just one basic criterion according to which a firm's competitiveness can be assessed - its ability to survive in competitive markets. At the macroeconomic level, at the national or supranational level, the problem of defining competitiveness is much more complicated.

Many authors have supported the view that nations do not compete in international markets in a similar way to firms (Porter 1990, p. xii; Krugman 1994b, p. 31; Hamel and Prahalad 1994, p. 268). Paul Krugman has come to the conclusion that "competitiveness is a meaningless word when applied to national economies" (1994b, p. 44). However, in an earlier paper Krugman recognised that there are real issues associated with the term "national competitiveness". In particular, the degree of competitiveness can affect the structural composition of trade and production, living standards and the distribution of income in an economy. (1991, p. 812).

Several definitions of national competitiveness can be found in the literature. Laura Tyson has presented the definition of competitiveness developed in a background report (Cohen et al. 1984, reference is given by Tyson), prepared by scholars for the commission established by President Reagan in 1983. Since that time this definition has been widely used as a standard. National economic competitiveness, according to this definition, is the "...ability to produce goods and services that meet the test of international markets while ... citizens enjoy a standard of living that is both rising and sustainable" (Tyson 1992, p. 1).

The most important feature of this definition is that sustainable living standards have been specified as one of the criteria of national competitiveness. However, there is no indication about the levels of welfare that would let one make a judgement about the degree of competitiveness of an economy. Neither has the rate of growth of the "rising and sustainable" living standard been mentioned. It is not quite convincing that an economy can be considered competitive just if the living standard of its citizens is rising and sustainable. However, it is important to note that, according to this definition, income levels should be evaluated under the condition of openness.

As Garelli pointed out, "... the real test of competitiveness takes place on international markets" (1997, p. 1). A competitive economy does not necessarily need to be open. But the openness of a country to international competition provides a real test for the level of competitiveness achieved. A fairly closed economy can reach relatively high living standards if particular circumstances existing in the global environment are favourable. For example, the former USSR managed to maintain quite high levels of welfare for its population when world prices for primary commodities (in particular on crude oil) were high. But the process of transition, that required opening all sectors of the economy to the global competition, has shown that the Soviet Union was not competitive.

The World Economic Forum, in the "World Competitiveness Report", has defined competitiveness as "the ability of a country to achieve sustained high rates of growth in GDP per capita" (Global Competitiveness Report 1997, Press Release 1997). This definition also emphasises the importance of growth of per capita income on a sustainable basis, however with no indication of the possible methods of evaluation of whether the rate of growth is sufficiently "high" to achieve a high level of per capita income relative to those in other countries.

Sachs has presented a concept of competitiveness accepted by the World Economic Forum: "... an economy is 'internationally competitive' if its institutions and policies will support sustained and rapid economic growth. Nations "compete mainly in the sense of choosing alternative national economic institutions and strategies to promote more rapid growth and increase in living standards" (Global Competitiveness Report 1996, A New Concept of Competitiveness 1997, p. 1). Thus, the World Economic Forum evaluates the ability of the national environment to provide conditions for the development of international competitiveness rather than the degree of competitiveness actually achieved.

The International Institute for Management Development (IMD) also assesses the ability of the national environment to support economic growth. "...nations compete ... by providing firms with an environment with the most adequate structure, institutions and policies" (World Competitiveness Yearbook, Methodology, 1997, p. 1).

Another definition has been developed by the OECD Secretariat. Competitiveness is "... the ability of companies, industries, regions, nations or supranational regions to generate, while being and remaining exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis" (Hatzichronoglou 1996, p. 20).

In this definition the same criteria are being applied to microeconomic and to macroeconomic entities. However, the objectives of a firm differ significantly from the objectives of a nation. As has been stressed by Hatzichronoglou, "...for a nation the aim is to maintain and improve its citizens' living standards, for a firm the object is to deal successfully with international competition by making profits and increasing its market shares" (1996, p. 3). The OECD version can perhaps be accepted as a working definition of competitiveness from the macroeconomic perspective. It allows us to specify a number of important criteria of national competitiveness:

- the ability to provide high living standards for citizens;
- the ability to achieve high levels of employment;
- the levels of welfare and employment should be assessed relative to the levels achieved by other countries;
- the sustainability of these factors, in the context of the ability to pass the test of openness to the global markets.

Two key implications, which are of particular relevance for this project, can be derived from the accepted definition and the specified criteria of national competitiveness.

First, this definition makes a clear distinction between the achieved levels of welfare and competitiveness. The fact that a particular national economy has achieved high living standards for the population, relative to those in other countries, does not provide a sufficient condition for a conclusion about a high level of national competitiveness, unless these high living standards can be sustained over a long period of time in open markets.

Second, it is important to stress that it is an ability to provide high living standards, or in other words, high levels of per capita income, rather than the rate of economic growth, which is specified among the criteria of national competitiveness. High rates of economic growth achieved in a particular economy are indicative of the improvements in national competitiveness. However, this condition is not sufficient for achieving a high level of national competitiveness. If the rates of economic growth are high, there are two additional conditions necessary to make a judgement whether they will lead to a high level of competitiveness. Firstly, the high rates of growth should lead to achieving high levels of per capita income by international standards; and secondly, as has been emphasised above, these high levels of income should be sustainable in the environment of open markets.

1.1.2 Indicators of National Competitiveness

Measuring competitiveness is even more problematic than defining it. Indicators of competitiveness have been developed in accordance with different definitions, and consequently differ substantially. Moreover, there is no agreement on what indicators should be used even for the same version of the definition of competitiveness. For example, GDP per capita levels and growth rates, the trade balance, performance in exports, outbound foreign investment, unit labour costs, and the degree of openness have all been used in measures of competitiveness.

Many authors have expressed critical comments about the validity of some indicators of competitiveness. For example, Garelli has argued that the GDP is an imperfect indicator of income creation because it does not distinguish between different types of wealth generation. For example, it does not distinguish between revenue from the depletion of non-renewable resources or the exploitation of assets accumulated by past generations, and revenues of true long term economic value, such as those deriving from innovation and technology (1997, p. 1). In Krugman's opinion, a positive balance of trade can be a misleading indicator of national competitiveness. A trade surplus may be a sign of national weakness, while a deficit may be a sign of strength. Besides this, the balance of trade is influenced by the exchange rate (Krugman 1994b, pp. 31-32). Hatzichronoglou has pointed out that the balance of trade is affected by the size of countries and by the extent of structural adjustment policies (1996, pp. 35, 37). He has also argued that traditional indicators of competitiveness were devised on a national basis and take little account of the various forms of globalisation (pp. 16, 26).

Hatzichronoglou has presented an alternative approach that incorporates the effects of the globalisation of the activities of multinational firms. National competitiveness is assessed according to the ownership of productive assets. Sales between enterprises belonging to the same owner country are excluded from international transactions (p. 38). Porter has emphasised the importance of the country of origin of internationally competitive firms for national competitive advantage. Leading successful firms in an industry, an industry cluster, originated from a particular country, form national competitive advantage (Porter 1990, p. 71). By contrast, in the World Competitiveness Yearbook, published by the IMD, the role of the enterprises operating in national economies has been stressed (World Competitiveness Yearbook, Methodology, 1997, p. 1).

The World Economic Forum and the IMD applied complex multi-dimensional methodologies for the assessment of relative national competitive positions. A wide range of indicators have been taking into account, covering performance in international trade, the development of financial markets, infrastructure, the role of the government, the quality of science & technology, labour market conditions and management. The index of competitiveness, developed by the World Economic Forum, is based on 155 indicators incorporating quantitative data and the findings of surveys of some 3000 of the world's business leaders. The final competitiveness ranking, developed by the IMD, is based on 136 hard criteria and on survey data. 2515 executives from the countries around the world presented their views on their countries' competitiveness (World Competitiveness Yearbook, Methodology, 1997; Global Competitiveness Report 1997, Financial Flows: Where the Smart Money's Going, 1997). In our view, an approach that incorporates such a great number of indicators is definitely valuable for assessing of whether a national environment is conducive to the development of a high level of competitiveness. As has been noted by Cohen, "competitiveness is a reconsideration of a broad set of indicators, none of which tells the whole story but that together provide a highly legitimate focus" (1994, p. 197). Nevertheless, attempts to incorporate all variables into one final index seem to be much more doubtful. There are two problems associated with the development of the weighted index. The first one is that of assigning weights to indicators that are very different, in both quantitative and qualitative terms, and are of different significance. The second problem is related to the application of the same indicators and the same weights to all countries.

In the light of the definition of national competitiveness given by the OECD (see Section 1.1.1), that has been accepted as a working definition for the present study, we can distinguish two stages of the analysis of national competitiveness:

- an evaluation of the achieved level of per capita income, and
- an assessment of the ability to develop and/or to sustain competitiveness in the future.

With some qualifications (as described above) per capita income of the national population can be measured by Gross Domestic Product per capita at purchasing power parity, GDP (PPP). Consequently, in our view, it can be accepted that changes in per capita income, expressed by per capita GDP (PPP), may reflect the dynamic development of national competitiveness. However, an analysis of national competitiveness should not be simply reduced to an assessment of the trend in per capita income. We would distinguish two different cases: the first – the declining, and the second – the rising income of the population. Declining living standards of the population of a particular national economy indicate that the level of national competitiveness is diminishing. In the case of rising living standards a more complex analysis is required to make a judgement whether economic growth will be eventually translated into a high level of competitiveness. As has been noted in the previous section, two additional conditions are necessary: economic growth should lead to achieving high levels of per capita income by international standards, and these high levels of income should be sustainable in the environment of open markets. It is also worth emphasising that a high rate of economic growth is not the absolute prerequisite for the development of a high level of national competitiveness. For an economy that initially had a low per capita income, achieving a high rate of economic growth is a necessary condition for developing a high level of competitiveness, but it is not a sufficient one (as follows from the argument presented above). A high-income economy may achieve a high level of competitiveness without being characterised by high rates of economic growth. In this case maintaining a high per capita income level, not achieving one, is the condition for competitiveness. For such an economy moderate growth rates may be sufficient for sustaining a high level of national competitiveness. Historically sustained high levels of per capita GDP, by international standards, are indicators of competitiveness. It is also worth noting that short-term fluctuations in the level of per capita income in either direction (cyclical or resulting from minor external shocks) do not affect the long-term trend and, thus, should not be taken into account in a study of competitiveness. In the next section we will present a review of recent empirical work analysing long-term trends in per capita income levels across different economies.

An evaluation of the ability to achieve and to sustain high levels of income over a long period is not an easy task. Many factors, economic and not only, can affect national competitiveness. Although, as has been noted by Porter, "whichever the definition of competitiveness adopted, an even more serious problem has been that there is no generally accepted theory to explain it" (1990, p. xii), new growth models can provide some theoretical background for an analysis of factors affecting long-term economic growth. Some of the relevant new growth theories will be considered in Chapter 2. Particular attention will be given to growth models investigating the effects of changes in industrial structure, technological development, innovation and the accumulation and diffusion of knowledge. In the next section we will consider the findings of recent empirical work investigating patterns of economic growth in different economies.

1.2 Empirical Tests of the Convergence Hypothesis

One of the major issues regarding national competitiveness is whether the existing extent of polarisation, in terms of per capita income, across the nations of the world is diminishing over time, or, in other words, whether low-income countries are catching up with high-income economies. Standard neoclassical growth theories predict conditional convergence (convergence to each individual steady state) as a general case and absolute convergence (convergence to a common level of GDP) of economies with similar tastes and technologies (Barro and Sala-i-Martin, 1995, p. 382). If individual steady states differ substantially across countries, conditional convergence may be consistent with actual polarisation of countries approaching their own steady states. Conditional convergence, thus, does not provide sufficient evidence that countries with initially low levels of income are catching up with high-income economies. One of the implications of the neoclassical theory is that, with globalisation of economic activities and deregulation of capital markets leading to the emergence of an integrated world economy, there is an increased opportunity for technological catch-up between countries. Consequently, many hold that there are reasons to expect that a pattern of absolute convergence across different national economies will be observed (see, for example, IMF 1997, p.78).

The convergence hypothesis is the proposition that over the long term countries are converging toward a common level of GDP per capita. Recent empirical work testing this hypothesis has shown a growing disparity across countries rather than convergence. These results make a significant contribution, contradicting the former views based on the neoclassical growth models, and raising some important questions. A review of recent empirical work testing the findings of the new growth models is presented in Dowrick (1998). Some of the results of recent tests of the convergence hypothesis are briefly outlined below.

The study undertaken by Dowrick and Nguyen (1989) revealed that the evidence of convergence in per capita levels for the OECD countries, over the period 1950-1985, was problematic for two reasons: first, for the period since 1973 convergence was weak; second, the results for the period since 1950 were critically dependent on the sample selection criteria.

In 1992 Dowrick subdivided the sample of 113 countries (from 1960-4 to 1984-8) into three groups, according to the levels of 1960-64 output per worker. The overall conclusion of this work was no evidence for the convergence hypothesis. Dispersion was found in income and productivity levels both within and across the three groups. The divergence trend was more pronounced for per capita income than for the output per worker, thus indicating a growing income inequality among the nations of the world.

More recent analyses of convergence have refined the previous findings of, generally speaking, non-convergence among nations as a whole. For example, Sala-i-Martin's tests, based on the neoclassical model, have led to some important conclusions. First, during the period 1960-1990 the pattern of global distribution of income showed no absolute convergence: poor countries did not grow faster than rich ones. Second, there is strong evidence of conditional convergence or, in other words, of convergence of countries and regions to their own steady state, although at a very low speed close to 2% per year (Sala-i-Martin 1996).

Barro and Sala-i-Martin found no absolute convergence for the sample of 118 countries, 1960-1985, but a strong evidence of absolute convergence for the sample of 20 OECD countries for the same period (1995, p. 27).

Quah formulated an alternative approach to studying convergence. Instead of applying cross-section regression analysis, which explores the average behaviour, he analysed the dynamics of the income distribution across countries. This study has shown that a process of polarisation of countries into two convergence clubs, rich and poor, representing the twin-peak distribution pattern, is under way. The analysis of the intra-distributional dynamics has led to the conclusion that immobility across the peaks is the persistent feature for most of the countries. There is, however, a positive probability (although minor in magnitude) for "growth miracles" to occur, as in the cases of Hong Kong, South Korea and Singapore (Quah 1996a, 1996b).

Jones (1997) has presented a more optimistic scenario for the "growth miracles". One of the possible explanations of the higher frequency of large upward movements within the … is gradually discovering the kind of institutions and …sful economic performance, and these discoveries are …" (Jones 1997, p. 34).

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… of divergence in per capita income across the nations of …vergence has been observed for particular groups of countries at particular time periods. Bernard and Jones tested the contribution of different sectors to the overall convergence among 14 industrialised countries over the period 1970-1987. The overall finding of this work is that aggregate productivity was converging over the period, but there was no uniform pattern of behaviour across sectors. The manufacturing sector showed very little or no convergence while the services sector presented strong evidence of convergence, thus influencing overall aggregate productivity trends. The changes in the trend for labour productivity in the manufacturing sector are particularly interesting: during the 1970s there was gradual convergence, though not

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Jones (1997) has presented a more optimistic scenario for the "growth miracles". One of the possible explanations of the higher frequency of large upward movements within the income distribution is that "society is gradually discovering the kind of institutions and policies that are conducive to successful economic performance, and these discoveries are gradually diffusing around the world" (Jones 1997, p. 34).

Pritchett (1997) has stressed that, although absolute divergence is prevailing, there are rare situations when less developed countries achieve strong economic growth, such as in some countries in East Asia. According to Pritchett, instead of trying to derive a single uniform growth model, it is crucial to understand what factors can cause strong and sustained economic performance and technological progress.

While the general finding has been of divergence in per capita income across the nations of the world in recent decades, convergence has been observed for particular groups of countries at particular time periods. Bernard and Jones tested the contribution of different sectors to the overall convergence among 14 industrialised countries over the period 1970-1987. The overall finding of this work is that aggregate productivity was converging over the period, but there was no uniform pattern of behaviour across sectors. The manufacturing sector showed very little or no convergence while the services sector presented strong evidence of convergence, thus influencing overall aggregate productivity trends. The changes in the trend for labour productivity in the manufacturing sector are particularly interesting: during the 1970s there was gradual convergence, though not sharply pronounced; after 1982 the trend changed to a steep divergence (Bernard and Jones 1994, 1996). These results, in our opinion, deserve further analysis at a higher level of disaggregation of manufacturing sector. Besides this, it would be useful to apply this type of research to Asian economies, where manufacturing industries have been structurally significant.

We can conclude that recent tests of the convergence hypothesis have shown that persistent polarisation in per capita income levels is the prevailing situation for nations as a whole. However, some countries, especially in East Asia, achieved high rates of economic growth, converging in terms of per capita income with the developed economies. This conclusion is of particular significance for this study. In terms of apparent convergence, some countries of East Asia appear as major variants from the international norm, providing strong reasons for examining factors that may have been central to their growth, such as specialisation in the computing and electronics industries. In Chapter 11 we will undertake tests of the convergence of income generated in the computing and electronics, textiles and clothing and total manufacturing industries, as well as economy-wide, in Chapter 12, across a range of countries.

Marked differences between the rates of economic growth achieved in different countries, especially the unprecedented growth of East Asian economies, highlighted in the findings of recent empirical work testing the convergence hypothesis, confirm that it is crucial to get a better understanding of what factors can cause strong and sustained economic growth. As has been pointed out by Durlauf, "the convergence hypothesis speaks to one of the critical economic motivations of the endogenous growth literature – namely the persistence of per capita income differences across countries" (1996, p. 1016). In the next chapter we will review some of the literature, in particular some new growth theories, which considers major factors affecting long-term economic growth at the current stage of technological development, such as changes in industrial structure, innovation, accumulation and diffusion of knowledge.

CHAPTER 2

RECENT LITERATURE ON THE THEORY OF ECONOMIC GROWTH – A BRIEF REVIEW

2.1 The Role of Changes in Industrial Structure for Economic Growth

In standard neoclassical theory there is no role for industrial structure in the theory of growth or in the determination of national competitiveness. The uninhibited, self-adjusting processes of the market generate the optimum level of output and/or growth, and the structure of a nation's economy emerges as a result of this process. But no particular industrial structure is privileged or essential for a high level of competitiveness. Nations can have strong levels of international competitiveness, and high levels of national income with quite different industrial structures. In this perspective, the key policy issue is to free up market processes to ensure optimum resource allocation and to allow the market to determine the best industrial structure for a given country.

Yet the presumption about the irrelevance of industrial structure to growth and competitiveness is not widely accepted. Development economists have long interpreted development in terms of industrialisation, that is in terms of a change in structure of the economy to one more conducive to high income levels. One of the early attempts to formulate optimal strategies for achieving sustained economic growth dates back to 1943, when Rosenstein-Rodan proposed the concept of the "Big Push" ("Problems of Industrialisation of Eastern and South-Eastern Europe", *Economic Journal*, LIII, 1943, pp. 202-11, summarised in Rosenstein-Rodan 1984, pp. 207-215). Rosenstein-Rodan envisaged a pivotal role for the government for transforming a stagnant economy into a state of sustained growth. In particular, he emphasised the role of large scale infrastructure investment as a basis for industrialisation and of public investment in education and training (Rosenstein-Rodan 1984, pp. 210-215, Rostow 1990, pp. 408-409; Haberler 1987, p. 79, Hoselitz 1960, p. 202; Sheehan 1993, Sheehan 1996, p. 60).

Some recent growth theorists have modelled growth in terms of changes in industrial structure and in terms of the significance of government policies influencing the trajectory of technological and economic development. Changes in the industrial structure of the economy with respect to the degree of openness of the economy, market structure and patterns of income distribution influencing the composition of domestic demand, have been important emphases in recent economic modelling. Murphy, Shleifer, and Vishny (1989a) explored the role of coordinated investment across sectors in a backward economy to achieve a big push into industrialisation. A number of models, presented in this work, are based on the existence of complementarities, or mutual spillover effects, between industrialising sectors. A firm exercising increasing returns can contribute to a profitable simultaneous expansion of several sectors, a big push, although such a firm would not generate profits if it industrialises alone. Increasing returns to scale and imperfect competition can thus lead to the possibility of the existence both low-output and high-output equilibria, because of spillover effects. Among the implications of this work is that there is a role for the government in the process of development: growth of income and welfare can be fostered if the government encourages simultaneous industrialisation in several sectors of the economy through a coordinated investment program.

In another paper Murphy, Shleifer and Vishny (1989b) presented a two sector model, in which industrialisation occurs due to an increase in productivity in a leading sector, agricultural production or mineral exports, translated into demand for domestic manufactures, due to a restricted access to foreign trade, given that demand is widely distributed across population. In this model industrialisation is viewed as a substitution of increasing returns technologies, possessed by a monopolist entering industrial production, for constant returns technologies prevailing in the traditional sector. This work provides a theoretical explanation of the transformation of an economy from a producer of primary commodities into an exporter of manufactured products. The model of economic growth consists of two stages: agricultural production or mineral exports boost industrialisation that in turn generates manufacturing exports. This model also provides some insights into the possible role of government policy to support successful industrialisation through encouragement of homogeneity of tastes provided by a particular pattern of income distribution conducive to generation of demand for domestic manufactures.

Another direction of economic modelling attempts to explain the growth differentials across countries by considering the constraints imposed on the growth of an open economy by the balance of payments (see, for example, Thirlwall and Dixon 1979, McCombie and Thirlwall 1994). In this modelling growth is driven by autonomous demand and is related to the change in productivity corresponding to output growth. However, the growth of demand will need to be constrained, either by market forces or by the authorities, if the structure of the economy is not sufficient to support a given level of demand with external balance. McCombie and Thirlwall have shown that growth rates actually achieved in several developed countries over the 1970-1985 period could be approximated by the rate of growth of exports divided by the income elasticity of demand for imports. This measure can, on certain assumptions, be regarded as determining the balance-of-payments equilibrium growth rate (1994, pp. 232-244). One of the possible implications of this type of modelling is that, given certain import requirements, an expansion of production and exports in particular sectors, rapidly growing in world markets, may stimulate economic growth by increasing the level of GDP at which the balance of payments constraint becomes operative.

The ability to generate spillovers to other economic activities is widely held to be one of the most important characteristics of the knowledge-intensive sectors, such as the information technology industries. Durlauf (1993) developed a dynamic, stochastic model, based on random field theory, of the evolution of an economy that consists of a countable set of industries exhibiting mutual intertemporal linkages provided by technological externalities, affecting the production functions of each sector. Strong cross-sector complementarities or, in other words, high levels of mutual sensitivity of the production decisions in different industries, can generate a combined effect on aggregate behaviour, leading to the possible existence of multiple equilibria in the long-run output of the economy. Depending on the magnitude of the sequential technological complementarities, affecting the conditional transition probabilities of current production in relation to the history of the economy, both low-output and high-output trajectories of economic development are possible. Thus, a shift across long-run equilibria can be achieved by changing the probability of high output in individual industries that can trigger industrialisation, that is by action to influence the industrial structure of the economy.

With respect to economic growth, Durlauf's model assigns a special role to the leading sectors, defined as industries trading with all other sectors. The aggregate output of the economy can be significantly affected by the production behaviour of the leading sectors, thus determining the actual path of economic development. "Expansion of leading sectors can, by reducing production costs for the rest of the economy, induce a sequence of local spillover effects which lead the economy to sustained high production" (Durlauf 1993, p. 350).

Technical change is viewed as the major factor affecting the high-output probabilities. Durlauf formulated two interpretations of the relationship between technological change and the simultaneous evolution of conditional high-production probabilities across sectors. A high degree of correlation of technical change across different technologies provides one of the interpretations. An alternative interpretation is the existence of a common factor affecting a number of industries. Transportation and steel production provide historic examples of leading industries capable of stimulating aggregate expansion throughout the economy.

This conclusion is of particular relevance to the topic of this research. Computing and electronics industries are at the core of the current stage of technological change, defined as the information technology revolution and, thus, can be regarded as the leading sectors. In Chapter 4 we will consider the attributes of computing and electronics industries in more detail.

2.2 Significance of Knowledge, Technology, and Innovation for Growth

The issue of to what extent scientific discoveries, inventions, and innovations contribute to economic performance is not new in the history of economic thought. For example, in 1966 Schmookler showed that for 'science-based' industries (such as electrical and electronics industries) scientific discoveries in many instances directly lead to patented industrial inventions (Scott 1989, p. 132). In 1971 Kuznets emphasised the role of technological change as a major source of economic growth (Rostow 1990, p. 355). The current stage of technological development, to which the information technology revolution is central, is characterised by an increased significance of knowledge and innovation for economic development. Many authors have argued that national competitive advantage is a function of the ability to generate and apply knowledge and new advanced technologies (see, for example, Porter 1990, pp. 165, 282). Advanced knowledge derived from continuous innovation is embodied in skilled labour, capital, intermediate and final products, as well as in modern production techniques. As has been stated in the recent OECD publication 'Benchmarking Knowledge-Based Economies', "the ability to create, distribute and exploit knowledge and information seems ever more important and is often regarded as the single most important factor underlying economic growth and improvements in the quality of life" (OECD 1999, p. 7).

Theories focusing on the effects of knowledge, technology and innovation on economic growth are of particular significance to the study of information technology industries. Grossman and Helpman (1994) have presented a review of economic models considering the effects of innovation and improvements in technology on the long-term growth through qualitative improvements in both capital and labour inputs. As has been noted by OECD, the major factor behind the invention and diffusion of technology is the quality of human resources (1999, p. 9). From this perspective economic models considering the development of human capital as a factor of economic growth deserve special attention.

In the contrast with standard neoclassical growth models implying convergence of countries, with similar physical endowments and access to similar technologies, to a unique balanced growth path, models developed by Romer (1986, 1990), Lucas, (1988) and Azariadis and Drazen (1990) have provided another type of theoretical justification for the observed divergence trends in economic development across countries. According to these models spillover effects, social increasing returns, generated by accumulation of human capital can be translated into diversity in growth rates, leading to the existence of multiple equilibria, or locally stable steady states. Let us consider findings of these models in more detail.

Romer (1986) developed a competitive equilibrium model of long-run growth, based on endogenous technological change. The accumulation of knowledge by forward-looking, profit-maximising agents is considered as the major factor of economic growth. Knowledge, being a product of technology exhibiting diminishing returns, is assumed to be an input of production, a capital good, with an increasing marginal productivity. Consequently, the production of consumption goods, as a function of stock of knowledge among the inputs, exhibits increasing returns. The rate of economic growth, providing social optimum, may be monotonically increasing approaching the upper bound determined by the maximum technologically feasible growth rate for knowledge. The model suggests that due to the existence of increasing returns and multiple equilibria a small disturbance of a change in policies can significantly affect the equilibrium reached. One of the implications of this model is that government intervention, that shifts the allocation of resources from current consumption towards research, can result in welfare improvements that can not be achieved by private agents. Firms tend to recognise private returns to knowledge but neglect positive externalities, thus competitive equilibrium solution results in excessively high level of consumption while the amount of research is not sufficient.

In another model (1990), based on augmented endogenous technological change that arises from investment decisions made by profit-maximising agents, Romer considered two separate components of knowledge: human capital, which is rival, and technology, which is non-rival. The model of the economy consists of three sectors. A research sector, which exhibits increasing returns, produces new knowledge in the form of designs for new producer durable goods by using human capital and the existing stock of knowledge. An intermediate goods sector uses the designs generated in the research sector to produce durables. The final goods sector uses labour, human capital and producer durables to produce final output. Among the assumptions used in the model are constant population and labour supply and a fixed stock of human capital. The model has particular properties. In the research sector productivity increases linearly with the growth in technological knowledge. The intermediate goods sector operates under monopolistic competition. Capital goods are assumed to be separable into an infinite number of distinct types of producer durables, which are perfect substitutes. One of the conclusions of this type of modelling is that the stock of human capital allocated to research determines the rate of economic growth. The socially optimal rate of growth can be achieved by subsidising the accumulation of technological knowledge. This model also suggests that having a large population is not a sufficient condition for economic growth. Less developed economies can rather benefit from economic integration with the rest of the world. "... what is important for growth is integration not into an economy with a large number of people but rather into one with a large amount of human capital (Romer 1990, p. 98).

Lucas (1988) has argued that human capital development achieved by education can significantly affect long-term economic growth patterns and the level of welfare. Accumulation of human capital is modelled by a simple linear function involving time spent on learning. It is assumed that there is an externality in production derived form the average level of human capital. Higher level of human capital through the generation of spillover effects productivity and hence economic growth. According to Lucas, enhancement of human capital through education and learning-by-doing, provided by knowledge externalities of high technology production activities, are the major drivers of economic growth.

A model developed by Azariadis and Drazen (1990) shows that multiple, locally stable stationary states are possible, due to increasing social returns to scale in the accumulation of human capital. Externalities associated with the process of creating human capital generate labour-augmenting effects, inducing multiple balanced growth paths as stationary equilibria. Moderate differences in the stocks of factor inputs, such as the stock of knowledge, given that certain critical values are surpassed, may result in markedly different growth rates, implying a rapid expansion of aggregate production possibilities. According to this model, human capital accumulation can lead to multiple growth paths in two different ways. First, when a certain level, a critical mass, of knowledge embodied in human capital is accumulated, it is easier to acquire further knowledge. Thus the existence of a critical mass of knowledge reduces the costs of acquiring further knowledge. Second, reaching critical mass of knowledge can induce a dramatic increase in production possibilities. In both cases threshold externalities, providing conditions for a development takeoff, are being generated. It is worth noting, however, that Azariadis and Drazen viewed a highly qualified labour force as a necessary but not a sufficient prerequisite for growth. Factors such as wasteful economic policies, wars and other political upheavals, natural disasters, can significantly impede economic progress (p. 519).

Other models, developed by Romer, have shown that foreign investment can play an important positive role for the development of industrialising countries. In particular, Romer has concluded that there can be first-order negative effects of trade restrictions that affect the flow of ideas from overseas, preventing the introduction of new technology (Romer 1994a). In two other papers Romer has investigated the importance of the idea gap existing between the developed and developing countries. The ideas gap "suggests that multinational corporations can play a special role as the conduits that let productive ideas flow across national borders" (Romer 1993, p. 544). New ideas, increasing the productivity of R&D, "... may tip the economy from a no-discovery equilibrium to one in which many new products and processes are discovered" (Romer 1992, p. 87).

Cozzi has explored the effects of the existence of a vector field of possible paths of development generated by a scientific discovery. The selection of the actual path of development results from the interaction of economic and technological forces. Subsidies to R&D or taxation can substantially alter the trajectory of technological development and have considerable long-term effects on economic growth. Moreover, the time of the policy changes also matters. Early implementation of the policies leading to a superior trajectory results in the convergence to a higher steady state of growth. Another important conclusion of the model is that the perfectly competitive market solution can generate a poverty trap for a backward country, when the preferred short-term gains impede the long-term growth. For an advanced economy the perfectly competitive conditions for R&D firms can lead to the development along the wrong path (Cozzi 1997).

Similar conclusions in terms of possible effects of national policies have been derived from a model developed by Klundert and Smulders. National competitive positions can be substantially affected by government policies targeting the development of high-tech production that increases learning opportunities. Strong policies can change the state of divergence into a converging growth path. Even temporary measures, such as "infant-industry" support, can have permanent effects (Klundert and Smulders 1996).

2.3 Factors of Uneven Growth and Geographic Distribution of Centres of Economic Activities

The global development of information technology industries has led to the emergence of new centres of concentration of production activities. Many countries of East Asia have emerged as major producers and exporters of computing and electronic products (see, for example, Wellenius, Miller, and Dahlman 1993, Kozmetsky and Yue 1997, Mathews and Cho 2000, Sheehan, Pappas, Tikhomirova and Sinclair 1995, Sheehan and Tikhomirova 1996, and also chapters 6, 7 and 8 of this study). In this perspective, models investigating the origin of uneven growth and of the geographic distribution of centres of economic activities deserve special attention. These models may refer to either the geographic distribution of economic activities with a country, or to their distribution across countries.

Krugman has developed a model of centripetal and centrifugal tendencies in an imperfectly competitive market environment. He argues that a certain combination of parameters can lead to the existence of multiple agglomerations allocated in a particular order within an economy (Krugman 1995). Another model, developed by Krugman and Venables, addresses the issue of the distribution of economic activity across countries. This model attempts to throw some light on the complex issues of which nations are likely to benefit from global economic integration. The overall conclusion of the model is that growth of income in industrialising countries can lead to erosion of the initial advantage of industrialised core (Krugman and Venables 1995, p. 876). "...the spread of industry to the South reduces relative and perhaps absolute Northern wages..." (p. 874). This conclusion is of special interest for this study: changes in wages of employees of computing and electronics industries in developed and developing countries will be discussed in chapters 10 and 11.

Another group of economic models considers different factors influencing patterns of the diffusion and adoption of innovation such as attractiveness of the innovation, efficiency of communication networks, industry structure, imperfection of information about innovation, and strategic behaviour (for references see Lissoni and Metcalfe 1994, pp. 109-125). Such models, combining diffusion and location theories, link the speed and direction of diffusion and of the adoption of technical knowledge with the spatial pattern of allocation of urban centres. One of the important results of such modelling is that, for example in the case of electronic industry, agglomerations of small firms are capable of competing with highly integrated big companies (p. 130). This theoretical conclusion implies the possibility for new entrants to change the balance of national competitiveness within the IT industry.

Conclusions

One central conclusion of this chapter is that there is a range of new growth models that envisage a role for changes in industrial structure in the growth of a particular economy. Many of these models consider long-run or steady state growth, in the context of an open economy, and hence link directly to competitiveness as defined earlier. The possibility of existence of multiple equilibria in the long-run output of the economy, resulting from the different, high/low output, trajectories of economic development, is a common feature of such theories. Different paths of economic development leading to locally stable steady states may also be reflected in regional divergence.

Another body of work suggests that the growth differentials across countries can be explained by the differences in the constraints imposed on growth by the balance of payments. This implies that an expansion of production and exports in particular sectors which are rapidly growing in world markets may stimulate economic growth.

A range of factors has been identified in these models as major drivers of economic growth, through qualitative improvements in both capital and labour inputs. Among such factors are:

- technical change and technological innovation;
- generation, accumulation, absorption and diffusion of knowledge;
- externalities associated with technology, innovation and learning;
- complementarities across industrial sectors and technologies.

One further implication of the recent growth theory literature is the possible existence of leading industrial sectors, which may be particularly important in terms of factors driving growth. Expansion of leading sectors can lead the economy to sustained high production. Hence such sectors may be a special locus of policies.

These conclusions are of particular relevance to the topic of this research. Contrary to the basic neoclassical view, there is in contemporary theory a range of models that suggest an association between industrial structure and growth/competitiveness. More specifically, the review of the literature suggests that there are four main types of reason why industrial structure may matter for growth and competitiveness. These are as follows:

- *direct effects*: some industries, and not others, generate high levels of value added per employee and wages per employee, and hence contribute directly to high levels of per capita GDP;
- *demand growth and increasing returns*: some industries, and not others, are associated with high rates of growth in demand (from either national or international sources) and also with increasing returns to scale, so that production within those industries will generate a virtuous cycle of rising demand, falling unit costs, further increases in demand and so on;
- *spillover effects on other industries*: some industries, and not others, generate high spillovers to other industries (in terms, for example, of technology, production knowledge, and design and product creation capabilities), and these spillovers spur the growth of the overall economy, and
- *balance of payments constraint effects*: export related growth in an industry growing rapidly in world markets may lift the balance of payments constraint on an economy, thereby allowing that economy to grow more rapidly than would otherwise have been the case.

Expansion of leading, strategic, sectors can change the trajectory of economic development and, thus, foster growth of national income and welfare. Indeed, such strategic sectors may embody each of the four reasons cited above through which industrial structure may influence long-term competitiveness – they may be high value industries contributing directly to high levels of GDP per capita, but they may also be high growth industries with increasing returns, generating high levels of spillovers to other industries and being strongly export oriented. The strategic importance of high-technology industries, and in particular of computing and information related industries, for economic development at the current stage of technological development has been stressed by many authors (see, for example, Magaziner and Reich 1982; Lawrence 1984; Prestowitz 1988; Dertouzos, Lester and Solow 1989; Tyson 1992; Thurow 1992; Carnoy, Castells, Cohen and Cardoso 1993; OECD 1996; OECD 1999). Chapter 3 shows that these industries have been widely viewed by governments as strategic sectors, and have been the subject of major policy initiatives.

CHAPTER 3

THE DEVELOPMENT OF INFORMATION TECHNOLOGY INDUSTRIES

It has been shown in Chapter 2 that, in contrast with the basic neoclassical model, a range of models suggest a decisive role for changes in industrial structure in longrun growth, and hence provide a possible theoretical basis for an association between industrial structure and competitiveness. This in turn may provide a justification for the view that strategic industries – those characterised, for example, by increasing returns, spillovers, high knowledge intensity, complementarities between technologies and with other industries– may have a special role in generating long-term growth. Many have held that the information technology industries are precisely of this character. That is, that they are characterised by high knowledge intensity and significant learning economies, increasing returns to scale and oligopolistic competition, reflecting the extent of sunk costs, and by a capability to produce rapid and multidirectional technological spillovers and externalities. These spillovers are generated in the process of design and production of computing and electronic equipment, for other industries and economic activities.

The computing and electronics industries are highly concentrated at regional and firm levels. In the early 1990s the top five computer firms had almost 40 per cent of the world market (Vickery 1996, p. 111). While production activities are focused on particular regional nodes, these industries are highly globalised. High levels of international investment in production, international sourcing of parts and components, intra-firm trade, and international collaboration agreements are the distinguishing features of these industries. They are also among the fastest growing in the world. Products of these industries, such as consumer electronics, communications and telecommunications equipment, have been a major source of growth in world trade. These and other characteristics of computing and electronics have led many to define these industries as strategic opportunity industries (see, for example, Carnoy, Castells, Cohen and Cardoso 1993, p. 131; Vickery 1996; Houghton and Flaherty 1997, pp. 131-143). (The attributes of the computing and electronics industries in comparison with characteristics of other manufacturing industries will be considered further in Chapter 4, Section 4.3).

The computing and electronics industries have been targeted as strategic in many developed and developing countries in North America, Europe, Asia, and Latin America (Kozmetsky and Yue 1997, pp. 10-17). “The semiconductor industry has been an explicit target of industry policy, whether in the guise of military policy in the United States or of commercial policy elsewhere in the world” (Yoffie 1993, p. 29).The effects of government intervention varied across countries depending on the type of policy employed and how it matched the industry’s condition (Yoffie 1993, p. 70). As has been noted by Chapman, the development of long-term industrial policy must be related to national objectives and requires multi-faceted and sophisticated strategic analysis (1991, p. 90). Although the degree of success of government policies targeting the development of computing and electronics industries differed across countries, it has been recognised that the long-term competitive position of national firms in international competition can be significantly affected by government policy (Borrus, Tyson, Zysman 1986, p. 92; Yoffie 1993, p. 446). By briefly reviewing in this chapter the development of these industries both in the advanced countries and in East Asia, the central role of government perceptions of these industries as strategic, and of the resulting policy initiatives, can be demonstrated.

3.1 The Development of Computing and Electronics Industries in the Advanced Countries

The history of the computing and electronics industries goes back to the time of the World War II. The necessity to achieve technological superiority during the war stimulated the development of the electronic digital computer (Flamm 1987, pp. 6-7; 1988, pp. 29-30). Technological development maintained its strategic significance during the postwar period as well. In the period 1945-1955 the government dominated the development of the computer industry in the United States. In fact, the first development stage was critically dependent on government policy, which established the industry’s technological trajectory. Government created initial markets through procurement and ensured the availability of technology at low cost (Borrus, Tyson, Zysman 1986, p. 93). Between 1949 and 1959 the U.S. government funded approximately 60% of all R&D projects within the U.S. computer industry (Kozmetsky and Yue 1997, p. 10). From the invention of transistors in 1948 through to the commercial introduction of the integrated circuit in 1962, the U.S. military, the “creative first user”, played a particularly important role for the development of computing and electronics. Military R&D programs set the direction for early product design by emphasising miniaturisation, high performance and reliability. The initial market for the integrated circuit was formed by military and space agency procurement. Diffusion of the integrated circuit into non-military markets and the entry of new firms were facilitated by the existence of strong government demand (Borrus, Tyson, Zysman 1986, pp. 94-95). After 1955 the government played the key role in the development and the application of high-end, large-scale computers. Low-end applications, based on minicomputers, were open to market competition. Since 1975 the computer has been considered as a low-cost, mass-produced good (Flamm 1987, p. 42).

In a similar vein, government policies have been important for the development of the electronics industries in the United States throughout the history of the industry. The whole range of policies, such as tax policy, direct funding and procurement, policies enhancing public-private cooperation, competition, education and training, have been applied (Flamm 1987, 1988; Wellenius et al. 1993; Kozmetsky and Yue 1997). Government funding has been primarily directed towards military and national security applications (Wellenius et al. 1993, p. 102). Flamm estimates that over the 1975-1984 period about 40 per cent of all computer research and 60-75 per cent of basic computer research was provided by the federal government (1987, p. 104).

In Japan and Europe the information technology industries have also been considered as strategic and government policies have played a significant role in the development of these industries. However, in the contrast with the United States where computer technology had a military focus, in Europe and Japan the strategic objective was primarily commercial.

The rapid emergence of Japan's electronics industry as a world-class competitor was a planned result of a concerted policy effort (Borrus, Tyson, Zysman 1986, p. 91). The establishment of the electronics industry began in the late 1950s (Kozmetsky and Yue 1997, p. 12). Japan lagged behind the United States in electronics technology at that time (Anchordoguy 1989, p. 19). The Japanese government nurtured and protected the "infant" electronics industry, applying the whole range of policies such as subsidies to domestic firms, control over foreign direct investment, import restrictions through tariffs and quotas, and foreign exchange allocations, while maintaining controlled competition between the protected Japanese firms (Kozmetsky and Yue 1997, pp. 12-13; Fransman 1995, pp. 22-23). The role of the government was also significant for the selection, purchase, and adoption of foreign technology (Kozmetsky and Yue 1997, p. 12; Yoffie 1993, p. 122) and in educating the entrepreneurs and technicians (Fransman 1995, p. 446). The government supported cooperative research in the area of emerging technologies that involved government, industry and academia. In the 1980's the Japanese electronics industry achieved world-class status, at the level of competitive parity with the USA andsurpassing Western Europe (Kozmetsky and Yue 1997, p.13). For a detailed description of the history of Japanese electronics and communications industry and the role of the government see Anchordoguy 1989, Fransman 1995, Kozmetsky and Yue 1997. Some additional information on government policies employed in Japan can also be found in Johnson 1982, Flamm 1987, Vestal 1993, Wellenius et al. 1993, Yoffie 1993.

In the United Kingdom, Germany and France the development of the indigenous computer technology base began at about the same time as in the United States. European governments, although providing support for national electronics and computer industries, have not been as successful as the American and the Japanese ones. In 1950 British technology was in many respects superior to that of the United States. However, their relative technological competitiveness declined within the next decade. In the 1970s the British computer producers were losing the market share even in the home market (Flamm 1987, pp. 159-160). The first fully operational electromechanical calculating machines were built in Germany in the 1941. During and after the war Germany continued research in computer related areas. By the mid-1950s several experimental machines were built, but no commercial models were produced because of the ban on constructing certain electronic devices. However, even after 1955, when the ban was lifted, commercial producers were lagging behind their foreign competitors (Flamm 1988, pp. 159-162). In the late 1960s "the first serious minicomputer producer", Nixdorf, achieved a certain degree of success but with "virtually no assistance from the German government" (Flamm 1987, p. 158).

In France the theoretical design of electromechanical calculators based on binary arithmetic was developed in the late 1930s. Before World War II France had a strong competitive position in the European punched card business machine market. In the 1950s France was using relatively backward technology in comparison with the United States. Although electronic computers were produced for military purposes, France had very little commercial success (Flamm 1988, pp. 150-152). Throughout the history of the development of electronics and computing the governments of the United Kingdom, Germany and France applied various policies such as tariffs, subsidies, interest-free loans, funding of R&D, public procurement. Although government policies employed in Europe were similar to those implemented in Japan, they were much less effective (Yoffie 1993,p.

122). European counties, famous for their world-class basic science and fundamental research, have not achieved competitive levels in the commercial electronics and computing industries comparable with those of USA and Japan.

3.2 The Emergence of Computing and Electronics Industries in East Asia

The emergence of East Asian countries as major producers and exporters of computing and electronic products is one of the most interesting and significant features of the economic history of the 20th century. The creation of knowledge-intensive, high-technology industries in East Asia and ASEAN is regarded as a major factor contributing to rapid economic growth achieved in these economies (see, for example, Mathews and Cho 2000, pp. xiii-xiv; Sheehan and Tikhomirova 1996, pp. 25-26). It has been suggested that, at the initial stage, the development of computing and electronics industries did not differ from that of other industries. East Asia emerged as an assembly base for many industries, including information technology industries. When electronic products approached the status of a commodity, the production and trade of such standard low-end products shifted to low-cost locations. This phenomenon can be explained by the standard trade theory based on focused on country-specific factor endowments. A "snowball effect" in terms of expansion of the types of goods produced and exported by this region can also be justified. First, as a result of rapid technological development and short product cycles more electronic products became standard, low-end (for information on the issue of "commoditisation" of computers see Vickery 1996, pp. 112-113). Second, East Asian countries experienced advantages of location: once the region became a location of production of some products it became more attractive as production base for other products as well (Yoffie 1993, pp. 3, 5, 430-432).

The technological development – the transition from a low-cost producer, an imitator of foreign technologies to an innovator, a producer of high value-added electronic goods– that has occurred in some East Asian economies can hardly be explained by the traditional theory of trade (Yoffie 1993, pp. 122-123, 180; Council on Competitiveness 1998, p. 9; Mathews and Cho 2000, p. 2). "It is the special achievements of East Asian countries such as Korea, Taiwan and Singapore in knowledge-intensive sectors which cannot be accounted for in terms of simple capital and labour inputs that call for a more sophisticated explanatory framework" (Mathews and Cho 2000, pp. 12-13). As has been argued by Mathews and Cho, in a detailed study of a semiconductor industry in East Asia, low labour costs were one of the advantages in the early 'labour-intensive' phase of industrialisation of East Asian countries. But they argue that this factor has little validity at the high technology phase of development, when labour accounts for so small proportion of the costs (p. 13). Moreover, according to Mathews and Cho, the low cost advantage was "rapidly diminishing by the time that these countries were ready to make their break into knowledge-intensive industries" (p. 7). Our analysis has shown that labour costs factor retained its validity at the high-technology phase of development. In the early 1990sin the developed economies proportions of labour costs in the overall value of computing and electronics production remained substantial: 26 per cent in Germany and more than 20 per cent in the Netherlands and in the USA. In East Asian economies at that time labour costs accounted for relatively minor proportions of gross output of the computing and electronics industries: in South Korea for 11 per cent, in Singapore for 8 per cent, and in Malaysia for 6.4 per cent (see Table 10.2 and Chart 10.5). Besides this, wages in the computing and electronics industries in East Asian economies were significantly lower than the levels of the developed countries (see Table 11.2 in Chapter 11).

Technological diffusion, via imitation, leverage and learning, rather than the generation of knowledge through R&D, has been widely held to be the major source of national wealth creation in East Asia (e.g. Mathews and Cho 2000, p. 17). Diffusion of information technology involves not only acquiring computerised equipment, product design and related know-how, but also continuous improvement after acquisition, and the development of technical change-generating capabilities (Hanna, Guy and Arnold 1995, p. xi). The emphasis of the approaches implemented in South Korea and Taiwan was not on 'passive' technology transfer but on 'active' technology leverage, that enabled these countries not only to absorb, adapt and disseminate foreign technology but also to improve it (Mathews 1995, p. 8). By the mid-1990s the R&D-based innovative capacity of some East Asian countries reached levels comparable with those of the developed economies. The growing number and sophistication of competing countries was viewed by the Council on Competitiveness as the largest threat to the U.S. competitive position in information technology industries (Council on Competitiveness 1998, p. 68). Between 1992-1996 more than 1000 IT patents, registered in the United States, were granted to Taiwan's inventors, and more than 1600 IT patents were granted to inventors from South Korea. These economies surpassed the United Kingdom in terms of the numbers of patents registered in the USA and approached Germany. Other countries, such as Singapore, Malaysia, and

Hong Kong, are occupying fast-follower position and are "capturing downstream jobs and wealth from innovative activity in the United States" (pp. 9, 68). Our analysis of the output of R&D activities in different countries (see Table 10.3, Chapter 10) confirms that in 1995, in terms of the numbers of patents granted by the U.S. Patent Office, South Korea and Taiwan were among the global leaders in IT related research. In Singapore, Hong Kong, and China the numbers of patents were increasing over time, but in the mid-1990s these countries were still lagging behind most of the advanced economies. Malaysia, Thailand, the Philippines, and Indonesia had virtually no patents registered in the United States.

The newly industrialised Asian countries, South Korea, Taiwan, Singapore, Malaysia, and Thailand, followed Japan in terms of industrial policies employed in the process of developing computing and electronics industries. The governments of these nations have supported firms "through direct funding, investment loans, and the establishment of national research centres for developing and transferring electronic technologies and for training engineers and other workers" (Kozmetsky and Yue 1997, p. 13).

South Korea presents one of the most interesting examples of the successful development of the electronics industry. South Korea is one of the "late comers" into the global electronics industry. The development of the electronics industry began in the late 1960s from the assembly of black-and-white TV sets (Amsden 1989, p. 82). The government played a key role in fostering South Korea's electronics industry. It protected local markets by imposing high tariffs and by import licensing, encouraged and directed the acquisition of foreign technology and capital, and funded R&D undertaken by universities and companies (Kozmetsky and Yue 1997, p. 14). In the late 1970s the government targeted a structural change in the electronics industry from pure assembly operations to the production of basic components and parts. Electronics was viewed as a major export industry, and semiconductors, computers and related items were selected as strategic products (Kim and Leipziger 1993, p. 20). At this stage the domestic market was highly protected and foreign direct investment in electronics was restricted (Amsden 1989, p. 82). In the 1980s the government realised the necessity to move into advanced, research-intensive areas of microelectronics. In order to get access to modern technologies, several policy revisions were made towards opening up South Korea's electronics industry to foreign direct investment and to allow greater involvement of foreign companies in research and production activities (Wellenius et al. 1993, p. 171). The government promoted R&D activities by supporting collaboration between private and public research institutions.

Among other initiatives, lower tariffs were imposed on imported equipment for R&D purposes and a percentage of profits used for investment in R&D was exempt from taxation (Amsden 1989, p. 83).

Taiwan, as well as South Korea, emerged as a major competitor in such areas as semiconductors, computers, and other electronic products, moving from low-skill assembly operations to high-value-added segments of the computing and electronics industries. In Taiwan, as in Japan and South Korea, government played a guiding role in fostering the development of the computing and electronics industries. Large-scale integrated circuits, automation, lasers, and computer hardware and software were targeted by the government direct initiatives involving acquisition of foreign technologies, market-oriented export promotion and provision of funds for the development of new technologies and training of engineers and programmers (Mathews 1995, p. 12; Kozmetsky and Yue 1997, p. 14). In spite of major similarities between the strategies for development of the electronics industry in South Korea and in Taiwan, there were some differences as well. In South Korea large established conglomerate firms (the chaebol), such as Samsung, Goldstar, and Hyundai, were the major vehicles for the development of the electronics industry. Small and medium-sized enterprise dominated in Taiwan. An important feature of the South Korean semiconductor industry was export orientation. In Taiwan export orientation was not of such overwhelming significance for the development of electronic industry. Supplying to the growing domestic market was equally important as exporting (Mathews 1995, pp. 8-16).

In Singapore and Malaysia multinational corporations were considered the major source of technology transfer. Most of the electronics firms in Singapore, Malaysia, and Thailand are characterised by assembly operations and dominated by offshore subsidiaries of U.S. and Japanese firms. Government incentives played an important role for the development of the electronics industries of these countries. In Singapore the government strategy to acquire, diffuse, and generate a next-generation of IT products and services was firmly grounded within a broader industrial policy developed in the 1960s. In 1968 the Development Bank was established to finance industrial development, with 49% government participation. In the late 1970s the Economic Development Board identified computers, peripheral equipment and microelectronics among eleven key industries. National R&D policy included a range of incentives such as expansion of training and education and increases in wages. The 1980-90 development plan was to restructure the economy on the basis of new knowledge-intensive products and services, the "second industrial revolution". In 1986 Singapore launched a plan targeting the improvement of productivity and competitiveness of the economy on the basis of the development of a strong export-oriented information technology industry (Wellenius et al. 1993, pp. 176-177; Mathews 1995, pp. 9-10; Hanna, Boyson, and Gunaratne 1996, p. 155; Kozmetsky and Yue 1997, pp. 14-15).

The fact that none of the firms in South Korea, Taiwan, Singapore and Malaysia were forced into bankruptcy during the global downturn in the world semiconductor industry related to 1997-98 Asian financial crisis (Mathews and Cho 2000, p. 31) indicates that these countries have reached the status of major players in the global electronics industry. Further description of the development of computing and electronics industries and of government strategies employed in different countries can be found in the studies cited throughout this chapter.

Conclusion

This brief overview of the development of the information technology industries, and of the government policies applied in different countries, allows us to draw some conclusions that are of particular relevance to this research. It was not our goal, in the foregoing discussion, to evaluate the degree of success of government policies which targeted the development of the computing and electronic industries. For our purposes, however, the fact that such policies have been applied is quite important. It indicates that governments in many industrialised and developing countries adopted the point of view that industry structure matters for economic development. In acting on that viewpoint, the computing and electronics industries were considered as strategically important.

The aim of this study is to throw light on the link between changes in industrial structure and national competitiveness, with particular emphasis on the strategic significance of the information technology industries. In the next chapter we will start the analysis by considering options for quantifying industrial composition of manufacturing sector and by developing a new approach for assessing manufacturing structure and structural changes over time. Particular attention will be given, in succeeding chapter, to the evaluation of the structural significance of computing and electronics industries in the composition of manufacturing trade and production of different countries and regions.

CHAPTER 4

A NEW APPROACH FOR ANALYSING MANUFACTURING STRUCTURE - INDEX OF LONG RUN INCOME POTENTIAL

As has been discussed in Chapters 2 and 3, both growth theories and practical experience of the implementation of industrial policies targeting the development of particular industries in many countries indicate that structural change can facilitate economic growth. In considering the role of certain industries in manufacturing structure, and in this study the role of the computing and electronics industries in particular, some framework or lens is necessary through which to view and describe changes in this structure. In this chapter we will consider options for quantifying industrial structure and will develop a new approach for assessing the industrial structure of the manufacturing sector, both at a given point of time and in terms of structural changes over time.

The chapter consists of six sections. In the first section we will briefly outline some methods that have been used for quantitative evaluation of industrial composition and of the structural significance of particular industries. In this section reasons for developing a new method, approaching assessment of industrial composition of manufacturing sector from the perspective of income generation, will be presented. In the second section we will discuss criteria for the selection of benchmarking characteristics germane to income generation and will rank manufacturing industries according to the selectedcharacteristics. Similarities and differences between industries in the manufacturing sector will be considered in the third section. In the next section a weighted index of industrial composition, the Index of Long Run Income Potential, will be introduced. Applications of the index for analysing the significance of a particular industry, or of a number of industries, in the composition of the manufacturing sector will be considered in the fifth section. In the final section of this chapter we will draw conclusions on the basis of the material presented, and discuss the limitations of the suggested approach.

4.1 Review of Approaches to Quantitative Evaluation of Industrial Composition and of the Structural Significance of Particular Industries

The most common approach to assessing the structural significance of a particular industry is to evaluate the degree of specialisation of a country, or a region, in that industry for a relevant variable, such as trade or output. In terms of trade, this method can been applied directly by considering sectoral shares of merchandise exports and imports. (See, for example, Drysdale 1988, Garnaut 1989, Anderson 1995.) Another way of evaluating industrial structure is to consider the specialisation of a country relative to the global average in the output of a certain industry. This approach, referred to as the Index of Revealed Comparative Advantage or the Index of Specialisation, was developed by Balassa in 1965 and has been widely used by many economists. Vollrath (1991, p. 269) has presented the RCA index in the most general way:

$$RCA_a^i = \left(X_a^i / X_t^i\right) / \left(X_a^w / X_t^w\right) \tag{4.1}$$

where X – exports,

a – any specific commodity,

t – all traded commodities,

i – a particular country,

w – the world.

Discussion about this method and examples of the application can be found in Drysdale 1988, Garnaut 1989, Vollrath 1991, Chow and Kellman 1993, Sheehan et al 1995. Forstner and Balance (1990, pp. 28-29) have applied this method to value added. In this study this method will be used in chapters 6 and 7 for evaluation of the degree of specialisation in exports and imports of computing and electronics products.

An assessment of the degree of specialisation can be considered as a powerful tool for evaluation of the importance of a particular sector of an economy. However, the most significant deficiency of this approach is that it is difficult to apply for analysing industrial structure as a whole. In order to make a judgement about overall industrial structure and the dynamics of structural change one has to consider specialisation in each and every sector.

Forstner and Balance (1990, p. 32) have approached the issue of the evaluation of changes in industrial structure by presenting the Index of Structural Change for a manufacturing sector consisting of 28 industries.

$$C = 0.5\sum_{i=1}^{28} \left|a_{iT} - a_{i0}\right| \tag{4.2}$$

where a_{it} – a three-year average of the share of industrial branch i,

i=1, 2,..., 28

$t=T$ – a three-year period 1984-86,

$t=0$ – a three-year period 1973-75.

The same approach has been applied by Productivity Commission (1998, pp. 69, 14) for evaluation of the changes in the structure consisting of 18 industry groups.

This approach is definitely a useful analytical tool for a cross-country comparison of the pace of structural change. However, the Index of Structural Change does not take into account the direction of changes in manufacturing structure.

Sheehan and Tikhomirova have developed an integrated indicator, the Index of Knowledge Composition, for the evaluation of the structure of the manufacturing sector as a whole with respect to knowledge embodied in the output of different industries (see Sheehan et al 1995, Sheehan and Tikhomirova 1996). The value of this index indicates the structure of manufacturing sector according to knowledge embodied in this structure. Upward movement in the values of the index is indicative to structural change towards higher knowledge intensity of the structure of manufacturing sector. In other words, higher values of the index correspond to a greater structural significance of knowledge-intensive industries.

In this study we seek to contribute in two ways to an improved framework for analysing structural changes of manufacturing sector, with a particular emphasis on the long run income potential of industry structure. Firstly, we outline five key characteristics of industries and use these characteristics to describe manufacturing industries. Secondly, we use these five characteristics to develop a particular analytical tool – termed the Index of the Long Run Income Potential – to assess changes in the structure of manufacturing trade and production for different countries and regions in a global context.

The overall rationale for the analysis is that the level of sustainable income which can be provided by an industrial structure is related to the level of value added per employee and to the extent to which the benefits of that value added can be transferred to employees in the form of wages per employee, rather than retained by the owners of capital. For a given level of value added or wages per employee, however, the long run potential of an industry structure must also be associated with the extent to which that structure relates to growth and change in the global economy. This element is captured by two aspects of the changing global demand for products of a given industry (the rate of growth of world exports and the industry share of total world manufacturing exports). Finally, at the current stage of technological and economic development, it is widely acknowledged that knowledge intensive industries are of particular importance (see the discussion in Chapter 2). Knowledge and innovation are the defining characteristics of these industries, and this element is captured by an indicator of the degree of innovation in an industry (R&D intensity).

Thus, the five indicators used in the analysis and incorporated in the index (see formula 4.3 in Section 4.4 and Table 4.4 in Section 4.2) are:

- value added per employee
- wage per employee
- global export growth
- sectoral export intensity
- R&D intensity

In the next section these indicators will be considered in more detail.

The index is based on the proposition that, other things being equal, a country with an industry structure showing a high value of the index, indicating a high income generating potential embodied in its industrial structure, should be able to generate a high level of per capita income for its citizens. However, the index is an analytical tool for evaluation of the manufacturing structure only, and no normative claims are made. Other things are never equal (for example, for a given industry the degree of value added or the level of R&D may be much lower in developing than in developed countries). It is not claimed that a high and/or rising value of this index is invariably associated with high and/or rapidly increasing per capita income, nor that individual countries should pursue an industry structure consistent with a high value of this index as the optimal development strategy. The components of the index serve to highlight relevant features of industries, based on weights drawn on the experience of selected developed countries, and the index provides a perspective on changes in the structure of trade or production globally and in different countries. The index is an analytical tool, which is capable of compressing five different dimensions of industry structure in a quantitative form, readily available for comparisons over time and across countries. The purpose of this study is to assess changes in the composition of manufacturing sector, with a special emphasis on the role of computing and electronics industries, with a perspective of further analysis of the degree of utilisation of income generating potential of manufacturing structure, and of computing and electronics industries in particular, in different economies.

4.2 Attributes and Ranking of Industries

In this section we will describe the reasons for selecting the five indicators in more detail, while the industry groups that constitute the manufacturing sector will be analysed in terms of these characteristics in Section 4.3.

Value Added per Employee

Value added generated in an economy is a conventional criterion of economic performance (GDP) and GDP per capita is a welfare indicator. A crucial factor for achieving high levels of welfare is the ability of a nation to generate high levels of value added, employing resources in the most productive and efficient way possible. The highest level of value added per employee achieved in the world at a particular time, thus, can be used as a benchmark for cross-industry comparison. Application of this benchmark makes it possible to highlight the differences between industries in terms of their potential to provide value-added generation at a particular level of technological development reached in the world at a certain period of time.

Three countries, Germany, Japan, and the USA were the world leaders in terms of labour productivity achieved in 1988-90. The period is determined by two major factors: the interest in understanding the significance of particular industries for Asian growth in the 80s and the availability of data for Germany (to consider productivity levels achieved in Western Germany undistorted by the influence of lower productivity of Eastern Germany). Value added per employee has been calculated for the three countries as a whole and averaged for the three-year period in order to eliminate the influence of annual fluctuations. The results (in current US $) for 22 industries are presented in Table 4.3 (column 1).

Wage per Employee

As a second component we consider an average wage per employee. Although value added is commonly used as a welfare indicator, it is also of interest to find out whether industries associated with high value added also provide high levels of income to the personnel employed. If high levels of value added per employee do not correspond to adequately high levels of earnings of employees, value added, and hence GDP, can be a misleading indicator of living standards. In this case a high level of value added per employee would reflect high capital intensity and/or high profits rather than high employee income. Thus, capital intensity and/or profits will contribute to the economy-wide GDP but not to the actual welfare of the people employed.

Another reason for incorporating an average wage per employee in the list of benchmarking characteristics for manufacturing industries is that changes in the values of the average wage per employee over time, for a particular industry, can be a useful indicator of qualitative transformation in the composition of employment in this industry. The data for the USA (Table 4.1) show that wage levels vary substantially across different categories of occupations, reflecting skills and qualifications of employees, as well as the complexity of work and the level of responsibility involved. Of the selection of occupations shown, scientists' salaries are the highest, engineers earn about 8 per cent less than mathematical and computer scientists, technicians' wages constitute about two thirds, and production workers' wages are at less than half of the scientists' level.

Table 4.1 Average Hourly Earnings – USA, 1990
Males Working Fulltime
by Selected Occupation Groups – 3 digit classification

	US $	Index, %
Mathematical and Computer Scientists	21.79	100
Natural Scientists	21.21	97.4
Engineers	20.08	92.1
Science Technicians	15.81	72.5
Engineering and Related Technologists and Technicians	14.54	66.7
Technicians; Except Health, Engineering, and Science	14.59	67.0
Machine Operators	10.43	47.9
Fabricators, Assemblers, and Hand Working Occupations	9.91	45.5

Source: Author estimates, based on US Current Population Survey.

In addition, more detailed data (Table 4.2) allow us to compare the levels of earnings by areas of specialisation within broader categories. Thus, engineers in the petroleum refining industry are the highest earning group among engineers, followed by electrical and electronic engineers. Mechanical engineers earn just slightly less than electrical and electronic engineers, and industrial engineers' salaries on average are less than 80 per cent of the level in petroleum refining.

Table 4.2 Average Hourly Earnings – USA, 1990
Males Working Fulltime
by Selected Occupation Groups – 3 digit classification
(US $)

Engineers	
Petroleum	23.24
Electrical and electronic	20.52
Mechanical	20.41
Aerospace	19.72
Chemical	19.28
Industrial	17.90
Engineering and Related Technologists and Technicians	
Industrial engineering technicians	16.35
Electrical and electronic technicians	15.39
Mechanical engineering technicians	15.24
Drafting occupations	12.77
Technicians; Except Health, Engineering, and Science	
Computer programmers	16.56
Tool programmers, numerical control	12.51
Machine Operators	
Printing Machine Operators	12.48
Metalworking and Plastic Working Machine Operators	11.70
Metal and Plastic Processing Machine Operators	11.61
Textile, Apparel, and Furnishings Machine Operators	7.82
Woodworking Machine Operators	7.76

Source: Estimates, based on US Current Population Survey.

Among engineering technologists and technicians industrial technicians are the highest paid group. Electrical and electronic technicians and mechanical technicians earn on average 94 and 93 per cent of this level respectively, while drafting occupations are about 22 per cent behind industrial technicians. Computer programmers' earnings are more than 30 per cent higher than numeric control and tool programmers' and slightly above industrial technicians' salaries. The divergence of income levels within working occupations is even greater: printing machine operators earn 60 per cent more than woodworking machine operators. Workers in the textile industry are paid at approximately the same level as those in the wood processing industry, at about 62 per cent of the salaries of printing machine operators, while in the metal and plastic processing industries workers earn on average about 93 per cent of this level.

The data for the American labour market, the most deregulated in the developed world, allow us to estimate the degree of sophistication of particular jobs, skill requirements (as well as the level of responsibilities) by industry for different occupational categories. The analysis of such information may have important industry policy implications.

In order to benchmark industries in accordance with their potential to generate income we use the same approach that has been applied to the value added per employee criterion: the level by industry achieved by the world leaders in terms of labour productivity. Wages per employee by industry, calculated for Germany, Japan, and the USA as one integrated economy and averaged for the three year period, are presented in Table 4.3 (column 2).

It is worth noting that the approach used to benchmark manufacturing industries according to the levels of value added and wages per employee achieved in the major developed economies – Germany, Japan, and the USA – does not provide information about actual levels of productivity and earnings in all countries. There can be great differences between the levels of value added per employee and wages actually achieved in different countries, and cross-industry proportions can also vary substantially from country to country depending on the stage of their technological development, specialisation and other country-specific factors. For an analysis of value added and wages per employee in computing and electronics production of different economies see Chapter 10.

Global Export Growth and Sectoral Export Intensity

World export average annual growth rates (1986-93) by industry and sectoral export shares for the world (1988-90), columns 3 and 4, Table 4.3, are used as indicators of global demand for the output of particular manufacturing industries. Domestic demand should not be underestimated: in some countries it is of higher significance than in others. The propensity to consume domestically produced goods can also be different for different types of production, for a number of reasons including cultural preferences. But in an open world it would be very unlikely that competitive (in a global sense) industries are locked within the boundaries of domestic demand, without trying to expand beyond the national borders. Thus global demand is an important factor for evaluation of the potential of particular industries. Even if some industries are characterised by high value added per employee and also provide high wages, it is not apparent that there are reasons to expect substantial potential contribution from these industries to the overall, economy- wide GDP or welfare if there is no significant global demand for their output. This does not mean, of course, that countries cannot succeed in filling existing narrow niches of demand, but this will be because of specific specialisation or a result of a previously achieved position in the world in particular types of production.

Table 4.3 Values of Benchmarking Indicators of Manufacturing Industries (All Manufacturing Industries)

N R&D		(VAD/E) JPN+USA+GER Average (88-90) cur. US $	(W/E) JPN+USA+GER Average (88-90) cur. US $	WLD Export Growth 86-93 %	WLD Export Shares Average (88-90) %	R&D Intensity
1	Aerospace	75.10	37.25	12.27	2.62	20.2
2	Computers	105.54	32.05	13.54	4.34	12.4
3	Electronics	75.11	27.05	13.63	6.70	10.8
4	Pharmaceuticals	188.46	35.04	12.84	1.23	10.3
5	Instruments	73.59	30.21	9.10	3.30	4.8
6	Motor vehicles	87.54	33.11	7.60	11.55	3.5
7	Chemicals	149.17	34.53	7.49	10.17	3.4
8	Elec. machinery	63.65	26.52	12.91	3.85	3.2
9	Machinery	67.39	29.63	8.39	11.45	2.1
10	Other transport equipment	50.28	26.75	10.29	0.53	1.9
11	Shipbuilding	51.59	27.61	9.28	1.35	1.4
12	Petroleum refining	300.46	39.48	2.81	3.34	1.1
13	Stone, clay and glass	73.16	25.80	9.60	1.68	1.1
14	Other manufacturing	53.45	20.81	11.72	2.16	1.0
15	Rubber and plastics	60.46	23.88	13.14	2.33	1.0
16	Non-ferrous metals	78.43	29.64	5.68	2.99	0.9
17	Ferrous metals	98.52	33.87	4.72	4.28	0.7
18	Fabricated metals	58.11	25.33	9.22	2.97	0.6
19	Food, drink and tobacco	87.99	21.76	7.46	7.41	0.3
20	Paper and printing	74.27	27.37	7.84	3.57	0.2
21	Textiles and clothing	36.83	16.47	10.13	9.46	0.2
22	Wood and furniture	44.00	20.29	11.44	2.29	0.1

Source: Estimates, based on ISIC Trade and Production Data accessed through IEDB database; OECD data on industry-specific R&D intensities.

R&D Intensity

The final industry-specific criterion to be incorporated is R&D intensity ratios (column 5, Table 4.3). We apply R&D intensity ratios (1987-89), calculated by the OECD as business expenditure on R&D (BERD) divided by production for 22 manufacturing industries. By contrast with the other criteria, the R&D intensity measure is calculated for 13 OECD countries. For each industry, each country's R&D intensity is weighted by that country's share in total output of OECD-13 expressed in common currency PPP, three-year averages (OECD 1994). R&D ratios are considered as indicators of the degree of sophistication of particular types of industrial output and of the level of knowledge embodied in the goods produced, and are thus important as characteristics of particular industries. The ability to develop and produce new goods allows firms not only to fill niches in existing demand, but also to generate new areas of demand and to overcome the limits posed by price competition. By targeting knowledge-intensive types of production a country can generate research potential for further development within these industries, as well as producing spillovers for other industries and providing a solid base for related sophisticated services. Besides this, R&D require a highly educated, skilled and creative labour force. By engaging its population in knowledge-based activities a nation provides the members of the society with opportunities for personal development.

Table 4.3 contains all five indicators for 22 manufacturing industries allocated according to the value of R&D intensity ratio in descending order, as in previous studies (see Sheehan et al 1995, Sheehan and Tikhomirova 1996). The 22 industries are ranked according to each indicator, and the higher value of an indicator is associated with the higher value of the rank.

The five indicators (Table 4.4) can be of different relative significance depending on specific conditions in particular countries, both purely economic and otherwise. For example, if there is a very high rate of unemployment and jobless people are mostly unskilled, high value added per employee can be of lesser importance than job growth. In such a situation it may be worth sacrificing economic growth in order to provide a large proportion of the population with labour-intensive, low-paid jobs in order to avoid social problems. Or, in conditions of tough non-economic competition, for example during the Cold War, the development of R&D potential can become a factor of overwhelming importance relative to the issue of providing economic wealth. In such situations weights can be applied to the components and the overall composite rank can be calculated as weighted index. But generally speaking, where no severe constraints are present, all five factors are of significance: value added per employee – an indicator of economic performance potential; average wage – an indicator of income generation; world export growth and sectoral shares – indicators of global demand; and R&D intensity – indicators of science and research potential for future development. In our opinion, it is not worth trying to set preferences between these factors; for many purposes, it is useful to set the relative significance of the five ranked indicators equal. The components' weights in our case, thus, are equal to one and the overall composite rank is derived as an arithmetic mean of the previous five ranks (Table 4.4). The numeric value of the overall rank indicates the combined effect of all five components, although the relative contributionof each factor is also important and will be discussed further on.

Table 4.4 Relative Ranks of Manufacturing Industries According to the Values of Benchmarking Indicators (All Manufacturing Industries)

N R&D		(VAD/E) JPN+USA +GER Average (88-90) Rank	(W/E) JPN+USA +GER Average (88-90) Rank	WLD Export Growth 86-93 Rank	WLD Export Shares Average (88-90) Rank	R&D Intensity Rank	Overall Composite Rank
1	Aerospace	13	21	17	8	22	**16.2**
2	Computers	19	16	21	16	21	**18.6**
3	Electronics	14	10	22	17	20	**16.6**
4	Pharmaceuticals	21	20	18	2	19	**16.0**
5	Instruments	11	15	9	11	18	**12.8**
6	Motor vehicles	16	17	6	22	17	**15.6**
7	Chemicals	20	19	5	20	16	**16.0**
8	Elec. machinery	8	8	19	14	15	**12.8**
9	Machinery	9	13	8	21	14	**13.0**
10	Other transport equipment	3	9	14	1	13	**8.0**
11	Shipbuilding	4	12	11	3	12	**8.4**
12	Petroleum refining	22	22	1	12	11	**13.6**
13	Stone, clay and glass	10	7	12	4	10	**8.6**
14	Other manufacturing	5	3	16	5	9	**7.6**
15	Rubber and plastics	7	5	20	7	8	**9.4**
16	Non-ferrous metals	15	14	3	10	7	**9.8**
17	Ferrous metals	18	18	2	15	6	**11.8**
18	Fabricated metals	6	6	10	9	5	**7.2**
19	Food, drink and tobacco	17	4	4	18	4	**9.4**
20	Paper and printing	12	11	7	13	3	**9.2**
21	Textiles and clothing	1	1	13	19	2	**7.2**
22	Wood and furniture	2	2	15	6	1	**5.2**

Source: Estimates, based on ISIC Trade and Production Data accessed through IEDB database; OECD data on industry-specific R&D intensities.

Finally, the industries are sorted according to the overall composite rank in descending order. In some cases, where the values of this rank are the same for two industries, the R&D

intensity rank is used as a secondary sorting criterion (taking into account the significance of knowledge intensity for future development). The resulting order of industries is presented in Table 4.5. It is worth noting that Computers and Electronics occupy the leading positions in the list of manufacturing industries.

Table 4.5 Overall Composite and R&D Intensity Ranks of Manufacturing Industries (All Manufacturing Industries)

Overall Composite Rank		Industry Number
18.6	Computers	1
16.6	Electronics	2
16.2	Aerospace	3
16.0	Pharmaceuticals	4
16.0	Chemicals	5
15.6	Motor vehicles	6
13.6	Petroleum refining	7
13.0	Machinery	8
12.8	Instruments	9
12.8	Elec. machinery	10
11.8	Ferrous metals	11
9.8	Non-ferrous metals	12
9.4	Rubber and plastics	13
9.4	Food, drink and tobacco	14
9.2	Paper and printing	15
8.6	Stone, clay and glass	16
8.4	Shipbuilding	17
8.0	Other transport equipment	18
7.6	Other manufacturing	19
7.2	Fabricated metals	20
7.2	Textiles and clothing	21
5.2	Wood and furniture	22

Source: Estimates, based on ISIC Trade and Production Data accessed through IEDB database.

4.3 Benchmarking Characteristics of Industries

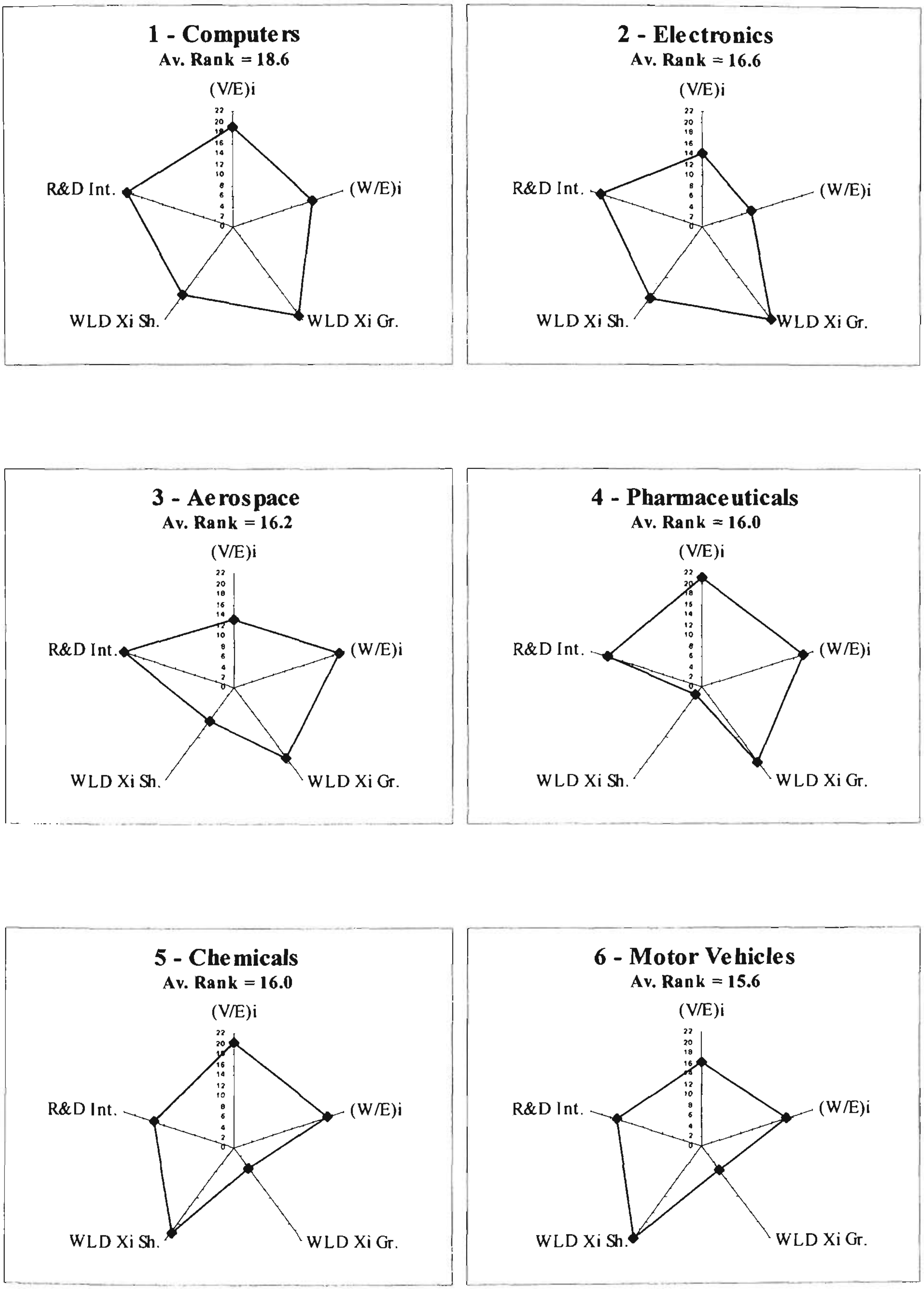
The value of the overall composite rank as a general indicator of income generating potential of manufacturing industries is a useful criterion according to which the industries can be allocated in a certain order and the relative positions of the industries can be evaluated. Nevertheless, for policy development in different countries particular industry characteristics can be of importance. Let us briefly consider some of these specific industry characteristics, presented in Table 4.4 and Chart 4.1, and their potential implications. Displaying the five characteristics graphically, for each industry, as in Chart 4.1 helps to bring out the differences between industries. The comments below are indicative only of the way in which this framework might be utilised in a more detailed analysis.

For Computers and Electronics all five components have relatively high ranks, which are reflected by their overall positions. The most distinctive feature of these two industries is the highest ranks for export growth among all industries. The combination of extremely high export growth and high export shares ranks gives cause to expect that the importance of these industries will be maintained in the future. It is notable that for both industries wages per worker are ranked lower than value added, whereas for Aerospace the reverse is the case. Exceptionally high ranks of R&D and wages are an indication of specific skill requirements in the Aerospace industry, while the combination of high R&D and much more moderate wage ranks for Computers and Electronics indicates a wide range of employment options at different qualification levels.

The Pharmaceuticals industry is characterised by very high ranks for all indicators with the exception of world export shares. World demand is rising but from a very low base and the combination of high skill standards, high value added and relatively low global demand for the output of this industry raises some doubts about the potential of this industry for development in all countries. The situation in Aerospace is similar to that in Pharmaceuticals, but lower value added in conjunction with high R&D and wages is a sign of even higher requirements for qualifications.

For the Chemicals industry, low export growth and high export share ranks indicate that the world market has reached a certain degree of saturation. In spite of the high potential contribution of this industry to GDP, and its ability to generate income supplemented by a moderate level of R&D, Chemicals appears to be an industry of limited potential relative to the industries noted above. For Motor Vehicles the average wage and value added ranks are slightly lower than for Chemicals but export growth is higher, so the overall conclusion is that the potential of the Motor Vehicles industry is moderate. Petroleum Refining has the highest value added rank and, this very high capital-intensive industry is also characterised by the highest wages rank although R&D intensity is modest. The combination of high potential contribution to GDP and welfare with fairly low skills required could make this industry attractive for many countries, but its potential is severely constrained by the lowest rank for world export growth and by capital intensity.

Chart 4.1



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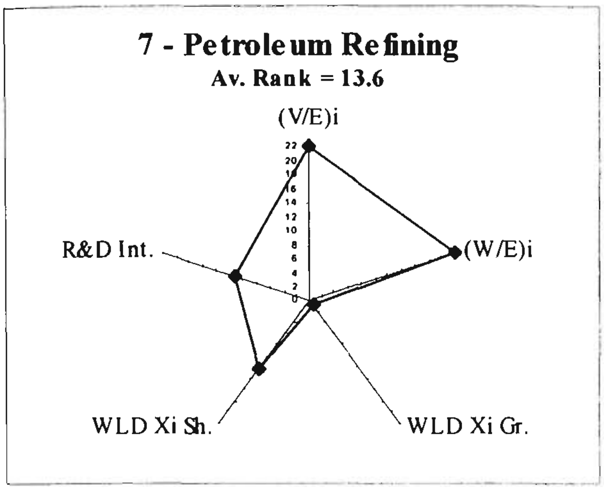
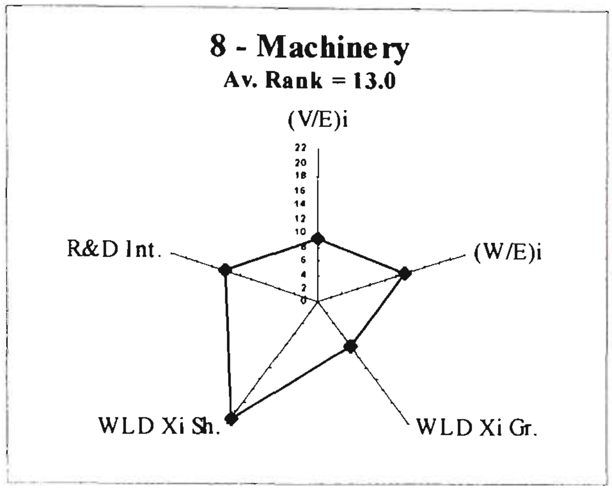
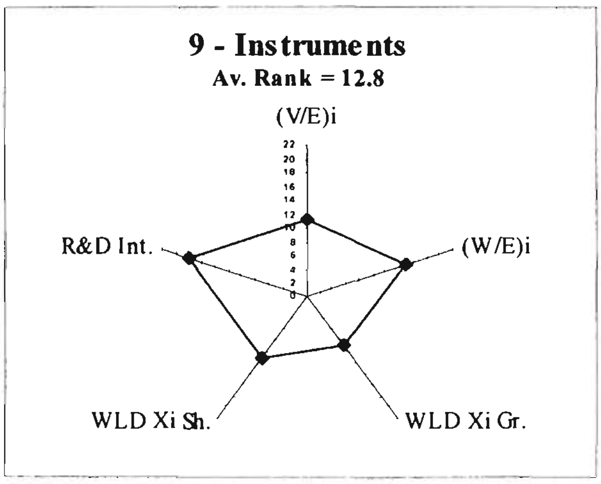
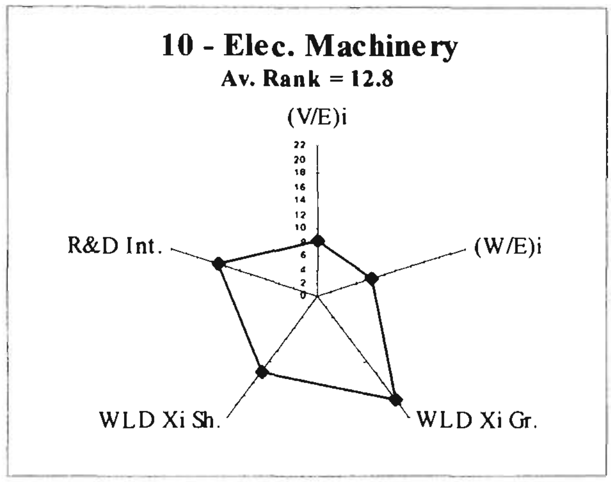
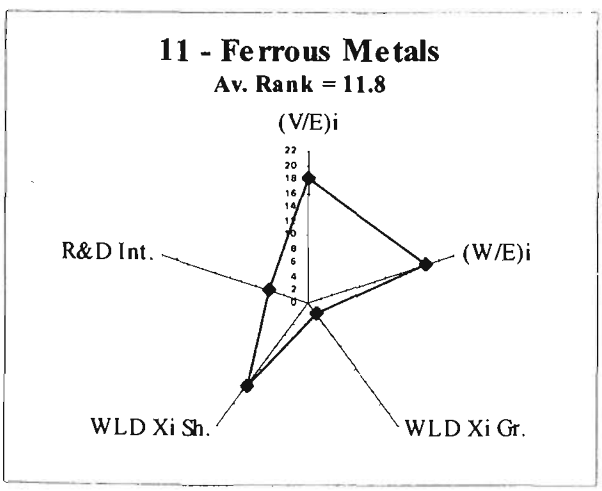
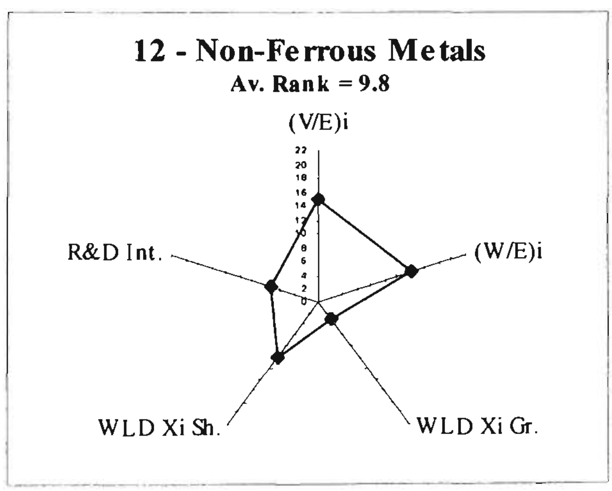

7 - Petroleum Refining
Av. Rank = 13.6
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


8 - Machinery
Av. Rank = 13.0
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


9 - Instruments
Av. Rank = 12.8
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

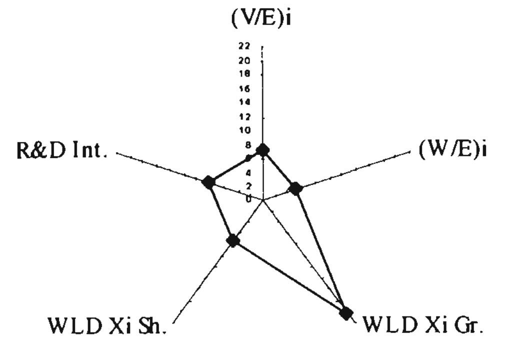

10 - Elec. Machinery
Av. Rank = 12.8
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


11 - Ferrous Metals
Av. Rank = 11.8
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

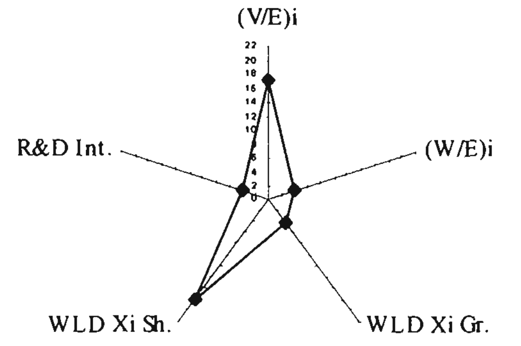

12 - Non-Ferrous Metals
Av. Rank = 9.8
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

Continued

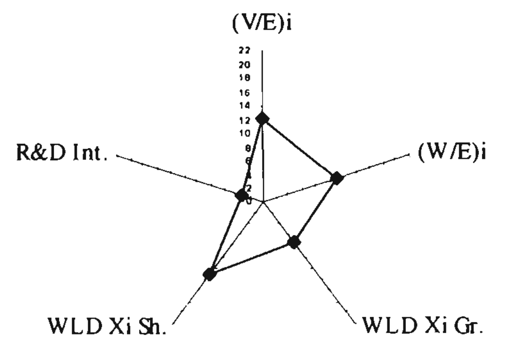
13 - Rubber and Plastics
Av. Rank = 9.4



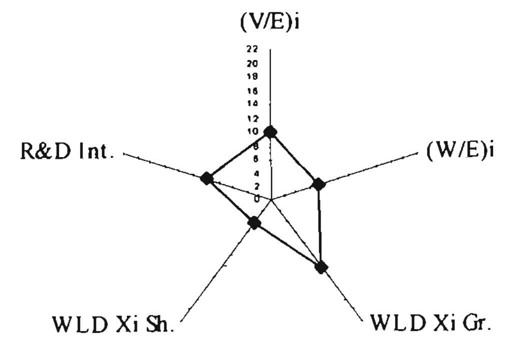
14 - Food, Drink and Tobacco
Av. Rank = 9.4



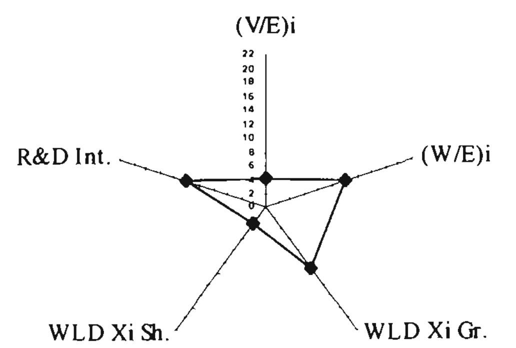
15 - Paper and Printing
Av. Rank = 9.2



16 - Stone, Clay and Glass
Av. Rank = 8.6

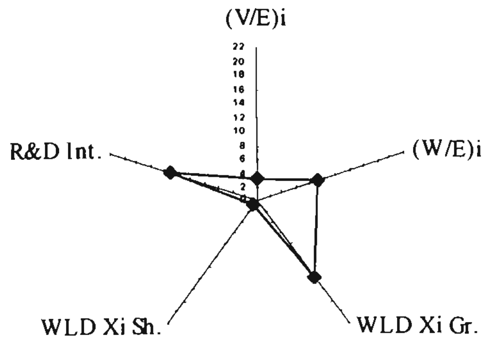


17 - Shipbuilding
Av. Rank = 8.4

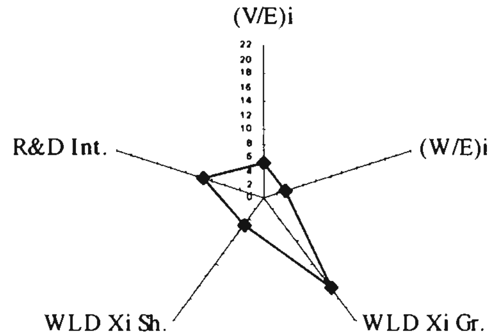


Continued

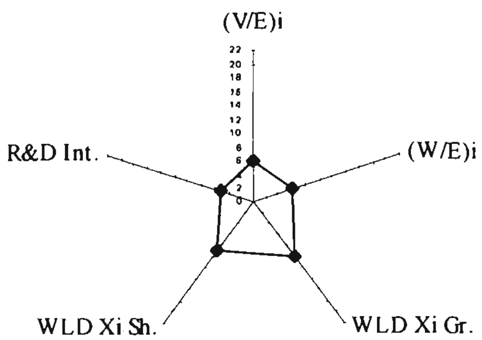
18 - Oth. Transport Equipment
Av. Rank = 8.0



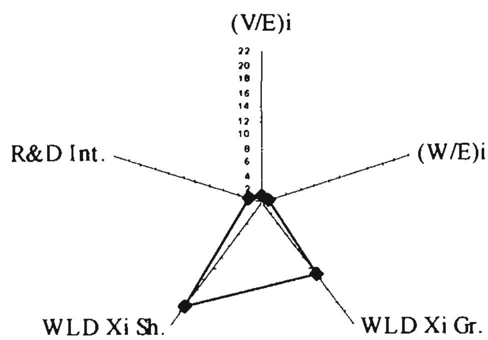
19 - Other Manufacturing
Av. Rank = 7.6



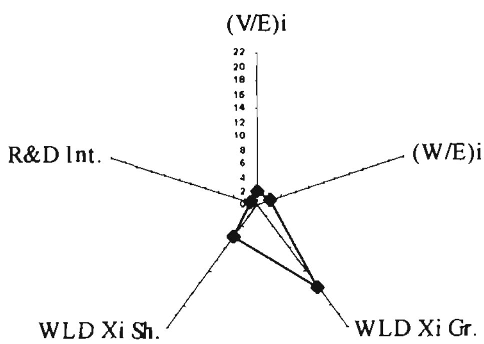
20 - Fabricated Metals
Av. Rank = 7.2



21 - Textiles and Clothing
Av. Rank = 7.2



22 - Wood and Furniture
Av. Rank = 5.2



Source: Estimates, based on ISIC Trade and Production Data accessed through IEDB database; OECD data on industry-specific R&D intensities.

Machinery, Instruments and Electrical Machinery have very similar values of the overall composite index and despite some industry-specific features their potential can generally be classified as average. The major feature of Ferrous and NonFerrous Metals industries is the low rank in terms of export growth, so the significance of these industries is likely to decline. Rubber and Plastics as well as Other Manufacturing, in spite of the high export growth rankings, provide neither high value added nor high income. Stone, Clay and Glass is similar but the export growth rank is even lower.

Food, Drink and Tobacco has equal low ranks for R&D, wages and export growth, but high values for export shares and value added indicators. For the Paper and Printing industries R&D is low, while all other indicators are at the average level. It appears that this industry may be of some interest for developing countries. The Shipbuilding and Other Transport Equipment industries are moderate in R&D, labour-intensive, capable of providing a fair income level, but their potential is limited by scale, despite the average value of the export growth rank. For Fabricated Metals all five components are below the average level.

Textiles and Clothing is a traditional, established industry with a high rank for export shares supplemented by a good pace of growth. The industry is the last in the list according to two indicators: value added and wages per employee, and is very low in R&D. Textiles and Clothing can provide employment but at a very low income level and can hardly stimulate economic growth. Finally, Wood and Furniture is another traditional industry, the last in knowledge intensity, and is similar to Textiles and Clothing but of smaller scale.

In this section we have presented only a brief analysis of selected features of manufacturing industries. However, this approach may be used as a basis for more detailed studies.

4.4 Index of the Long Run Income Potential

In order to evaluate industrial structure, consisting of a number of sectors, and the process of structural change over time, the shares of all sectors, and changes in these shares, need to be assessed. Thus, in order to evaluate the composition of total manufacturing, the sectoral shares of all manufacturing industries have to be considered. This approach can be very efficient when analysing the significance of one or several manufacturing sectors. But for assessing the structure of total manufacturing (consisting of 22 industries) the task becomes very laborious and the results are difficult to interpret, especially for cross-country comparisons. The allocation of industries in a certain order according to a particular criterion that has a numeric value enables the development of a weighted index of structural composition. In previous work this method has been used for the evaluation of industrial structure according to knowledge intensity, applying R&D intensity ratios as industry-specific weights (see Sheehan et al 1995, p. 61; Sheehan and Tikhomirova 1996, p. 10). The application of the values of the overall composite industry rank as industries' weights allows the development of the Index of the Long Run Income Potential of an industrial structure.

As noted above, we define the Index of the Long Run Income Potential applying the same approach used previously for the Index of Knowledge Composition (see Sheehan et al 1995, p. 61; Sheehan and Tikhomirova 1996, p. 10).

$$\boxed{CI_T^i = \frac{\sum_j^n \left(X_j^i \cdot I_j\right)}{\sum_j^n X_j^i}} \qquad (4.3)$$

where CI - the Index of the Long Run Income Potential of Industrial Structure,

i - a country,

j - an industry,

n - the total number of manufacturing industries,

I - a weight (the value of the overall composite industry rank),

X - exports.

If manufacturing exports were equally divided across industries,

$$X_j^i = \frac{X_T^i}{n} = \frac{\sum_j^n X_j^i}{n},$$

where X_T^i - total manufacturing exports for country '*i*'.

$$CI_T^i = \frac{\sum_j^n \left[\left(\frac{\sum_j^n X_j^i}{n}\right) \cdot I_j\right]}{\sum_j^n X_j^i} = \frac{\sum_j^n X_j^i \cdot \sum_j^n I_j}{n \cdot \sum_j^n X_j^i} = \frac{\sum_j^n I_j}{n} = \overline{CI_T}$$

$$\overline{CI_T} = \frac{\sum_j^n I_j}{n} = \frac{I_T}{n} \tag{4.4}$$

where $\overline{CI_T}$ - the average value of the Index of Income Potential ($X_j^i = \frac{X_T^i}{n}$),

I_T - the sum of the values of the overall composite industry rank for all manufacturing industries.

The value of $\overline{CI_T}$ can be used as a base for benchmarking the value of the Index of Income Potential:

$$RCI_T^i = \frac{CI_T^i}{\overline{CI_T}} = \frac{\sum_j^n \left(X_j^i \cdot I_j\right)}{\left(\sum_j^n X_j^i\right) \cdot \overline{CI_T}} \tag{4.5}$$

where RCI - the Rebased Index of the Long Run Income Potential of Industrial Structure.

If the value of the Index of Income Potential is equal to the average value, the Rebased Index is equal to 1. In the charts, further on, this particular case is presented as a base level.

The same approach can be applied for the evaluation of the structure of imports, gross output, value added, and employment.

High values of the index indicate that the industrial structure is biased towards the areas of higher income generating potential. In other words, industries characterised by high values of the overall composite rank have higher shares of total manufacturing than other industries. This implies that such a structure is favourable for generating high levels of welfare, but the actual income levels achieved by different countries depend on their ability to utilise the potential of manufacturing sectors with high values of the composite rank. It is worth noting that the ranks of the manufacturing industries are based on the performance of major developed countries. It is possible that some countries may have high shares of the industries characterised by high values of the composite rank, however, without the underlying industrial performance characteristics. This situation is referred to as the potential of the industrial structure not being utilised. The analysis of industrial structure and of structural changes can provide a good basis for further studies of economic performance in different parts of the world.

4.5 Some Applications of the Index of the Long Run Income Potential

The Index of the Long Run Income Potential can be used for analysing the significance of a particular manufacturing sector or a number of sectors in the industrial structure. Here we will describe three methods (based on different assumptions) applying them to manufacturing exports.

I. Let us assume that in a given country the share of a particular industry (t) of total manufacturing exports is equal to zero, while the values of other industries' shares and industry-specific weights (the values of the overall composite rank) are unchanged. In this case the sum of the export shares of all other industries is not equal to one. The value of total manufacturing exports remains unchanged.

$$CI^i_{T-t} = \frac{\sum_{j \neq t}^{n} \left(X^i_j \cdot I_j\right)}{X^i_T} = \frac{\sum_{j}^{n} \left(X^i_j \cdot I_j\right) - X^i_t \cdot I_t}{X^i_T} = \frac{\sum_{j}^{n} \left(X^i_j \cdot I_j\right)}{X^i_T} - \frac{X^i_t \cdot I_t}{X^i_T}$$

$$\boxed{CI^i_{T-t} = CI^i_T - \left(\frac{X^i_t}{X^i_T}\right) \cdot I_t} \qquad (4.6)$$

$$\boxed{CI^i_T - CI^i_{T-t} = \left(\frac{X^i_t}{X^i_T}\right) \cdot I_t} \qquad (4.7)$$

The difference between the two values of the Index of Income Potential is equal to the share of the industry t multiplied by this industry's weight. This measure directly shows the contribution of the industry t to the overall value of the Index.

Let us apply the same approach to the Rebased Index of Income Potential. We have assumed that the export share of the industry t is equal to zero while export shares of all other industries remain unchanged. Total manufacturing still consists of 22 industries, characterised by the same weights. Then the average value of the Index is the same in both cases:

$$\overline{CI_{T-t}} = \frac{\sum_{j}^{n} I_j}{n} = \overline{CI_T} \qquad (4.8)$$

$$RCI^i_{T-t} = \frac{CI^i_{T-t}}{CI_{T-t}} = \frac{CI^i_T - \left(\frac{X^i_t}{X^i_T}\right) \cdot I_t}{CI_T} = \frac{CI^i_T}{CI_T} - \left(\frac{X^i_t}{X^i_T}\right) \cdot \frac{I_t}{CI_T}$$

$$\boxed{RCI^i_{T-t} = RCI^i_T - \left(\frac{X^i_t}{X^i_T}\right) \cdot \frac{I_t}{CI_T}} \tag{4.9}$$

$$\boxed{RCI^i_T - RCI^i_{T-t} = \left(\frac{X^i_t}{X^i_T}\right) \cdot \frac{I_t}{CI_T}} \tag{4.10}$$

The difference between the values of the Rebased Index of Income Potential is equal to the share of the industry t of total manufacturing exports multiplied by the weight of this industry and divided by the average value of the Index. In other words, the difference between the two values of the Rebased Index is equal to the rebased weighted share of the industry t of total manufacturing exports.

The same method can be used in order to show the contribution of a number of industries to the overall value of the indicator of industrial structure. For example, for two industries we will get the following formulae:

$$CI^i_{T-(t+s)} = \frac{\sum\limits_{j \neq t,s}^{n} \left(X^i_j \cdot I_j\right)}{X^i_T} \tag{4.11}$$

$$RCI^i_{T-(t+s)} = \frac{CI^i_{T-(t+s)}}{CI_T} \tag{4.12}$$

$$CI^i_T - CI^i_{T-(t+s)} = \left(\frac{X^i_t}{X^i_T}\right) \cdot I_t + \left(\frac{X^i_s}{X^i_T}\right) \cdot I_s \tag{4.13}$$

$$RCI^i_T - RCI^i_{T-(t+s)} = \left(\frac{X^i_t}{X^i_T}\right) \cdot \frac{I_t}{CI_T} + \left(\frac{X^i_s}{X^i_T}\right) \cdot \frac{I_s}{CI_T} =$$

$$= \frac{1}{CI_T} \cdot \left[\left(\frac{X^i_t}{X^i_T}\right) \cdot I_t + \left(\frac{X^i_s}{X^i_T}\right) \cdot I_s\right] \tag{4.14}$$

II. Another way of looking at the effect of a particular industry's exports on the value of the overall indicator of the structure of manufacturing exports is to assume that there are no exports generated by this industry in a given country.

$$X_t^i = 0$$

The values of other industries' exports are unchanged. Total manufacturing exports are equal to the sum of exports of other (21, in our case) exporting industries.

$$X_{T-t}^i = \sum_{j \neq t}^{n} X_j^i \tag{4.15}$$

Thus, the shares of other industries of total manufacturing exports will take different values, compared with the values of sectoral export shares in the case when all (22) industries are exporting and the value of total manufacturing exports is the sum of the exports of 22 industries. The manufacturing sector still consists of 22 industries. The absence of exports of an industry in a country cannot affect the inherent characteristics of manufacturing industries. So, the industry-specific weights remain unchanged for all industries. In other words, for a given country we compare two different structures of manufacturing exports: the first - total manufacturing consists of 22 exporting industries, and the second - of 21 exporting industries, while industry-specific weights are the same in both cases.

$$CI_{T-t}^i = \frac{\sum_{j \neq t}^{n} \left(X_j^i \cdot I_j\right)}{X_{T-t}^i} = \frac{\sum_{j \neq t}^{n} \left(X_j^i \cdot I_j\right) \cdot \sum_{j}^{n} \left(X_j^i \cdot I_j\right) \cdot \sum_{j}^{n} X_j^i}{\sum_{j \neq t}^{n} X_j^i \cdot \sum_{j}^{n} \left(X_j^i \cdot I_j\right) \cdot \sum_{j}^{n} X_j^i} =$$

$$= \frac{\sum_{j}^{n} \left(X_j^i \cdot I_j\right)}{\sum_{j}^{n} X_j^i} \cdot \frac{\sum_{j}^{n} X_j^i}{\sum_{j \neq t}^{n} X_j^i} \cdot \frac{\sum_{j \neq t}^{n} \left(X_j^i \cdot I_j\right)}{\sum_{j}^{n} \left(X_j^i \cdot I_j\right)} = CI_T^i \cdot \frac{X_T^i}{X_T^i - X_t^i} \cdot \frac{\sum_{j}^{n} \left(X_j^i \cdot I_j\right) - X_t^i \cdot I_t}{\sum_{j}^{n} \left(X_j^i \cdot I_j\right)} =$$

$$= CI_T^i \cdot \frac{1}{1 - \frac{X_t^i}{X_T^i}} \cdot \left(1 - \frac{X_t^i \cdot I_t}{\sum_{j}^{n} \left(X_j^i \cdot I_j\right)}\right)$$

$$\boxed{CI_{T-t}^i = CI_T^i \cdot \left(\frac{1}{1 - \frac{X_t^i}{X_T^i}}\right) \cdot \left(1 - \frac{X_t^i \cdot I_t}{\sum_{j}^{n} \left(X_j^i \cdot I_j\right)}\right)} \tag{4.16}$$

or, alternatively, from (4.16):

$$= \left(CI_T^i - \frac{\sum_j^n (X_j^i \cdot I_j) \cdot (X_t^i \cdot I_t)}{\sum_j^n X_j^i \cdot \sum_j^n (X_j^i \cdot I_j)} \right) \cdot \left(\frac{1}{1 - \frac{X_t^i}{X_T^i}} \right) = \left(CI_T^i - \frac{X_t^i \cdot I_t}{\sum_j^n X_j^i} \right) \cdot \left(\frac{1}{1 - \frac{X_t^i}{X_T^i}} \right)$$

$$\boxed{CI_{T-t}^i = \left(CI_T^i - \frac{X_t^i}{X_T^i} \cdot I_t \right) \cdot \left(\frac{1}{1 - \frac{X_t^i}{X_T^i}} \right)} \tag{4.17}$$

The first part of the formula (4.17) is exactly the same as the righthand part of the equation (4.6), the value of the second part of (4.17) is a function of the sectoral exportshare of the industry t. The larger the share, the smaller the denominator, and, consequently, the larger the value of the whole fraction. If the sectoral share of the industry$t$ is relatively small the value of the $CI^i_{T\text{-}t}$ in the second method (II) is close to the value of the $CI^i_{T\text{-}t}$ in the first method (I). The difference between CI^i_T and $CI^i_{T\text{-}t}$ in this case will almost directly reflect the actual effect of the industry t's exports on the value of the Index of Income Potential. If the sectoral share is large the second part of the formula (4.17) will have a multiplying effect on the value of $CI^i_{T\text{-}t}$. In this case the difference between CI^i_T and $CI^i_{T\text{-}t}$ should not be considered as an indicator of the direct effect of the industry's exports on the existing structure of manufacturing exports. The value of $CI^i_{T\text{-}t}$ indicates the structural composition of the manufacturing sector that consists of the remaining exporting industries; and comparison of CI^i_T and $CI^i_{T\text{-}t}$ (that represent the two structures of manufacturing) allows us to estimate the impact of the industry t's exports on the overall structural composition.

The exact formula for the difference between CI^i_T and $CI^i_{T\text{-}t}$ can be easily derived from (4.16):

$$CI_T^i - CI_{T-t}^i = CI_T^i - CI_T^i \cdot \left(\frac{1}{1 - \frac{X_t^i}{X_T^i}} \right) \cdot \left(1 - \frac{X_t^i \cdot I_t}{\sum_j^n (X_j^i \cdot I_j)} \right)$$

$$\boxed{CI_T^i - CI_{T-t}^i = CI_T^i \cdot \left[1 - \left(\frac{1}{1 - \frac{X_t^i}{X_T^i}} \right) \cdot \left(1 - \frac{X_t^i \cdot I_t}{\sum_j^n (X_j^i \cdot I_j)} \right) \right]} \tag{4.18}$$

As has been noted above, there are 22 manufacturing industries in both cases: in the first case all 22 industries are exporting, in the second one - 21 industries are exporting and one industry (the industry t) is not generating any exports. The industry-specific weights remain unchanged for all 22 industries. The average value of the Index of Income Potential is the same in both cases, as shown in (4.8).

The formula for the Rebased Index in this case will take the following form:

$$RCI^i_{T-t} = \frac{CI^i_{T-t}}{CI_{T-t}} = \frac{CI^i_{T-t}}{CI_T} = \frac{CI^i_T}{CI_T} \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right)$$

$$\boxed{RCI^i_{T-t} = RCI^i_T \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right)} \qquad (4.19)$$

$$\boxed{RCI^i_T - RCI^i_{T-t} = RCI^i_T \cdot \left[1 - \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \right]} \qquad (4.20)$$

The relationship between RCI^i_{T-t} and RCI^i_T (4.19) is exactly the same as the relationship between CI^i_{T-t} and CI^i_T (4.16), and the formula (4.20) is similar to the equation (4.18). We can conclude that the Rebased Index can be used for the comparison of the two structures of manufacturing exports in the same way as has been described above referring to the Index of Income Potential. Furthermore, the rebased form of the Index has an additional useful feature for cross-structural comparison, according to the average value of the Index. If the value of the Index of Income Potential is equal to the average value, the Rebased Index is equal to 1. As has been noted above, the average value of the Index is the same for both structures. Therefore we can compare each of the two structures with the same average value, and thus estimate the significance of the industry t for the overall composition of manufacturing exports.

In the case of two non-exporting industries:

$$CI^i_{T-(t+s)} = CI^i_T \cdot \left(\frac{1}{1 - \frac{X^i_t + X^i_s}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t + X^i_s \cdot I_s}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \quad (4.21)$$

$$CI^i_T - CI^i_{T-(t+s)} = CI^i_T \cdot \left[1 - \left(\frac{1}{1 - \frac{X^i_t + X^i_s}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t + X^i_s \cdot I_s}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \right] \quad (4.22)$$

$$RCI^i_{T-(t+s)} = RCI^i_T \cdot \left(\frac{1}{1 - \frac{X^i_t + X^i_s}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t + X^i_s \cdot I_s}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \quad (4.23)$$

$$RCI^i_T - RCI^i_{T-(t+s)} = RCI^i_T \cdot \left[1 - \left(\frac{1}{1 - \frac{X^i_t + X^i_s}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t + X^i_s \cdot I_s}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \right] \quad (4.24)$$

The same approach can be applied in order to estimate the effect of several non-exporting industries.

III. This method is based on the assumption that the industry t is excluded from the list of manufacturing sectors. In this case the structure of manufacturing is different, total manufacturing exports is equal to the sum of exports of the remaining industries. The purpose of this approach is to compare two different structures: the first- consisting of 22 industries, and the second - of 21 industries (or less, if the effect of a number of industries has to be evaluated).

Table 4.6 Values of Benchmarking Indicators of Manufacturing Industries (Manufacturing Excluding Computers and Electronics)

N R&D		(VAD/E) JPN+USA+GER	(W/E) JPN+USA+GER	WLD Export Growth	WLD Export Shares	R&D Intensity
		Average (88-90) cur. US $	Average (88-90) cur. US $	86-93 %	Average (88-90) %	
1	Aerospace	75.10	37.25	12.27	2.62	20.2
4	Pharmaceuticals	188.46	35.04	12.84	1.23	10.3
5	Instruments	73.59	30.21	9.10	3.30	4.8
6	Motor vehicles	87.54	33.11	7.60	11.55	3.5
7	Chemicals	149.17	34.53	7.49	10.17	3.4
8	Elec. machinery	63.65	26.52	12.91	3.85	3.2
9	Machinery	67.39	29.63	8.39	11.45	2.1
10	Other transport equipment	50.28	26.75	10.29	0.53	1.9
11	Shipbuilding	51.59	27.61	9.28	1.35	1.4
12	Petroleum refining	300.46	39.48	2.81	3.34	1.1
13	Stone, clay and glass	73.16	25.80	9.60	1.68	1.1
14	Other manufacturing	53.45	20.81	11.72	2.16	1.0
15	Rubber and plastics	60.46	23.88	13.14	2.33	1.0
16	Non-ferrous metals	78.43	29.64	5.68	2.99	0.9
17	Ferrous metals	98.52	33.87	4.72	4.28	0.7
18	Fabricated metals	58.11	25.33	9.22	2.97	0.6
19	Food, drink and tobacco	87.99	21.76	7.46	7.41	0.3
20	Paper and printing	74.27	27.37	7.84	3.57	0.2
21	Textiles and clothing	36.83	16.47	10.13	9.46	0.2
22	Wood and furniture	44.00	20.29	11.44	2.29	0.1

Source: Estimates, based on ISIC Trade and Production Data accessed through IEDB database; OECD data on industry-specific R&D intensities.

It is has not been possible to derive the exact formula for the relationship between the two values of the Index of Income Potential of Industrial Structure. In order to determine the industry-specific weights the ranking procedure has to be applied to the new structure of manufacturing. The values of the ranks depend on the position of the excluded industries in the list of manufacturing sectors. Consequently the values of the overall composite rank will be different for the two structures as well as the average value of theIndex of Income Potential of Industrial Structure.

In order to evaluate the contribution of particular industries we apply the same formula (4.5) for the Rebased Index for the two cases and compare the values relative to the average value of the Index. Thus we can evaluate the structural composition of the remaining industries and estimate the effect of the excluded sectors.

Table 4.7 Relative Ranks of Manufacturing Industries According to the Values of Benchmarking Indicators (Manufacturing Excluding Computers and Electronics)

N R&D		(VAD/E)i JPN+USA +GER Average (88-90) Rank	(W/E)i JPN+USA +GER Average (88-90) Rank	WLD Xi Growth 86-93 Rank	WLD Xi Shares Average (88-90) Rank	R&D Intensity Rank	Overall Composite Rank
1	Aerospace	13	19	17	8	20	**15.4**
4	Pharmaceuticals	19	18	18	2	19	**15.2**
5	Instruments	11	14	9	11	18	**12.6**
6	Motor vehicles	15	15	6	20	17	**14.6**
7	Chemicals	18	17	5	18	16	**14.8**
8	Elec. machinery	8	8	19	14	15	**12.8**
9	Machinery	9	12	8	19	14	**12.4**
10	Other transport equipment	3	9	14	1	13	**8.0**
11	Shipbuilding	4	11	11	3	12	**8.2**
12	Petroleum refining	20	20	1	12	11	**12.8**
13	Stone, clay and glass	10	7	12	4	10	**8.6**
14	Other manufacturing	5	3	16	5	9	**7.6**
15	Rubber and plastics	7	5	20	7	8	**9.4**
16	Non-ferrous metals	14	13	3	10	7	**9.4**
17	Ferrous metals	17	16	2	15	6	**11.2**
18	Fabricated metals	6	6	10	9	5	**7.2**
19	Food, drink and tobacco	16	4	4	16	4	**8.8**
20	Paper and printing	12	10	7	13	3	**9.0**
21	Textiles and clothing	1	1	13	17	2	**6.8**
22	Wood and furniture	2	2	15	6	1	**5.2**

Source: Estimates, based on ISIC Trade and Production Data accessed through IEDB database; OECD data on industry-specific R&D intensities.

Let us present an example of the application of this method. As for the previous two methods we will evaluate the significance of Computers and Electronics. The two industries are excluded from the manufacturing sector (Table 4.6). In this case there are 20 industries remaining, therefore the ranks of all five components of the overall composite rank will take values from 1 to 20 (Table 4.7). The average value of the Index of Income Potential of Industrial Structure is equal to 10.5 (while for the 22-industries structure it is equal to 11.5). Applying the values of the overall composite rank as weights and of the average valueof the Index as the base level, we derive the values of the Rebased Index for the 20-industries manufacturing sector, formula (4.5).

If manufacturing exports are equally divided across all industries in both cases the value of the Index of Income Potential of Industrial Structure equals the average value, formula (4.4). Although, as has been noted above, the average values of the Index for the two cases are different, the values of the Rebased Index, formula (4.5), will be the same and equal to 1 in both cases. Thus, we can compare the composition of the actual manufacturing sector with the manufacturing structure as if there were no Computers and Electronics at all.

Examples of the application of the three methods, described in this section, can be foundin Tikhomirova 1997.

The same approach can be applied for analysing the structural composition of production, value added, and employment.

4.6 Conclusions

In this chapter we have presented a new approach for the quantitative analysis of the industrial structure of the manufacturing sector, and of structural changes over time, with a particular emphasis on the long run income potential of industry structure. The main activities undertaken in this chapter, and the key outcomes of the chapter, are listed bebw.

1. Methods that have been used for quantitative evaluation of industrial composition and of structural significance of particular industries have been outlined, and the reasons for developing a new method, approaching the assessment of industrial composition from the perspective of income generation, have been presented.
2. Criteria for the selection of benchmarking characteristics germane to income generation have been discussed, five key industry characteristics have been determined, and an overall composite rank, the numeric value of which indicates the combined effect of all five components, has been developed.
3. Similarities and differences between manufacturing industries have been displayed according to the five benchmarking characteristics and the overall composite rank.
4. Marked differences, in terms of income generating potential, have been found across manufacturing industries.
5. The ranking of manufacturing industries in terms of 'high income potential' has shown that the computing and electronics industries occupy the highest positions.

6. Applying the overall composite industry rank, a particular analytical tool, a weighted index of industrial composition for a quantitative evaluation of the structure of manufacturing trade and production of different countries and regions in a global context, has been developed. This tool is referred to as the Index of the Long Run Income Potential.
7. High values of the index indicate that industries characterised by high income generating potential constitute high proportions of total manufacturing, thus implying that such a manufacturing structure is conducive to the generation of high levels of economic welfare.
8. Three methods, based on different assumptions, of application of the index for analysing the significance of a particular industry or a number of industries in the composition of manufacturing sector have been considered.

It is also worth noting that the approach, presented in this chapter, has some limitations. The estimates of the values of the overall rank are based on real data for the countries that achieved the highest levels of labour productivity in the second half of the 80's. The ranks, therefore, are benchmarks valid for a particular period of time but do not provide any information about actually achieved productivity or wage levels in individual countries.

The Index of the Long Run Income Potential of Industry Structure is an indicator of industrial structure and of the process of structural change, but the value of the index is not a criterion of an optimal structure. High values of the index indicate that the industrial structure is favourable for generating high levels of welfare, but the actual income levels achieved by different countries depend on their ability to utilise the potential of manufacturing sectors with high values of the composite rank. The ranks of the manufacturing industries are based on the performance of major developed countries. It is possible that in some countries high shares of the industries, characterised by high values of the composite rank, are not supported by the underlying industrial performance characteristics. In this situation a high potential of the industrial structure to generate income is not utilised. The analysis of the changes in manufacturing structure and of the role of the computing and electronics industries in these changes can provide a good basis for the subsequent analysis of the performance of different countries in these industries and of the effects on national competitiveness.

PART B

CHANGES IN THE STRUCTURE OF MANUFACTURING TRADE, THE ROLE OF THE COMPUTING AND ELECTRONICS INDUSTRIES

The second group of chapters (Chapters 5-7) considers the changing pattern of industrial structure of manufacturing trade in a selected group of developed and developing countries over the period 1970-96, and the increasing role of the computing and electronics industries in most economies over that period. In particular, it documents the sharp increase in the importance of these industries in the manufacturing trade of the rapidly growing East Asian countries.

Chapter 5 starts the analysis of changes in the structure of manufacturing trade by considering the changing pattern of specialisation in exports globally, and in selected regions and countries. Specialisation in exports of manufactured products has been one of the main indicators of degree of industrial development. Traditionally, industrialised economies have been specialised in exporting manufactured goods while developing countries have specialised in primary products. This chapter is aimed to throw light on the issue of whether this traditional pattern of international trade has changed, with particular emphasis on changes in the structural significance of products generated in industries characterised by high income generating potential, such as computing and electronics. One of the conclusions of this analysis is that there has been a pronounced trend of convergence between industrialised and developing economies countries in terms of the increased significance of manufactured exports in the composition of total merchandise exports, as well as in the structure of manufacturing production. In East Asian economies the structural adjustment was mostly marked.

Another finding of this chapter is that for most countries there was a positive correlation between growth and structural change in manufactured exports towards a higher proportion of products generated in industries of high income generating potential. An analysis of changes in the composition of manufactured exports, undertaken further in this chapter, has shown that during 1970-1996 there was a major shift towards industries characterised by a high income generating potential in the composition of global manufactured exports. This global trend was largely determined by changes in the structural composition of the manufactured exports of developed countries. In the 1990s the influence of ASEAN and the NICs on this trend became particularly noticeable. The pace of structural change in manufactured exports was the most marked in East Asian economies.

In Chapter 6 the analysis of structural changes in the manufactured exports of different regions and countries is extended by considering the particular role of the computing and electronics industries. The aim of this chapter is to find out whether the contribution of these industries to the increased significance of industries of high income generating potential in the composition of manufactured exports globally, and in particular regions and countries, differed from that of other industries. Among the conclusions is that in most countries exports of computing and electronic products were growing faster than exports of other manufactured goods. This phenomenon was mostly pronounced in East Asian economies. Unprecedented growth rates of exports of computing and electronic products, achieved by Asian economies, were reflected in the changes in the pattern of regional distribution of global exports of these products. During 1985-1996 ASEAN, Japan and NICs, became the major exporters of computers and electronics, providing a half of the world's exports of these products. The results of further analysis indicate that the degree of specialisation in exports of computers and electronics in many rapidly growing East Asian economies was higher than in most other countries. For these East Asian economies computing and electronics industries were not just of high structural significance, but played a decisive role in the change in the composition of manufactured exports.

An analysis of the role of computing and electronics industries in the composition of manufactured imports, undertaken in Chapter 7, shows that the products of these industries played an important role in the structure of manufactured imports of many Asian countries, and especially of countries of the ASEAN region. Further, the structural significance of products of these industries in terms of imports was increasing over time. For most of the developed countries, by contrast, the significance of these products in the composition of manufactured imports diminished over the period of 1970-1996. There were also major changes in the pattern of net trade in these products, with many developed countries becoming net importers and many Asian countries becoming net exporters of these products.

The analysis to this stage might be seen as supporting the central role of a change in industrial structure and, in particular, of high degree of specialisation in computing and electronic production and trade, in the rapid growth of the East Asian economies. However, a high and increasing significance of these products in the composition of manufactured imports of East Asian economies suggests that further analysis of the composition of computing and electronic production and trade at a higher level of disaggregation is required. This is undertaken in Parts C and D.

CHAPTER 5

CHANGES IN THE COMPOSITION OF EXPORTS: THE ROLE OF INDUSTRIES OF HIGH INCOME POTENTIAL

While there have been some notable exceptions, specialisation in exports of manufactured products has long been seen as one of the main indicators of the degree of industrial development. Traditionally, developed economies have been specialised in exporting manufactured goods while developing countries were specialised in exports of primary products. This traditional pattern of international trade has changed substantially, and many developed and developing countries now trade in similar products (see, for example, Haque 1995, p. 6). However, the issue of whether there is an actual convergence in the trade patterns, and in the types and quality of products traded across countries, is not so clear. This part of the research is aimed at throwing light on these issues, with particular emphasis on changes in the structure of exports of products generated in industries characterised by high income generating potential, such as computing and electronics.

To achieve this general aim, the particular objectives of this chapter are:

1. to evaluate changes in the significance of manufacturing exports in the composition of total merchandise exports and of manufacturing production;
2. to consider whether the growth of manufacturing exports is positively correlated with structural change in manufacturing exports, defined in terms of income generating potential (see Chapter 4); and
3. to analyse structural change in manufacturing exports, from a perspective of income generating potential, in major regions and selected countries.

In the next chapter the role of computing and electronics products in the composition of manufactured exports will be assessed, while the character of production activities in these industries in various countries is analysed in later chapters of this study.

5.1 The Structural Significance of Manufacturing Exports

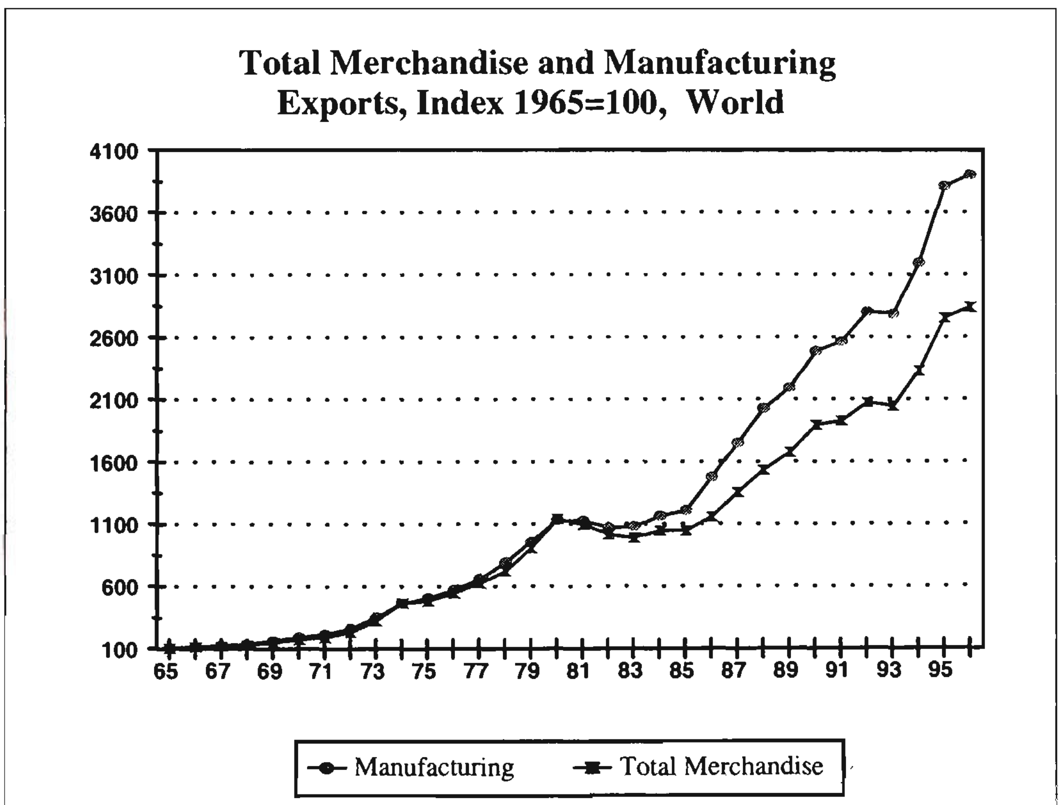
In this section the issue of the structural significance of trade in manufactured products will be approached from two points of view:

- manufacturing exports as a component of total merchandise exports;
- exports as a part of production of manufactured goods.

5.1.1 The Role of Manufacturing Exports in Total Merchandise Exports

One of the most remarkable features of modern economic development has been a dramatic increase in the volume of trade. World merchandise exports grew steadily over the period 1965–1996, growing at an average annual rate of 11.4 per cent and reaching almost US$5 trillion in 1996. In the second half of the 1960s and in the 1970s, the growth of manufactured exports followed the trend of total merchandise exports (Chart 5.1). The period starting in 1980 was characterised by unprecedented structural change in exports in favour of manufacturing. Over the period 1980-1996 the volume of manufactured exports increased 3.5 times while merchandise exports in 1996 were 2.5 times higher than in 1980. The most pronounced shift occurred in the second half of the 1980s, when manufactured exports grew at 15.6 per cent per annum in comparison with 12.7 per cent growth of total merchandise exports. In 1980 manufacturing accounted for 56 per cent of merchandise exports, about the same level as in 1965, but this share reached 77 per cent in 1996.

Chart 5.1



Source: Based on UN Trade Data accessed through IEDB database.

Structural change towards a greater share of manufacturing in total merchandise exports was occurring in all regions, and in most countries, relevant to this study. (Table 5.1).

However, while in some countries this share was already relatively high in 1965, other economies experienced the process of dramatic structural change in the period after 1980.

Table 5.1 **Share of Manufacturing Exports in Total Merchandise Exports, Selected Regions and Countries**
(Based on data in current US $)

	1965	**1975**	**1985**	**1990**	**1996**
			per cent		
EEC-12	75.9	78.0	75.5	81.6	82.9
USA	65.4	68.6	74.6	78.1	81.9
NICs	74.0	86.2	92.1	93.6	93.1
ASEAN	11.4	17.8	35.5	59.4	76.0
Japan	91.1	95.7	97.3	97.4	97.3
China	45.8	42.1	50.4	73.5	84.5
India	48.7	45.1	58.2	72.3	74.2
Australia	14.5	18.8	18.6	36.1	32.9
Mexico	16.4	31.1	27.1	43.5	78.3
World	**56.0**	**59.2**	**64.8**	**73.6**	**77.0**

Source: UN Trade Data accessed through IEDB database.

In Japan exports of manufactured goods accounted for 91 per cent of total merchandise exports in 1965, reached more than 97 per cent in 1980 and since that time have remained at approximately the same level.

In EEC-12, during the 1960s and the 1970s manufacturing exports were growing more rapidly than total merchandise exports, with the share of manufacturing products rising from slightly more than 75 per cent in 1965 to more than 78 per cent in 1978. In the late 1970s and the early 1980s, however, the manufacturing export share fell, reaching the minimum of 74.3 per cent in 1984. In the mid 1980s high growth was restored, leading to an export share of about 83 per cent in 1996. There were quite pronounced differences across European economies. Thus, in Germany, the most industrialised country in Europe, manufacturing exports constituted a high proportion of merchandise exports during the whole period 1965-1996, growing from 88 per cent to more than 90 per cent. In Italy, the United Kingdom and France manufacturing was also dominant in goods exports, with the shares in 1996 ranging from 80 per cent in France to about 90 per cent in Italy. In Denmark and the Netherlands manufactured products were not as significant in terms of the structure of merchandise exports as in other European countries. Although shares of manufacturing exports were growing steadily over the period in Denmark and over the 1980-1996 period in the Netherlands, in both countries at the end of the period manufactured goods accounted for just slightly more than 65 per cent, the proportion that Sweden had in 1965. In Spain and Ireland the pace of structural change was quite striking. At the beginning of the period manufacturing exports constituted less than 40 per cent of merchandise exports in Spain, and only one third in Ireland. In 1996 the export share in both countries approached the average European level.

In the United States structural change in this respect was more pronounced than in EEC-12. In 1965 the proportion of exports accounted for by manufacturing in the USA was about 65 per cent, but by 1996 had approached European levels at about 82 per cent. In Canada the share of manufacturing exports in total merchandise exports rose from slightly more than one third in 1965 to more than two thirds in 1996, still at the level that the USA had in the second half of the 1960s. Structural change in Mexico was spectacular: the proportion of manufactured products in total merchandise exports rose from 16.4 in 1965 to 78.3 per cent in 1996, reaching the Northern American level at that time. About half of this growth occurred in the 1990s, presumably reflecting the impact of NAFTA on Mexican trade. Manufacturing exports also rose substantially as a share of merchandise exports in Australia (from 14.5 per cent in 1965 to 32.9 per cent in 1996) and in New Zealand (rising from 5.4 per cent to 29.6 per cent over the same period), but still remained at a low level by international standards.

The share of manufactured exports in overall merchandise exports in the Newly Industrialising Countries (Hong Kong, South Korea and Taiwan) in 1996 was greater than in all other regions of the world, and was approaching the Japanese level. However, while in Hong Kong manufactured products accounted for more than 93 per cent of merchandise exports in 1965, in South Korea and Taiwan the composition of exports changed dramatically over the period 1965-1975. In 1965 manufactured goods amounted to about 60 per cent of merchandise exports in South Korea and to just slightly more than 40 per cent in Taiwan. In 1975 shares of manufacturing were greater than 80 per cent in both countries.

In China major restructuring occurred later than in South Korea and Taiwan. In 1985 manufactured products accounted for half of merchandise exports. Over the next ten years manufacturing exports were growing at the rate of 25 per cent per annum, almost five times faster than other exports. By 1994 the share of manufacturing exports in total goods exports in China exceeded that of EEC-12.

Changes in the structure of merchandise exports in the ASEAN economies were also striking. Singapore was the only economy in the ASEAN region that had a relatively high proportion of manufactured products in goods exports in 1965, at 34.2 per cent. During the period 1965-1996 the share of manufacturing exports was growing at 3 per cent per annum in Singapore. In 1985 manufacturing reached the same degree of structural significance in exports in that country as in Denmark, and by 1996 approached the share of Swedish manufactured exports. In Malaysia and the Philippines in 1965 manufactured goods amounted to only about 6 per cent of total merchandise exports; in Thailand and Indonesia they accounted for less than 4 per cent. In 1996 manufactured exports in the Philippines constituted more than 83 per cent of merchandise exports, as in the United Kingdom. In the 1985-1996 period the share of manufacturing exports in Malaysia was growing at the rate of about 10 per cent per annum, reaching 77 per cent of merchandise exports, a proportion comparable with the levels achieved in Spain and France. Thailand also experienced spectacular structural change in merchandise exports, with the share of manufacturing reaching 74 per cent in 1996. Indonesia, however, was quite different to other ASEAN economies. Structural change began later than in other countries, in early 1980s. In 1982 the share of manufactured products in total merchandise was the same as in 1965, less than 4 per cent. By 1985 the share had increased to more than 13 per cent, and it continued to grow subsequently. By 1996 manufactured goods accounted for more than a half of Indonesian merchandise exports, still well below the proportions in other ASEAN economies.

Conclusion

During the period 1965-1996 there was a major shift in the structure of merchandise exports in favour of manufactured products. For the world as a whole, the share of manufacturing increased from slightly more than a half to about 80 per cent of merchandise exports. Manufacturing gained greater structural significance in exports in both developed and developing countries. A remarkable feature of modern economic development has been the convergence between developed and some developing countries in terms of the structural significance of manufacturing exports. Thus, ASEAN economies, for example, achieved unprecedented rates of structural adjustment, at least in terms of exports.

5.1.2 The Export Component of Manufacturing Production

In this section the significance of manufactured exports will be evaluated from another perspective, namely the export intensity of manufacturing production. Table 5.2 below outlines the ratio of exports to the gross value of manufacturing production for 23 countries from 1970 to 1995 (or the latest available year). It is apparent that there were marked differences across countries in terms of the actual levels of export intensity. At the end of the period seven countries exported more than half of their manufacturing gross output, while for several the proportion exported was less than 15 per cent.

The export intensity of production in the Netherlands reached 82 per cent in 1995, the highest in the sample. The export intensity of manufacturing in Ireland was higher than in such export oriented Asian economies as Hong Kong and Malaysia: in 1993 the export share in Ireland was above 70 per cent of manufacturing production, while in Hong Kong it was 68.7 and in Malaysia 65 per cent in that year. The Mexican propensity to export in 1994 was higher than in Malaysia in 1994. Danish and Swedish exports accounted for about 60 per cent of manufactured goods produced in these countries. Canada and Taiwan in 1995 exported about half of the output. The United Kingdom, Germany, New Zealand and France exported about one third of the manufactured goods produced, approximately the same share as the Philippines and Indonesia. In Spain and South Korea exports accounted for slightly less than 30 per cent of manufactured output. China's exports amounted to one fifth of its manufacturing production. Australia's propensity to export manufactured goods in 1992 was quite low, with 14.2 per cent of manufactured output exported. This figure was comparable with the export shares of such economies as the USA, Japan and India, where the domestic market plays a dominant role.

Although, as has been shown above, the propensity to export differed substantially across countries, there was a general tendency towards a greater export orientation of manufacturing production over the period. In all countries presented in Table 5.2, the export share at the end of the period was higher than at the beginning. In the USA the share rose 2.5 times over the period 1970-1995, while in Germany in 1994 the proportion of exports was 1.5 times higher than in 1965. Spain achieved the highest rates of growth of export intensity among European countries: in 1995 the ratio was 3.2 times higher than in 1970. In Ireland export intensity changed significantly as well, 2.7 times. In Australia and

New Zealand growth of manufacturing export shares was more modest than in Europe; in 1992 export shares were 1.3 times higher than in 1970.

Table 5.2 Manufacturing Exports, Shares of Gross Output, Selected Countries
(Based on data in current US $)

	1970	1975	1980	1985	1990	1995
			per cent			
USA	5.5	7.8	9.0	7.4	11.3	13.6
Canada	24.5	21.4	26.8	31.1	33.0	49.2
Denmark	38.2	50.1	50.1	56.3	55.9	59.8[3]
France	15.7	19.7	22.4	27.0	28.2	32.7
Germany	23.2	29.6	28.8	35.7	35.1	34.4[1]
Ireland	26.8	38.7	46.4	60.5	64.8	72.6
Italy	24.7	27.0	29.9	35.8	33.9	41.0[2]
Netherlands	39.4	48.6	55.5	71.2	72.2	82.1
Spain	9.2	10.3	12.4	21.1	19.4	29.0
Sweden	31.6	35.8	40.5	48.4	47.7	59.7[1]
United Kingdom	16.7	20.3	23.8	25.6	28.2	34.4
Australia	10.5	12.2	15.1	13.0	11.6	14.2[3]
New Zealand	25.3	20.5	30.1	29.3	30.3	33.7[3]
Mexico	na	na	na	19.2	25.4	65.2[1]
China	na	na	5.1	7.2	14.5	20.7[1]
Hong Kong	na	60.8	60.5	71.1	68.3	68.7[2]
India	7.2	8.9	6.9	6.5	9.3	14.5[2]
Indonesia	22.4	23.9	28.4	20.9	31.6	32.6
Japan	9.7	12.6	13.2	15.5	12.5	12.6
Malaysia	50.7	46.9	42.2	45.1	59.1	71.7
Philippines	17.1	18.6	18.1	19.7	18.0	35.2
South Korea	16.3	27.0	27.5	32.9	25.0	27.1
Taiwan	na	na	34.6	39.2	38.8	49.9

Notes: 1. 1994;
2. 1993;
3. 1992.

Source: ISIC Trade and Production Data accessed through IEDB database.

In Asian economies the increase in the export intensity of manufacturing production was quite marked. Thus, in Japan export shares rose 1.3 times, in Malaysia 1.4 times, in Indonesia 1.5 times, in South Korea 1.7 times, and in the Philippines 2.1 times, over the period 1970-1995. In Taiwan export shares increased 1.4 times during 1980-1995, while in

Hong Kong the increase was a factor of 1.1 during 1975-1993. India experienced a strong growth in export orientation of manufacturing, with export shares more than doubling during the period 1970-1993. Changes in the export intensity of Chinese manufacturing sector were quite remarkable: in 1994 the export share was more than 4 times its level in 1980. The only country that achieved comparable rates of growth was Mexico, where the export intensity rose 3.4 times during 1985-1994.

Conclusion

Over the period 1970-1995, although there were marked differences across countries in terms of the actual levels of export intensity, in all countries considered in this section there was a general tendency towards a greater export orientation of manufacturing production. The structural significance of exports in this regard increased in both developed and developing countries. Export oriented Asian economies, such as Malaysia, Hong Kong and Taiwan, achieved very high ratios of exports to production, ranging from about a half of the overall manufacturing output in Taiwan to almost 70 per cent in Hong Kong. The propensity to export in some European countries, however, was even higher than in these Asian economies. Thus, for example, in 1995 the Netherlands exported more than 80 per cent of all manufactured products. In all countries, considered in this section, except for the USA, Australia, and India, exports constituted substantial portions of manufacturing production. Thus, the structure of exports can significantly influence the structure of the overall manufacturing production. Consequently, an analysis of the structure of exports and changes in this structure can provide a valuable starting point for a study of national competitiveness.

5.2 The Structure of Manufactured Exports

5.2.1 The Significance of Structural Change in Manufactured Exports

As discussed in Chapter 4, manufacturing industries differ substantially in their potential to stimulate the generation of economic wealth, and a detailed description of industry characteristics was presented in that chapter. As has been shown above, in most countries considered in Section 5.1.2, exports constitute a sufficient proportion of manufactured gross output to influence the structure of the overall manufacturing sector. In this section we will consider whether the growth of manufactured exports is positively correlated with changes in the composition of manufactured exports, defined in terms of income generating potential embodied in the structure of those exports. It is not the purpose of this analysis to determine causality between structural change and growth of exports; neither do we attempt to consider structural change as the only factor relevant to growth of the manufactured exports. The purpose of the panel regression analysis, presented in this section, is to find out whether there is a positive correlation between structural change in, and the growth of, manufactured exports in different countries and, if it is so, whether the relationship between structural change and growth in manufactured exports is similar across countries.

The panel regression results are presented in Table 5.3. The values of the Index of the Long Run Income Potential of exports have been used as an independent variable, and the values of manufacturing exports as the dependent variable. Both variables are in logarithmic form and, thus, should be interpreted in terms of growth rates. The data set covers 25 countries (see the notes, Table 5.3) for the period 1970-1996. The data are unbalanced, the number of observations for individual countries varies from 22 to 27, depending on the availability of the data.

A fixed effects model has been used. Such a model assumes a homogeneous slope and heterogeneous intercepts across sections, in our case representing particular countries. In our application the slope represents the coefficient on the industrial structure variable. Application of this model allows us to test two relationships: whether the slope coefficients for individual countries constituting a sample are similar, and, if so, to determine whether there is a statistically significant correlation between the two variables for these countries as a whole. Thus, by applying a fixed effects model we can define subsets of countries that exhibit correlations with similar coefficients, which are statistically significant for each subset, between structural change and the growth of manufactured exports. Analysis of covariance, based on an F-test, is used to test the acceptance of the restriction of homogeneity of regression coefficients. A value of F, exceeding the critical value, indicates that the assumption of a common slope coefficient is not valid. In this case a single least-squares regression using all observations of cross-sectional units through time may be seriously biased, and the pooled least-square estimates may lead to false inferences (see, for example, Hsiao 1986, pp. 5-18).

The results of the first regression, covering all 25 countries, do not allow us to draw any conclusion about a common correlation between the variables. The results should be rejected on the basis of F test. These results indicate that there is a significant variation in individual countries' coefficients. Disaggregation of the data set into two groups, 14 developed countries and 11 Asian countries, leads to a similar outcome. The results of the panel regressions for the ASEAN economies and for other 14 countries (the eighth regression) also require the hypothesis of similar coefficients to be rejected.

Table 5.3 Evidence of Correlation between Structural Change and Growth of Manufacturing Exports, 1970-1996

Dependent variable – ln of the values of Manufacturing Exports (bill. curr. $ US)
Independent variable – ln of the values of the Index of the Long Run Income Potential of Manufacturing Exports

		Coeff-t	t-ratio	R-sq. adj.	Number of observations	SEE	F test ($A_i,B = A_i,B_i$)	Critical F value
1	All countries (25)[1]	10.7	26.6	0.79	670	327.7	34.3	6.8
2	Developed (14)[2]	13.7	21.4	0.85	378	109.6	22.4	6.1
3	Asian countries (11)[3]	9.6	17.3	0.70	292	201.0	44.3	5.8
4	ASEAN (5)[4]	7.2	8.4	0.46	130	128.7	65.5	4.9
5	NICs (3)[5]	12.1	22.3	0.87	81	16.3	1.9	4.3
6	NICs+ MYS+THA (5)	11.6	24.7	0.85	135	39.7	2.9	4.9
7	CHN+IND	25.7	11.7	0.76	54	19.0	0.8	3.8
8	Other (14)[6]	14.0	22.3	0.85	378	115.1	21.1	6.1
9	Other (10)[7]	18.0	25.0	0.89	270	55.1	5.5	5.7

Notes: 1. AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, MEX, NLD, NZL, SWE, USA, CHN, HKG, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (70-96), IDN (75-96);

2. AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, JPN, NLD, NZL, SWE, USA;

3. CHN, HKG, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN;

4. IDN, MYS, PHL, SGP, THA;

5. HKG, KOR, TWN;

6. AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, MEX, NLD, NZL, SWE, USA;

7. AUS, CAN, ESP, FRA, GBR, MEX, NLD, NZL, SWE, USA.

Source: Estimates based on ISIC Trade Data accessed through IEDB database.

However, four other panel regression tests lead to statistically significant results, indicating a positive common correlation between structural change and growth of manufactured exports for the countries of those groups. Thus, a regression for the three newly industrialising countries, Hong Kong, South Korea and Taiwan, exhibits a strong, positive common relationship between the variables. Addition of two other Asian economies, Malaysia and Thailand, into the data set with the three NICs leads to similar results, namely a positive common correlation, although the coefficient is slightly lower than in the case of NICs. The results of the panel regression for a selection of other ten economies (see the note 7, Table 5.3) are also statistically significant with a higher coefficient than for NICs. A coefficient of the regression testing an aggregated sample, incorporating the data for China and India, indicates a very strong association between structural change and export growth for these two countries.

Thus, according to the results of the four panel regression tests, discussed above, seventeen economies (Hong Kong, South Korea, Taiwan, Malaysia, Thailand, China, India Australia, Canada, Spain, France, the United Kingdom, Mexico, the Netherlands, New Zealand, Sweden, and the USA) of the initially considered twenty five exhibit a positive correlation between structural change and growth of manufactured exports. The regression results for the remaining eight individual countries (Indonesia, the Philippines, Singapore, Japan, Germany, Denmark, Ireland, and Italy), included in the initial data set consisting of twenty five countries, are presented in the Appendix, Table 5.A1. Six countries (the Philippines, Singapore, Japan, Germany, Denmark, and Ireland) exhibit a positive correlation between structural change and growth of manufactured exports.

There are marked differences between the coefficients for the three ASEAN economies, Indonesia, the Philippines and Singapore. The coefficient for Indonesia is negative. The positive coefficients, in the cases of the Philippines and Singapore, differ substantially from the coefficient for the five Asian economies including Malaysia and Thailand (Table 5.3). Such significant differentials between the values of the individual coefficients have been reflected in the negative F test result for the panel regression for the five ASEAN economies. The positive coefficient for Japan is higher than the coefficients for the data sets for panel regressions that included Japan (all twenty five countries, fourteen developed and eleven Asian economies). Marked differences between the individual coefficients for the four European countries, Germany, Denmark, Ireland and Italy, have also affected the F test for the panel regressions (Table 5.3) for all twenty five countries (the first regression), fourteen developed countries (the second regression) and other fourteen countries (the eighth regression).

It is worth noting some other panel regression results, shown in the Appendix, Table 5.A2. The same variables have been used as in the panel regression, described above, but in the form of values, not in logarithms. Thus, this statistical test has been aimed to find out whether there is a correlation between the structure and the values of manufactured exports. Although the coefficients for all regressions are positive, it is impossible to draw a conclusion about a positive common correlation between the structure and the values of manufactured exports. The results have to be rejected on the basis of the F test. The only fact that can be derived from the regression analysis is that there are significant differences between the individual countries' coefficients.

Conclusions:

The main conclusions of this section can be summarised as follows. There is a positive correlation between structural change and growth of manufactured exports for twenty three of the twenty five countries, considered in this section (seventeen – on the basis of panel regression tests and six – on the basis of regressions for individual countries). The panel regression results indicate that there are groups of countries that exhibit similar positive coefficients between changes in export structure and growth in manufactured exports. These groups are:

- Hong Kong, South Korea, Taiwan, Malaysia and Thailand;
- China and India; and
- Australia, Canada, Spain, France, the United Kingdom, Mexico, the Netherlands, New Zealand, Sweden, the USA;

It is also clear that there are marked differences between the values of the coefficients for particular countries and groups of countries, and there is no evidence of positive common correlation between export structure and the level of manufactured exports for these countries.

It is notable that structural change, not an advanced structure, is correlated with growth of exports. In other words, there is no empirical evidence that specialisation in exports of the products of industries characterised by high income generating potential is correlated with a high level of exports. In the next section changes in the composition of manufactured exports will be analysed, with a particular emphasis on the role of industries of the high income generating potential.

5.2.2 Structural Change in Manufactured Exports

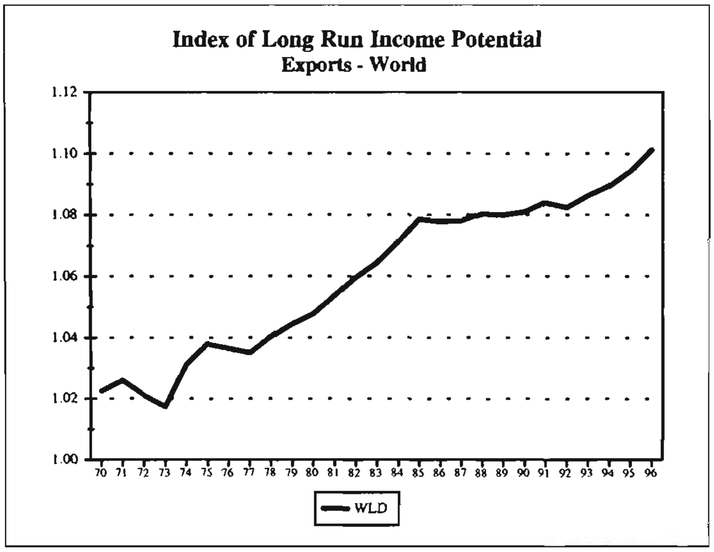
The new analytical tool, the Index of the Long Run Potential, described in the previous chapter, will be used here for the analysis of the structure of manufacturing exports and of the changes in this structure. It is worth noting that this index is an indicator of industrial structure, measured according to the benchmark potential of manufacturing industries to stimulate generation of economic wealth. The index is not an indicator of the competitive strength actually achieved in different countries and regions. Nor do the values of the index reflect the nature of production activities undertaken in different countries. Changes in the value of the index are associated with a change in manufacturing structure in a particular direction, towards a higher proportion of products generated in industries characterised by a higher income potential (see Table 4.5). In other words, higher values of the index indicate a higher structural significance of these industries, measured by sectoral shares of total manufacturing.

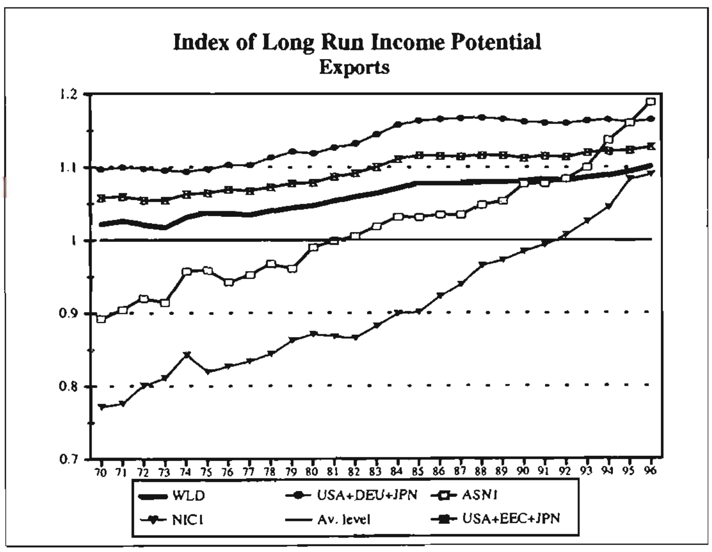
The upper panel of Chart 5.2 shows the values of the Index of Long Run Income Potential for the world's manufactured exports for the period 1970-1996. The values of the index changed from 1.02 to 1.10 over the period, indicating that the structural significance of industries of higher income generating potential increased. In the 1970s there were some variations in the values of the index related to the structural adjustment consequent upon the first 'oil shock'. The period 1977-1985 was one of relatively rapid change in the structure of global manufactured exports. The values of the index changed from 1.03 to 1.08 during eight years. Since 1985 structural change slowed down and renewed in 1992. The marked difference between the pace of structural change of the world's manufactured exports for the periods 1985-1992 and 1992-1996 is also presented on the third panel of Chart 5.2, in the index form.

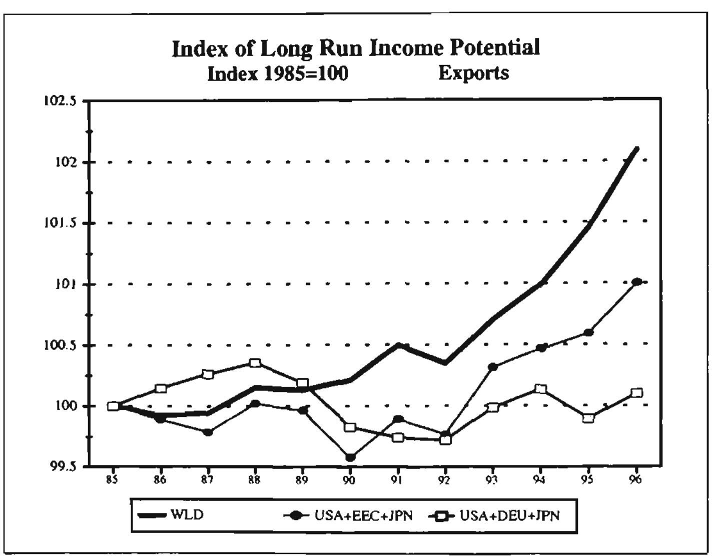
The second panel of Chart 5.2 provides some information about the process of structural change in manufactured exports that occurred globally and in different regions during 1970-1996. Several observations can be derived from this chart.

First, the trend of the values of the index for the world replicates the pattern of the structural change of exports of the major developed countries, the USA, EEC-12 and Japan.

Chart 5.2







Source: Based on ISIC Trade Data, from IEDB database.

This reflects the fact that the world's manufactured exports are dominated by the major developed economies.

Second, the values of the index for the world's exports are significantly below the levels for the major developed countries and are, to an even greater extent below the values for the USA, Germany and Japan. Industries of a higher income potential are, thus, structurally more significant for exports of the major developed countries than for exports of the world as a whole. Germany's manufactured exports are characterised by a higher concentration of high income potential industries than exports generated by the twelve European countries. The value of the index for the world's exports in 1996 reached the value of the index observed in the three major economies in the 1970. The lower values of the index for the world indicate that the structure of exports generated by the rest of the world was biased, in relative terms, towards the industries characterised by low income generating potential.

Third, the values of the index for the world and for the major developed countries, during virtually all of the period 1970-1996, were greater than one, the average value of the index which corresponds to an even distribution of exports across all manufacturing industries. Thus the structure of manufactured exports of the world, and of the major developed economies in particular, was biased towards industries of high income generating potential.

Fourth, the pace of structural change of manufactured exports of ASEAN and the NICs (Hong Kong, South Korea and Taiwan) was remarkable. In 1970 the value of the index for ASEAN was about 0.9, well below the average value for the world as a whole. In 1996 the value of the index reached 1.19, a much higher value than that for the USA, Germany and Japan, which was 1.13. Structural change of manufactured exports in the NICs was even more striking. At the beginning of the period the value of the index was much lower than for ASEAN, but during the period 1970-1996 the value of the index changed from 0.77 to 1.09, approaching the value for the world as a whole.

Rapid structural change in the manufactured exports of the ASEAN countries and the NICs was reflected in a deviation of the global trend in the 1990s from the pattern determined by the structure of the developed countries. This deviation is apparent in the index form, 1985=100, shown in the third panel of Chart 5.2. Until 1985 the trend for the world replicated that for the developed countries. Since that time structural change in the world's manufactured exports was more pronounced than in those of the developed countries. A greater pace of structural change for the world as a whole is indicative of the fact that manufacturing exports generated by other countries, including the countries of ASEAN and the NICs, are sufficient to influence the structure of the world exports. A comparison between the trends for the three countries and the EEC-12, the USA and Japan gives a reason to conclude that structural change in other European countries was more marked than in Germany.

The relative positions of twenty five countries according to the value of the Index of the Long Run Income Potential are presented in Table 5.4. Countries are listed according to the change in relative positions during the period 1970-1996, and their ranking in terms of index level is provided for each year. The most noticeable fact is that most of Asian economies moved up in the list, while the relative positions of the developed countries deteriorated. The pace of structural change of ASEAN countries is again shown as remarkable. Singapore, an economy accounting for more than 40 per cent of ASEAN manufactured exports, is ranked first in 1996. During the period 1970-1990 Singapore moved up seven positions and since that time has remained at the top of the list. Malaysia moved thirteen places up, and the Philippines' position in 1996 was sixteen places higher than it had been in 1970. The positions of Malaysia and the Philippines in 1996 are relatively high, the fourth and the fifth respectively. The positions of the two other ASEAN economies are not so high. Thailand's position is the thirteenth, six places higher than in 1970. Indonesia's relative position deteriorated significantly over the period from the number eleven in 1970 to the second last in the list in 1996. However, because of their relatively small shares of total ASEAN manufacturing exports, slightly above 15 per cent for Thailand and 10 per cent for Indonesia, the structural composition of exports of these countries does not have a dominant effect on the structure of ASEAN exports as a whole.

The pace of structural change in South Korea was also striking. South Korea moved 15 places up from the lowest, the twenty fifth, position in 1970 to the tenth in 1996. Taiwan was number fourteen in 1996, that is four places higher than it was in 1970. Hong Kong occupied the twenty first position in 1996. The share of Hong Kong in NICs manufactured exports decreased from more than 50 per cent to about 10 per cent during the period 1970-1996, so that the structural composition of NICs' manufactured exports is almost entirely determined by the structure of exports of South Korea and Taiwan.

Ireland is only developed country that achieved a pace of structural change of manufactured exports comparable with that of South Korea. The value of the Index of the Long Run

Income Potential in 1996 was almost 1.5 times higher than in 1970 for Ireland, and just slightly more than 1.5 times higher for South Korea. Since 1975 Ireland moved fourteen places up, from the sixteenth to the second position.

Table 5.4 Relative Positions of Selected Countries According to the Value of the Index of the Long Run Income Potential of Exports[1]

	1970	1975	1980	1985	1990	1996	Change 1970-96
Philippines	21	23	25	20	21	5	16
South Korea	25	19	18	17	14	10	15
Ireland	16	16	11	4	4	2	14
Malaysia	17	18	17	13	10	4	13
Singapore	8	2	3	3	1	1	7
Thailand	19	24	22	21	19	13	6
Taiwan	18	17	19	18	15	14	4
Mexico	12	12	8	8	5	8	4
Japan	6	5	2	2	2	3	3
Hong Kong	24	25	20	19	20	21	3
China	22	22	21	22	22	22	0
Spain	15	15	12	12	11	15	0
India	23	21	24	25	24	25	-2
New Zealand	20	20	23	24	23	23	-3
Australia	14	13	15	14	18	18	-4
United Kingdom	3	4	5	5	6	7	-4
Netherlands	7	6	6	9	12	11	-4
USA	1	1	1	1	3	6	-5
Denmark	13	14	16	16	17	19	-6
Germany	2	3	4	6	7	9	-7
Sweden	10	10	9	11	13	17	-7
France	4	7	7	10	8	12	-8
Canada	5	8	10	7	9	16	-11
Italy	9	9	13	15	16	20	-11
Indonesia[2]	11	11	14	23	25	24	-13

Notes: 1. The order of countries in the list is determined according to the change in relative positions during the period 1970-1996;

2. For Indonesia the value of the index for 1970 is not available, the position is assigned as for 1975.

Source: Estimates based on ISIC Trade Data accessed through IEDB database.

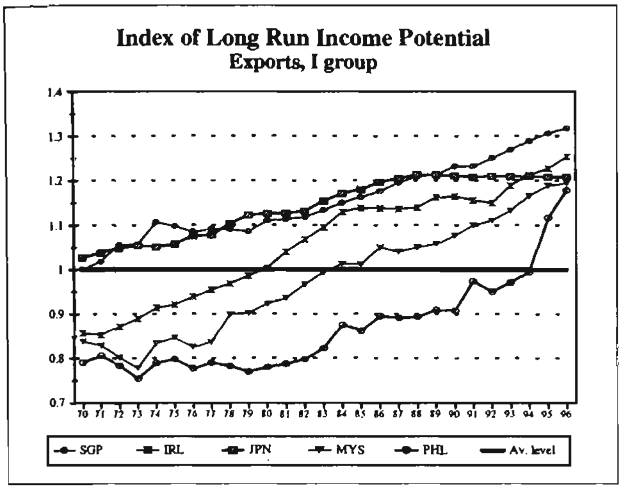
Thus, the relative positions of countries changed dramatically during the period 1970-1996. The changes in the structure of manufactured exports of ASEAN economies, NICs and Ireland is reflected in a marked upward movement of their relative positions. Consequently, most of the developed countries were shifted down. However, it is worth noting that most of the countries considered in this section experienced structural change towards industries of higher income generating potential. Only for two countries, Indonesia and Italy, were the values of the Index of the Long Run Income Potential lower in 1996 than for 1970. For Italy the value of the index for 1996 was 97.5 per cent, and for Indonesia about 84 per cent, of the 1970 levels. For Germany, for example, the 1996 value was 2 per cent higher and for the USA 3 per cent higher than in 1970, while for the United Kingdom and the Netherlands the increase was about 9 per cent.

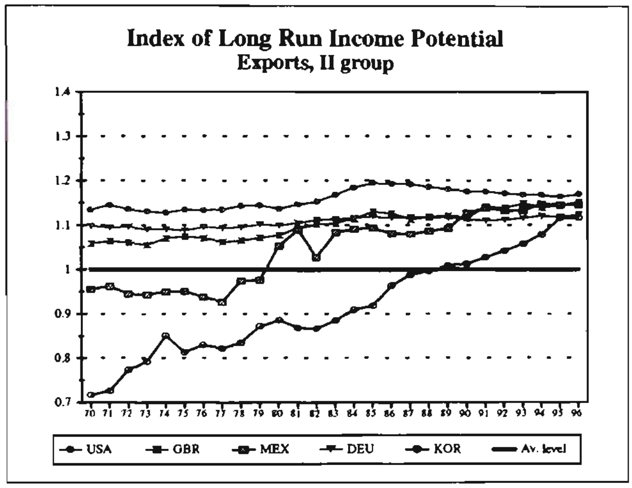
Chart 5.3 provides some additional information for cross-country comparison of the process of structural changes in manufactured exports. The twenty five countries are subdivided into five groups according to the value of the index for 1996. There are quite marked differences between the groups of countries as well as between countries within groups. An analysis of the standard deviation of natural logarithms of the values of the index for all, twenty-five, countries (Table 5.5) confirms that there was no convergence in the values of the index in 1975-1985 for the groups as a whole. Although the trend changed since that time, the differences across countries remained quite marked, and the standard deviation for 1996 is greater than for 1975.

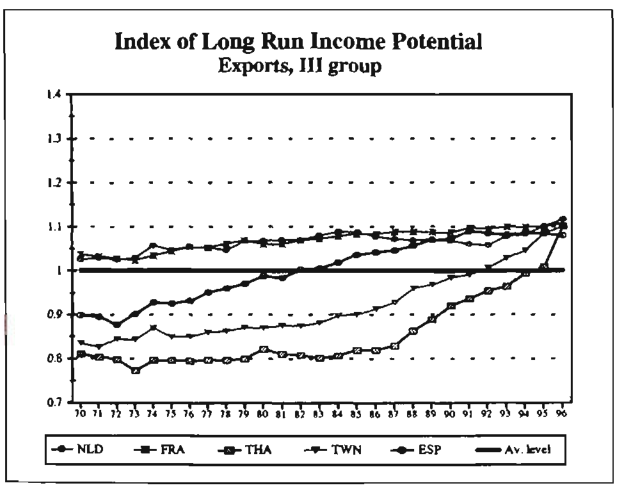
The structure of exports of the countries of the first group – Singapore, Ireland, Japan, Malaysia, and the Philippines – changed substantially. During 1970-1996 the average value of the index for this group of countries changed from 0.9 to 1.23. The dispersion in the values of the index across countries of this group was diminishing since 1980. The standard deviation for 1996 is only 40 per cent of that for 1970. The values of the index for Singapore and Ireland in 1996 were greater than that of Japan, the leader of the group at the beginning of the period, while the values of the index for Malaysia and the Philippines approached the Japanese level.

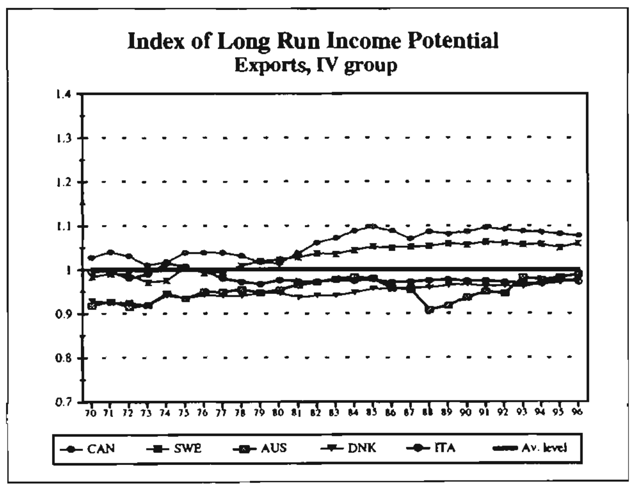
Convergence of the values of the index is most marked for the countries of the second and the third groups. The standard deviation fell from 0.15 to 0.024. There are pronounced differences between the trends of the values of the index for the countries of these two groups. The values of the index for the USA, Germany, the United Kingdom the Netherlands and France were relatively high at the beginning of the period and rose at a moderate pace during the period. Spain and Mexico experienced a substantial structural adjustment. The pace of structural change of manufactured exports of Taiwan, Thailand, and especially South Korea is striking.

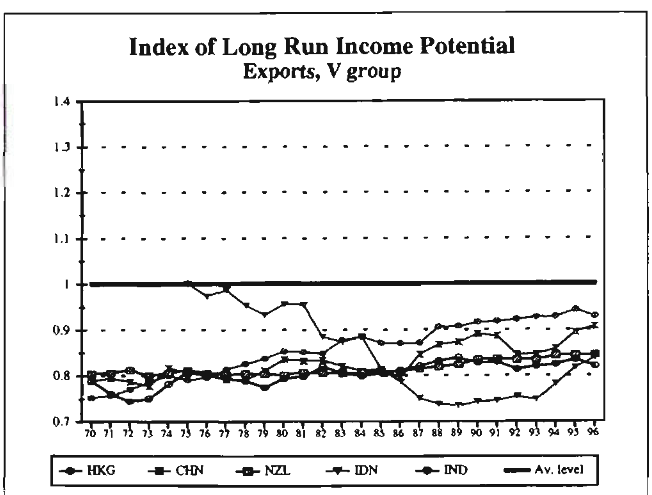
Chart 5.3











Source: Estimates based on ISIC Trade Data accessed through IEDB database.

Table 5.5 Standard Deviation of LN of the Values of the Index of the Long Run Income Potential

	I group	II & III groups	IV group	V group	All countries
1970	0.115	0.150	0.048	na	na
1975	0.138	0.129	0.048	0.098	0.121
1980	0.151	0.112	0.035	0.074	0.118
1985	0.132	0.120	0.058	0.033	0.134
1990	0.125	0.073	0.063	0.081	0.128
1996	0.045	0.024	0.047	0.054	0.127

Source: Estimates based on ISIC Trade Data accessed through IEDB database.

Industries of higher income generating potential gained structural significance in the composition of exports of the countries of the fourth group. However, the pace of restructuring was relatively low. The average values of the index changed from 0.97 to 1.01 over the period. There were some fluctuations in the values of standard deviation but they were not significant. At the end of the period standard deviation was at approximately the same level as in 1970.

The structural composition of exports of the fifth group of countries changed only marginally, from 0.84 to 0.87, remaining below the average level of the index. Variations in the values of standard deviation are mostly determined by the trends of the index for Indonesia and Hong Kong. The values of the index for Indonesia were steadily diminishing during the period 1975-1988, then remained virtually unchanged until 1993. Since that time structure of manufactured exports shifted towards the industries of higher income potential, converging with the value of the index for New Zealand, still substantially below the initial level. The structure of exports of Hong Kong was changing steadily over the period, however, with the index growing slowly from 0.75 for 1970 to 0.92 for 1996.

Conclusions

There are three main conclusions from the analysis of this section. First, in 1970-1996 there was an increase in structural significance of industries of high income generating potential in the composition of manufactured exports of the world as a whole, and of most of the countries considered here. Second, the structure of world manufactured exports was largely determined by the structural composition of the exports of developed countries, but in the 1990s the influence of ASEAN and NICs became quite noticeable. Third, the pace of structural change of manufactured exports differed significantly across countries, and was most remarkable for South Korea, the Philippines, Ireland, Malaysia, Thailand, Taiwan, and Singapore.

To summarise, in this chapter we have shown that over the 1970-1996 period there was a major shift in the structure of merchandise exports in favour of manufactured products. At the end of the period manufactured products accounted for more than two thirds of merchandise exports in most of the developed and industrialising countries. There was a general tendency towards a greater export orientation of manufacturing production. In all countries, considered in this section, except for the USA, Australia, and India, exports constituted substantial portions of manufacturing production. Also, for most countries considered in this chapter, growth of manufactured exports was positively correlated with changes in the composition of manufactured exports towards a higher income generating potential. Over the period there was an increase in the structural significance of industries of high income generating potential, such as the computing and electronics industries, in the composition of manufactured exports of most countries considered in this chapter. The pace of structural change of manufactured exports achieved in most economies of ASEAN region and the NICs was remarkable. In the next chapter we will consider the role of the computing and electronics industries in the overall structural change of manufactured exports of different regions and countries.

Appendix: Chapter 5

Table 5.A1 Regression Results of the Effects of Structural Change on Growth of Manufacturing Exports, Selected Countries

Dependent variable – ln of the values of Manufacturing Exports (bill. curr. $ US)
Independent variable – ln of the values of the Index of the Long Run Income Potential of Manufacturing Exports

	Coefficient	t-ratio	R-sq. adj.	Number of observations	SEE
Indonesia	-8.2	-6.1	0.63	22	9.3
Philippines	6.8	7.8	0.70	27	6.7
Singapore	17.2	17.4	0.92	27	3.7
Japan	14.8	18.9	0.93	27	1.4
Germany	62.1	6.8	0.63	27	5.6
Denmark	42.8	13.0	0.87	27	1.9
Ireland	9.4	20.6	0.94	27	2.0
Italy	-47.9	-5.0	0.48	27	9.0

Source: Estimates based on ISIC Trade Data accessed through IEDB database.

Table 5.A2 Regression Results of the Effects of Industrial Structure on Values of Manufacturing Exports

Dependent variable – the values of Manufacturing Exports (bill. curr. $ US)
Independent variable – the values of the Index of the Long Run Income Potential of Manufacturing Exports

	Coeff-t	t-ratio	R-sq. adj.	Number of observations	SEE	F test (A_i,B= A_i,B_i)	Critical F value
All countries (25)[1]	0.31	10.1	0.60	670	1.79	32.0	6.8
Developed (14)[2]	0.62	8.3	0.56	378	1.60	29.2	6.1
Asian countries (11)[3]	0.28	10.6	0.66	292	0.42	82.2	5.8
ASEAN (5)[4]	0.12	9.1	0.49	130	0.03	65.2	4.9
NICs (3)[5]	0.32	23.6	0.89	81	0.01	43.4	4.3
CHN+IND	0.68	7.6	0.59	54	0.02	17.5	3.8
Other (14)[6]	0.38	5.7	0.55	378	1.37	26.0	6.1

Notes: as for Table 5.1.

Source: Estimates based on ISIC Trade Data accessed through IEDB database.

CHAPTER 6

THE ROLE OF COMPUTERS AND ELECTRONICS IN THE STRUCTURE OF MANUFACTURING EXPORTS

As has been shown in Chapter 4 (Table 4.5), according to the overall composite rank incorporating the benchmarking indicators germane to generation of economic wealth, computers and electronics occupy the highest positions among all manufacturing industries. According to all five benchmarks - value added and wages per employee, two indicators of global demand, and R&D intensity - these industries are ranked relatively highly (see Table 4.4 and Chart 4.1, Chapter 4). It is worth noting again that the benchmarking indicators of the income generating potential of manufacturing industries are based on various types of international data: average annual growth rates for exports and sectoral export shares for the world, R&D intensity ratios for thirteen major OECD countries, value added and wages per employee achieved in the major developed economies – Germany, Japan, and the USA. This approach does not provide information about actual levels of R&D intensity, productivity, and earnings in all countries; neither does it show the contribution of particular countries to global exports of computing and electronic products.

The degree of utilisation of the high potential of the computing and electronics industries can differ substantially across countries. Globalisation of economic activities provides conditions for the allocation of different stages of product development and production in different countries. Research and development in relation to new high-tech products and sophisticated technological processes may be undertaken in some countries, while the mass production of such products and application of advanced technologies may take place in other countries. Thus, different countries may have a similar structure in terms of the value of the Index of Long Run Income Potential while undertaking quite different activities within industries.

In this chapter we will analyse the significance of products of the computing and electronics industries in the composition of the manufactured exports of different regions and countries. Further on, in the following chapters, this analysis will be extended to other areas related to trade in, and production of, computing and electronic equipment, components and consumer goods.

6.1 The Growth of Computing and Electronics Exports

Table 6.1 provides information on exports of computing and electronics products, together with data for exports of other manufactured products, for selected regions and countries for the periods 1970-1985 and 1985-1996. Several trends that can be derived from these data are of special importance.

First, during the period 1970-1996, global exports of computing and electronic products were growing faster than exports of other manufactured goods: computing and electronic exports were increasing at an average annual rate of 16.2 per cent by comparison with 11.2 per cent for other manufactured exports. For every country, with only one exception (Italy), the growth rate of computing and electronic exports exceeded the growth rate of other manufactured exports. Thus, the growing structural significance of computing and electronics exports was a feature of structural change that occurred in the 1970-1990s in most countries. With very few exceptions, this more rapid growth of computing and electronic exports than other manufactured exports growth is true for all countries, in both of the separate periods shown in Table 6.1.

Second, in most countries exports of computing and electronic products were growing at higher rates in the 1970-1985 period than over 1985-1996. During the first period exports of new computing, electronic and communications equipment were growing at high rates from a low base. During the second period, however, the growth of exports of these products also remained relatively high, with an average annual growth rate for the world of 15.4 per cent per annum, by comparison with 16.9 per cent for the earlier period. But, as is evident from Table 6.1, in some countries the growth rates of exports of these products in the second period exceeded the rates of growth achieved in the first period.

Third, the rates of growth of the computing and electronics exports of Asian countries were significantly higher than those of other countries. Japan's exports of computing and electronic products were growing rapidly during the first period, 1970-1985. Over 1970-1985 Japan's rates of growth of these exports exceeded those of the USA, being about 20 per cent per annum for Japan versus almost 15 per cent for the USA. Consequently, Japan's position as an exporter of computing and electronic products improved over this period (see the next section). Over 1985-1996 the growth of Japan's computing and electronic exports slowed down to a rate below the growth rates of most other countries (see Table 6.1), which could possibly be a result of the transfer of Japanese production capacity offshore.

Table 6.1 Exports of Computers and Electronics Relative to Exports of Other Manufactured Products, Selected Regions and Countries, 1970-1996

	Computing and Electronics Exports					All Other Manufactured Exports	
	US $ billion			*Average Annual Growth Rate per cent*		*Average Annual Growth Rate per cent*	
	1970	**1985**	**1996**	**70-85**	**85-96**	**70-85**	**85-96**
World	**12.8**	**132.3**	**639.3**	**16.9**	**15.4**	**12.4**	**9.7**
EEC-12	**6.1**	**41.9**	**178.0**	**13.7**	**14.0**	**11.8**	**9.7**
United Kingdom	1.1	9.0	42.7	15.1	15.1	9.8	9.6
Germany	2.1	12.5	40.7	12.6	11.3	11.8	9.2
France	0.8	6.3	27.2	14.8	14.2	11.9	10.2
Netherlands	0.8	4.2	26.2	11.6	18.2	12.4	8.2
Ireland	0.0	2.4	15.1	36.4	18.3	16.5	14.1
Italy	0.7	4.0	9.5	12.4	8.1	12.9	8.6
Sweden	0.5	2.7	9.4	12.3	11.9	10.6	8.6
Spain	0.0	0.8	4.6	21.7	17.5	17.5	13.7
Denmark	0.1	0.6	2.7	13.6	14.2	11.1	9.4
North America	**3.8**	**30.5**	**113.5**	**14.8**	**12.7**	**10.9**	**9.6**
USA	3.4	27.6	100.3	14.9	12.5	10.5	10.2
Canada	0.4	2.9	13.1	13.8	14.6	11.6	8.1
Australia	0.0	0.1	1.4	12.9	28.4	9.0	11.2
New Zealand	0.0	0.0	0.2	27.2	18.8	10.6	8.5
Mexico	0.0	1.2	15.4	26.6	25.6	17.3	21.0
Japan	2.6	38.2	103.7	19.7	9.5	15.2	7.4
ASEAN	**0.1**	**7.6**	**134.4**	**37.9**	**29.8**	**18.2**	**15.1**
Singapore	0.1	4.8	69.0	34.0	27.4	20.2	11.8
Malaysia	0.0	2.3	35.5	61.1	28.3	15.2	16.9
Thailand	0.0	0.1	16.4	59.6	54.6	20.6	18.2
Philippines	0.0	0.3	10.2	91.4	39.5	10.8	13.7
Indonesia	na	0.1	3.3	na	35.7	na	18.8
NICs	**0.4**	**10.9**	**76.5**	**25.3**	**19.4**	**21.2**	**10.2**
Taiwan	0.2	4.4	36.5	24.1	21.1	23.5	10.8
South Korea	0.0	4.1	35.2	35.4	21.7	27.5	12.0
Hong Kong	0.2	2.4	4.8	20.2	6.6	14.3	4.3
China	0.0	0.4	17.4	38.6	41.6	19.2	19.4
India	0.0	0.0	0.6	11.0	28.6	10.8	13.0

Source: Based on ISIC Trade Data accessed through IEDB database.

The growth of ASEAN exports of computers and electronics was quite spectacular, albeit initially from a low base. During both periods the average annual rates for ASEAN exceeded the rates for all other regions and countries presented in Table 6.1, with the only exception being China. The growth of computing and electronic exports from the NICs was quite pronounced as well. The only two non-Asian economies that can be compared with some countries of ASEAN and the NICs, in terms of the growth rates and the values of exports of computing and electronic equipment exports, are Ireland and Mexico.

As a result of these trends, the shares of Asian countries of global computing and electronic exports were rising steadily and persistently over the period 1970-1996. Trends in the distribution of global exports of computing and electronic products across major regions and countries will be discussed in the next section.

Fifth, in all of the Asian countries shown the growth rate of exports of computing and electronic goods exceeded the growth rate of other manufactured exports to a significantly larger extent than in most other countries. This phenomenon is particularly noticeable for the period 1985-1996, but is true for the earlier period as well. Thus, ASEAN exports of computers and electronics were growing at an average rate of about 30 per cent per annum over 1985-1996, by comparison with about 15 per cent for other manufactured exports. For the NICs the growth rate of exports of computing and electronic products was also about twice that of other manufactured exports, 19.4 per cent per annum versus 10.2 per cent.

It is worth mentioning that the data, considered in this section, are in current price $ US and, thus, the growth of exports of computing and electronics relatively to that of other manufactured goods is likely to be understated to the extent that prices in US dollars for computing and electronics products were falling relative to those for other goods.

Conclusions

In most countries, considered in this section, exports of computing and electronic products were growing faster than exports of other manufactured goods during the period 1970-1996. Within this context of more rapid growth, Asian countries achieved significantly higher rates of growth of exports of computing and electronics equipment than most other countries. In terms of the composition of export growth within the Asian economies, the growth of exports of computing and electronic goods exceeded the growth of other manufactured exports to a significantly larger extent than for most other countries.

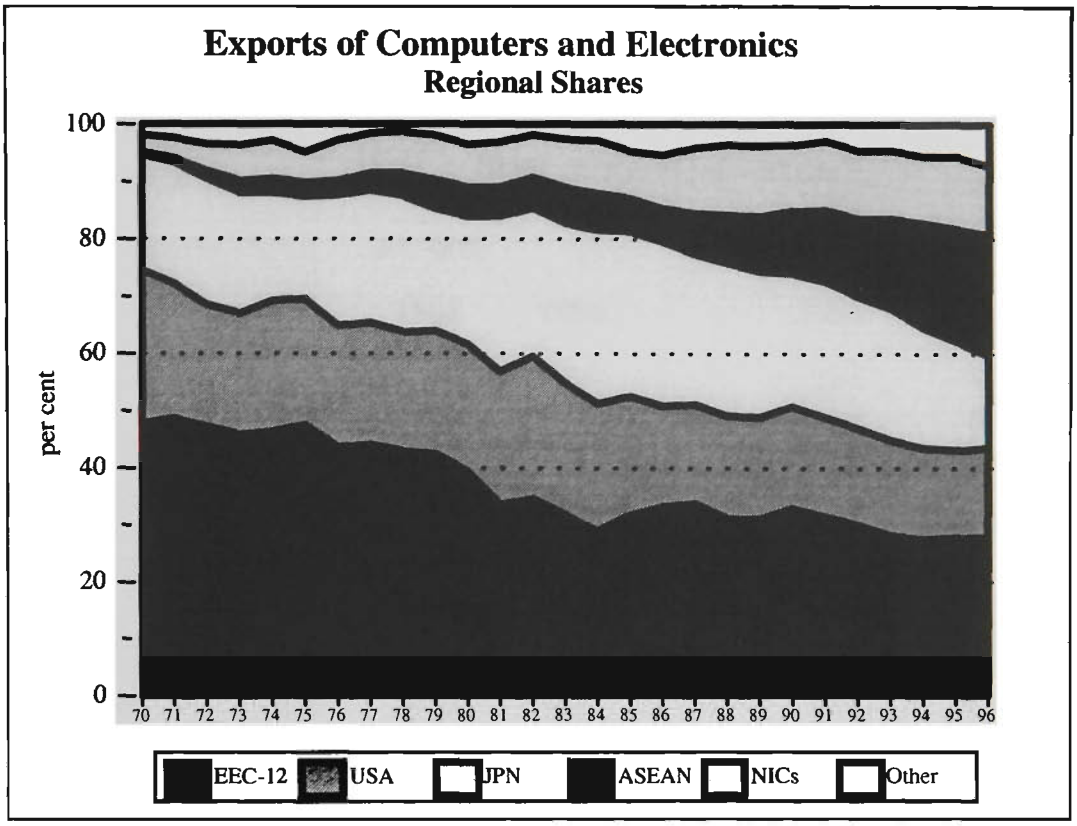
6.2 The Regional Distribution of Global Computing and Electronics Exports

The phenomenon of very rapid growth of exports of computing and electronic products achieved by Asian economies was reflected in the pattern of regional distribution of global exports of these products. The changes in this pattern are illustrated in Chart 6.1 and Table 6.2. In 1970 exports of computing and electronic goods from the EEC-12, the USA and Japan accounted for about 95 per cent of global exports of these products. The EEC-12 contributed almost 48 per cent of the world's exports. The share of the USA constituted almost 27 per cent, and the share of Japan was about 20 per cent. Higher growth rates of exports of computing and electronic products of ASEAN and the NICs than that of Europe, the USA and Japan resulted in a gradual decline of the shares of the latter. By 1996 the combined share of EEC-12, the USA and Japan had fallen to about 60 per cent. Although in 1996 EEC-12 remained the major exporter of computing and electronic products, the share of the twelve European countries fell by 20 percentage points between 1970 and 1996. The share of the USA also diminished from about 27 per cent to less than 16 per cent of global exports. During 1970-1996 the regional shares of computing and electronic exports of ASEAN and the NICs were growing steadily. The growth of the ASEAN share was most remarkable. While the NICs' exports of computers and electronics accounted for 3 per cent of global exports in 1970 and reached 12 per cent in 1996, ASEAN's computing and electronic exports were growing from a significantly lower base. In 1970 the share of ASEAN countries was 0.5 per cent, but it rose to about 6 per cent by 1985, and to 21 per cent of the world's exports by 1996.

A comparison between regional shares of exports of computing and electronics products and of other manufactured goods, excluding computers and electronics, for the periods 1970-1985 and 1985-1996 (Table 6.2) can lead to some important conclusions.

During 1970-1985 the major European countries and the USA were the leading exporters of computers and electronics. Although over this period their shares were in decline, in 1985 they exported more than a half of global exports of these products. At the same time the combined share of ASEAN, the NICs and Japan was growing steadily over the period. However, in 1985 the combined share of these Asian countries was about 10 percentage points below the combined European and American share of global exports. Rapid growth of Japanese exports of computing and electronic products (see the previous section) resulted in a change of positions of Japan and the USA. During 1970-1985 the NICs remained the second largest exporter among Asian countries, after Japan.

Chart 6.1



Source: Based on ISIC Trade Data accessed through IEDB database.

For other manufactured products, except computers and electronics, during 1970-1985 the situation developed in a similar way: the combined share of the EEC-12 and the USA was declining, while the share of Asian countries was rising. However, the relative values of these shares were markedly different to the shares for computing and electronic products. In 1985, for other manufactured exports, the share of Asian countries constituted just one third of the share of European countries and the USA. The decline of the combined share of the EEC-12 and the USA for other manufacturing was less rapid than for computers and electronics. As a result of this, in 1985 the shares EEC-12 and the USA combined for the two groups of products became equal, constituting 52.5 per cent of the world's exports. The relative positions of the countries and regions did not change significantly for other manufactured exports during 1970-1985. The EEC-12 was the major exporter, followed by the USA and Japan. As for computers and electronics ASEAN region was lagging behind the NICs. However, while for computers and electronics the share of ASEAN accounted for more than two thirds, for other manufactured goods it was just about a half of the NICs' share.

Table 6.2 Distribution of Global Manufactured Exports Selected Regions and Countries, 1970-1996

	Computing and Electronics Exports			All Other Manufactured Exports		
	Share of world total in each year Based on data in current US $					
	per cent			*per cent*		
	1970	**1985**	**1996**	**1970**	**1985**	**1996**
ASEAN	0.5	5.7	21.0	1.2	2.5	4.2
NICs	2.9	8.2	12.0	1.6	5.0	5.3
Japan	20.2	28.8	16.2	7.2	10.5	8.4
Sub-total	**23.5**	**42.8**	**49.2**	**10.0**	**18.0**	**17.9**
EEC-12	47.8	31.7	27.8	45.0	41.6	41.7
USA	26.8	20.8	15.7	14.0	11.0	11.6
Sub-total	**74.6**	**52.5**	**43.5**	**59.0**	**52.5**	**53.2**
Total	**98.1**	**95.3**	**92.7**	**69.0**	**70.6**	**71.1**
World	**100**	**100**	**100**	**100**	**100**	**100**

Source: Based on ISIC Trade Data accessed through IEDB database.

For 1985-1996 a comparison between regional export shares for computers and electronics and other manufactured goods gives quite different results to those for the previous period. During 1985-1996 the shares of the NICs and ASEAN for computers and electronics continued to grow rapidly. This remarkable growth allowed Asian countries to become the major exporters of computing and electronic products in spite of the decline of Japanese share. In 1996 the combined share of Japan, ASEAN and the NICs constituted about a half of the world's exports of these products, and ASEAN became the second largest exporter of computing and electronic products after the EEC-12.

For all other manufactured products the situation in the late 1980s and early 1990s was characterised by a remarkable stability in the values of the regional shares. In 1996 the regional shares of the EEC-12, the USA and the Asian countries remained at approximately the same levels as they were in 1985. The EEC-12 was the major exporter of other manufactured goods, followed by the USA, Japan, and then by the NICs and ASEAN.

Thus, the EEC-12 remained the major exporter for both types of goods, computing and electronic products and other manufactured products. However, for other manufacturing the European share was more than twice the combined share of Japan, ASEAN and the NICs. The leading position of the EEC-12, as an exporter of computing and electronic products, had been challenged by Asian countries. The share of ASEAN alone in 1996 approached the value of the European regional share. The combined share of the NICs and ASEAN was higher than the share of the EEC-12 by about 5 percentage points.

The USA managed to maintain the second place as an exporter of other manufactured goods. Although the share of the USA of global exports of computers and electronics was higher than its share for other manufacturing, the relative position of the USA as an exporter of computing and electronic products seriously deteriorated.

Japan's share for both types of products was increasing in 1970-1985 and declining in 1985-1996. However, by 1996 Japan's share for computers and electronics was about twice its share for other manufactured goods.

By 1996 ASEAN region had become the second largest exporter of computing and electronic products. For other manufactured goods its regional share was only one fifth of its share for computers and electronics. The NICs exported more other manufactured goods than ASEAN, while their share for computers and electronics was almost twice lower than the share of ASEAN.

Let us extend the analysis by considering the pattern of distribution of global exports of computing and electronic and other manufactured goods across particular countries. Table 6.3 presents the shares of twenty five countries in the world's exports of computers and electronics and other manufactured products for the period 1970-1996. The countries are ranked and sorted according to their share of total world exports of computing and electronic products, and a ranking is also provided in terms of their share in other manufacturing exports.

In 1970 Japan was the second largest exporter of computing and electronic products, following the USA, by 1985 Japan had become the global leader: Japanese exports of computing and electronic products in 1985 amounted to US$38.2 billion, by comparison with $27.6 billion for the USA. Over 1985-1996 Japan's average annual rate of export growth was below the rate for the USA, the rates being 9.5 and 12.5 per cent per annum respectively (see Table 6.1). Although in 1996 Japan retained its leading position in the list of exporters of computing and electronic goods, the USA's share of global exports of computing and electronic products approached that of Japan.

In 1996 Singapore occupied the third position. The shares of the United Kingdom and Germany, in 1996, were higher than the shares of Taiwan, Malaysia, and South Korea. The contribution to the world's exports of computers and electronics made by two other European countries, France and the Netherlands was much greater than the shares of such exporters of growing significance as China and Thailand.

In terms of the shares of global exports of computing and electronic products for 1996, the twenty five countries can be divided into five groups. The first group consists of three countries, Japan, the USA, and Singapore, each with shares greater than 10 per cent of the world's exports in 1996. The second group includes next seven countries, which had export shares above four per cent. The next group consists of five countries, which exported more than two per cent of global exports of computing and electronic products. The next three countries, the Philippines, Italy, and Sweden had export shares between one and two per cent. The last seven countries, which make the fifth group, in 1996 had shares of less than one per cent of the world's exports of computers and electronics.

ASEAN economies are evenly distributed among the five groups. Singapore occupies the third place in the first group of major exporters of computers and electronics. Malaysia belongs to the second group, Thailand to the third, the Philippines to the fourth, and Indonesia occupies the third place in the fifth group of countries that exported less than one per cent of global exports of computing and electronic goods each. Among the NICs Taiwan and South Korea occupy relatively high positions in the second group. Hong Kong's position is much lower: it is the leader in the last group of countries. China occupies the first place in the third group, ahead of Thailand. India is the second last in the list.

The relative positions of the European countries are quite strong, although none of European countries belong to the first group. Four European countries are found in the second group. The United Kingdom is the leader of this group, followed by Germany. France and the Netherlands also belong to this group.

Table 6.3 Distribution of Global Manufactured Exports Selected Countries, 1970-1996

	Computing and Electronics Exports				All Other Manufactured Exports			
	Based on data in current US $							
	Share of world total in each year per cent				*Share of world total in each year per cent*			
	1970	**1985**	**1996**	***Rank 1996***	**1970**	**1985**	**1996**	***Rank 1996***
Japan	20.2	28.8	16.2	**1**	7.2	10.5	8.4	**3**
USA	26.8	20.8	15.7	**2**	14.0	11.0	11.6	**2**
Singapore	0.5	3.6	10.8	**3**	0.4	1.2	1.4	**15**
United Kingdom	8.6	6.8	6.7	**4**	7.5	5.3	5.3	**5**
Germany	16.5	9.5	6.4	**5**	13.7	12.6	12.1	**1**
Taiwan	1.4	3.3	5.7	**6**	0.5	2.0	2.2	**12**
Malaysia	0.0	1.7	5.6	**7**	0.3	0.5	0.9	**17**
South Korea	0.3	3.1	5.5	**8**	0.3	2.0	2.5	**11**
France	6.3	4.8	4.2	**9**	6.8	6.4	6.7	**4**
Netherlands	6.3	3.2	4.1	**10**	4.1	4.1	3.5	**8**
China	0.0	0.3	2.7	**11**	0.6	1.4	3.5	**9**
Thailand	0.0	0.1	2.6	**12**	0.1	0.4	0.8	**18**
Mexico	0.3	0.9	2.4	**13**	0.3	0.6	1.8	**14**
Ireland	0.2	1.8	2.4	**14**	0.3	0.5	0.8	**19**
Canada	3.3	2.2	2.1	**15**	5.4	4.9	4.2	**7**
Philippines	0.0	0.2	1.6	**16**	0.2	0.2	0.2	**25**
Italy	5.5	3.1	1.5	**17**	5.3	5.6	5.0	**6**
Sweden	3.8	2.1	1.5	**18**	2.6	2.1	1.9	**13**
Hong Kong	1.2	1.8	0.7	**19**	0.8	1.1	0.6	**23**
Spain	0.3	0.6	0.7	**20**	0.8	1.7	2.5	**10**
Indonesia	na	0.1	0.5	**21**	na	0.3	0.8	**21**
Denmark	0.7	0.5	0.4	**22**	1.3	1.1	1.1	**16**
Australia	0.1	0.1	0.2	**23**	1.1	0.7	0.8	**20**
India	0.1	0.0	0.1	**24**	0.6	0.4	0.6	**22**
New Zealand	0.0	0.0	0.0	**25**	0.4	0.3	0.3	**24**

Source: Based on ISIC Trade Data accessed through IEDB database.

Another fact, which is quite remarkable, is that, in spite of the overall picture of diminishing shares of European countries, the shares of some European countries were rising. Thus, in 1996 the share of the Netherlands was about 30 per cent higher than in 1985. Ireland's exports of computing and electronic products increased by one third over the period 1985-1996 and in 1996 accounted to more than 15 billion US dollars, that is 12 times higher than in 1970. Although Spain belongs to the last group of countries, exports of computing and electronic goods from Spain were also increasing steadily during 1970-1996.

A comparison between the relative ranks of countries according to their performance in exports of computing and electronic products and other manufactured goods is also of interest. Several observations can be made on the basis of analysis of the data presented in Table 6.3.

Most Asian countries are characterised by higher ranks for export shares of computing and electronics than of other manufactured goods. Thus, Japan is ranked the first according to shares of computers and electronics and the third according to other manufacturing export shares. Among ASEAN economies Singapore occupies the third place according to its performance in exports of computers and electronics and only the fifteenth for that of other goods. The relative ranks of Malaysia are the seventh and the seventeenth respectively. Thailand's relative ranks are the twelfth and the eighteenth. The Philippines is ranked the sixteenth according to its relative performance in exports of computers and electronics and the last, the twenty fifth, according to export share of other manufacturing. Indonesia is the only country of ASEAN that has the same relative positions for both types of exports. Moreover, the share of Indonesia's exports of global exports of other manufactured goods is higher than its share of the world's exports of computers and electronics.

The relative ranks of all of the NICs, as of most of ASEAN countries, are higher for computers and electronics than for other manufacturing. Taiwan is ranked the sixth according to its export share of computing and electronics, and the twelfth for other manufacturing exports. The ranks of South Korea are the eighth and the eleventh respectively. Hong Kong occupies the nineteenth and the twenty third positions.

The relative strength in exports of China and India differ from that of most other Asian countries. Both the positions and the export shares in 1996 of these countries are higher for other manufactured goods. China is ranked eleventh according to export shares of computers and electronics and ninth for other manufactured products. India occupies the twenty fourth and the twenty second places for the two export groups respectively.

The relative positions of most developed countries are higher according to export shares of other manufactured goods than to shares of computing and electronic products. Germany, the global leader in exports of other manufacturing in 1996, is ranked the fifth according to its export share in computing and electronic products. France is ranked the fourth for other manufacturing and the ninth for computers and electronics. For Canada, Italy Sweden, Spain, Denmark, Australia, and New Zealand the situation is quite similar. However, some developed countries perform better in exports of computing and electronic products than of other manufactured goods. The rank of the United Kingdom is higher for computers and electronics than for other manufactured goods. Ireland has a much stronger relative position as an exporter of computers and electronics than of other manufacturing. In 1996 the share of Ireland of global exports of computers and electronics was three times its export share of other manufactured goods. The USA, although ranked second according to both types of exports, had higher shares of global exports of computers and electronics than of other manufacturing exports. For the Netherlands, although its relative position is higher for other manufacturing than for computers and electronics, in terms of export shares the situation is different: in 1996 for computers and electronics the share of the Netherlands constituted 4.1 per cent and for other manufactured products constituted 3.5 per cent of global exports.

Conclusions

While there are many other conclusions of interest which can be drawn from this analysis, the central result is that, by 1996, the degree of specialisation in exports of computers and electronics in most Asian economies was considerably higher than in most other countries. In the next section we will analyse this issue in detail, using more specific quantitative techniques.

6.3 The Structural Significance of the Computing and Electronic Industries

6.3.1 Index of Specialisation, a Description of the Technique

The index of specialisation in trade, or Balassa's index of revealed comparative advantage (RCA), is a widely used measure of relative performance in trade (see also Chapter 4, Section 4.1). Vollrath (1991, p. 269) has presented the RCA index in the most general way:

$$\boxed{RCA_a^i = \left(X_a^i / X_t^i\right) / \left(X_a^w / X_t^w\right)} \qquad (6.1)$$

where X – exports,

a – any specific commodity,

t – all traded commodities,

i – a particular country,

w – the world.

The RCA index, for a given product in a given country, is the ratio of the share of that product in the country's exports to the share of that product in total world exports. The RCA index measures the degree of specialisation of a country in exporting a particular commodity relative to the world average level. A higher value of the index corresponds to a higher degree of specialisation. The value of the index above 1 indicates above average specialisation of a country in exporting a particular commodity, and below 1 indicates that specialisation is below the world average.

We apply this method to show the degree of specialisation of different regions and countries in exports of computing and electronic products. In this particular case the formula will take the following form:

$$RCA_{ce}^{i} = \left(X_{ce}^{i} / X_{mnf}^{i}\right) / \left(X_{ce}^{w} / X_{mnf}^{w}\right) \qquad (6.2)$$

where ce – products of computing and electronics industries,

mnf - products of total manufacturing,

i - a particular country or a region,

w - the world.

The value of the index of specialisation in exports of computing and electronics is the ratio of the share of these products in exports of all manufactured products of a country or a region to the share of computing and electronic products in total manufacturing exports for the world as a whole.

6.3.2 Specialisation in Exports of Computers and Electronics of Selected regions and Countries

Table 6.4 presents the values of the index of specialisation in exports of computing and electronic products for selected regions and countries. It is useful to supplement a cross-country comparison of the values of the index of specialisation with an analysis of the pattern of change in the shares of computing and electronic products in total manufactured exports. For selected years these shares are also presented in Table 6.4, while Chart 6.2

shows these shares, for selected regions and for the world, on an annual basis over the period 1970-1996.

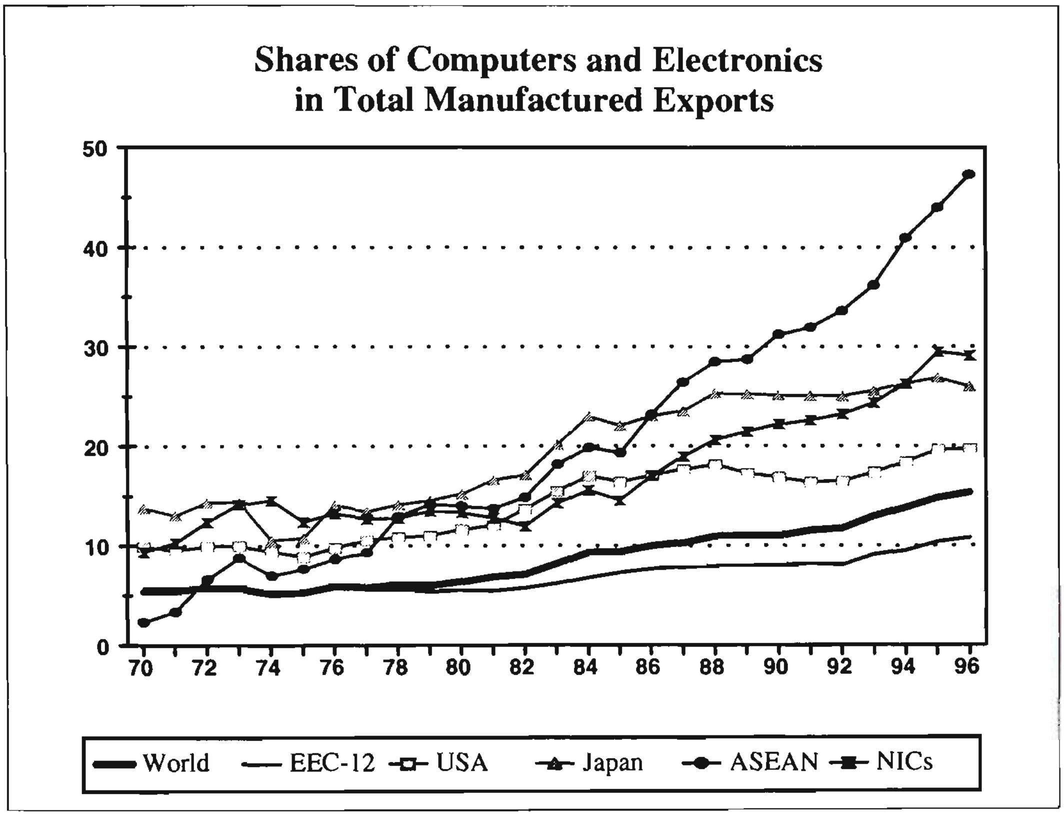
Table 6.4 Export Shares and Specialisation in Computers and Electronics, Selected Countries, 1970-1996

	Index of Specialisation				Share in Total Manufacturing Exports *per cent*				Rank 1996
	1970	1980	1990	1996	1970	1980	1990	1996	
World					**5.4**	**6.4**	**11.0**	**15.3**	
EEC-12	**1.06**	**0.86**	**0.73**	**0.70**	**5.7**	**5.5**	**8.0**	**10.8**	
Ireland	0.58	1.66	2.43	2.22	3.1	10.6	26.8	34.0	**5**
United Kingdom	1.14	1.06	1.26	1.21	6.2	6.8	13.8	18.5	**11**
Netherlands	1.49	0.94	0.87	1.13	8.1	6.0	9.6	17.3	**13**
Sweden	1.40	1.22	0.81	0.82	7.6	7.8	8.9	12.5	**14**
France	0.93	0.82	0.71	0.67	5.0	5.2	7.9	10.3	**17**
Germany	1.19	0.95	0.67	0.57	6.5	6.1	7.3	8.7	**18**
Denmark	0.58	0.51	0.49	0.45	3.2	3.2	5.4	6.9	**20**
Italy	1.04	0.74	0.51	0.33	5.6	4.7	5.6	5.1	**21**
Spain	0.39	0.33	0.35	0.33	2.1	2.1	3.8	5.0	**22**
North America	**1.50**	**1.54**	**1.31**	**1.11**	**8.1**	**9.8**	**14.4**	**16.9**	
USA	1.82	1.81	1.53	1.29	9.9	11.6	16.8	19.7	**9**
Canada	0.62	0.52	0.60	0.53	3.4	3.4	6.6	8.2	**19**
Australia	0.11	0.13	0.24	0.31	0.6	0.8	2.6	4.7	**23**
New Zealand	0.01	0.04	0.05	0.09	0.1	0.3	0.6	1.4	**25**
Mexico	0.87	2.66	0.41	1.25	4.7	17.0	4.5	19.1	**10**
Japan	2.54	2.37	2.28	1.70	13.8	15.1	25.1	26.0	**8**
ASEAN	**0.43**	**2.18**	**2.83**	**3.08**	**2.3**	**13.9**	**31.1**	**47.2**	
Singapore	1.09	3.02	3.70	3.78	5.9	19.3	40.7	57.8	**1**
Philippines	0.00	0.29	1.36	3.53	0.0	1.9	15.0	54.0	**2**
Malaysia	0.05	3.02	3.61	3.37	0.2	19.3	39.7	51.5	**3**
Thailand	0.01	0.34	1.72	2.33	0.0	2.2	19.0	35.6	**4**
Indonesia	na	0.51	0.10	0.69	na	3.2	1.1	10.5	**16**
NICs	**1.72**	**2.08**	**2.01**	**1.90**	**9.3**	**13.3**	**22.1**	**29.0**	
Taiwan	2.59	2.23	2.00	2.08	14.0	14.2	22.0	31.9	**6**
South Korea	1.13	1.83	2.23	1.88	6.1	11.7	24.6	28.8	**7**
Hong Kong	1.38	2.16	1.55	1.17	7.5	13.8	17.0	17.8	**12**
China	0.04	0.10	0.58	0.81	0.2	0.6	6.4	12.4	**15**
India	0.12	0.08	0.13	0.18	0.6	0.5	1.5	2.7	**24**

Source: Based on ISIC Trade Data accessed through IEDB database.

As detailed above, the composition of global manufactured exports changed significantly over 1970-1996 in favour of products of the computing and electronics industries. The share of these products in total manufactured exports increased almost threefold: from about 5.5 per cent in 1970 to more than 15.3 per cent in 1996. The significance of computing and electronic products in the composition of manufactured exports increased for all countries and regions shown in Chart 6.2. However, the differences between the countries and regions were quite marked.

Chart 6.2



Source: Based on ISIC Trade Data accessed through IEDB database.

The structural significance of computing and electronic products rose most dramatically for the ASEAN countries: over 1970-1996 the share of these products in their total manufactured exports increased twenty times. While in 1970 the share of computing and electronic goods in total manufactured exports of ASEAN was less than half of that for the world, by 1996 it became three times higher (see the values of the index of specialisation, Table 6.4). The ASEAN share of computers and electronics exports was growing steadily and persistently during the whole period 1970-1996. However, since 1985 this growth has been especially marked. The rising significance of these products in the overall composition of ASEAN manufactured exports is indicated by a steep slope of the trend-line for ASEAN (Chart 6.2).

The change of the role of computing and electronics in the composition of manufactured exports of the NICs was quite remarkable as well. The share of computing and electronic exports tripled over the period 1970-1996. However, in contrast with ASEAN, the share of these products for the NICs was relatively high at the beginning of the period, much higher than the world average. The values of the index of specialisation for the NICs changed from 1.7 to 1.9, indicating high and growing significance of computing and electronics exports (although not as rapid growth as for ASEAN). The modest growth of the index of specialisation in spite of rapid relative growth in exports is a sign of the rising share of computing and electronics exports in overall world exports.

In Japan the share of computers and electronics of total manufacturing exports almost doubled. However, the value of the index of specialisation decreased. This is indicative of the fact that the structural significance of these products in the composition of exports of the world was growing faster than that of Japan.

For North America the value of the index of specialisation for these products diminished, although the share of computers and electronics more than doubled. In 1996 the degree of specialisation in exports of these products was still above the world average.

For the EEC-12 the situation is different to the North American. The values of the index of specialisation in exports of computers and electronics decreased to the level of 0.7, indicating that the share of computing and electronic goods was significantly below the world average. The gradual deviation of the line for the EEC-12 from the world trend, especially in the 1980s and 1990s, is quite noticeable on Chart 6.2.

The twenty five countries are ranked according to the value of the index of specialisation in exports of computing and electronic products in Table 6.4. Four ASEAN countries occupy the leading positions in the list. In 1996 computing and electronic products accounted for more than a half of manufactured exports of Singapore, the Philippines and Malaysia. In Thailand these products constituted more than one third of manufacturing exports.

Ireland occupies the fifth place. Ireland is the only one of the developed countries that has achieved a degree of specialisation in exports of computing and electronic products comparable with that of Asian economies. By 1996 in Ireland these products constituted more than one third of manufactured exports, a figure that was slightly less than in Thailand but more than in Taiwan. Taiwan and South Korea occupy the sixth and the seventh positions respectively. Japan is the number eight in the list.

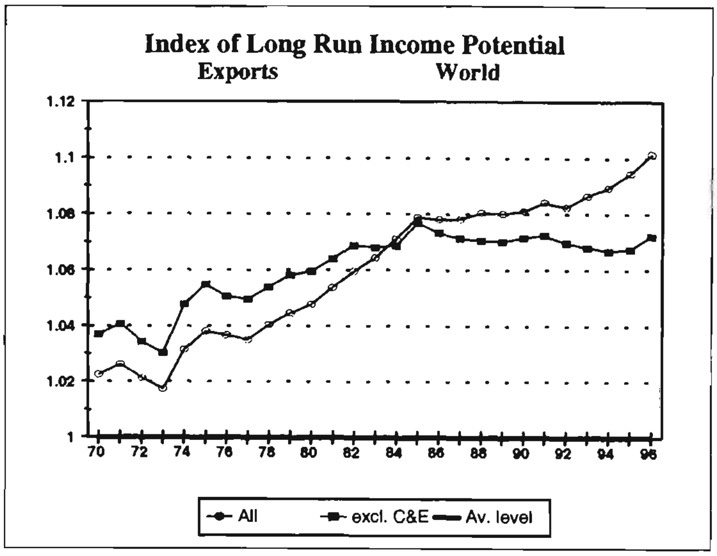
6.3.3 The Effects of Computers and Electronics on the Structure of Manufactured Exports of Selected regions and Countries

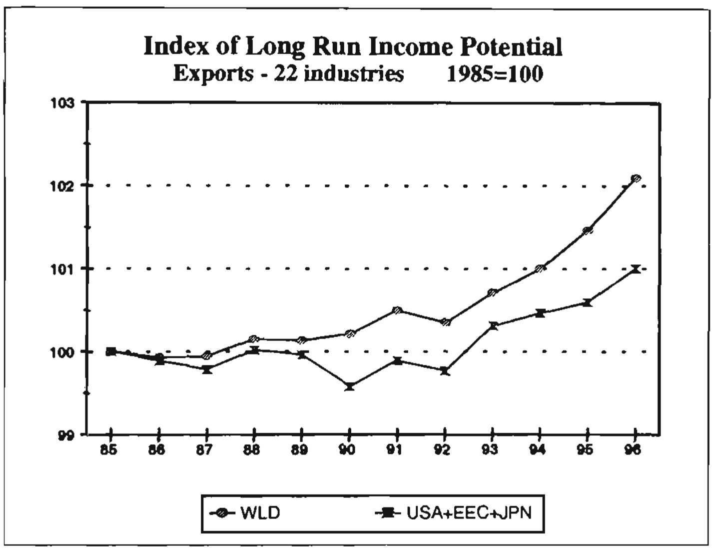
Another way of evaluating the importance of products of the computing and electronics industries in the composition of manufacturing exports is to analyse the effect of these industries on the Index of the Long Run Income Potential. We will apply the third method discussed in Chapter 4, based on the assumption that a particular industry or a group of industries is excluded from the list of manufacturing sectors (see Chapter 4, Section 4.5).

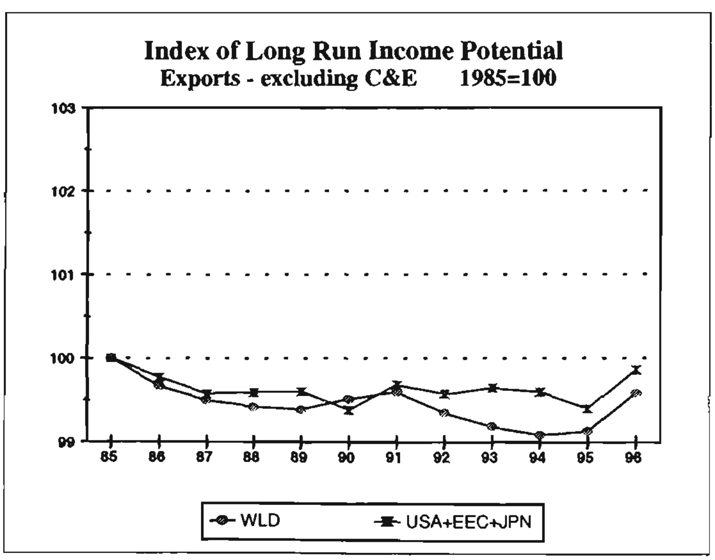
The first panel of Chart 6.3 presents the changes over time in two different structures of global manufactured exports for the period 1970-1996. The first structure relates to the manufacturing sector consisting of all twenty two industries, and the second to a hypothetical manufacturing sector that consists of twenty industries, all industries except the computing and electronics industries. During the 1970-1985 period both structures were shifting towards a higher proportion of products of industries characterised by high income generating potential. However, the structural change in total manufacturing exports was more rapid than the change in the composition of manufactured exports excluding computing and electronic goods. Since 1985 the process of structural change in manufacturing exports excluding computers and electronics has been reversed. The values of the Index of Long Run Income Potential were in decline until 1995. Although in 1996 the value of the index was relatively higher than in 1995, it still remained below the level of 1985. (The index form of this trend, 1985=100, is also presented on the third panel of Chart 6.3.) In 1985-1996 structural change towards a higher income potential of total manufactured exports continued, although at a lower pace than in 1970-1985. Thus, exclusion of computing and electronic products significantly altered the trend of structural change of manufacturing exports. We can conclude that products of computing and electronics industries played a crucial role in the changing composition of global manufactured exports, and that the significance of these products was increasing over the period 1970-1996.

Several observations can be made on the basis of a comparison between the direction and the pace of structural change of manufactured exports of the world and of the major

Chart 6.3







Source: Based on ISIC Trade Data, from IEDB database.

developed countries, the USA, the EEC-12 and Japan (the second and the third panels of Chart 6.3).

First, for the 1985-1996 period there are quite noticeable similarities between the trends for the world and for the major developed countries for both structures of manufacturing exports, that consisting of all twenty two industries, and that consisting of only twenty industries.

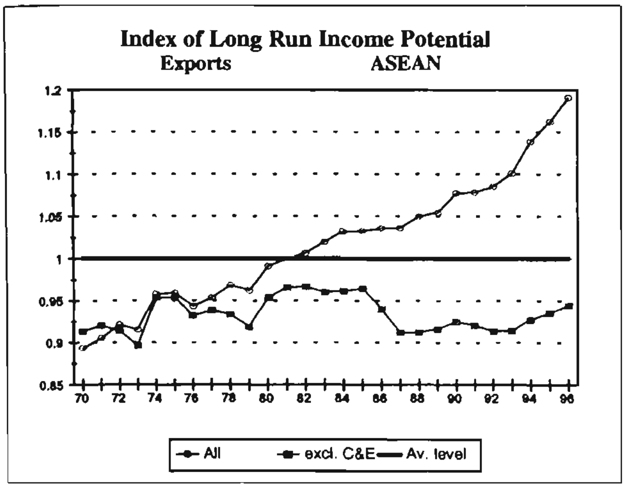
Second, the composition of manufactured exports was changing towards industries of a higher income generating potential for both the major developed countries and for the world as a whole. The pace of structural change of global manufactured exports was higher than that for the major developed countries (the second panel of Chart 6.3).

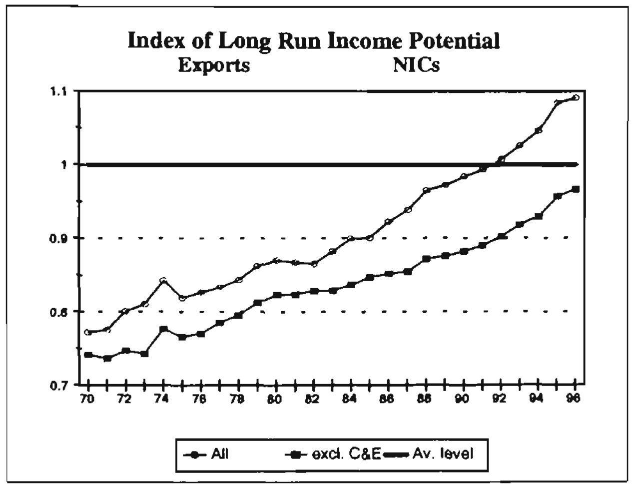
Third, for manufactured exports that exclude products of the computing and electronics industries the situation was the opposite (the third panel of Chart 6.3). For both, the major developed countries and the world as a whole, the values of the index were decreasing. The pace of this decrease was lower for the major developed countries than for the world.

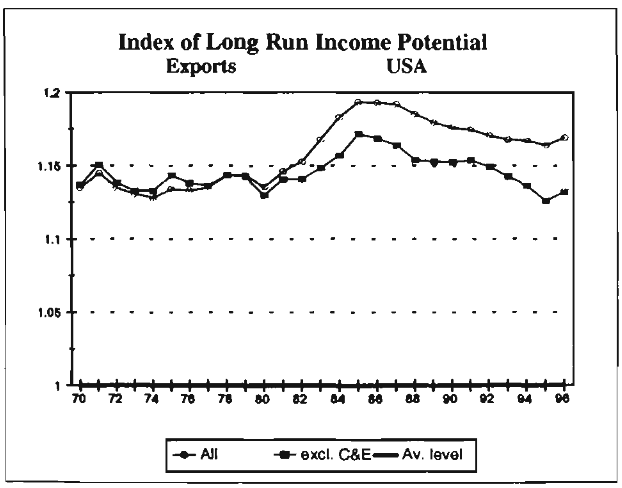
We can conclude that the structure of exports of the major developed countries had a dominant effect on the structure of global exports in both cases, for the complete manufacturing structure and for the structure of manufactured exports excluding exports generated in computing and electronic industries. However, a high degree specialisation of other countries, including ASEAN and the NICs, in exports of computing and electronic products had a significant effect on the complete structure of global manufactured exports, enhancing the pace of the structural shift. In the absence of computing and electronics industries the effect was the opposite, which implies that in terms of structural change of other manufactured exports, the countries other than the developed were lagging behind the global trend.

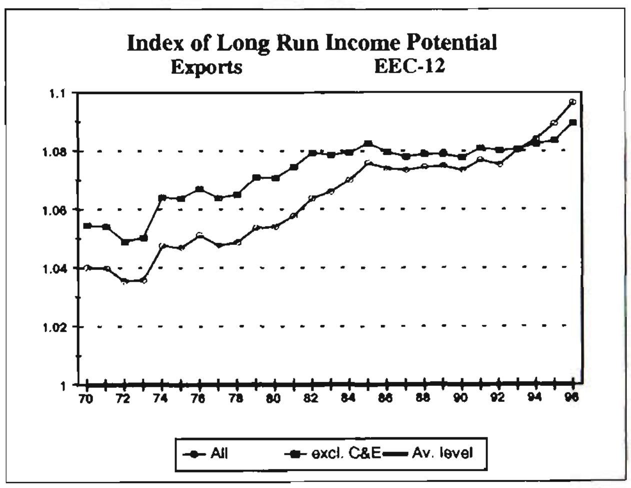
Chart 6.4 presents the trends in the composition of the two structures of manufacturing exports for selected regions and countries for the 1970-1996 period. The effect of computing and electronic products on the overall composition of manufactured exports of ASEAN economies was most marked. While the structure of total manufactured exports was shifting rapidly towards a higher income generating potential, the structure of manufactured exports excluding computers and electronics was virtually stagnant, remaining below the average level.

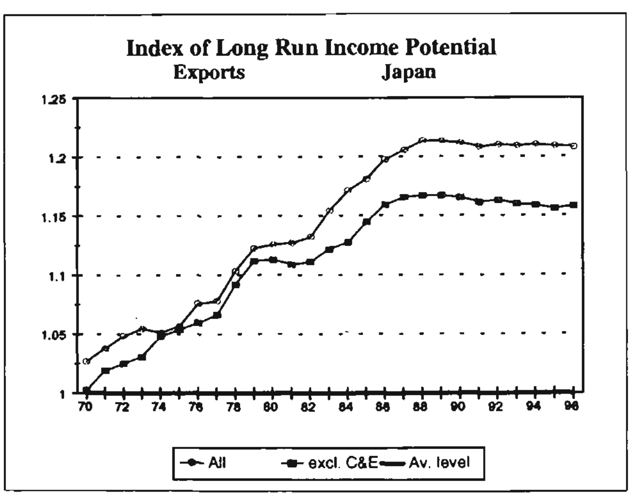
Chart 6.4











Source: Estimates based on ISIC Trade Data accessed through IEDB database.

For the NICs the difference between the trends for the two structures of manufactured exports is less pronounced. During 1970-1996 both structures were changing towards a higher income generating potential, but the gap between the trends was increasing over time. These facts indicate that products of the computing and electronics industries were of high and increasing significance in the composition of manufactured exports of the NICs, but that other industries of high income generating potential determined the direction of structural change.

The similarities between the trends for the two structures of manufactured exports for the USA, the EEC-12 and Japan are quite marked. The effect of computing and electronic products on the overall structure of manufactured exports of the major developed economies was increasing over time but to a lesser extent than for ASEAN and the NICs. Changes in the structure of manufactured exports of the major developed countries were determined to a large extent by the products of other industries.

A more detailed information for such analysis, for seventeen countries is presented on Chart 6.A1 in the Appendix. A comparison between the trends for the two structures of manufactured exports shows that for some Asian countries, for example Singapore, Malaysia, and the Philippines, computing and electronic products were not only of high and growing significance, but were the major factor contributing to the shift towards a higher income potential in the overall composition of manufactured exports. For some other Asian countries, such as South Korea and Taiwan, computers and electronic products were significant but were not the only cause of the structural change towards a higher income potential of manufactured exports. Ireland is the only non-Asian country where computing and electronic exports had a significant effect on the overall composition of manufactured exports.

Another way of analysing the effects of computing and electronic products on the overall composition of manufactured sector is to compare changes in the relative positions of the countries (Table 6.5). The twenty five countries are ranked according to the value of the Index of Long Run Income Potential for 1996 for total manufacturing exports and for manufactured exports excluding computing and electronic products. The order of the countries is determined according to the difference between their ranks for the two structures of manufactured exports.

Table 6.5 Relative Positions of Selected Countries According to the Value of the Index of the Long Run Income Potential of Exports - 1996, Total Manufacturing and Excluding Computers and Electronics

	Total Manufacturing	Manufacturing excluding Computers and Electronics	Difference in Relative Positions
Philippines	5	22	**-17**
Malaysia	4	18	**-14**
Singapore	1	10	**-9**
Thailand	13	19	**-6**
South Korea	10	13	**-3**
Taiwan	14	17	**-3**
Hong Kong	21	23	**-2**
Ireland	2	3	**-1**
Indonesia	24	25	**-1**
Netherlands	11	11	**0**
United Kingdom	7	6	**1**
China	22	21	**1**
India	25	24	**1**
Japan	3	1	**2**
USA	6	4	**2**
Mexico	8	5	**3**
Denmark	19	16	**3**
New Zealand	23	20	**3**
Australia	18	14	**4**
France	12	7	**5**
Sweden	17	12	**5**
Italy	20	15	**5**
Germany	9	2	**7**
Spain	15	8	**7**
Canada	16	9	**7**

Source: Estimates based on ISIC Trade Data accessed through IEDB database.

Computing and electronic products had immense effects on the relative positions of most ASEAN countries. Exclusion of computing and electronic products resulted in a significant deterioration of relative positions of the Philippines, Malaysia, Singapore, and Thailand. Computers and electronics had a significant effect on the relative positions of the NICs. Among developed countries computing and electronic products were the most important in the composition of manufactured exports of Ireland. However, in the absence of computing and electronics industries Ireland's relative rank was also very high, indicating the presence of other industries of high income generating potential. Exclusion of these industries had no effect on the relative position of the Netherlands. The relative positions of all other developed countries improved.

Marked downward shifts in the relative ranks of many Asian countries, especially of ASEAN economies, are indicative of the fact that computing and electronic products were not only significant in the composition of manufactured exports, but were the major factor contributing to high values of the Index of Long Run Income Potential. Low relative ranks for the remaining manufactured industries indicate that other industries of high income potential were not structurally significant. For many developed countries the situation is quite different: other industries of high income potential, as well as computers and electronics, contributed to the values of the index.

Conclusions

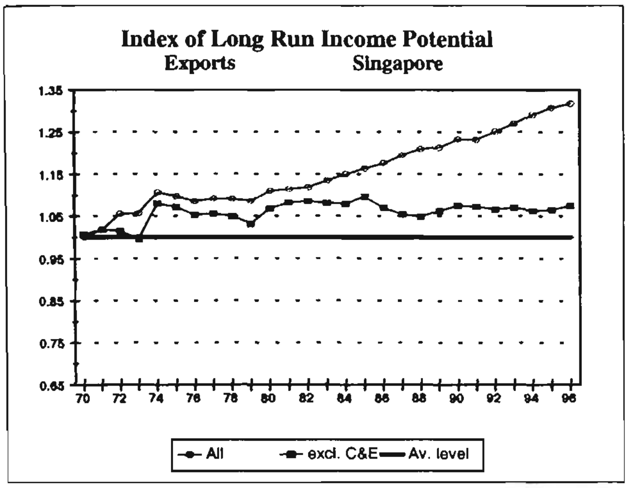
The main conclusions of this section are as follows:

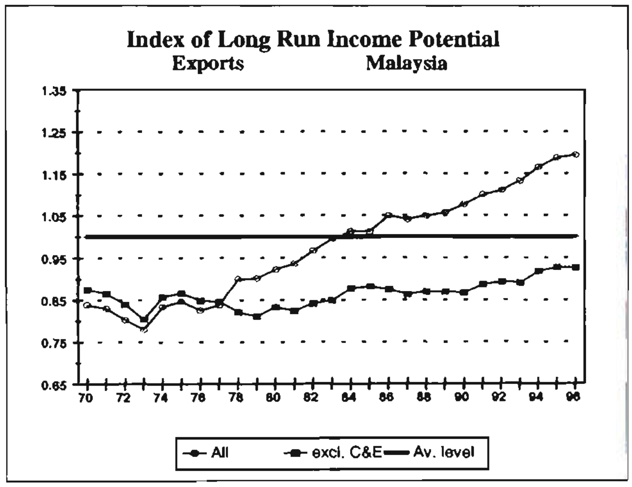
- during the period 1970-1996 the structural significance of computing and electronic products in the composition of manufactured exports increased for all regions and countries considered in this section;
- by 1996 many Asian countries, and in particular most of ASEAN economies, achieved a higher degree of specialisation in exports of computing and electronics products than most other countries;
- Ireland is the only non-Asian economy where the degree of specialisation in exports of computing and electronic products reached the level comparable with that of Asian countries;
- for many Asian countries the computing and electronics industries were not just of high structural significance, but played a decisive role in the changes in the composition of manufactured exports.

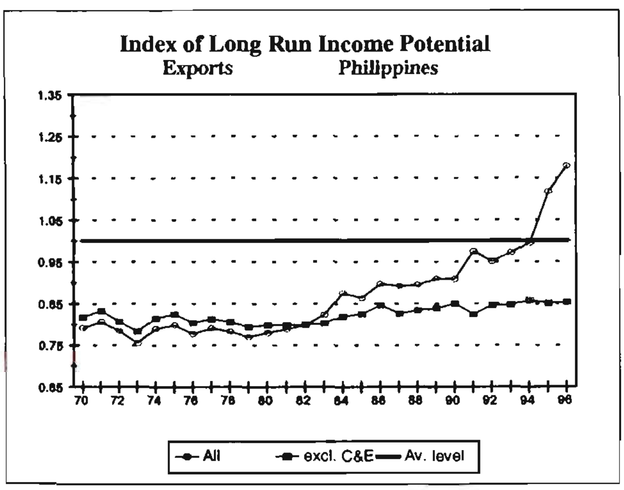
To summarise, in this chapter we have shown that during the period 1970-1996 in most countries considered, and especially in Asian economies, the rates of growth of exports of computing and electronic products exceeded the corresponding growth rates of other manufacturing exports. As a result of these trends, the pattern of distribution of global exports of computing and electronic products changed substantially over the period. Although by 1996 the EEC-12 remained the major exporter of computing and electronic products, the shares of the developed countries (the EEC-12, the USA and Japan) in global exports of these products declined and the shares of ASEAN and the NICs rose significantly. In 1996 the Asian economies (Japan, ASEAN and the NICs) were providing almost half of world exports of computing and electronic products. In the 1970-1996 period, the structural significance of computing and electronic products in the composition of manufactured exports increased for all regions and countries considered in this chapter. In many Asian countries, and in particular in most of the ASEAN economies, the degree of specialisation in exports of computing and electronics products was particularly high. Products of computing and electronics industries played a decisive role in the changes in the composition of the manufactured exports of these economies.

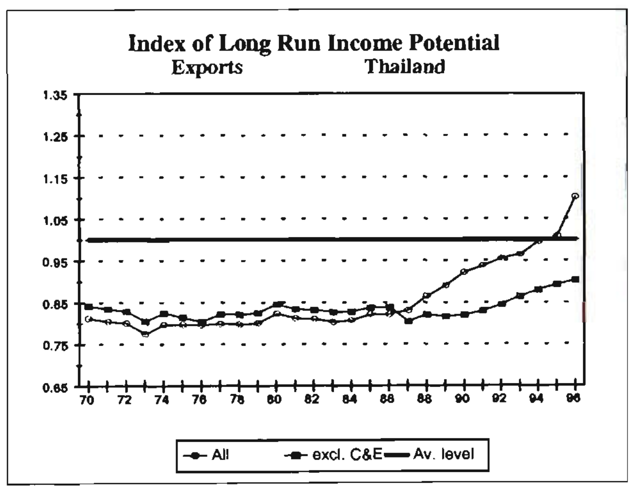
Appendix: Chapter 6

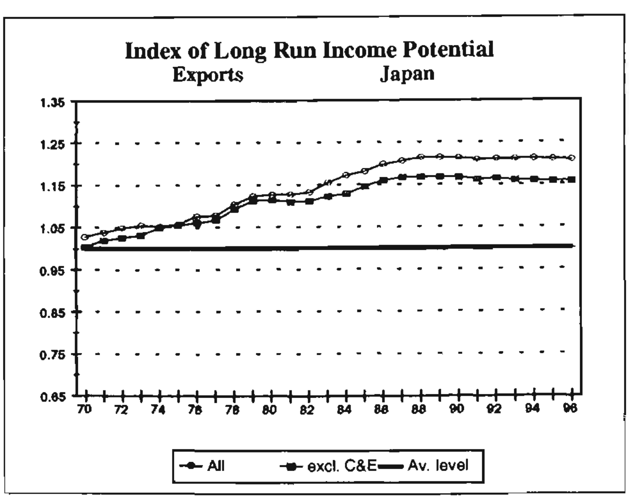
Chart 6.A1











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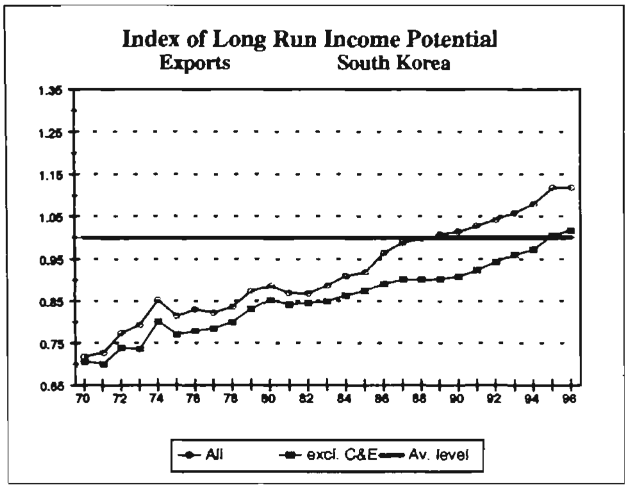
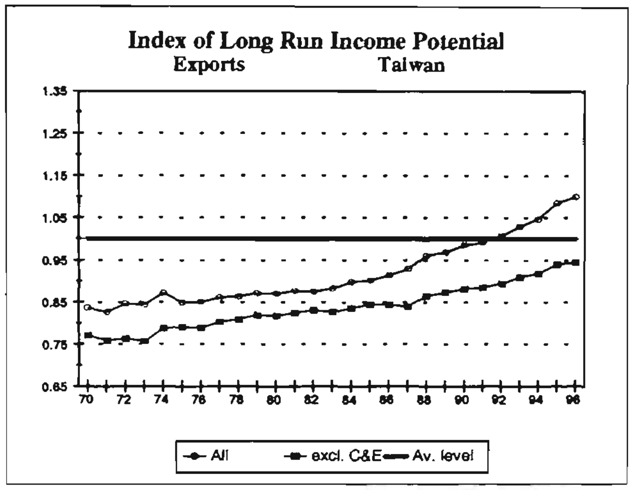
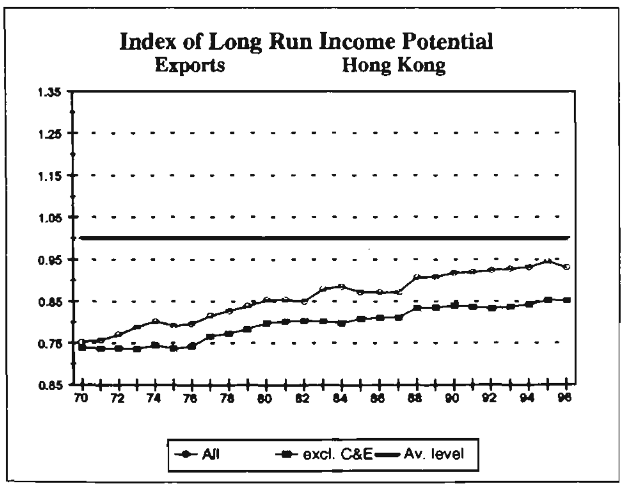
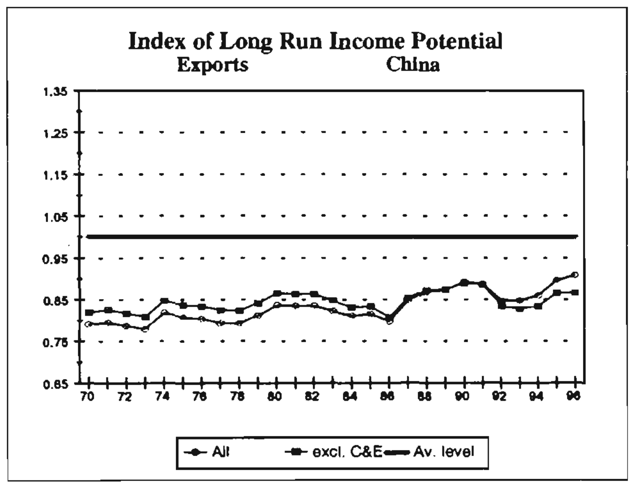

Index of Long Run Income Potential
Exports South Korea
1.35
1.25
1.15
1.05
0.95
0.85
0.75
0.65
70 72 74 76 78 80 82 84 86 88 90 92 94 96
All
excl. C&E
Av. level


Index of Long Run Income Potential
Exports Taiwan
1.35
1.25
1.15
1.05
0.95
0.85
0.75
0.65
70 72 74 76 78 80 82 84 86 88 90 92 94 96
All
excl. C&E
Av. level


Index of Long Run Income Potential
Exports Hong Kong
1.35
1.25
1.15
1.05
0.95
0.85
0.75
0.65
70 72 74 76 78 80 82 84 86 88 90 92 94 96
All
excl. C&E
Av. level


Index of Long Run Income Potential
Exports China
1.35
1.25
1.15
1.05
0.95
0.85
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70 72 74 76 78 80 82 84 86 88 90 92 94 96
All
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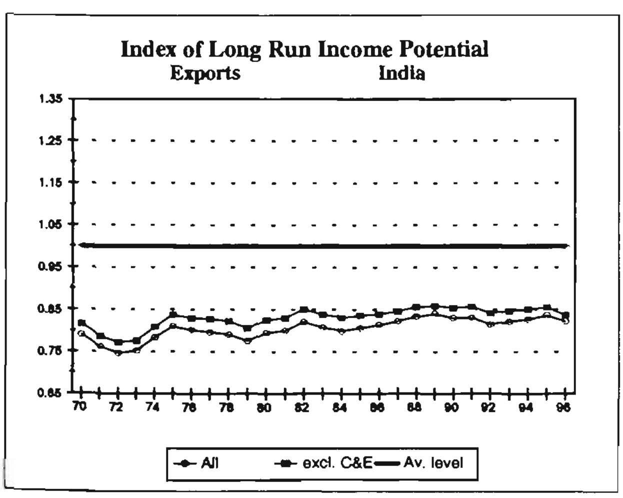
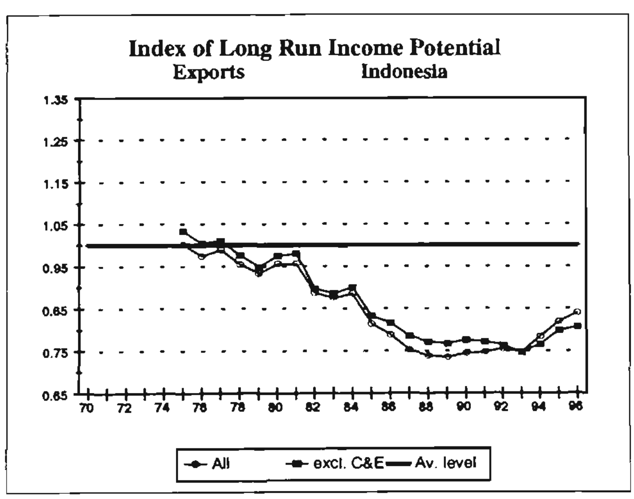
Av. level


Index of Long Run Income Potential
Exports India
1.35
1.25
1.15
1.05
0.95
0.85
0.75
0.65
70 72 74 76 78 80 82 84 86 88 90 92 94 96
All
excl. C&E
Av. level


Index of Long Run Income Potential
Exports Indonesia
1.35
1.25
1.15
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70 72 74 76 78 80 82 84 86 88 90 92 94 96
All
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Av. level

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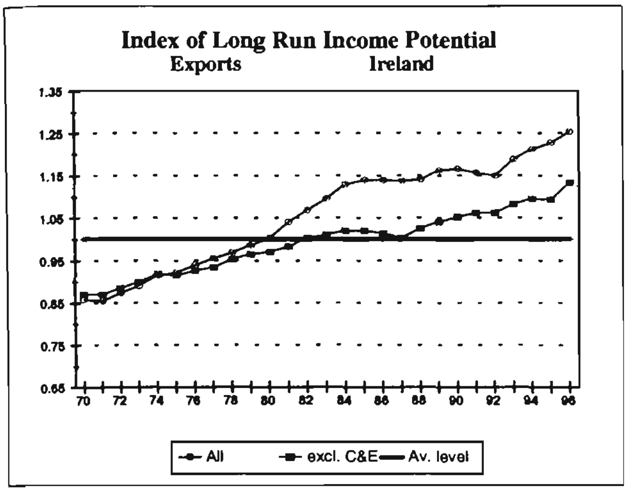
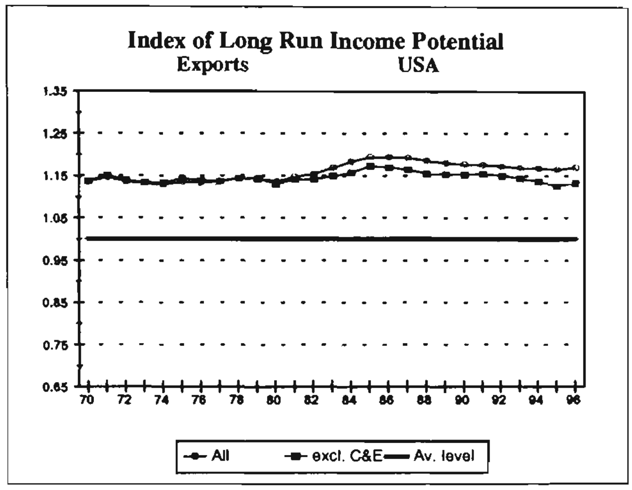
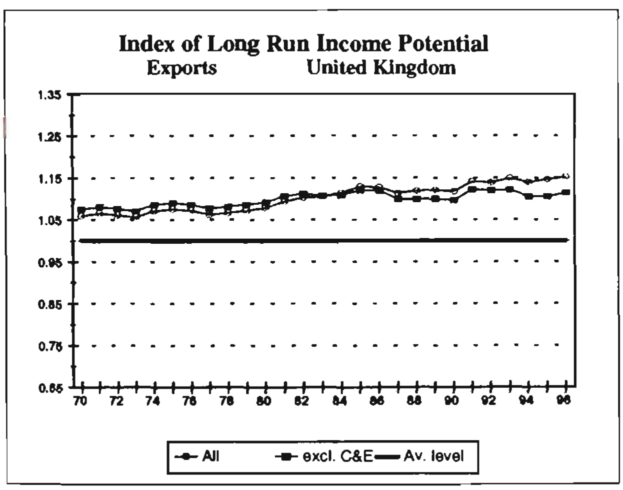
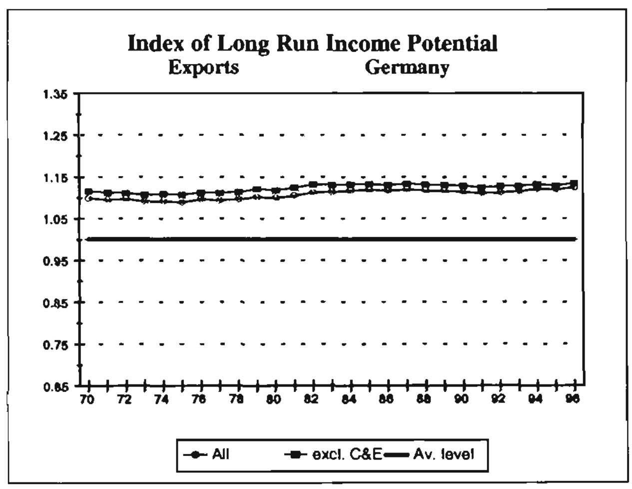
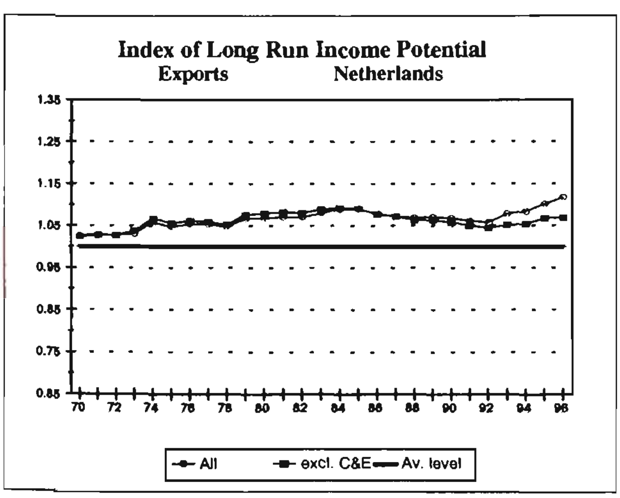
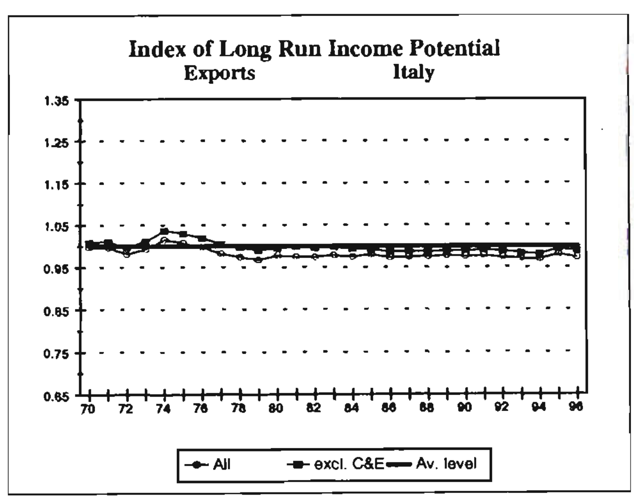












Source: Estimates based on ISIC Trade Data accessed through IEDB database.

CHAPTER 7

COMPUTERS AND ELECTRONICS: IMPORTS AND BALANCE OF TRADE

In the previous two chapters the process of structural change of manufacturing exports and the role of products of computing and electronics industries in this change have been analysed. In this chapter we will consider imports of computing and electronics products in terms of growth and of structural significance in the composition of manufactured imports of different regions and countries. Further, in this chapter, intra-industry trade and balance of trade in these products will be analysed.

Many factors influence the level of imports of a given country in a particular industry, so that changes in the level of imports can be indicative of many different processes at work. Several such factors may be particularly important in the case of the computing and electronics industries. The products of these industries may be imported to meet final demand by consumers or businesses; such imports will vary with the overall level of domestic demand and the competitiveness of local producers. These products may also be imported as intermediate goods to production processes within the computing and electronics industries, and the level of such imports will depend on the size of the domestic industry and its degree of dependence on imported inputs. More generally, imports may rise as part of a general process of increased intra-industry trade, as trade between countries in similar products grows over time. Analysis of trends in the level and structure of imports will not define directly which of these mechanisms are at work in a given country, but will provide an important background to subsequent, more detailed analyses.

7.1 Imports of Computing and Electronic Products

7.1.1 Growth of Computing and Electronics Imports

Information on imports of computing and electronics products for selected regions and countries for the periods 1970-1985 and 1985-1996 is provided in Table 7.1. The most important observation that can be made on the basis of these data is that over the 1970-1996 period in the Asian economies imports computing and electronic products, as well as exports of these products (see Section 6.1 in the previous chapter), were growing at significantly higher rates than in other countries. In ASEAN the growth rate of computing and electronics imports was 25 per cent per annum, and in the NICs it was 22.5 per cent. Among individual countries, such as China, Malaysia and Singapore, the rates of growth of computing and electronics imports were particularly high, although initially from low bases. Ireland was the only developed country that had the rate of growth of imports of these products comparable with their growth rates in Asian countries.

Table 7.1 Imports of Products of the Computing and Electronics Industries Selected Regions and Countries, 1970-1996

		US $ billion			*Average Annual Growth Rate per cent*	
	1970	**1985**	**1996**	**70-85**	**85-96**	**70-96**
World	**14.4**	**152.2**	**747.3**	**17.0**	**15.6**	**28.0**
EEC-12	**5.8**	**49.3**	**202.6**	**15.3**	**13.7**	**14.6**
United Kingdom	1.1	11.4	46.8	17.2	13.7	15.7
Germany	1.4	12.0	48.9	15.6	13.6	14.7
France	1.0	7.4	28.8	14.6	13.2	14.0
Netherlands	0.8	4.9	24.7	12.8	15.7	14.0
Ireland	0.1	1.6	9.6	24.1	17.8	21.4
Italy	0.6	5.6	15.2	16.5	9.5	13.5
Sweden	0.4	2.7	8.6	13.0	11.0	12.2
Spain	0.2	2.1	10.5	17.1	15.6	16.5
Denmark	0.2	1.2	4.6	11.4	12.8	12.0
North America	**3.2**	**46.7**	**176.2**	**19.5**	**12.8**	**16.6**
USA	2.5	40.1	152.6	20.5	12.9	17.2
Canada	0.8	6.6	23.6	15.4	12.2	14.1
Australia	0.3	2.9	9.3	16.0	11.4	14.0
New Zealand	0.1	0.5	1.6	16.5	10.7	14.0
Mexico	0.2	2.1	14.2	15.9	19.1	17.3
Japan	0.6	4.0	47.5	13.7	25.2	18.4
ASEAN	**0.3**	**7.8**	**102.5**	**24.0**	**26.3**	**25.0**
Singapore	0.1	3.9	49.5	26.9	25.9	26.5
Malaysia	0.0	2.5	26.9	30.7	24.2	27.9
Thailand	0.1	0.6	13.3	17.2	31.8	23.2
Philippines	0.1	0.3	9.8	12.2	37.0	22.1
Indonesia	0.0	0.5	2.9	17.5	18.0	17.7
NICs	**0.4**	**9.0**	**87.6**	**22.3**	**22.9**	**22.5**
Taiwan	0.1	2.3	21.6	20.0	22.7	21.1
South Korea	0.1	2.8	21.5	25.5	20.5	23.4
Hong Kong	0.2	4.0	44.5	21.9	24.5	23.0
China	0.0	4.3	16.6	51.6	13.2	33.9
India	0.1	0.5	2.7	17.2	15.8	16.6

Source: Based on ISIC Trade Data accessed through IEDB database.

While for the world as a whole, for the twelve European countries and for North America imports of computers and electronics were growing more rapidly during the first period, 1970-1985, than in the second period, 1985-1996, in Japan, ASEAN and the NICs the situation was the opposite. In Japan the difference between the rates of import growth for the two periods was most marked. This fact may be related to the transfer of Japanese production of computers and electronics offshore, followed by imports of the products back into Japan.

Among ASEAN economies and the NICs, in Singapore, Malaysia and South Korea the growth rates of imports of computing and electronic products for the first period exceeded the rates of growth for the second period. In Thailand, the Philippines, Indonesia, Taiwan and Hong Kong, on the contrary, the growth rates for the second period were higher the corresponding rates of growth for the first period.

The observed differentials in the growth rates of imports of computing and electronic products across different economies provide a reason for undertaking further analysis of the composition of trade in and production of computing and electronic goods at a higher level of disaggregation, in order to get a better understanding about the degree of product differentiation within computing and electronics industries across countries.

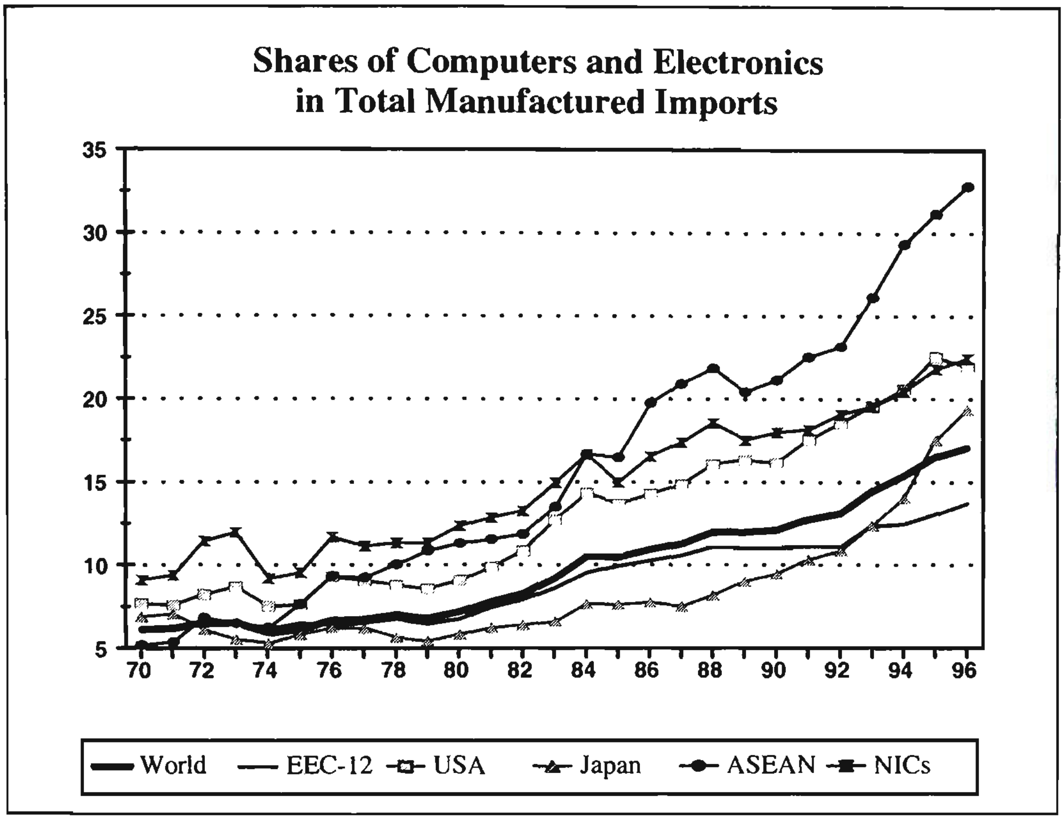
In the next section we will consider the role of computing and electronics products in the composition of manufactured imports of selected regions and countries.

7.1.2 The Structural Significance of the Computing and Electronic Industries for Manufactured Imports

Chart 7.1 shows the shares of computing and electronic products in total manufactured imports, for selected regions and for the world as a whole, on an annual basis over the period 1970-1996. Computing and electronic products gained a greater structural significance in the composition of global manufactured imports and of manufactured imports for all countries and regions shown in the chart.

The increase in the share of computing and electronic products in total manufactured imports was most marked for the ASEAN economies. Over the period the share rose more than sixfold, from slightly more than 5 per cent of their total manufactured imports to almost 33 per cent. By the end of the period computing and electronic products were also of high significance in the composition of manufacturing imports of the NICs: in 1996 these products accounted for more than 22 per cent of their total manufactured imports. Although for both ASEAN and the NICs the import shares of computers and electronics were below the corresponding export shares (see Section 6.3 in Chapter 6), the structural significance of computing and electronic products rose markedly for manufactured imports as well as for exports.

Chart 7.1



Source: Based on ISIC Trade Data accessed through IEDB database.

In Japan the share of computers and electronics of manufactured imports increased dramatically in the 1990s: from less than 10 per cent in 1990 to almost 20 per cent in 1996, which was still below the corresponding export share.

In the EEC-12 and the USA structural significance of computing and electronic imports increased markedly as well. However, the situation in these countries was quite different to that in Asian countries: at the end of the period in the EEC-12 and the USA import shares of computers and electronics of total manufacturing exceeded the corresponding export shares.

Let us consider the significance of computing and electronic products in the composition of manufactured imports of particular regions and countries, relative to that of their manufactured exports, in more detail. The values of the index of specialisation in imports of computers and electronics for selected countries and regions are presented in Table 7.2. (For a description of the index of specialisation see Section 4.1 in Chapter 4 and Section 6.3.1 in Chapter 6.) The countries are ranked according to the value of the index for 1996 and sorted in descending order within the regions they belong to. In addition to this, the ranks according to the value of the index of specialisation in exports of computing and electronics goods (for 1996) are presented, for comparison between the degree of specialisation in imports and in exports.

It is quite noticeable from the data presented in Table 7.2 that specialisation in imports of computers and electronics was higher for some countries in 1970 than in 1996. Canada, Mexico, Australia, New Zealand, and the European countries, except Ireland, belong to this category. Among Asian countries there are just three countries for which specialisation in imports declined over the period 1970-1996: Indonesia, Taiwan and Hong Kong. However, for Taiwan and Hong Kong the degree of specialisation in 1996 remained quite high relatively to other countries. For Japan the value of the index was declining during 1970-1990 and rose substantially in the 1990s. For South Korea the picture is the opposite: the index was increasing during the 1970s and then declined, although the value of the index for 1996 was still greater than for 1970.

Specialisation in imports of computers and electronics for China and India increased over the period, however remaining below the global average level in 1996. For the ASEAN countries (except Indonesia) the significance of computers and electronics in the composition of manufactured imports increased dramatically. The only developed country that can be compared with the countries of ASEAN region in terms of structural significance of imports of computers and electronics is Ireland. Another developed country for which the value of the index increased during 1970-1996 is the USA. For all other developed countries the role of electronic products in the structure of imports diminished. Further analysis of specialisation of different economies in production of and in trade of computing and electronic products at a higher level of disaggregation (see Chapter 8) can provide some explanations for the observed trends.

An analysis of the values of the index of specialisation in imports of computers and electronics for different countries for 1996 shows that these products were exceptionally important for many Asian countries.

Table 7.2 Index of Specialisation in Imports of Computers and Electronics, Selected Regions and Countries, 1970-1996

	Computers & Electronics - Specialisation in Imports							*Exports*
	1970	1975	1980	1985	1990	1996	**Rank 1996**	**Rank 1996**
EEC-12	**1.01**	**1.06**	**0.94**	**0.95**	**0.91**	**0.80**		
Ireland	0.82	0.99	1.13	1.75	1.44	1.82	**4**	**5**
United Kingdom	1.09	1.09	1.01	1.20	1.15	1.07	**12**	**11**
Netherlands	1.27	1.32	0.96	0.97	1.02	1.06	**13**	**13**
Sweden	1.15	1.07	1.06	1.09	0.96	0.89	**16**	**14**
Germany	1.02	1.06	1.01	0.97	0.94	0.80	**17**	**18**
Denmark	1.06	1.07	0.84	0.78	0.79	0.75	**19**	**20**
France	1.08	1.05	0.91	0.87	0.82	0.70	**21**	**17**
Italy	0.89	1.00	0.97	0.86	0.86	0.63	**23**	**21**
Spain	0.98	1.23	1.28	1.21	0.92	0.60	**24**	**22**
North America	**1.21**	**1.16**	**1.23**	**1.24**	**1.28**	**1.22**		
USA	1.26	1.24	1.26	1.31	1.33	1.29	**9**	**9**
Canada	1.09	0.97	1.12	0.94	1.05	0.91	**15**	**19**
Mexico	1.65	0.93	1.41	1.42	0.94	1.29	**8**	**10**
Australia	1.27	1.86	1.25	1.30	1.17	0.97	**14**	**23**
New Zealand	0.80	1.10	0.67	0.94	1.03	0.70	**20**	**25**
Japan	1.13	0.95	0.81	0.72	0.78	1.14	**10**	**8**
ASEAN	**0.84**	**1.24**	**1.57**	**1.57**	**1.74**	**1.92**		
Singapore	0.97	1.88	2.21	2.04	2.46	2.44	**1**	**1**
Malaysia	0.68	1.46	2.28	2.14	2.07	2.23	**2**	**3**
Philippines	0.92	0.87	0.84	1.10	0.96	1.93	**3**	**2**
Thailand	0.82	0.70	0.88	0.88	1.26	1.42	**6**	**4**
Indonesia	0.73	0.81	0.63	0.53	0.50	0.45	**25**	**16**
NICs	**1.48**	**1.55**	**1.71**	**1.43**	**1.48**	**1.32**		
Taiwan	2.18	1.69	1.99	1.65	1.65	1.49	**5**	**6**
Hong Kong	1.40	1.44	1.65	1.44	1.48	1.37	**7**	**12**
South Korea	1.08	1.56	1.55	1.27	1.36	1.09	**11**	**7**
China	0.11	0.29	0.81	1.23	0.78	0.78	**18**	**15**
India	0.60	0.57	0.27	0.44	0.49	0.68	**22**	**24**

Source: Based on ISIC Trade Data accessed through IEDB database.

Thus, Singapore is ranked first in the list of the twenty five countries with the value of the index, the value being almost 2.5 times higher than the world average. Malaysia and the Philippines follow Singapore, being the second and third in the list. Ireland, the only of the developed countries for which the value of the index is comparable with the values of ASEAN countries, occupies the fourth position. The degree of specialisation in imports of electronic goods of Taiwan is the highest among the NICs. The value of the index is one and a half times higher than for the world as a whole. Among developed countries, except Ireland, just three countries, the USA, the UK and the Netherlands were specialised in imports of computers and electronics above the world average level.

The results of a comparison between the relative ranks for imports and exports are of particular interest. For many countries there is a striking similarity between ranks for imports and exports. For Singapore, the USA and the Netherlands the ranks according to specialisation in imports and exports are exactly the same. For seven countries - Malaysia, Ireland, Taiwan, Germany, Denmark, the Philippines, and the United Kingdom - the difference between the ranks is equal to one. For Mexico, India, Thailand, Japan, Sweden, Italy and Spain the difference is equal to two. However, the relative positions of some other countries are quite different. Thus, Indonesia is ranked sixteenth according to specialisation in exports of computers and electronics and last, twenty fifth, according to that in imports. Australia's relative position, on the contrary, is higher in terms of specialisation in imports than in exports of computers and electronics. For Hong Kong and New Zealand the difference between the ranks is also substantial. For both countries the structural significance of computing and electronics products is higher for imports than for exports. However, for most of the countries presented in Table 7.2, the relative positions are rather similar for exports and for imports.

The fact that for many countries computers and electronics were of similar structural significance for the composition of both exports and imports provides a reason for considering intra-industry trade in computers and electronics.

7.2 Analysis of Intra-Industry Trade in Computers and Electronics

In some models of international trade, it is assumed that each country has a comparative advantage in some industry, and that each country exports in some industries and imports, but does not export, in others. But in practice countries both export and import in most industries, and this is referred to as a situation of intra-industry trade. It is evident from the foregoing that intra-industry trade is prevalent in computers and electronics. Here we study it more precisely.

We adopt the Grubel-Lloyd definition of intra-industry trade. Intra-industry trade is defined as the value of exports of an industry which is exactly matched by the imports of the same industry (Grubel and Lloyd 1975, p. 20). Thus intra-industry trade for country i and industry j can be defined as follows:

$$\boxed{IIT_j^i = \left(X_j^i + M_j^i\right) - \left|X_j^i - M_j^i\right|} \tag{7.1}$$

where IIT – Intra-Industry Trade,

X – exports,

M – imports,

i – a country,

j – an industry.

From this definition the Index of Intra-Industry Trade can be developed as follows:

$$\boxed{IITI_j^i = IIT_j^i / TT_j^i = 1 - \left(\left|X_j^i - M_j^i\right| / \left(X_j^i + M_j^i\right)\right)} \tag{7.2}$$

where $IITI$ – Index of Intra-Industry Trade,

TT – Total Trade, equal to $X + M$.

Let us briefly consider the possible values of the Index of Intra-Industry Trade.

I. Balanced trade, $X_j^i = M_j^i$.

$$IIT_j^i = TT_j^i \Rightarrow IITI_j^i = 1$$

II. Perfect specialisation or perfectly unbalanced trade, $X_j^i = 0$ or $M_j^i = 0$.

$$IIT_j^i = 0 \Rightarrow IITI_j^i = 0$$

III. Imperfect specialisation or unbalanced trade, $X_j^i > M_j^i$ or $M_j^i > X_j^i$.

$$\left.\begin{array}{l}\left|X_j^i - M_j^i\right| > 0 \\ \left|X_j^i - M_j^i\right| < \left(X_j^i + M_j^i\right)\end{array}\right\} \Rightarrow 0 < IIT_j^i < TT_j^i \Rightarrow 0 < IITI_j^i < 1$$

Thus in all cases it must be true that $0 \leq IITI_j^i \leq 1$.

If the value of the Index of Intra-Industry Trade is equal to 1, trade is balanced with exports equal to imports. If the value of Index is equal to 0, trade is perfectly unbalanced or, in other words, trade consists of either exports or imports. If the value of the Index is in the interval between 0 and 1, trade is unbalanced, with either exports greater than imports or imports greater than exports. The closer the value of the Index to 0, the greater the value of trade balance, whether it is positive or negative. Thus, the value of the Index indicates the extent to which trade is unbalanced. However, in the case of unbalanced trade some other techniques of analysis are necessary to clarify whether exports are prevailing over imports or vice versa.

As is well known from the literature (see, for example, Grubel and Lloyd 1975, pp. 2-5), the degree of aggregation of trade statistics affects, to a large extent, the level of observed simultaneous export and import of goods of the same industry. The extent of intra-industry trade may be expected to be higher if industries are broadly defined than if they are narrowly defined. In this section we will analyse intra-industry trade in computing and electronics industries defined at the four-digit level of aggregation of the International Standard Industrial Classification (ISIC): codes 3825 for computers and 3832 for electronics. This remains a broad industry definition – in the next chapter trade in computing and electronics products will be analysed at a higher level of disaggregation.

The values of the Index of Intra-Industry Trade in computers and electronics for selected regions and countries are presented in Table 7.3. These data exhibit an interesting pattern, which is explicit for some countries and rather subtle for the others. The values of the Index increase to a certain point and then decrease. This pattern is particularly marked for ASEAN, North America and the NICs. The maximum values of the Index for different regions, however, are reached at different points of time. Thus, for EEC-12 the value of the Index is at the maximum in the 1970s, for North America the maximum value is in 1980, for ASEAN in 1985 and for the NICs in 1990.

The same pattern can be observed for some particular countries as well. Thus, for Italy the values of the Index reached a peak in 1975, for the United Kingdom and Ireland in 1980, for Germany and Sweden in 1985, for Denmark and Spain in 1990. For some countries the values of the Index show two maxima: for France in 1975 and in 1990, and for the Netherlands in 1970 and in 1996. The patterns for the USA and Canada are quite different. The values of the Index for the USA were at their peak point in 1990, while for Canada the highest values were reached at the beginning and the end of the period, with the point of minimum being in 1980. For Mexico the maximum was reached in 1996. The values of the Index for Australia and New Zealand reached their peak at the end of the period, although at a very low level in comparison with other countries.

Table 7.3 Index of Intra-Industry Trade in Computers and Electronics, Selected Regions and Countries

	1970	1975	1980	1985	1990	1996
EEC-12	**0.97**	**0.97**	**0.96**	**0.92**	**0.86**	**0.94**
France	0.91	0.98	0.93	0.92	0.86	0.97
Netherlands	1.00	0.97	0.98	0.91	0.90	0.97
Sweden	0.95	0.86	0.94	1.00	0.94	0.96
United Kingdom	0.98	0.97	0.99	0.89	0.91	0.95
Germany	0.79	0.78	0.93	0.98	0.91	0.91
Ireland	0.53	0.89	1.00	0.80	0.72	0.78
Italy	0.90	0.99	0.88	0.84	0.75	0.77
Denmark	0.55	0.60	0.67	0.68	0.75	0.74
Spain	0.34	0.34	0.41	0.53	0.39	0.61
North America	**0.91**	**0.92**	**0.93**	**0.79**	**0.85**	**0.78**
USA	0.84	0.82	0.85	0.81	0.88	0.79
Canada	0.70	0.59	0.57	0.61	0.66	0.71
Mexico	0.28	0.24	0.75	0.75	0.35	0.96
Australia	0.09	0.12	0.12	0.06	0.15	0.26
New Zealand	0.02	0.02	0.11	0.08	0.07	0.18
Japan	0.37	0.32	0.25	0.19	0.32	0.63
ASEAN	**0.33**	**0.71**	**0.93**	**0.99**	**0.92**	**0.87**
Philippines	0.00	0.04	0.33	0.92	0.81	0.98
Indonesia	na	0.05	0.39	0.39	0.21	0.94
Thailand	0.00	0.30	0.34	0.35	0.90	0.90
Malaysia	0.08	0.39	0.89	0.96	0.88	0.86
Singapore	0.70	0.99	0.91	0.90	0.85	0.84
NICs	**0.91**	**0.87**	**0.91**	**0.91**	**0.95**	**0.93**
South Korea	0.64	0.92	0.84	0.81	0.74	0.76
Taiwan	0.92	0.76	0.77	0.68	0.75	0.74
Hong Kong	0.85	0.95	0.89	0.74	0.52	0.19
China	0.51	0.34	0.18	0.16	0.84	0.98
India	0.27	0.30	0.26	0.13	0.33	0.37

Source: Based on ISIC Trade Data accessed through IEDB database.

For Japan the picture is similar to that of Australia and New Zealand, albeit a higher value of the Index. For the countries of the ASEAN region the situation is as follows: the values of Index of Intra-Industry Trade for Singapore reached the maximum in 1975, for Malaysia in 1985, and for Thailand, Philippines and Indonesia at the end of the period. Among NICs, the values for Taiwan were at the peak at the beginning of the period, for South Korea and

Hong Kong in 1975. For China and India the maxima were reached at the end of the period, although the fluctuations in values of the Index were quite marked during the period with the minima in 1985 for both countries.

As has been noted above, if the value of the Index is equal to 1, trade is balanced. The closer the value of the Index to 0, the greater the value of trade balance, although the value of the Index does not indicate whether the balance of trade is positive or negative. So, the pattern observed in the values of the Index for most countries (Table 7.3) indicates that there were changes from unbalanced trade in computers and electronics towards balanced and then in the opposite direction. However, it is not quite clear yet whether there were changes in the sign of trade balance or variations in the magnitude of trade surplus of deficit. An analysis of trade balance can shed light on this issue.

7.3 The Balance of Trade in Computers and Electronics

In this section we will consider the balance of trade in computing and electronic products as a share of total trade in these products for a given country or region, a measure that allows us to present the data for different countries and regions on a comparable basis (Table 7.4).

For countries of ASEAN region changes in the balance of trade in computers and electronics during 1970-1996 were spectacular. At the beginning of the period Malaysia, Thailand, the Philippines, and Indonesia had trade deficits that constituted more than 90 per cent of total trade in these products. For Singapore the trade deficit was also quite substantial – almost one third of total trade. By 1996, for all ASEAN countries trade in computers and electronics was in surplus, with the shares of the surplus in total trade ranging from 2 per cent for the Philippines to 16.5 per cent for Singapore. The situation for South Korea was similar to that of Singapore, although the trade surplus was growing more rapidly than for Singapore, reaching 24 per cent of total trade by 1996. For Taiwan the trade balance was positive at the beginning of the period; in 1985 the share of trade surplus reached 32 precent of total trade then it declined, and in 1996 constituted about 26 per cent of total trade. Hong Kong's trade balance in computers and electronics was negative in 1970, changed to a surplus at 5 per cent of total trade in 1975, then became negative again and by 1996 the deficit reached more than 80 per cent of total trade.

In China the trade deficit was rising from about 50 per cent of total trade in 1970 to more than 83 per cent in 1985.Then, as export activity began to develop, it rapidly declined, turning into a surplus of 2.4 per cent of total trade in 1996. India has had a continuing strong trade deficit in computers and electronics that reached its maximum in the mid-1980s.

Table 7.4 Balance of Trade as a Share of Total Trade, Computers and Electronics, Selected Regions and Countries, 1970-1996

	1970	1975	1980	1985	1990	1996
			per cent			
EEC-12	**2.5**	**2.5**	**-3.9**	**-8.0**	**-13.7**	**-6.5**
Ireland	-47.0	-10.6	0.4	20.0	28.1	22.2
Sweden	5.0	13.7	5.9	0.2	-6.4	4.3
Netherlands	-0.1	-3.2	-2.0	-8.5	-10.3	3.0
France	-8.8	-1.8	-6.9	-7.7	-14.3	-2.9
United Kingdom	2.3	3.1	-1.4	-11.4	-9.2	-4.6
Germany	21.1	21.8	7.2	2.0	-8.5	-9.2
Italy	10.2	-1.0	-12.5	-16.1	-25.0	-23.1
Denmark	-45.0	-40.5	-33.4	-32.3	-25.4	-25.8
Spain	-66.0	-65.6	-59.0	-46.6	-61.3	-39.2
North America	**8.7**	**8.3**	**7.0**	**-21.1**	**-15.0**	**-21.7**
USA	16.4	17.7	14.8	-18.5	-11.9	-20.7
Canada	-29.7	-40.7	-43.0	-38.9	-34.2	-28.6
Mexico	-72.3	-76.3	-24.6	-25.0	-64.7	3.9
Australia	-91.0	-88.0	-88.3	-93.9	-85.3	-73.9
New Zealand	-97.7	-97.7	-89.4	-91.5	-92.9	-82.5
Japan	62.9	68.2	74.7	80.9	68.2	37.1
ASEAN	**-67.1**	**-29.2**	**-7.3**	**-1.5**	**8.1**	**13.5**
Singapore	-30.2	0.6	8.7	9.9	14.9	16.5
Malaysia	-92.3	-61.1	-11.2	-4.0	12.1	13.7
Thailand	-99.6	-69.6	-65.9	-64.8	-10.4	10.3
Indonesia	na	-95.0	-61.4	-61.3	-78.7	5.8
Philippines	-99.9	-96.4	-66.9	-7.8	-19.3	2.0
NICs	**-9.4**	**12.7**	**9.2**	**9.1**	**4.7**	**-6.8**
Taiwan	8.1	23.8	22.8	32.2	24.8	25.7
South Korea	-35.9	7.6	16.3	18.9	26.1	24.2
Hong Kong	-15.3	5.4	-10.9	-25.7	-48.3	-80.6
China	-49.1	-65.5	-82.2	-83.6	-16.2	2.4
India	-72.7	-69.9	-74.2	-86.8	-66.6	-63.2

Source: Based on ISIC Trade Data accessed through IEDB database.

For Japan the picture was the opposite. Over the period 1970-1996 Japan had a strong surplus, in 1985 constituting more than 80 per cent of total trade. However, starting from the mid-1980s the share of the trade surplus in total trade was declining and by 1996 was equal to 37 per cent, which was still much higher than for any other country.

The transformation of the trading position of the USA in computing and electronics products is well known, and was the subject of intense policy debate in that country in the 1980s. In 1970 the USA had the surplus of about of 17 per cent of total trade in computers and electronics, but it turned into a substantial deficit in the first half of the 1980s, and by 1996 constituted more than 20 per cent of the total trade in these products. Canada's trade in electronic products was in deficit during the whole period. Mexico had a strong deficit during 1970-1990, which was characterised by significant variations in the values of shares of the total trade. However, during the 1990s this deficit changed into a surplus, and in 1996 the trade surplus was about 4 per cent of total trade in computers and electronics.

Ireland is the only European country where the earlier trade deficit in these products, equal to 47 per cent of total trade in 1970, had by the mid-1980s turned into a substantial surplus. In 1990 the trade surplus constituted 28 per cent of total trade in computers and electronics, a figure comparable with the shares for Taiwan and South Korea. Sweden and the Netherlands are other European countries that in 1996 had a positive balance of trade in computing and electronics goods. However, as a share of total trade their surpluses were significantly lower than for Ireland. Besides this, during 1970-1990 the Netherlands had a negative trade balance in computers and electronics that changed into surplus only in the first half of the 1990s. Sweden's relatively high surplus of almost 14 per cent of total trade in 1975 diminished of the period to 1990, and in 1990 its trade position on these products was in deficit, to the extent of 6.4 per cent of total trade in electronic products. Then the situation changed again and by 1996 Sweden's positive trade balance constituted more than 4 per cent of the total trade. For France, Denmark and Spain the balance of trade in these goods was negative during the whole period of 1970-1996, although France's deficit was, as a share of total trade, substantially lower than that of Denmark and Spain. For other European countries during the same period initial surpluses of trade in computers and electronics changed to deficits. For Germany and Italy this change was quite dramatic. In 1970 the trade surplus as a share of total trade constituted more than 20 per cent for Germany and 10 per cent for Italy, while in 1996 the deficit reached 9 per cent for Germany and 23 per cent of total trade in computers and electronics for Italy.

To summarise, in this chapter we have shown that during the 1970-1996 period computing and electronic products were of growing significance in the composition of manufactured imports of many Asian countries. By the end of the period these products played an important role for manufactured imports of these economies as well as for their manufactured exports. Over the 1970-1996 period there were major changes in the patterns of trade in computing and electronic products in most countries considered in this chapter. Many developed countries became net importers and many Asian countries emerged as net exporters of these products. These findings provide a basis for further analysis of the composition of production of and trade in computing and electronic goods at a higher level of disaggregation, in order to get a better understanding of the degree of product differentiation within computing and electronics industries across countries and of the nature of the production activities undertaken in these industries in different countries.

PART C

PRODUCT SEGMENTATION OF THE GLOBAL ELECTRONIC INDUSTRY

The third group of chapters (Chapters 8-9) looks beneath the measures of industry structure defined at the twenty two industry level, to examine production and trade in representative products of the computing and electronic industries. One persistent finding of this analysis is that product differentiation across developed and East Asian countries was a dominant feature of global electronic production. In the 1990s the developing East Asian countries tended to be producing and exporting electronic products of high global demand, but characterised by significantly lower unit prices than the electronic goods produced and exported by the developed countries.

The analysis undertaken in Chapter 8 shows that over the 1985-1995 period the pattern of product segmentation of global electronic production and trade in electronic products became clearly defined. Most countries of the ASEAN region and the NICs were specialised in producing electronic goods characterised by high global demand, such as electronic data processing equipment and components. Consumer electronics was also important in the composition of electronic production of many East Asian economies. The role of electronic products of high global demand in the structure of electronic production of developed countries, except Ireland, was relatively modest. These countries were mostly specialised in production of control and instrumentation, industrial and medical, communications and radar, and telecommunications equipment. The pattern of distribution of global electronic production across countries was reflected in their specialisation in trade in particular categories of electronic products. Most developed countries had a surplus of trade in control and instrumentation, communications and radar, medical and industrial and telecommunications equipment, and a deficit in electronic data processing, office equipment, consumer electronics, and components. Most East Asian economies a had surplus of trade in electronic data processing, office equipment, consumer electronics and components, and a deficit in control and instrumentation, communications and radar, medical and industrial and telecommunications equipment.

Chapter 9 continues the analysis of the segmentation of global electronic production, extending it to the assessment of product differentiation across countries in terms of functional sophistication and quality of electronic goods. Such an assessment can only be undertaken on a case study basis. A cross-country comparison of production and import unit prices, based on case studies of particular types of video and audio electronic equipment, reveals that in the 1990s there were marked differentials between countries in terms of technical characteristics and quality of the electronic equipment produced. The relatively low unit prices of electronic goods produced in East Asian economies indicate that these countries produced and exported relatively simple electronic products that corresponded to consumer quality standards in their domestic markets and in the markets of the countries to which they export. By contrast, developed economies produced and exported electronic equipment characterised by high unit prices, which suggests that their production and trade involved professional functionally sophisticated equipment of high quality but of moderate demand. The market shares of different countries in global exports reflected the differentials between the unit prices of electronic products in inverse order: higher market shares corresponded to the lower unit prices.

The analysis undertaken in this section reveals that product segmentation across developed and East Asian countries was a dominant feature of global electronic production. This suggests that care should be taken in drawing conclusions from export data specified at the twenty two industry level.

CHAPTER 8

PRODUCT SEGMENTATION IN GLOBAL ELECTRONIC PRODUCTION AND TRADE

In the previous chapters we have analysed the role of products of the computing and electronics industries in the structure of overall manufacturing trade over the 1970-1996 period. Computing and electronic products were of growing significance in the composition of the manufactured exports of many economies, especially for many East Asian countries. The significance of these products in the composition of manufactured imports was increasing as well, again particularly for many countries in East Asia. In most countries there were major changes in the patterns of trade in computing and electronic products during the period: many developed countries became net importers and many East Asian countries emerged as net exporters of these products. An analysis of the composition of production of, and trade in, computing and electronic goods at a higher level of disaggregation can contribute to a better understanding of the underlying causes of such changes. It can provide information about the degree of product differentiation within the computing and electronics industries across countries and about the nature of the production activities undertaken in different countries.

The Yearbook of World Electronics Data provides a unique source of detailed data on production and apparent consumption of electronic equipment and components (software and services are not included) for fifty countries. The program was originally set up by Mackintosh Consultants, transferred to Benn Electronic Publications in the early 1980s, then to Elsevier in 1988 and to Reed Business Publishing in 1997 (Yearbook of World Electronics Data 1996, p. 4). As has been stated by the head of the research team of the Yearbook program, research consultant Kenneth Wilson, by 1996 the program of research for the Yearbook was operating for over 24 years and had become the definitive reference source for data on global electronics production and markets (p. 4).

The estimates and forecasts are based on annual surveys of the 30 major countries of the world and on biannual surveys of emerging economies and Eastern European countries. The statistical information, used in this thesis, has been obtained from the 1996 edition of the Yearbook for the emerging countries (volume 3), from the 1997 edition for other countries (volumes 1, 2 and 4); and from the electronic 1997 edition for Western Europe, America, Japan and Asia Pacific.

In the Yearbook, production data incorporate the output of electronic products for domestic consumption and for export, but exclude imports and re-exports of finished goods. Apparent Consumption is defined as follows:

Apparent Consumption = Production + Imports - Exports

Estimates of Apparent Consumption also exclude re-exports and, thus, can be considered as a reliable source of information on the domestic use of computing and electronics products.

Trade statistics are presented in the summary tables of the Yearbook of World Electronics Data. However, re-exports, which are included in their exports and imports data, may cause significant distortions of the actual values of exports originating in the country and of imports for use within the country, especially for Hong Kong, Singapore and the Netherlands (see Appendix 4.5, Yearbook of World Electronics Data, 1997, vol. 1, pp. 272-273). In order to avoid statistical bias incorporated in export and import data, we will confine our research to the analysis of production, apparent consumption, and the balance of trade.

8.1 The Classification of Electronic Products and Analytical Techniques

8.1.1 Classification of Electronic Products

We adopt the classification suggested in the Yearbook of World Electronics Data, where all electronic products are grouped into 8 major categories which are common across all countries (1997, vol. 1, p. 5). The definition of the categories of the classification can be found in the Yearbook of World Electronics Data (see Appendix 4.7, Yearbook of World Electronics Data, 1997, vol. 1, pp. 278-285). The major items of this classification are outlined below (see Box 8.1). It is worth noting that in this classification computing products belong to the category 'electronic data processing' equipment. For this reason in this chapter, products of both computing and electronics industries will be referred to as electronic products.

8.1.2 The Index of Relative Global Demand, a Description of a New Technique

The objective of this chapter is to analyse whether specialisation in production and trade of electronic goods differs across countries by product type. First we will approach this issue by assessing the overall structure of electronic production in terms of the different types of

Box 8.1

Classification of Electronic Products

Electronic Data Processing	computers and complete systems, peripherals storage, input/output equipment, accessories and parts.
Office Equipment	electronic typewriters, calculators, cash registers, accounting machines, dictation equipment, photocopiers.
Control and Instrumentation	industrial and process control systems, process control instruments, oscilloscopes, analytical and nucleonic instruments, signal generators, telecommunication instruments, machine and material test instruments, electrical quantity measuring instruments, other test and measuring instruments, accessories and parts.
Medical and Industrial	medical and industrial X-ray and industrial radiation equipment, electrocardiographs, other electromedical equipment, hearing aids, railway and other traffic signalling equipment, security and fire alarms, other signalling equipment, induction and dielectric equipment.
Communications and Radar	radar, navigational aids, radio communications transmission and reception apparatus, transceivers, mobile radio telephones, pocket pagers, public broadcasting transmitters, public broadcast other, other communications and military equipment, accessories and parts.
Tele-communications	switching equipment, facsimile equipment, data and text terminal equipment, telephone sets, other telecommunications equipment, accessories and parts.
Consumer	consumer video: colour and monochrome television, video recorders, video cameras and combinations, tuners and satellite receivers; consumer audio: portable radios and radio recorders, mains radios and combinations, car radios and combinations, tape recorders and decks, record players and decks, compact disk players; consumer personal: electric/electronic watches and clocks, electronic flashlights.
Components	active components: colour and monochrome television tubes, X-ray tubes, other valves and tubes, diodes, thyristors, photoelectric cells, piezoelectric crystals, other discrete semiconductors, integrated circuits - linear and digital, hybrids, other; passive components: electrolytic capacitors, other fixed capacitors, fixed resistors, variable resistors, multi-pin and RF connectors, other connection devices, small transformers, chokes, coils and other inductors, relays, switches, printed circuit boards; audio components: microphones, loudspeakers, amplifiers, aerials, unrecorded media, cabinets for radios, TV and professional communications equipment, accessories and parts for consumer equipment.

products (see Box 8.1). For this purpose we will apply a similar method to the one that has been used for analysing the structure of manufacturing trade and production. A weighted index of structural composition will be developed and applied to the structure of electronic production. The changes in the values of such a weighted index indicate structural change in a particular direction.

The direction of structural change is determined by a specific criterion, an indicator, the numeric values of which are used as weights. In this case the structure of electronic production, and changes in this structure, in particular regions and countries, will be assessed relative to the structure of global demand for different types of electronic products.

Two variables are used as indicators of global demand: the shares of particular types of electronic goods in the world market for all electronic products (defined as apparent consumption for the 50 countries covered in the dataset) and the growth of global markets for the various types of electronic products. In the 1990s there were marked differences across different types of electronic products in terms of both the shares of the global market and growth in apparent consumption (Table 8.1). Over 1993-1995 components constituted the highest proportion of the global market for electronic products, almost 29 per cent. The share of electronic data processing equipment was slightly lower than that of components, at 27 per cent. The shares of other types of electronic products were significantly lower than the shares of components and electronic data processing equipment. Thus, communications and radar equipment accounted for 11 per cent of global electronic consumption, while consumer goods accounted for almost 10 per cent. The share of telecommunications equipment was 9 per cent of global markets, or one third of the consumption of data processing equipment. Control and instrumentation provided about 8 per cent of the global consumption of electronic products. The global market for medical and industrial equipment was relatively small, at 3.5 per cent of the overall electronics market, as was the market for office electronic equipment (2.2 per cent). The ranking of different types of electronic products according to their contribution to the global market is shown in column 3 of Table 8.1, with the higher values of the ranks corresponding to the higher values of the shares.

The differences across the groups of electronic products in terms of changes in global demand are quite pronounced as well. Over the 1993-1998 period the world markets for components and for electronic data processing equipment were growing more rapidly than for other groups. Electronic data processing products were ranked the highest among all electronic goods (column 5, Table 8.1), as global markets for data processing equipment were growing at a rate of 12.5 per annum. The growth of global markets for components was also substantial, at 10.5 per cent per annum.

Table 8.1 Relative Ranks of Electronic Products According to Indicators of Global Demand

	Shares of Market For All Electronic Products Average (1993-1995)		Market Growth 1993-1998		
	Shares of Total World Apparent Consumption %	*Rank*	*Average Annual Growth Rates of Global Apparent Consumption %*	*Rank*	*Overall Average Rank*
Electronic Data Processing	27.3	7	12.5	8	7.5
Office Equipment	2.2	1	4.0	1	1.0
Control & Instrumentation	8.3	3	6.9	5	4.0
Medical & Industrial	3.5	2	6.9	4	3.0
Communications & Radar	11.0	6	7.8	6	6.0
Tele-communications	9.1	4	5.4	3	3.5
Consumer	9.9	5	5.1	2	3.5
Components	28.8	8	10.5	7	7.5

Source: Estimates based on World Electronics Data 1996, 1997.

Growth rates for other types of electronic products were significantly lower than for data processing equipment and components. Global apparent consumption of communications and radar equipment was growing at an annual rate of almost 8 per cent. The rate of growth of markets for control and instrumentation equipment was exactly the same as for medical and industrial electronic products, almost 7 per cent per annum, while apparent consumption of telecommunication equipment was growing at a relatively low rate of 5.4

per cent, and of consumer electronic goods at the rate of 5 per cent per annum. Office equipment was the slowest growing category among all types of electronic products, the annual rate of growth being 4 per cent.

It is worth noting that two types of electronic products, data processing equipment and components, are quite distinctive in Table 8.1 – they are ranked the highest according to both global market shares and growth rates. Moreover, both the market shares and the rates of growth for these products were significantly higher than that for other electronic goods. This combination of high market shares and high rates of growth of global apparent consumption indicates that, if the growth rates remain relatively high, these electronic products are likely to continue to play a key role in the composition of global markets. If there are no dramatic changes in the rate of growth, the relative significance of electronic office equipment, on the contrary, is likely to weaken in the future, as both market shares and the rates of growth were low relatively to that of other types of electronic products.

In order to develop a measure that can be used as a proxy for relative global demand for different types of electronic goods both indicators, market shares and the rates of growth, have to be incorporated. The overall relative rank (column 6, Table 8.1), calculated as arithmetic mean of the two ranks, represents an indicator of the relative position of different types of electronic products according to global demand for these products. The values of the overall relative rank will be used as weights in the Index of the Relative Global Demand.

The adapted formula for the Index of Composition (see equation 4.3, Chapter 4) in this case will take the following form:

$$IRD_T^i = \frac{\sum_j^n \left(P_j^i \cdot I_j\right)}{\sum_j^n P_j^i} \qquad (8.1)$$

where IRD – Index of Relative Global Demand,

i - a country,

n - the total number of types of electronic products, $n=8$,

j - a particular type of electronic products, $1 \leq j \leq 8$,

I - a weight (the value of the overall average rank),

P - production.

If electronic production were equally divided across all types of products,

$$P_j^i = \frac{P_T^i}{n} = \frac{\sum_j^n P_j^i}{n},$$

where P_T^i - total electronic production for country i, then

$$IRD_T^i = \frac{\sum_j^n \left[\left(\frac{\sum_j^n P_j^i}{n} \right) \cdot I_j \right]}{\sum_j^n P_j^i} = \frac{\sum_j^n P_j^i \cdot \sum_j^n I_j}{n \cdot \sum_j^n P_j^i} = \frac{\sum_j^n I_j}{n} = \overline{IRD_T}$$

$$\boxed{\overline{IRD_T} = \frac{\sum_j^n I_j}{n} = \frac{I_T}{n}} \qquad (8.2)$$

where $\overline{IRD_T}$ - the average value of the Index of Relative Global Demand ($P_j^i = \frac{P_T^i}{n}$),

I_T - the sum of the values of the overall average rank for all types of electronic products.

The value of $\overline{IRD_T}$ can be used as a benchmark for the value of the Index of Relative Global Demand:

$$\boxed{RIRD_T^i = \frac{IRD_T^i}{\overline{IRD_T}} = \frac{\sum_j^n \left(P_j^i \cdot I_j\right)}{\left(\sum_j^n P_j^i\right) \cdot \overline{IRD_T}}} \qquad (8.3)$$

where $RIRD$ - the Rebased Index of Relative Global Demand.

If the value of the Index of Relative Global Demand is equal to the average value of the Index in the equally divided production case, the Rebased Index is equal to 1.

In Section 8.2.3 the Index of Relative Global Demand will be applied for the evaluation of the structure of electronic production of different regions and countries, and of changes in this structure. In all cases we will use the Rebased Index, which will hereafter be referred to as the Index.

8.2 Production of Electronic Equipment, Selected Regions and Countries

8.2.1 Preliminary Review

Table 8.2 presents the data on the production of electronic equipment in the major regions and in Japan for 1985 and 1995 and the average annual rates of growth for this period. The order of particular types of electronic products is determined by their overall average rank in relation to global demand (see Table 8.1). Several observations can be made on the basis of the analysis of this information.

First, the rates of growth of total electronic production differed to a large extent across the regions (and a country) for this period. ASEAN economies achieved the highest rate of growth, 27.3 per cent per annum. Electronic production of the NICs was growing at the rate of 18.8 per cent, which was significantly higher than the growth rates achieved in developed countries. In North America the rate of growth was lower than the growth rates of all other regions (and Japan) presented in Table 8.2.

Second, in spite of the high rates of growth of electronic production achieved in the ASEAN economies and the NICs during the 1985-1995 period, at the end of this period developed countries remained the major producers of electronic goods.

Third, in terms of the combined electronic production of the major regions and Japan, the differences between the growth rates for particular types of electronic goods were quite marked. Production of electronic components was growing more rapidly than the production of all other types of electronic goods, at an average annual rate of 12.8 per cent. Production of electronic data processing equipment was also expanding rapidly, at 11.2 per cent per annum. Office equipment was the slowest growing category among all types of electronic products.

Fourth, the differences between the regions in terms of growth rates for particular types of electronic production were also quite pronounced. ASEAN achieved the highest growth rates of production of all types of electronic goods among all regions (and a country) considered in Table 8.2. For most categories of electronic products the rates of growth achieved in the NICs were higher than those achieved in other regions (and Japan), except for ASEAN. However, in Japan production of control and instrumentation and of telecommunications electronic equipment was growing more rapidly than in the NICs. The differences between Western Europe and North America were also quite distinct.

Table 8.2 **Production of Electronic Equipment Selected Regions and Countries, 1985-1995**

			West Europe		North America		Japan		ASEAN		NICs		Total West Europe, North America, Japan, ASEAN, NICs	
			US $ billion	*Av. An. Growth 1985-95 %*	*US $ billion*	*Av. An. Growth 1985-95 %*	*US $ billion*	*Av. An. Growth 1985-95 %*	*US $ billion*	*Av. An. Growth 1985-95 %*	*US $ billion*	*Av. An. Growth 1985-95 %*	*US $ billion*	*Av. An. Growth 1985-95 %*
1	*Electronic Data Processing*	*1985*	22.5		48.4		18.3		1.3		2.2		**92.8**	
		1995	53.2	*9.0*	82.7	5.5	73.5	*14.9*	33.0	*37.8*	25.1	*27.4*	**267.5**	***11.2***
2	*Components*	*1985*	14.9		34.2		28.9		4.1		5.5		**87.7**	
		1995	41.4	*10.8*	75.3	*8.2*	102.3	*13.5*	31.7	*22.6*	40.8	*22.1*	**291.4**	***12.8***
3	*Communications & Radar*	*1985*	9.8		41.0		4.2		0.3		0.7		**55.9**	
		1995	28.2	*11.2*	53.3	*2.7*	17.6	*15.2*	3.1	*28.4*	3.6	*18.5*	**105.8**	***6.6***
4	*Control & Instrumentation*	*1985*	11.8		21.3		3.7		0.2		0.2		**37.2**	
		1995	29.6	*9.7*	32.4	*4.3*	11.0	*11.3*	1.0	*18.1*	0.5	*10.5*	**74.5**	***7.2***
5	*Telecommunications*	*1985*	13.5		18.3		6.1		0.4		1.6		**39.8**	
		1995	29.5	*8.1*	26.4	*3.7*	21.4	*13.4*	3.1	*23.8*	4.4	*10.7*	**84.9**	***7.9***
6	*Consumer*	*1985*	6.9		6.0		20.7		1.5		5.0		**40.2**	
		1995	16.8	*9.3*	7.4	*2.1*	27.2	*2.7*	16.2	*27.1*	12.2	*9.3*	**79.9**	***7.1***
7	*Medical & Industrial*	*1985*	3.4		6.5		2.4		0.1		0.2		**12.6**	
		1995	10.0	*11.3*	13.1	*7.2*	7.4	*12.0*	0.5	*24.5*	0.8	*16.6*	**31.8**	***9.7***
8	*Office Equipment*	*1985*	2.1		7.1		4.4		0.2		0.4		**14.3**	
		1995	4.3	*7.4*	5.3	*-2.9*	6.9	*4.5*	1.0	*19.2*	1.0	*9.2*	**18.5**	***2.6***
	All Electronic Goods	*1985*	**84.9**		**182.8**		**88.9**		**8.0**		**15.8**		**380.4**	
		1995	**213.1**	***9.6***	**296.0**	***4.9***	**267.1**	***11.6***	**89.7**	***27.3***	**88.4**	***18.8***	**954.3**	***9.6***

Source: Estimates based on World Electronics Data 1996, 1997.

In Western Europe the rates of growth of production of all types of electronic products, except electronic components and medical and industrial electronic equipment, were significantly higher than in North America. In terms of the relative growth rates of production of electronic office equipment the differences between the two regions were most marked. While in Western Europe this type of electronic production was growing at a relatively high rate of 7.4 per cent per annum; production of electronic office equipment in North America was contracting, at 3 per cent per annum.

Fifth, there were marked differences between the categories of electronic products with respect to the growth rates achieved in particular regions. In ASEAN and the NICs electronic data processing equipment was growing more rapidly than other types of electronic production. In Japan the rate of growth of production of communications and radar equipment was the highest among all product categories. Electronic components was the fastest growing category in North America, while in Western Europe production of medical and industrial equipment was expanding more rapidly than that of other electronic goods.

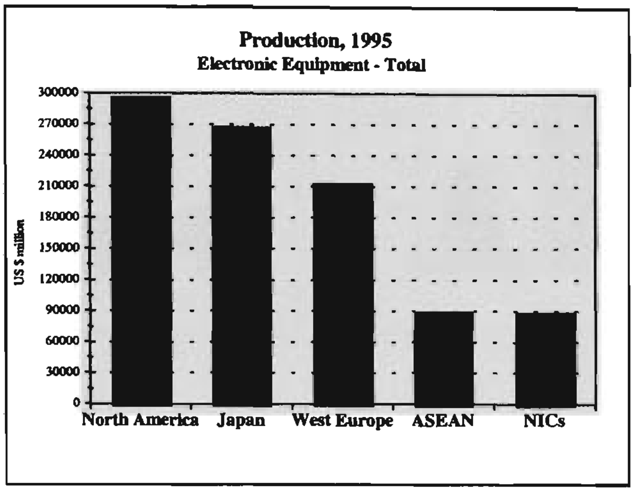
In the next section we will consider the implications of the observed marked differences between the major regions (and Japan) in terms of the regional distribution of global production of different types of electronic goods.

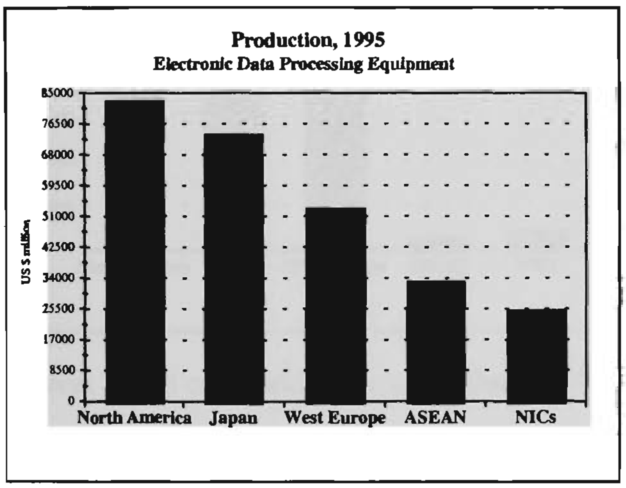
8.2.2 Regional Distribution of Global Computing and Electronics Production

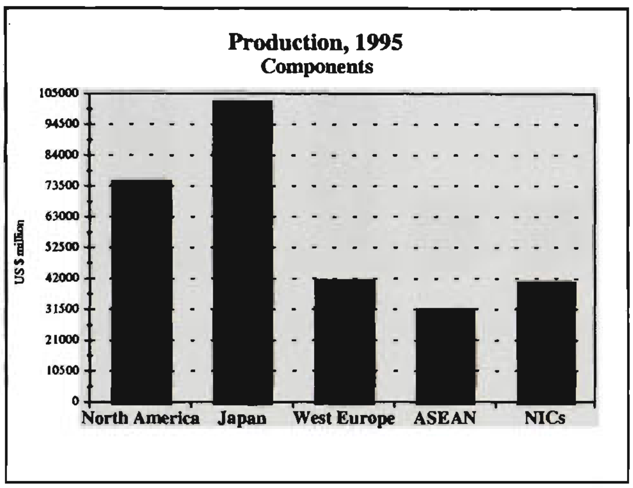
Chart 8.1 shows the values of production of particular types of electronic goods for the major regions and Japan, for 1995. The shares of these regions (and Japan) in the total production of electronic products by the fifty countries that here represent global production and markets, are presented on Chart 8.2 and in Table 8.3. This table also contains more detailed information about the shares of particular countries. Several facts can be derived on the basis of this information.

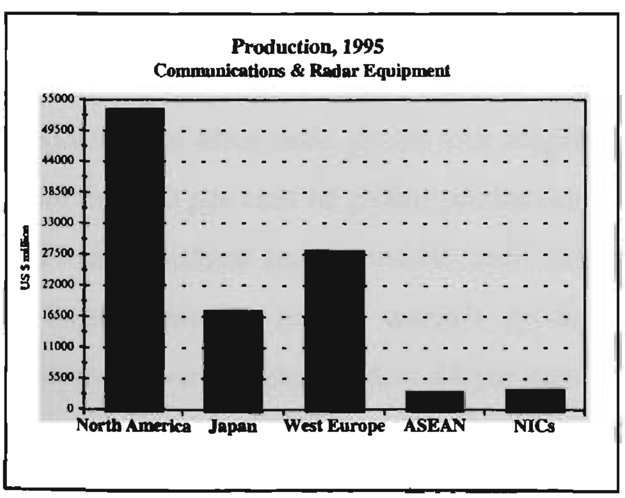
First, in 1995 Western Europe, North America and Japan were the major producers of electronic goods: their combined share constituted about 75 per cent of global electronic production. Western Europe, North America, and Japan contributed 93 per cent of global production of electronic control and instrumentation equipment, and more than 80 per cent of communications and radar, medical and industrial, telecommunications, and office equipment produced in the world. These countries produced more than 70 per cent of

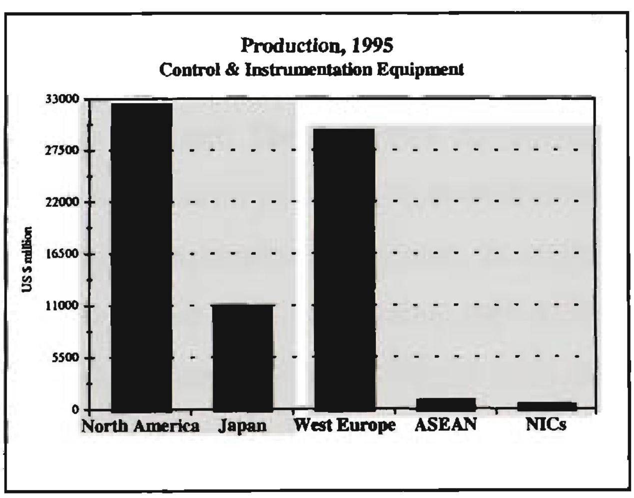
Chart 8.1











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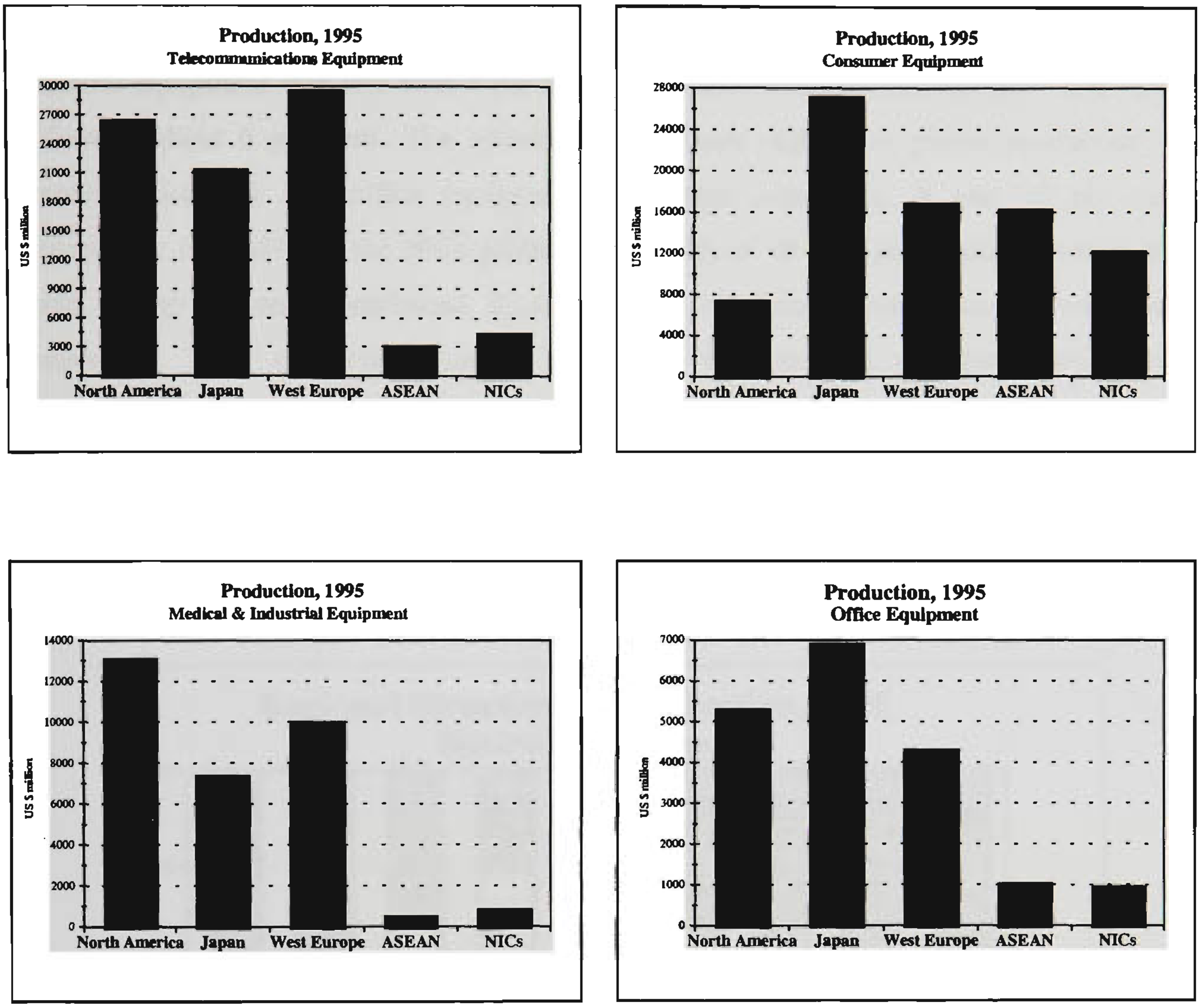


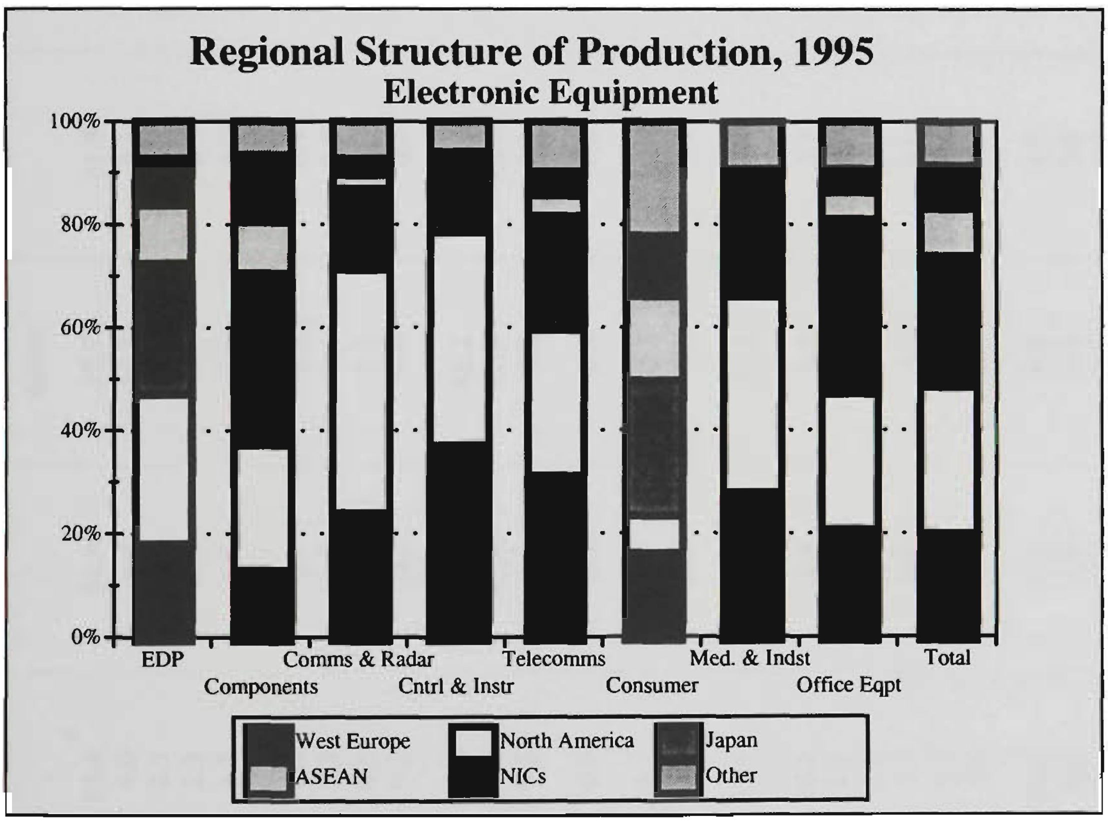
Source: Based on World Electronics Data 1997.

global production of data processing equipment and electronic components. Consumer electronics was the only type of electronic products, for which the combined share of these countries was close to 50 per cent of global production.

Second, the combined share of Western Europe and North America in the overall global production of electronic goods was slightly below 50 per cent. These regions contributed more than 50 per cent of global production of control and instrumentation, communications and radar, medical and industrial, and telecommunications equipment. However, the shares of these countries in the world's production of electronic data processing and office equipment were slightly below 48 per cent, of electronic components about 38 per cent, and of consumer electronics only 24 per cent.

Third, ASEAN and the NICs accounted for a relatively small portion of the overall global production of electronic products, less than one fifth of the world's production. These regions produced only 2 per cent of global production of electronic control and instrumentation equipment. Their combined share of global production of medical and industrial equipment was less than 4 per cent and of electronic communications and radar equipment about 6 per cent. The contribution of these regions to global production of telecommunications and office equipment was more substantial, 8 and 10 per cent respectively. ASEAN and the NICs produced one fifth of all data processing goods in the world. These regions contributed 23.4 per cent of global production of electronic components. Their combined share in production of electronic consumer goods was remarkably high: almost 28 per cent of global production. For comparison, the combined share of Western Europe and North America for the same year accounted to 23.7 per cent of global production of consumer electronics.

Chart 8.2



Source: Based on World Electronics Data 1997.

Let us consider the relative performance of particular countries in the production of different types of electronic products (Table 8.3). Germany was the major producer of electronic equipment among the European countries, and in 1995 its share of global electronic production amounted to 5 per cent. The share of Germany of the world's production of electronic control and instrumentation equipment was almost three times, and of medical and industrial electronic equipment twice, than this figure, at 14.7 per cent and

Table 8.3 Electronic Production, Shares of 50 Countries' Total (%), Selected Regions and Countries, 1995

	Electronic Data Processing	*Components*	*Communications & Radar*	*Control & Instrumentation*	*Telecommunications*	*Consumer*	*Medical & Industrial*	*Office Equipment*	*All Electronic Goods*
West Europe	**18.5**	**13.4**	**24.9**	**37.7**	**31.5**	**16.5**	**28.7**	**21.3**	**20.5**
Germany	2.8	4.0	4.0	14.7	8.1	3.3	9.6	6.1	5.0
United Kingdom	4.2	2.3	5.6	5.3	2.4	2.5	3.7	3.2	3.5
France	2.7	2.3	6.8	3.7	6.3	2.1	3.0	3.2	3.4
Italy	2.4	1.2	1.8	3.6	3.7	0.9	2.4	2.0	2.0
Netherlands	1.5	0.7	0.7	2.2	1.1	0.3	3.5	4.6	1.2
Ireland	2.2	0.4	0.4	0.3	0.4	0.0	0.4	0.2	0.9
Sweden	0.1	0.3	2.4	1.4	2.0	0.0	0.6	0.1	0.7
Spain	0.6	0.3	0.3	0.3	2.3	1.0	0.5	0.4	0.6
Denmark	0.1	0.2	0.2	0.6	0.2	0.2	0.9	0.1	0.2
North America	**28.9**	**24.4**	**47.1**	**41.2**	**28.2**	**7.2**	**37.6**	**26.2**	**28.5**
USA	27.1	24.2	45.9	40.0	26.0	6.9	36.0	25.6	27.4
Canada	1.7	0.2	1.2	1.2	2.3	0.4	1.5	0.6	1.0
Mexico	1.0	0.9	0.9	0.4	0.8	4.2	1.6	1.4	1.2
Australia	0.4	0.1	0.5	0.4	0.8	0.2	0.3	0.1	0.3
New Zealand	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0
Japan	25.6	33.1	15.5	14.0	22.8	26.6	21.2	34.1	25.7
ASEAN	**11.5**	**10.2**	**2.8**	**1.3**	**3.3**	**15.9**	**1.4**	**5.1**	**8.6**
Singapore	7.4	4.1	1.0	0.7	0.6	3.2	0.3	1.7	3.8
Malaysia	1.8	3.6	0.8	0.3	1.7	8.2	0.4	0.8	2.7
Thailand	1.9	1.1	0.4	0.2	0.6	1.9	0.2	2.1	1.2
Indonesia	0.2	0.3	0.3	0.1	0.3	2.1	0.4	0.4	0.5
Philippines	0.2	1.0	0.3	0.1	0.2	0.4	0.1	0.1	0.5
NICs	**8.7**	**13.2**	**3.2**	**0.7**	**4.7**	**11.9**	**2.4**	**4.7**	**8.5**
South Korea	2.4	9.3	1.9	0.4	2.5	8.0	1.1	1.7	4.8
Taiwan	5.6	3.0	0.7	0.2	1.8	1.2	0.7	0.7	2.8
Hong Kong	0.8	0.9	0.5	0.1	0.4	2.8	0.6	2.3	0.9
China	1.7	2.5	1.7	0.6	2.1	9.9	1.7	4.1	2.7
India	0.3	0.3	0.6	0.3	0.8	1.4	0.3	0.3	0.5

Source: Estimates based on World Electronics Data 1997.

9.6 per cent respectively. The shares of the United Kingdom, the second largest European producer of electronic equipment, of global production of electronic communications and radar, control and instrumentation and data processing equipment were particularly high. The contribution of France was especially large in production of communications and radar and telecommunications equipment. Italy and Spain had relatively strong positions in the production of telecommunications equipment, and the Netherlands was strong in office and medical and industrial equipment. Ireland was the only European country the share of which of global production of data processing equipment was significantly higher than its shares for other types of electronic goods.

The shares of the USA, the largest producer of electronic equipment among all countries, were particularly high in the production of communications and radar, control and instrumentation, and medical and industrial electronic equipment. Canada's shares in global production of electronic data processing and medical and industrial equipment were higher than its shares for other categories of electronic products.

The areas where the shares of Japan, the second largest producer of electronic equipment in the world, were particularly high differed significantly from those of other developed countries. Japan had particularly high shares in global production of office equipment and electronic components, 34.1 per cent and 33.1 per cent respectively. In consumer electronics and data processing equipment the shares of Japan were also relatively high.

Among ASEAN economies, Singapore's shares of global production of electronic data processing equipment, components and consumer electronics were greater than its shares of the world's production of other types of electronic goods. The contribution of other ASEAN economies to global production of consumer electronics was also larger relatively to their contribution to the production of other categories of electronic products.

The differences between the NICs were quite marked. The shares of South Korea of global electronic production were particularly high for electronic components and consumer electronics. Taiwan's shares of the world's production of electronic data processing equipment and, to a lesser extent, of electronic components were quite substantial. The contribution of Hong Kong to global production of consumer electronics and of electronic office equipment was noticeably greater than to production of other types electronic equipment.

China made a particularly strong contribution to global production of consumer electronics, accounting for almost 10 per cent of world production in this area. For electronic office equipment China's share of global production was also relatively high, being more than 4 per cent of global output.

Conclusions

By 1995 the pattern of distribution of global electronic production for electronic products was clearly defined:

- Western Europe, North America, and Japan were the major contributors to the global production of electronic goods, with their combined share being about 75 per cent;
- Western Europe and North America provided about a half of global electronic production;
- ASEAN and NICs contributed less than one fifth of the world's electronic production;
- the contribution of developed countries to global production of control and instrumentation, medical and industrial, communications and radar and telecommunications equipment was particularly large;
- for consumer electronics, components and, to a lesser degree, for electronic data processing equipment the shares of ASEAN, the NICs and China in global production reached levels comparable with those of developed countries.

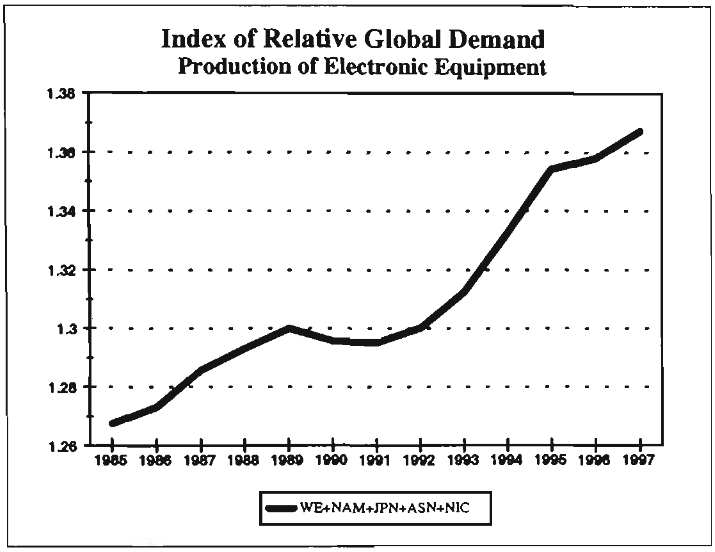
8.2.3 Structure of Production of Electronic Equipment, Selected Regions and Countries

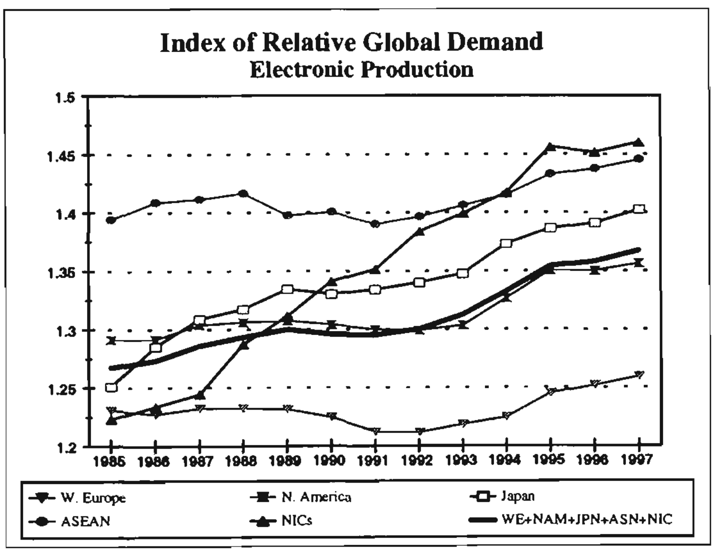
In the previous section we have analysed the distribution of global production of different types of electronic goods. In this section the structural significance of particular electronic products in the composition of electronic production of the major regions and selected countries will be considered.

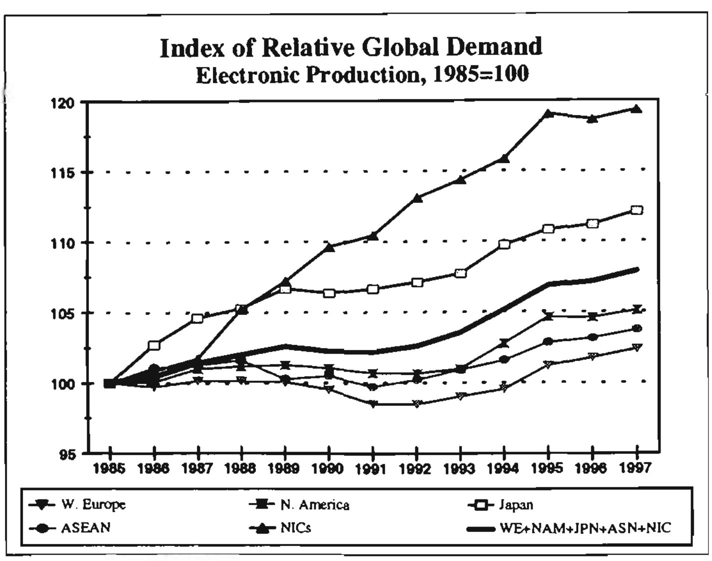
The Index of Relative Global Demand

The upper panel of Chart 8.3 shows the values of the Index of Relative Global Demand (for the description see section 8.1.2) for the production of electronic goods of Western Europe, North America, Japan, ASEAN and NICs taken together. Because these regions (and the country) dominate world electronics production, changes in the composition of their combined production of electronic goods can be accepted as an indicator of global structural changes.

Chart 8.3







Source: Based on World Electronics Data 1997.

During the 1985-1997 period products characterised by high demand gained increased significance in the composition of global electronic production, which is indicated by the changes in the values of the Index of Relative Global Demand from 1.27 to 1.37. It is worth noting that actual data for production and markets for electronic products are available for 1985-1995. Forecasts are presented in the Yearbook of World Electronics Data at 1995 constant values and exchange rates for production for 1996-1997 and for markets – for 1996-2000 (1997, vol. 1, p. 5). Thus, the values of the Index for 1985-1995 are based on actual data and for 1996 and 1997 are based on these forecasts.

There are marked differences between different regions (and Japan) in terms of their contribution to structural change in global electronic production (the second panel of Chart 8.3). The trend representing the values of the Index for North America virtually replicates the trend for Western Europe, North America, Japan, ASEAN and NICs taken together. This fact indicates that electronic production of North America had a dominant structural effect on the world's production of electronic goods. However, the global trend is steeper than the trend for North America. This difference between the slopes of the two trends can be explained by a more pronounced structural change in electronic production in other countries, particularly in the NICs and in Japan (see the third panel of Chart 8.3). The speed of structural change in electronic production of NICs was remarkable. Over the period the value of the Index rose by 20 per cent. Structural change in Japan's electronic production was quite marked as well. During the period the value of the Index increased by 12 per cent. As follows from the third panel of Chart 8.3, the speed of the changes in the composition of electronic production in Western Europe and in ASEAN was modest relatively to that in other regions (and Japan). However, with respect to the composition of production of electronic equipment the difference between Western Europe and ASEAN was striking (see the second panel of the chart). At the beginning of the period the values of the Index for ASEAN were significantly higher than the values for all other regions (and Japan). By the end of the period the value of the Index remained higher than for all other regions (and Japan), except for the NICs. In Western Europe electronic products of high global demand were not structurally significant, relative to the role of these products in the structure of electronic production of other regions (and Japan).

To summarise, by the end of the period electronic products characterised by high global demand were of higher structural significance in the electronic production of East Asian countries than in that of Western Europe and North America. In the NICs the speed of structural change was the highest among all regions. In Japan the changes in the composition of electronic production were also quite marked. Although in ASEAN structural change was relatively modest, products of high global demand played an important role in the composition of electronic production of this region throughout the period.

The relative positions of selected countries according to the value of the Index of Relative Global Demand of electronic production, for the 1985-1995 period, are presented in Table 8.4. Lower values of the ranks correspond to higher values of the Index. The order of the countries in the list is determined according to the value of the Index for 1995.

Table 8.4 Index of Relative Global Demand, Production of Electronic Goods, Selected Countries, 1985-1995

	Rank 1985	Rank 1990	Rank 1995	*Change in the relative rank 85-95*	*Change in the value of the index 85-95*
Ireland	1	1	1	*0*	*4.3*
Taiwan	8	3	2	*6*	*21.6*
Singapore	4	2	3	*1*	*10.9*
Philippines	2	4	4	*-2*	*1.1*
South Korea	13	7	5	*8*	*17.3*
Thailand	5	5	6	*-1*	*2.9*
Japan	11	6	7	*4*	*10.8*
USA	6	9	8	*-2*	*4.5*
United Kingdom	9	10	9	*0*	*4.9*
Malaysia	3	8	10	*-7*	*-9.8*
Canada	16	17	11	*5*	*9.2*
Italy	10	13	12	*-2*	*0.8*
France	7	11	13	*-6*	*-0.9*
Australia	17	15	14	*3*	*8.5*
Hong Kong	18	12	15	*3*	*10.3*
Netherlands	15	14	16	*-1*	*3.9*
Germany	14	16	17	*-3*	*-1.6*
Denmark	21	18	18	*3*	*7.8*
Sweden	19	19	19	*0*	*3.5*
India	22	20	20	*2*	*9.6*
Spain	12	21	21	*-9*	*-7.5*
Indonesia	20	22	22	*-2*	*2.4*
Total*					*6.8*

Note: includes Western Europe, North America, Japan, ASEAN and the NICs.

Source: Based on World Electronics Data 1997.

It is quite noticeable that most Asian countries are concentrated at the top of the list, signifying the fact that electronic goods of high global demand played an important role in the structure of electronic production of these countries. However, it is worth noting that during the whole period the first position was occupied by Ireland.

The relative position of Taiwan changed by six places: in 1985 Taiwan occupied the eighth place, in 1990 it was third and by 1995 had become the second among the twenty two countries. The relative positions of South Korea and Japan changed in a similar way. The relative rank of South Korea increased by eight places. For Japan an increase in the value of the Index corresponded to an upward movement in rank by four places. The position of Singapore changed by just one place, which is explained by a high initial value of the Index.

In the cases of the Philippines and Thailand a modest increase in the value of the Index, at a rate well below the world average, corresponded to a downward change in the relative position, although in 1995 these two countries still occupied high positions in the list. Products of high global demand became more significant for the composition of electronic production of Hong Kong. As a result of this Hong Kong moved three places up, although in 1995 its rank was relatively low – the fifteenth. Indonesia's relative position changed from the twentieth place to the last one, although the composition of electronic production in this country changed towards the high demand end, from a very low base. Malaysia presents a case of structural change in electronic production dramatically different to those of other Asian countries. During 1985-1995 the relative rank of Malaysia changed by 7 places down in the list, from the third to the tenth position, reflecting a decrease in the value of the Index of Relative Global Demand by almost 10 per cent.

Over the period 1985-1995 in most developed countries products of high global demand gained significance in electronic production, but in most cases at a lower speed than in the world as a whole. The values the Index of Relative Global Demand rose for nine of the twelve non-Asian countries presented in Table 8.4. None of the developed countries, except Ireland, occupied high positions according to the value of the Index. In 1995 the USA was ranked the highest among the developed countries, the eighth in the list.

To summarise, over the 1985-1995 period in most East Asian countries products characterised by high global demand gained increased significance. By the end of the period these products played an important role in the composition of electronic production of most East Asian economies. In Malaysia, however, the direction of structural change of production of electronic goods was the opposite to that of most other East Asian countries. In the structure of electronic production in developed non-Asian countries, except Ireland, the role of the products of high global demand was relatively modest.

The finding that for most Asian countries the computing and electronic industries were not only of immense significance in the structure of the manufacturing sector but that these countries also captured the high demand component of electronic production is of interest and value in its own right. It also provides, in our view, a reason for further investigation of narrowly defined areas of specialisation of different countries, and especially of the East Asian economies. As follows from the information presented in Table 8.1, specialisation in production of different types of electronic goods can result in high demand intensity of the overall electronic production, measured by the value of the Index of the Relative Global Demand. For example, the overall average ranks, used as weights in this Index, have the same values for electronic data processing equipment and components, for telecommunications equipment and for consumer goods. Thus, further, more detailed, analysis is required in order to get a better understanding of particular areas of specialisation in electronic production of different countries.

The Index of Specialisation

The Index of Specialisation will be used for the evaluation of the degree of specialisation of different regions and countries in production of electronic goods of different categories (for a description of the Index see section 6.3.1 and for a description of the classification of electronic product – section 8.1.1). In this case, the Index of Specialisation, for a given type of electronic equipment in a given country, is the ratio of the share of that type of electronic equipment in the country's total electronic production to the share of that type of electronic equipment in total world electronic production. Thus, the Index of Specialisation measures the degree of specialisation of a country in producing a particular type of electronic goods relative to the world average level. The values of the Index of Specialisation in the production of particular types of electronic goods in selected regions and countries, relative to Western Europe, North America, Japan, ASEAN and the NICs taken as a whole, for 1985 and 1995 are presented in Table 8.5. For reference, the shares of particular types of electronic goods in overall electronic production for 1985 and 1995 for the same regions and countries are shown in Table 8.6. Changes over time in the distribution of production across product categories for the major regions and Japan are shown on Chart 8.4 and for selected countries on Chart 8.A1 in the Appendix. In the 1985-1995 period global electronic production was characterised by marked differences across regions in terms of the areas of their specialisation.

Western Europe

For Western Europe the value of the Index of Specialisation in 1995 (Table 8.5) was highest for control and instrumentation. The share of these products in overall electronic production in Western Europe was 1.8 times greater than that in the world as a whole. The structural significance of these products was quite high in 1985, and rose significantly over time. Other areas of specialisation in Western Europe were telecommunications, medical and industrial equipment, and communications and radar. In 1995 the value of the Index of Specialisation for electronic components was the lowest among all types of electronic production.

Most European countries were specialised in the production of industrial and medical, communications, telecommunications, and control and instrumentation equipment. Thus, for example, in Germany the major areas of specialisation were control and instrumentation, medical and industrial, and telecommunications equipment, while in the United Kingdom they were communications and radar and control and instrumentation equipment. It is worth noting that Ireland differed dramatically from other European countries in terms of its pattern of specialisation in electronic production. In Ireland production was highly concentrated just in one area – electronic data processing equipment.

North America and Mexico

The particular areas of specialisation of North America were also quite distinct. Communications and radar equipment was the most significant type of electronic goods. Other two areas of high and increasing structural significance were control and instrumentation, and medical and industrial equipment. The structural importance of telecommunications was increasing over the 1985-1995 period, however, and in 1995 the share of telecommunications in North American electronic production was at the world average level. Data processing equipment was losing its share in total electronic production. Production of electronic components gained some structural significance but only marginally, with the share still remaining below the global average in 1995. The structural significance of consumer goods declined marginally. Over the whole period the share of

Table 8.5 **Index of Specialisation in Production of Electronic Equipment, Selected Regions and Countries (relative to West Europe, North America, Japan, ASEAN and NICs), 1985-1995**

	Electronic Data Processing		*Components*		*Communications & Radar*		*Control & Instrumentation*		*Tele-communications*		*Consumer*		*Medical & Industrial*		*Office Equipment*	
	1985	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*
West Europe	**1.09**	**0.89**	**0.76**	**0.64**	**0.78**	**1.20**	**1.42**	**1.78**	**1.52**	**1.56**	**0.77**	**0.94**	**1.22**	**1.41**	**0.67**	**1.04**
Germany	1.00	0.55	0.89	0.78	0.34	0.78	1.82	2.84	1.41	1.64	0.92	0.77	1.36	1.93	0.93	1.21
United Kingdom	1.11	1.17	0.77	0.64	1.18	1.56	1.47	1.47	1.20	0.70	0.53	0.85	1.04	1.07	0.47	0.91
France	1.00	0.79	0.84	0.66	1.44	1.97	0.94	1.06	1.67	1.87	0.46	0.73	0.72	0.89	0.35	0.93
Italy	1.42	1.15	0.60	0.56	0.75	0.89	1.09	1.73	1.72	1.89	0.53	0.53	1.20	1.20	0.66	1.01
Netherlands	1.20	1.24	0.71	0.57	0.62	0.55	1.48	1.75	0.94	0.93	0.30	0.33	2.64	2.92	2.43	3.87
Ireland	2.70	2.58	0.62	0.45	0.15	0.41	0.77	0.39	0.66	0.47	0.08	0.05	0.38	0.41	0.31	0.22
Sweden	0.79	0.14	0.53	0.46	0.78	3.45	1.13	1.94	3.60	2.89	0.31	0.00	1.34	0.83	0.23	0.16
Spain	1.44	0.90	0.52	0.47	0.55	0.41	0.26	0.51	2.27	3.69	1.48	1.82	0.75	0.82	0.03	0.61
Denmark	0.40	0.31	0.73	0.99	0.91	0.74	2.72	2.63	0.82	1.04	0.77	1.05	4.46	4.14	0.54	0.24
North America	**1.09**	**1.00**	**0.81**	**0.83**	**1.52**	**1.62**	**1.19**	**1.40**	**0.96**	**1.00**	**0.31**	**0.30**	**1.08**	**1.33**	**1.04**	**0.92**
USA	1.09	0.97	0.82	0.86	1.54	1.64	1.20	1.41	0.91	0.96	0.30	0.29	1.08	1.32	1.06	0.94
Canada	0.98	1.61	0.54	0.17	1.04	1.09	1.04	1.12	2.47	2.19	0.63	0.42	1.20	1.49	0.52	0.53
Mexico	na	0.79	na	0.70	na	0.70	na	0.32	na	0.67	na	4.04	na	1.30	na	1.17
Australia	0.87	1.16	0.34	0.33	1.41	1.53	1.12	1.25	2.61	2.44	0.74	0.57	0.98	1.01	0.24	0.40
New Zealand	na	0.62	na	0.33	na	1.52	na	3.46	na	2.28	na	0.11	na	2.21	na	0.00
Japan	0.85	0.98	1.41	1.25	0.33	0.59	0.43	0.53	0.65	0.90	2.21	1.22	0.81	0.83	1.33	1.33
ASEAN	**0.68**	**1.31**	**2.25**	**1.16**	**0.22**	**0.32**	**0.24**	**0.14**	**0.44**	**0.39**	**1.74**	**2.16**	**0.21**	**0.17**	**0.59**	**0.59**
Singapore	1.21	1.89	1.78	1.05	0.08	0.26	0.25	0.17	0.30	0.16	1.75	0.99	0.14	0.09	0.99	0.44
Malaysia	0.09	0.68	3.09	1.32	0.38	0.29	0.14	0.09	0.51	0.63	1.29	3.59	0.19	0.17	0.02	0.31
Thailand	0.36	1.55	2.38	0.92	0.38	0.29	0.26	0.14	0.13	0.49	2.45	1.88	0.31	0.17	0.04	1.76
Indonesia	0.21	0.48	1.22	0.72	0.45	0.69	0.50	0.24	1.13	0.66	3.70	5.34	0.49	0.79	0.71	0.88
Philippines	0.05	0.38	3.39	2.21	0.25	0.69	0.18	0.13	0.67	0.36	0.60	1.09	0.29	0.18	0.26	0.14
NICs	**0.58**	**1.01**	**1.52**	**1.51**	**0.28**	**0.36**	**0.13**	**0.08**	**0.96**	**0.56**	**3.01**	**1.65**	**0.34**	**0.28**	**0.67**	**0.56**
South Korea	0.37	0.49	1.77	1.91	0.14	0.40	0.17	0.09	1.14	0.54	3.08	1.97	0.22	0.24	0.33	0.37
Taiwan	0.70	1.95	1.68	1.02	0.24	0.25	0.06	0.05	0.85	0.63	2.54	0.50	0.39	0.25	0.80	0.23
Hong Kong	0.74	0.81	0.83	0.98	0.59	0.55	0.17	0.13	0.83	0.47	3.63	3.50	0.50	0.61	1.06	2.51
China	na	0.61	na	0.88	na	0.60	na	0.22	na	0.76	na	4.29	na	0.63	na	1.52
India	0.26	0.52	0.74	0.63	0.84	1.28	0.84	0.68	1.18	1.73	3.75	3.37	0.65	0.59	0.47	0.62

Source: Estimates based on World Electronics Data 1996, 1997.

consumer goods in overall electronic production accounted to about one third of the corresponding share for the world as a whole.

The pattern of specialisation in electronic production in the USA was quite different to that in Canada. The USA was mostly specialised in the production of communications and radar, control and instrumentation, and medical and industrial equipment. The major areas of Canada's specialisation were telecommunications, electronic data processing, and medical and industrial equipment.

Mexico was mostly specialised in production of consumer electronics. The sectoral shares of medical and industrial equipment and of electronic office equipment in the composition of Mexico's electronic production were also higher than the world average.

Japan

The pattern of specialisation in the production of electronic goods in Japan differed significantly from that of most other developed countries. Japan was mostly specialised in production of electronic office equipment, components and consumer electronics. The degree of specialisation of Japan in office equipment, relative to the global average, was very stable. For 1985 and for 1995 the shares of office equipment in the overall electronic production of Japan were 1.33 times higher than the shares of these products for the world. The role of consumer goods in the structure of Japan's electronic production declined substantially: in 1985 the share of these electronic goods was 2.2 times higher than the world average share, in 1995 the value of the Index was equal to 1.22. Components also lost their relative structural significance: the value of the Index declined from 1.41 to 1.25. Although the shares of all other types of products in the overall electronic production of Japan increased over time, in 1995 they were still below the global benchmark levels.

ASEAN

The areas of specialisation of electronic production of ASEAN were well defined: consumer electronics, data processing equipment, and to a lesser degree electronic components. In 1985 the share of consumer goods was relatively high, 1.74 times greater than the share of these products in the world's electronic production. By 1995 specialisation of ASEAN in production of consumer goods became the highest among all regions presented in Table 8.5. Electronic data processing equipment was another area of specialisation of ASEAN. During 1985-1995 the value of the Index of Specialisation for these electronic goods increased from 0.68 to 1.31. At the same time electronic components

Table 8.6 **Production - Shares of All Electronic Goods (%), Selected Regions and Countries, 1985-1995**

	Electronic Data Processing		*Components*		*Communications & Radar*		*Control & Instrumentation*		*Tele-communications*		*Consumer*		*Medical & Industrial*		*Office Equipment*	
	1985	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*	*1985*	*1995*
Total*	**24.4**	**28.0**	**23.0**	**30.5**	**14.7**	**11.1**	**9.8**	**7.8**	**10.5**	**8.9**	**10.6**	**8.4**	**3.3**	**3.3**	**3.7**	**1.9**
West Europe	**26.5**	**24.9**	**17.5**	**19.4**	**11.5**	**13.3**	**13.9**	**13.9**	**15.9**	**13.8**	**8.1**	**7.9**	**4.0**	**4.7**	**2.5**	**2.0**
Germany	24.4	15.4	20.4	23.9	5.0	8.7	17.8	22.2	14.8	14.6	9.7	6.4	4.5	6.4	3.5	2.4
United Kingdom	27.1	32.9	17.9	19.6	17.3	17.3	14.4	11.5	12.5	6.2	5.6	7.1	3.4	3.6	1.7	1.8
France	24.3	22.0	19.3	20.3	21.1	21.8	9.2	8.3	17.5	16.7	4.8	6.1	2.4	3.0	1.3	1.8
Netherlands	29.3	34.6	16.3	17.3	9.1	6.1	14.5	13.7	9.8	8.3	3.1	2.8	8.7	9.7	9.1	7.5
Italy	34.6	32.3	13.8	17.2	11.0	9.8	10.7	13.5	18.0	16.8	5.6	4.4	4.0	4.0	2.5	2.0
Ireland	65.8	72.3	14.2	13.6	2.2	4.6	7.5	3.1	6.9	4.2	0.9	0.4	1.3	1.4	1.2	0.4
Sweden	19.2	3.8	12.1	13.9	11.4	38.3	11.1	15.2	37.7	25.7	3.3	0.0	4.4	2.8	0.9	0.3
Spain	35.2	25.1	12.1	14.4	8.1	4.6	2.5	3.9	23.8	32.8	15.7	15.3	2.5	2.7	0.1	1.2
Denmark	9.7	8.7	16.8	30.2	13.4	8.2	26.7	20.5	8.6	9.3	8.1	8.8	14.7	13.8	2.0	0.5
North America	**26.5**	**28.0**	**18.7**	**25.5**	**22.4**	**18.0**	**11.7**	**10.9**	**10.0**	**8.9**	**3.3**	**2.5**	**3.6**	**4.4**	**3.9**	**1.8**
USA	26.5	27.3	18.9	26.2	22.6	18.2	11.7	11.0	9.5	8.5	3.2	2.5	3.6	4.4	4.0	1.8
Canada	23.8	45.1	12.4	5.1	15.3	12.1	10.2	8.7	25.8	19.5	6.6	3.5	3.9	5.0	2.0	1.0
Mexico	na	22.2	na	21.2	na	7.8	na	2.5	na	5.9	na	33.8	na	4.3	na	2.3
Australia	21.2	32.6	7.9	10.1	20.7	16.9	10.9	9.8	27.3	21.7	7.8	4.8	3.2	3.4	0.9	0.8
New Zealand	na	17.5	na	10.1	na	16.9	na	27.0	na	20.2	na	0.9	na	7.4	na	0.0
Japan	20.6	27.5	32.6	38.3	4.8	6.6	4.2	4.1	6.8	8.0	23.3	10.2	2.7	2.8	5.0	2.6
ASEAN	**16.7**	**36.8**	**51.8**	**35.3**	**3.2**	**3.5**	**2.4**	**1.1**	**4.6**	**3.5**	**18.4**	**18.1**	**0.7**	**0.6**	**2.2**	**1.1**
Singapore	29.6	53.0	41.0	32.0	1.1	2.8	2.5	1.3	3.1	1.4	18.5	8.3	0.5	0.3	3.7	0.8
Malaysia	2.3	19.0	71.2	40.2	5.6	3.2	1.3	0.7	5.3	5.6	13.6	30.1	0.6	0.6	0.1	0.6
Thailand	8.7	43.5	54.8	28.2	5.6	3.2	2.5	1.1	1.4	4.3	25.8	15.7	1.0	0.6	0.1	3.4
Indonesia	5.2	13.4	28.1	22.0	6.7	7.7	4.9	1.9	11.8	5.9	39.1	44.7	1.6	2.6	2.7	1.7
Philippines	1.2	10.7	78.1	67.5	3.6	7.7	1.8	1.0	7.0	3.2	6.4	9.1	1.0	0.6	1.0	0.3
NICs	**14.1**	**28.4**	**35.0**	**46.1**	**4.1**	**4.0**	**1.3**	**0.6**	**10.1**	**5.0**	**31.8**	**13.8**	**1.1**	**0.9**	**2.5**	**1.1**
South Korea	9.0	13.8	40.8	58.3	2.1	4.4	1.7	0.7	12.0	4.8	32.5	16.5	0.7	0.8	1.2	0.7
Taiwan	17.1	54.8	38.7	31.0	3.6	2.7	0.6	0.4	8.9	5.6	26.8	4.2	1.3	0.8	3.0	0.5
Hong Kong	18.1	22.6	19.0	30.0	8.6	6.1	1.6	1.0	8.6	4.2	38.4	29.3	1.6	2.0	4.0	4.9
China	na	17.0	na	26.8	na	6.7	na	1.7	na	6.8	na	35.9	na	2.1	na	3.0
India	6.4	14.4	17.1	19.3	12.4	14.2	8.2	5.3	12.4	15.4	39.6	28.2	2.2	2.0	1.8	1.2

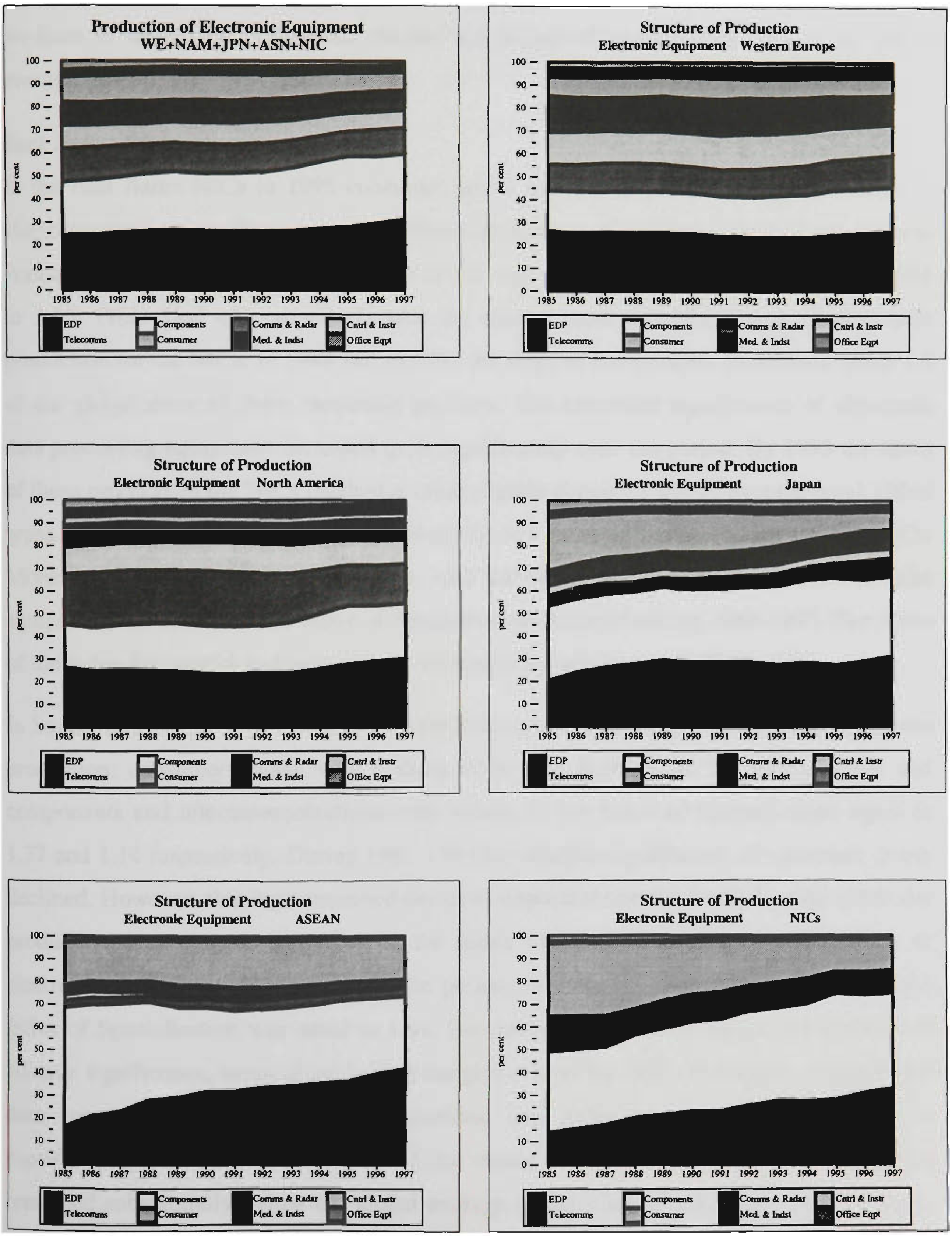
Note: includes West Europe, North America, Japan, ASEAN and the NICs.
Source: Estimates based on World Electronics Data 1997.

lost their relative significance. The value of the Index declined from 2.25, the highest figure among all regions, to 1.16, which was lower than the values of the Index for NICs and Japan. The sectoral shares of all other types of electronic goods were significantly below the global benchmarks. Moreover, the values of the Index for telecommunications, control and instrumentation, and medical and industrial equipment all declined over the period.

The areas of specialisation in electronic production of different countries of the ASEAN region were remarkably diverse. In Singapore there was a major shift in specialisation in electronic production during the 1985-1995 period. Consumer goods and components, in which Singapore had been specialised in the mid-1980s, lost their structural importance, while electronic data processing equipment became substantially more significant. By 1995 this type of electronic products became the major item in the composition of electronic production of Singapore. Malaysia was mostly specialised in production of electronic consumer goods and of components. The relative significance of these two categories of electronic products changed during 1985-1995. In the mid-1980s Malaysia was highly specialised in production of components: the sectoral share of these products was more than three times greater than the global benchmark. By 1995 the value of the Index of Specialisation for the production of components declined to 1.32. Consumer goods, on the contrary, gained substantially in terms of structural significance. Over 1985-1995 the value of the Index increased from 1.29 to 3.59.

In Thailand components lost their share in the composition of electronic production, so that by 1995 the sectoral share of these products became lower than the global average. The relative significance of consumer goods declined as well; however, in 1995 the value of the Index of Specialisation in production of consumer products was still higher than the values of the Index for all other types of electronic goods. During 1985-1995 electronic data processing and office equipment emerged as major areas of specialisation for Thailand. In Indonesia production of electronic consumer goods was the only area of high and of growing significance. The value of the Index of Specialisation in production of these products increased from 3.7 to 5.34, indicating that in 1995 the share of consumer electronics in Indonesian electronic production was more than five times greater than the share of these products in the overall electronic production of the world. However, components, another area where Indonesia had been specialised above the global average level, lost ground. In 1995 the value of the Index for components was equal to 0.72. In the Philippines the relative significance of electronic components declined as well. However, in

Chart 8.4



Source: Based on World Electronics Data 1997.

1995 components remained the most important item in the overall composition of electronic production of the Philippines. Production of consumer goods, on the contrary, was growing rapidly. By 1995 consumer goods became the second category of electronic products in which the Philippines reached the degree of specialisation above the global average level.

East Asian NICs

In the East Asian NICs in 1995 consumer goods was the major area of specialisation in electronic production. However, the relative significance of consumer electronics declined dramatically over 1985-1995. The value of the Index of Specialisation changed from 3.01 to 1.65. Production of components was the second most significant area of electronic production for the NICs. In 1985 and in 1995 the share of components constituted about 1.5 of the global share of these electronic products. The structural significance of electronic data processing equipment increased quite significantly over the period. By 1995 the share of these products in the NICs reached a value slightly above the global average level. Other types of electronic products were of relatively low structural significance for the NICs. Moreover, for all other electronic goods, with the exception of communications and radar equipment, the values of the Index of Specialisation declined during 1985-1995. The value of the Index for control and instrumentation was especially low, at 0.08 for 1995.

In South Korea in the mid-1980s there were three major areas of specialisation in electronic production: consumer goods, with a share three time higher than the global share, and components and telecommunications with values of the Index of Specialisation equal to 1.77 and 1.14 respectively. During 1985-1995 the relative significance of consumer goods declined. However, this item remained the most important one for South Korean electronic production according to the value of the Index of Specialisation (1.97). The share of electronic components increased over the period: in 1995 the corresponding value of the Index of Specialisation was equal to 1.91. But telecommunications equipment declined in relative significance, being about half of the global level by 1995. Production of electronic data processing, office and communications and radar equipment was growing in significance in Korea, although in 1995 the shares of these types of electronic products remained substantially below the global average levels. Control and instrumentation was the least significant item in the composition electronic production of South Korea, as well as in that of other NICs.

In Taiwan changes in the structure of electronic production were even more pronounced than in South Korea. For Taiwan during 1985-1995 the value of the index of Specialisation of electronic consumer goods declined from 2.5 to 0.5. The share of components in the overall electronic production also diminished quite significantly: from 1.7 of the corresponding global share to the average global level. Data processing equipment emerged as the most important item of electronic production of Taiwan. The value of the Index for data processing equipment rose from 0.7 to 1.95 over the period. In 1985 other types of products were not significant in the composition of Taiwan's electronic production. During 1985-1995 the relative significance of other electronic products declined even further, with the only exception being communications and radar equipment, which did not change over the period.

Hong Kong was specialised mostly in the production of electronic consumer goods. In 1995 the share of consumer goods in the composition of electronic production of Hong Kong was 3.5 times higher than the global benchmark. Another important area of specialisation for Hong Kong was office equipment: the value of the Index increased from 1.06 to 2.51 over the 1985-1995 period. The structural significance of components and data processing equipment was growing as well. However, in 1995 the shares of these products in the overall electronic production of Hong Kong remained below the global average levels.

China

Data on China's electronic production for 1985 are not available, so it is impossible to evaluate the dynamics of the structural changes that occurred during the period of 1985-1995. The composition of electronic production of China for the period 1993-1996, for which the data are available, is presented in Chart 8.A1 in the Appendix. Although the share of consumer goods declined since 1993, in 1995 electronic production was still highly concentrated in the area of consumer goods. The share of consumer products in China's overall electronic production was 4.3 times higher than the world average share for these products. The share of electronic office equipment was also relatively high, 1.5 times the global benchmark. Data processing equipment was gaining structural significance in the composition of China's electronic production. However, in 1995 the value of the Index of Specialisation for production of data processing equipment was equal to 0.61, thus indicating that the share of these products in the composition of electronic production in China was significantly lower than the corresponding global benchmark. For all other types of electronic goods the values of the Index were also lower than one. As for ASEAN and NICs, production of electronic control and instrumentation equipment was characterised by the lowest value of the Index of Specialisation across all product groups.

Conclusions

The conclusions that can be drawn from this analysis of patterns of specialisation in global production and trade are many and varied. The main general conclusions are that:

- over the 1985-1995 period products of high global demand became more significant in the composition of the world's electronic production;
- this structural shift towards a higher proportion of products characterised by high global demand was particularly marked in most East Asian countries;
- the role of products of high global demand in the structure of electronic production in developed non-Asian countries, except Ireland, was relatively modest;
- there were marked differences between developing countries and most developed non-Asian countries in terms of particular areas of specialisation in their electronic production;
- in particular most developed non-Asian countries were specialised in production of control and instrumentation, industrial and medical, communications and radar, and telecommunications equipment, while most East Asian countries were specialised in products of high global demand, such as components, consumer products and electronic data processing equipment, and
- nevertheless, there were significant differences between the patterns of specialisation in the East Asian countries.

8.3 The Balance of Trade in Electronic Equipment, Selected Regions and Countries

As has been found in the previous section, during the 1985-1995 period product segmentation was a dominant feature of global electronic production. In this section we will consider the balance of trade in particular categories of electronic goods, in order is to find out whether the segmentation of global electronic production was reflected in the pattern of international trade in electronic products. First, changes in the balance of trade in particular categories of electronic products for major regions and Japan will be analysed. Second, changes in the structure of balance of trade in electronic goods of particular countries will be considered.

As noted earlier, trade statistics are presented in the summary tables of the Yearbook of World Electronics Data; however, there are two reasons for not using export and import data directly. First, including re-exports may cause significant distortions in the actual values of export and import flows, especially for Hong Kong and Singapore, (see Appendix 4.5, Yearbook of World Electronics Data, 1997, vol. 1, pp. 272-273). Second, export and import data are only available for 1993-1994 for China, Mexico and New Zealand and for 1994-1995 for the other countries considered in this study. Thus, the available data on exports and imports of electronic products do not provide sufficient information for the evaluation of changes in the structure of trade over time. For reference, however, export and import data for 1994 for the major regions and the twenty five countries, considered in this study, are presented in the Appendix (Tables 8.A1 and 8.A2).

Thus the trade balance does not include imports and re-exports of finished goods and can be derived as the difference between the values of production and of apparent consumption (see the introduction to Chapter 8). Applying this approach, the balance of trade for different categories of electronic products has been calculated for major regions and countries, for 1985 and 1995. In order to relate the magnitudes of the trade balance to the volumes of trade flows of particular regions and countries, the trade balance as a share of total trade for all categories of electronic products for 1994 is shown in Table 8.7. It is worth noting that the figures presented in this table are based on export and import statistics and, thus, include re-exports of finished goods.

The Trade Balance at the Regional Level

In 1985 Japan, ASEAN and the NICs had a surplus, while North America and Western Europe had a deficit, in trade in electronic products (see the first panel of Chart 8.5). In 1995 the picture remained broadly the same, although the relative magnitudes of the trade balances had changed. In 1985 Japan had a surplus of trade in electronic products of US$36.4 billion. In 1995 this surplus reached US$76.1 billion. In 1985 the trade deficit of North America amounted to about 37 per cent, and by 1995 to almost 72 per cent, of Japan's surplus. Over the period the trade deficit of Western Europe rose from US$10 billion to US$34 billion, or from 26.5 per cent to 44.3 per cent of Japan's surplus. The trade surplus of ASEAN increased almost 20 times, from US$2.2 billion to US$42.4 billion.

Table 8.7 Trade Balance as a Share of Total Trade – Electronic Products, %, Selected Regions and Countries, 1994

	Electronic Data Processing	*Components*	*Communications & Radar*	*Control & Instrumentation*	*Tele-communications*	*Consumer*	*Medical & Industrial*	*Office Equipment*	*All Electronic Goods*
Total (50 countries)	**1.1**	**1.6**	**11.0**	**-0.6**	**8.7**	**6.9**	**6.7**	**-0.3**	**3.0**
West Europe	**-18.1**	**-16.5**	**19.0**	**9.3**	**15.6**	**-18.5**	**12.2**	**-14.9**	**-10.1**
Germany	-30.7	-8.0	25.7	32.7	18.8	-38.1	28.7	-20.6	**-8.9**
United Kingdom	-7.6	-17.2	23.5	12.6	-11.3	-14.7	5.7	-21.0	**-8.2**
France	-22.2	-10.0	32.5	-10.0	38.5	-31.3	-8.9	-18.7	**-10.3**
Netherlands	-7.8	-32.1	-43.2	-14.1	0.0	-52.4	10.5	-19.2	**-21.0**
Italy	-7.5	-8.7	-20.1	-1.6	-6.0	-25.7	22.4	14.2	**-6.3**
Ireland	28.5	-28.7	59.3	5.3	9.8	-71.6	-35.0	-100.0	**13.3**
Sweden	-57.8	-42.3	51.0	-0.1	51.3	-63.0	15.6	-81.8	**-11.8**
Spain	-38.1	-43.2	-36.0	-36.8	11.5	-30.4	-31.2	-46.5	**-32.5**
Denmark	-44.4	-10.6	14.5	42.5	-25.2	-28.1	50.8	-61.4	**-13.9**
North America	**-18.3**	**-19.6**	**13.7**	**20.9**	**-7.1**	**-76.3**	**7.1**	**-71.7**	**-19.3**
USA	-17.6	-17.4	18.7	33.0	-13.4	-75.3	9.4	-70.3	**-17.9**
Canada	-23.2	-35.4	-14.5	-43.7	18.5	-87.3	-24.5	-84.2	**-28.6**
Mexico	-3.2	-22.4	-1.1	-48.6	-8.9	46.1	25.2	18.7	**-1.0**
Australia	-56.2	-76.4	-85.4	-57.3	-12.4	-91.0	-51.6	-93.3	**-61.7**
New Zealand	-96.1	-79.3	-47.9	-49.1	-75.3	-100.0	-90.0	-100.0	**-82.5**
Japan	52.0	59.4	48.1	32.0	67.2	68.3	50.4	85.1	**57.7**
ASEAN	**41.2**	**9.9**	**-4.2**	**-45.5**	**6.4**	**51.3**	**-35.8**	**27.7**	**23.3**
Singapore	40.3	9.6	32.4	-18.8	4.0	18.2	-28.2	10.8	**22.0**
Malaysia	45.7	11.7	-6.8	-71.2	56.4	89.0	-1.7	46.5	**31.2**
Thailand	47.3	-5.8	-71.6	-79.1	-10.0	60.2	-92.3	61.1	**13.8**
Indonesia	23.9	-29.1	-50.7	-96.7	-58.8	95.4	-54.6	11.1	**6.2**
Philippines	-9.8	56.8	20.8	-97.6	-52.2	38.1	-100.0	-100.0	**27.6**
NICs	**41.4**	**9.8**	**10.2**	**-57.0**	**24.2**	**24.0**	**-11.9**	**17.4**	**17.3**
South Korea	21.6	47.6	15.8	-77.3	31.4	89.6	-59.1	43.4	**38.1**
Taiwan	76.1	-9.4	42.2	-64.4	58.0	14.7	2.8	17.1	**26.5**
Hong Kong	4.1	-4.7	5.1	-8.8	-0.6	9.1	3.8	14.8	**2.2**
China	6.4	-15.4	-31.0	-77.4	-38.8	69.1	-20.1	75.1	**0.7**
India	-26.4	-47.4	-91.8	-70.7	-80.0	74.4	-67.6	-42.9	**-40.5**

Source: Estimates based on World Electronics Data 1996, 1997.

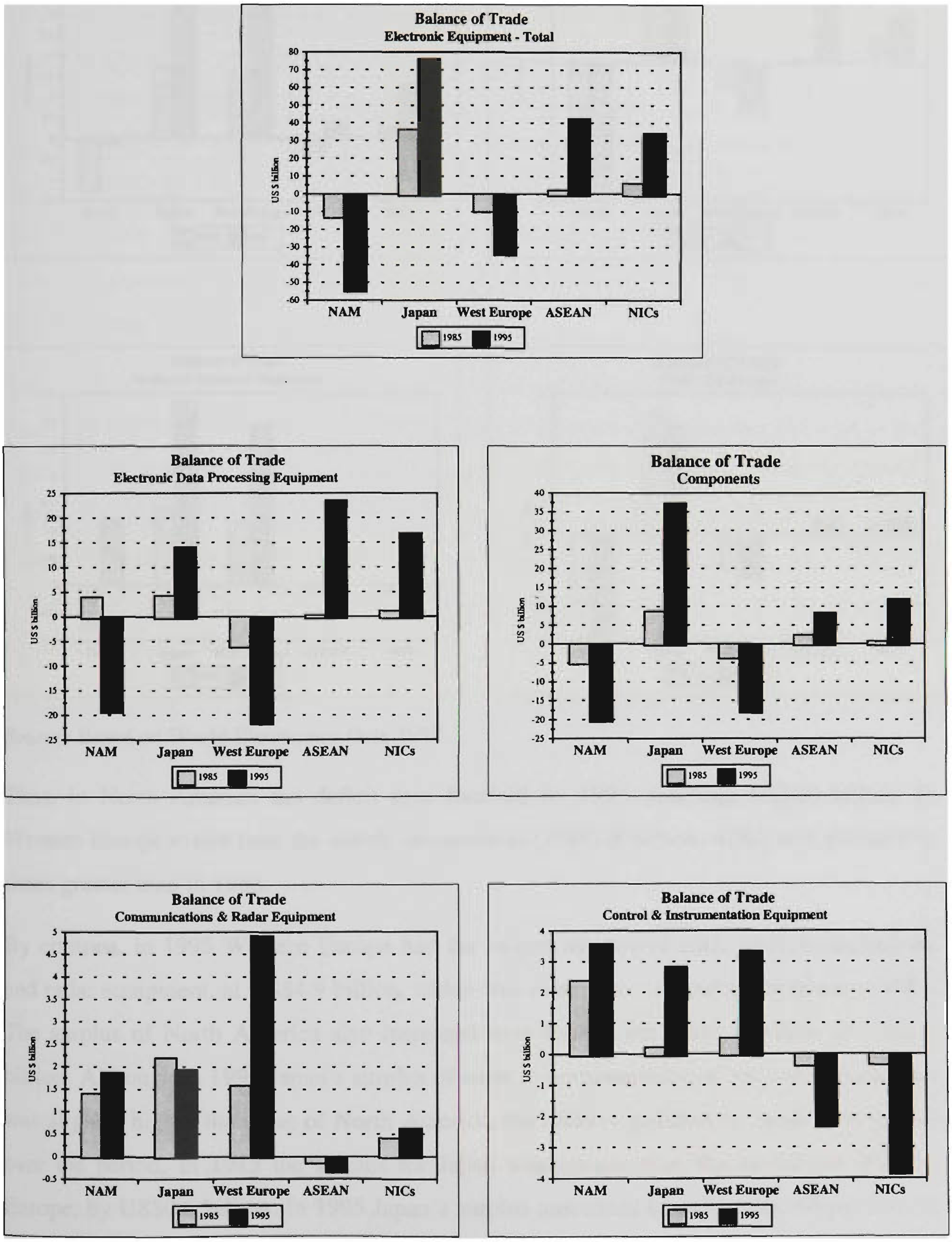
The increase in the trade surplus of the NICs was also substantial: it rose from US$6 billion to US$34.4 billion between 1985 and 1995.

A comparison between the relative values of the balances of trade in particular types of electronic products for the major regions and Japan leads to quite interesting results. The relative values for the balance of trade in components, consumer electronics and office equipment were similar to the pattern described above: in 1985 and 1995 North America and Western Europe had deficits, and Japan, ASEAN and the NICs had surpluses. For trade in control and instrumentation, medical and industrial, communications and radar, and telecommunications equipment the situation was very different. Let us describe the net trade positions in different categories of electronic products for the major regions and Japan in more detail.

In 1985 Japan had the largest surplus of trade in electronic data processing, at US$4.3 billion, while the surplus of North America was just slightly below this level. ASEAN had a relatively small surplus, equal to less than 5 per cent of Japan's surplus of trade in these products. In the mid-1980s the NICs had a much stronger position than ASEAN: the surplus of the NICs was six times greater than that of ASEAN. Western Europe was the only region that had a large deficit of trade in electronic data processing equipment, equal to US$6 billion. By 1995 the situation changed. The deficit of Western Europe had increased more than 3.5 times. The surplus of North America had changed to a large deficit, at almost US$20 billion. Japan's surplus rose threefold and the surplus of the NICs increased 14 times. The change in the relative position of ASEAN was the most spectacular: the surplus rose from US$0.2 billion to US$23.5 2 billion. In 1995 ASEAN had the leading position in trade in electronic data processing equipment, at least as measured by the balance of trade.

Asian countries also had the leading position in trade in components. The surpluses of Japan, ASEAN, and the NICs increased significantly over the 1985-1995 period. Japan maintained its position as the world leader in trade of components. Japan's surplus rose from US$8.6 billion to US$37.3 billion. In ASEAN the surplus increased 3.5 times, reaching US$8.3 billion, and in the NICs the surplus of trade in components rose 15 times, from US$0.8 billion to US$12 billion. This dramatic increase in the surplus of trade in electronic components for the East Asian countries was offset by an increase in the deficit of North America and Western Europe.

Chart 8.5



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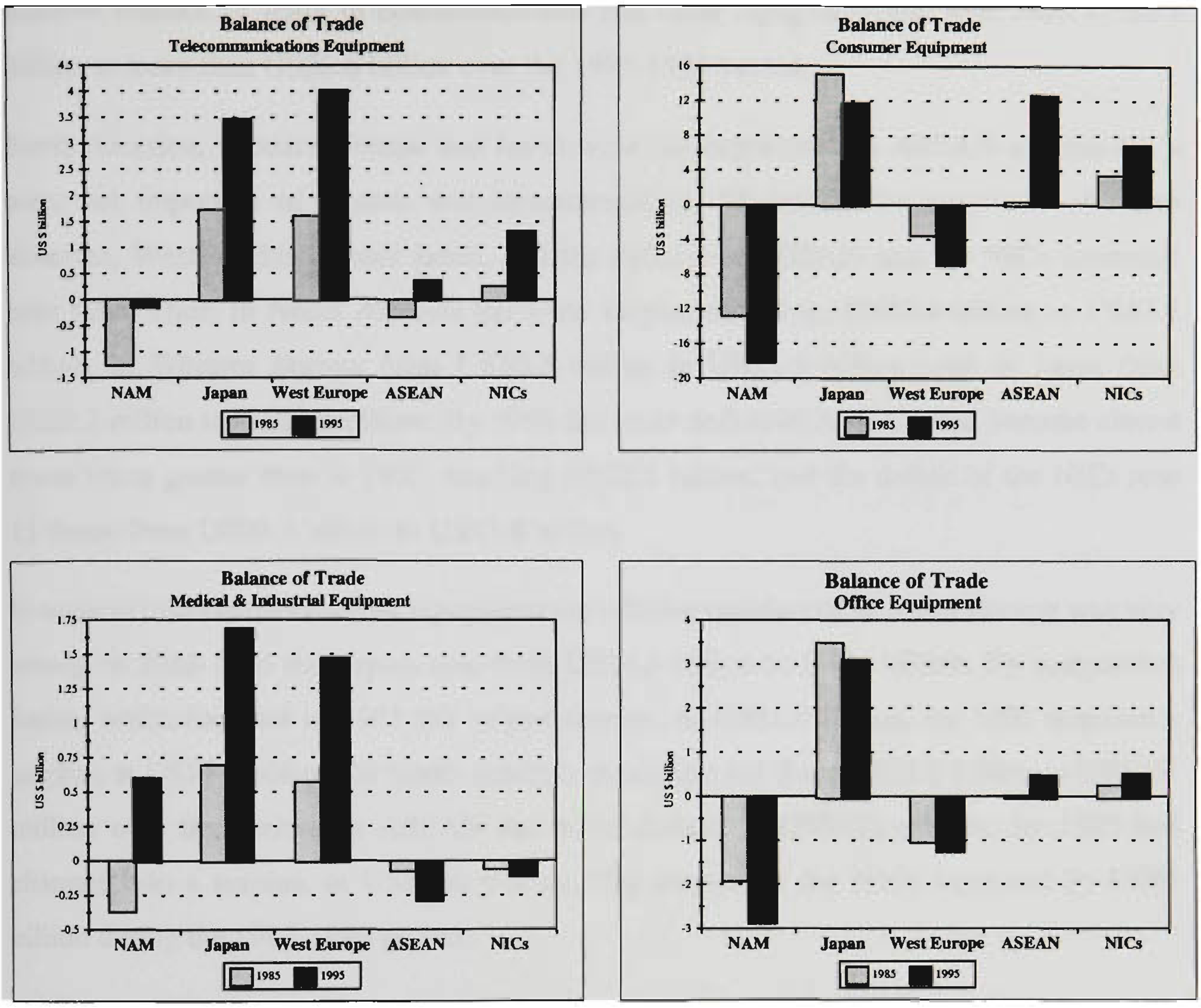


Source: Based on World Electronics Data 1997.

Thus, in North America the deficit rose fourfold by 1995, reaching US$20 billion. In Western Europe at that time the deficit amounted to US$17.8 billion, which was almost five times greater than in 1985.

By contrast, in 1995 Western Europe had the largest surplus of trade in communications and radar equipment, at US$4.9 billion, which was more than a threefold increase on 1985. The surplus of North America also increased over time, from US$1.4 billion to US$1.9 billion. Although in 1995 Japan's surplus of trade in communications and radar equipment was slightly higher than that of North America, the relative position of Japan deteriorated over the period. In 1985 the surplus for Japan was greater than the surplus of Western Europe, by US$0.6 billion. In 1995 Japan's surplus amounted to only about 40 per cent of the surplus of Western Europe. It is worth noting that in trade in communications and radar equipment ASEAN and the NICs performed differently. In 1985 ASEAN had a deficit of US$130 million, by 1995 this deficit increased 2.5 times. The NICs, on the contrary, had a positive balance of trade in communications and radar equipment that rose from US$0.4 billion to more than US$0.6 billion over the 1985-1995 period.

North America, Western Europe and Japan were net exporters and ASEAN and the NICs were net importers of control and instrumentation. Moreover, the surpluses of North America, Western Europe and Japan, and the deficits of ASEAN and the NICs increased over time. Thus, in North America the trade surplus rose from US$2.4 billion to US$3.6 billion, in Western Europe from US$0.5 billion to US$3.3 billion, and in Japan from US$0.2 billion to US$2.8 billion. By 1995 the trade deficit of ASEAN had become almost seven times greater than in 1985, reaching US$2.3 billion, and the deficit of the NICs rose 13 times, from US$0.3 billion to US$3.8 billion.

In trade in telecommunications equipment the relative position of Western Europe was very strong: in 1985-1995 its surplus rose from US$1.6 billion to US$4 billion. By comparison Japan, which had had in 1985 the largest surplus, at US$1.7 billion, by 1995 acquired a surplus, at US$3.5 billion. In North America the deficit fell from US$1.2 billion to US$131 million over the period. In ASEAN the initial deficit, at US$322 million, by 1995 had changed into a surplus, at US$366 million. The surplus of the NICs increased by US$1 billion during the 1985-1995 period.

Consumer electronics was the area where the performance of the East Asian countries was particularly strong. In 1985 Japan had the largest surplus, at more than US$15 billion. At that time the surplus of the NICs was equal to about US$3.5 billion and the positive balance of trade of ASEAN accounted to US$360 million. By 1995 Japan's surplus was reduced to US$11.8 billion, while the surplus of the NICs doubled and ASEAN's surplus increased 35 times, reaching US$12.6 billion. The deficits of trade in consumer electronics in Western Europe and North America increased over the period. In North America the deficit rose by more than 40 per cent, reaching US$18 billion in 1995, while in Western Europe the deficit increased from US$3.3 billion to US$6.8 billion.

Japan was the world leader in trade in medical and industrial equipment, and during 1985-1995 its surplus in this area rose from US$0.7 billion to US$1.7 billion. The surplus of Western Europe increased 2.5 times, reaching US$1.5 billion in 1995. Substantial deficit of North America, equal to US$0.4 billion in 1985, changed into surplus, at US$0.6 billion. Deficits of ASEAN and the NICs increased quite significantly over time: from US$70 million to US$276 million in ASEAN, and from US$52 million to US$103 million in the NICs.

Finally, in trade in office equipment the deficits of North America and Western Europe increased during 1985-1995. The surplus of the NICs rose from US$0.2 billion to US$0.5 billion, and the positive balance of trade of ASEAN rose very sharply from a small base (rising from US$6.6 million to US$482 million), approaching the value of the surplus of the NICs by 1995. Japan maintained its leading position in trade of office equipment in spite of the diminished surplus, which fell slightly from US$3.5 billion to US$3.1 billion.

We can summarise that over the 1985-1995 period areas of specialisation in trade in electronic products of major regions (and Japan) became well defined. North America and Western Europe were net exporters of control and instrumentation, medical and industrial, and communications and radar equipment, and net importers of electronic data processing and office equipment, consumer electronics, and components. North America had particularly strong position in trade in control and instrumentation equipment. Communications and radar, and telecommunications equipment were the areas of trade where Western Europe was especially strong, although in control and instrumentation, and medical and industrial equipment the values of trade surplus of this region were also high relatively to those of other regions. In trade in telecommunications equipment North America and Western Europe performed differently: Western Europe had a surplus and North America – a deficit. Japan was net exporter of all categories of electronic products. Japan had the leading position in trade in electronic components, office, and medical and industrial equipment. ASEAN and the NICs were net exporters of electronic data processing, office and telecommunications equipment, consumer electronics and components, and net importers of control and instrumentation, and medical and industrial equipment. In trade in communications and radar equipment the NICs had a surplus and ASEAN – a deficit. Electronic data processing equipment and consumer electronics were the areas of particularly strong performance in trade of ASEAN and the NICs.

Trade Balance by Product and Country

The Developed Countries

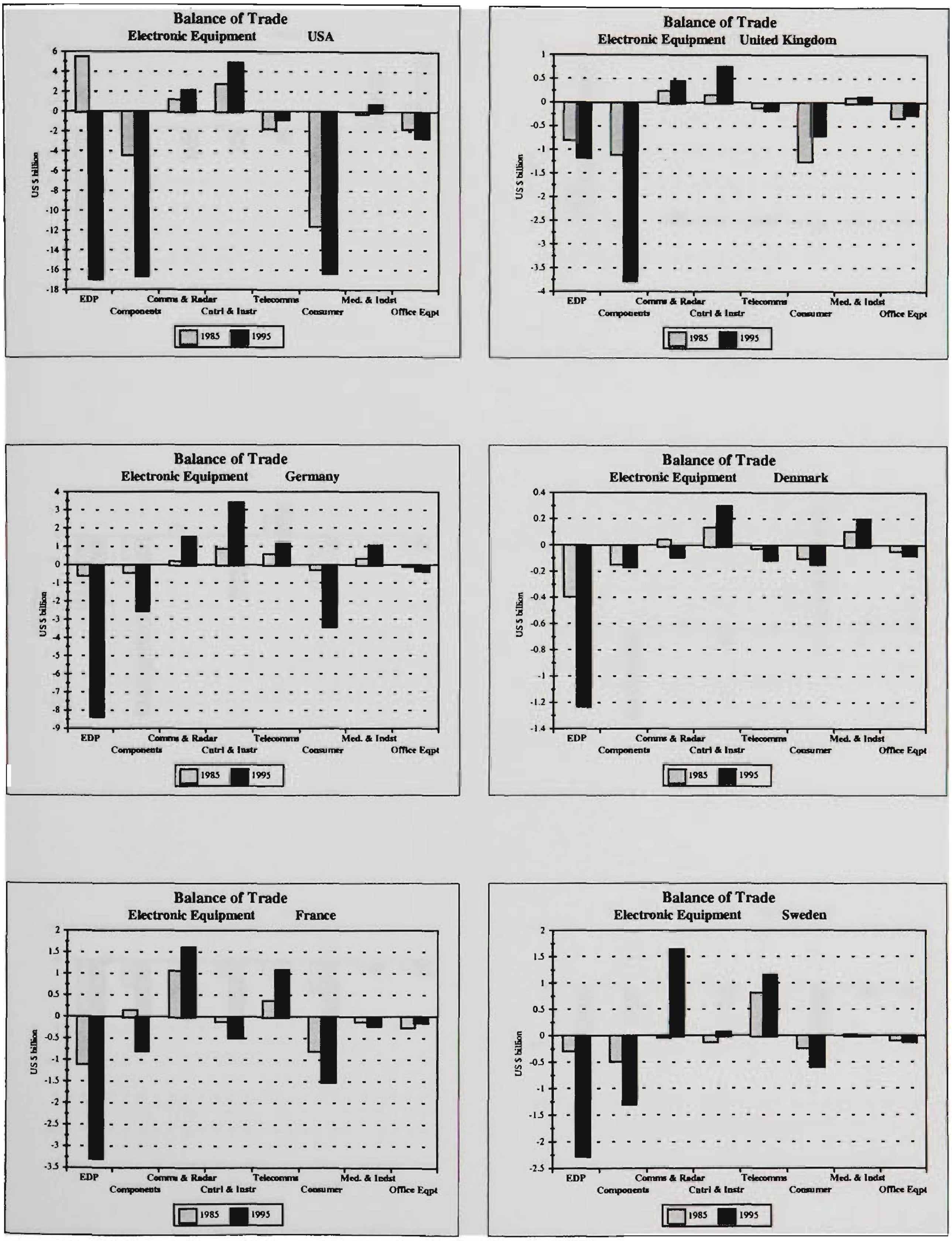
Control and instrumentation equipment was of particular significance for trade in electronic products of the USA, the United Kingdom, Germany and Denmark (Chart 8.6). During 1985-1995 the values of the trade surpluses in these products were growing. By the end of the period the trade surpluses in control and instrumentation equipment became larger than in any other categories of electronic goods in these countries. Communications and radar equipment was the most important in the structure of trade of France and Sweden. These electronic products also played a significant role for trade of the USA, the United Kingdom and Germany.

In 1985 and 1995 Germany had a positive balance of trade in four categories of electronic products: control and instrumentation, communications and radar, medical and industrial, and telecommunications equipment. Moreover, the value of surplus in each product area increased during the period. In the USA and the United Kingdom trade was in surplus in three types of electronic products: control and instrumentation, communications and radar, and medical and industrial equipment. Denmark, France, Sweden and the Netherlands had surpluses of trade in two categories of electronic products: control and instrumentation, and medical and industrial equipment in Denmark, communications and radar, and telecommunications equipment in France and Sweden, and office, and medical and industrial equipment in the Netherlands. The Netherlands was the only country among all developed non-Asian countries, considered in this study, that had a surplus of trade in office equipment. In 1985 Canada had surpluses of trade in two categories of electronic products: communications and radar, and telecommunications equipment. By 1995 telecommunications remained the only type of electronic goods in which Canada had a positive balance of trade.

Most of the developed non-Asian countries had deficits of trade in electronic data processing and office equipment, consumer electronics and components. Thus, in the USA, the deficits of trade in electronic data processing equipment, consumer electronics and components were especially large. The United Kingdom and Canada had their largest deficits of trade in components, and while in Germany, Denmark, France and Sweden the largest deficits were in electronic data processing equipment. In the Netherlands the deficit of trade in consumer electronics was the largest, although the deficits in components and electronic data processing were also substantial.

The pattern of specialisation in trade in electronic goods in Ireland was dramatically different from that in other developed countries. Ireland was the only developed country that had a large surplus of trade in electronic data processing equipment. Moreover, during 1985-1995 this surplus increased fivefold. Electronic components were the area in which

Chart 8.6



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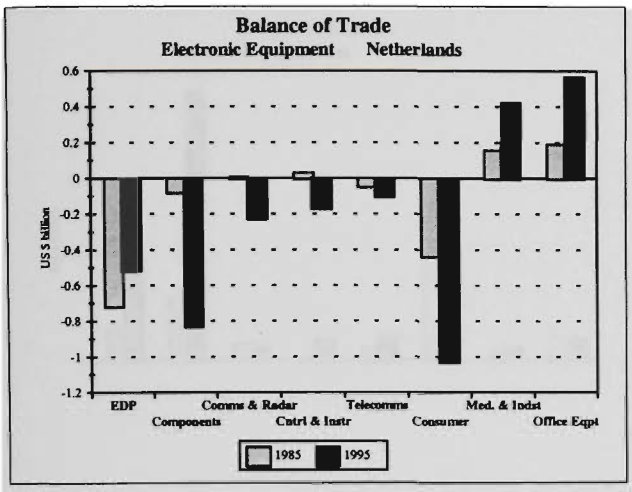
Balance of Trade
Electronic Equipment Netherlands
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
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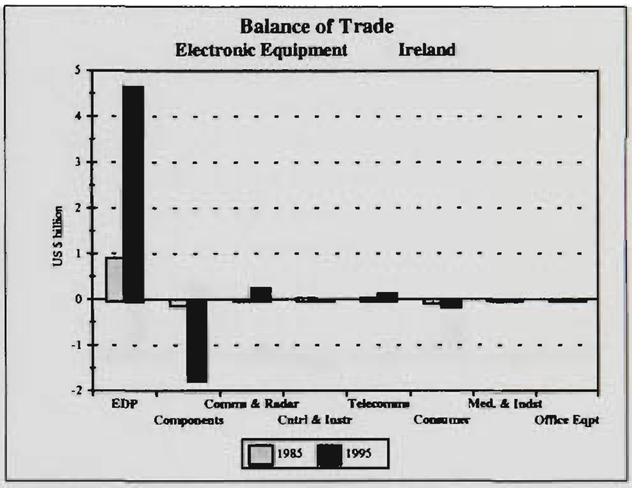
Balance of Trade
Electronic Equipment Ireland
US $ billion
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Components
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Office Eqpt
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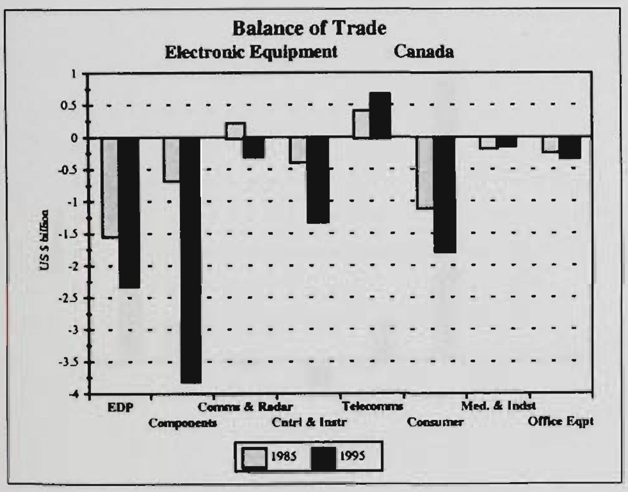
Balance of Trade
Electronic Equipment Canada
US $ billion
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Components
Comms & Radar
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Telecomms
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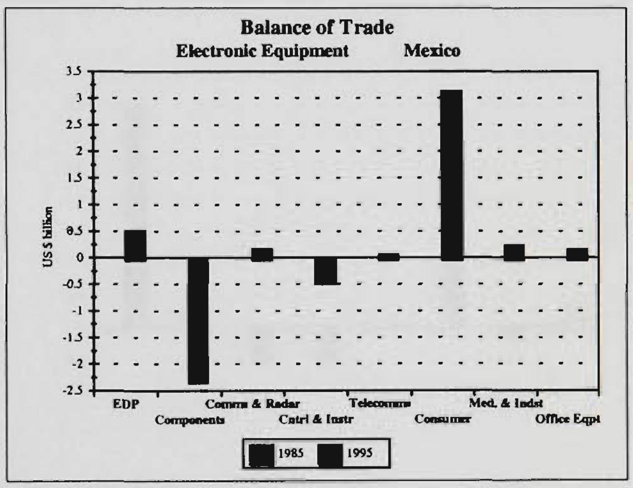
Balance of Trade
Electronic Equipment Mexico
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
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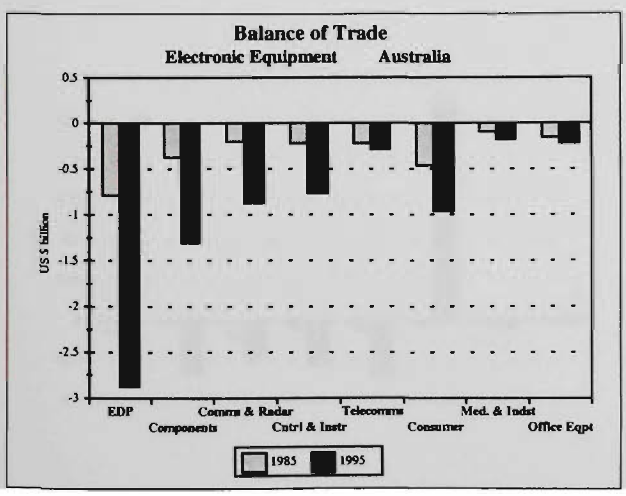
Balance of Trade
Electronic Equipment Australia
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
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Consumer
Med. & Indst
Office Eqpt
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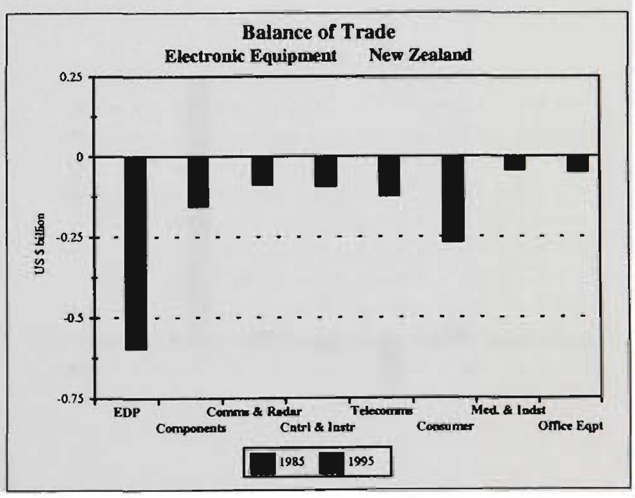
Balance of Trade
Electronic Equipment New Zealand
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
1985
1995

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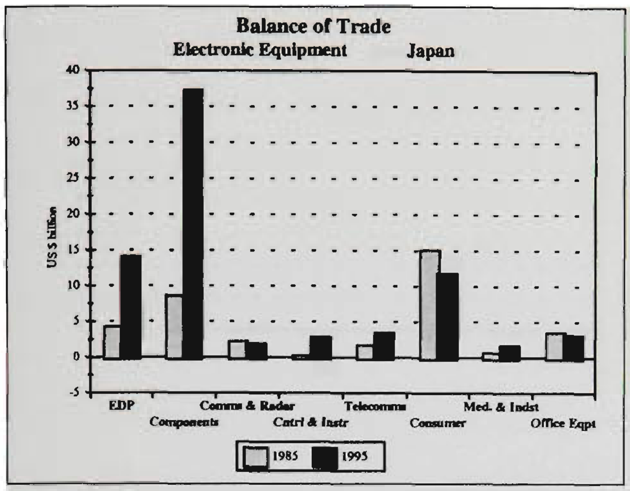
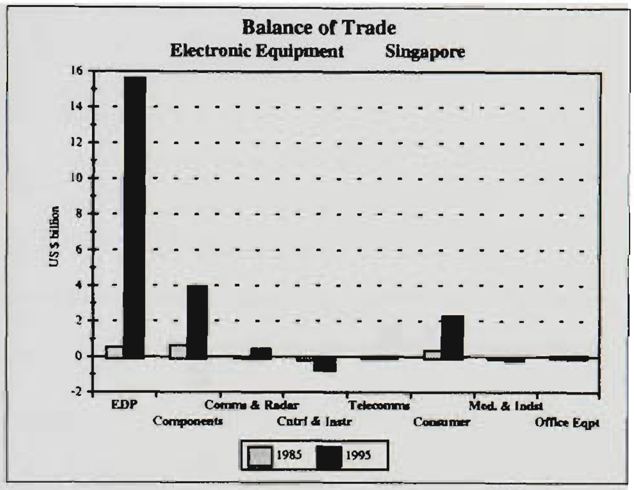

Balance of Trade
Electronic Equipment Japan
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
1985
1995


Balance of Trade
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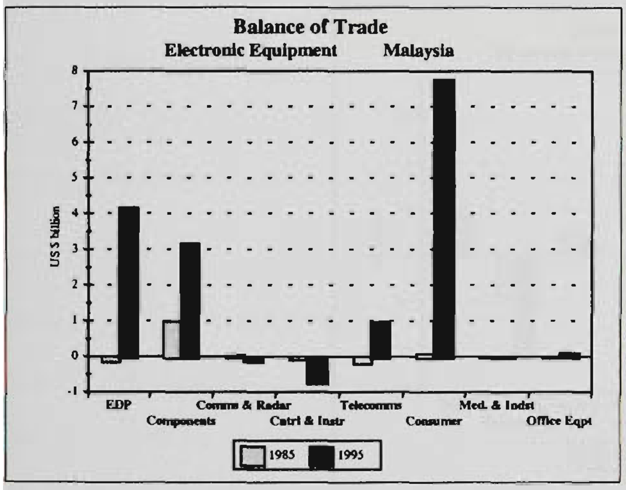
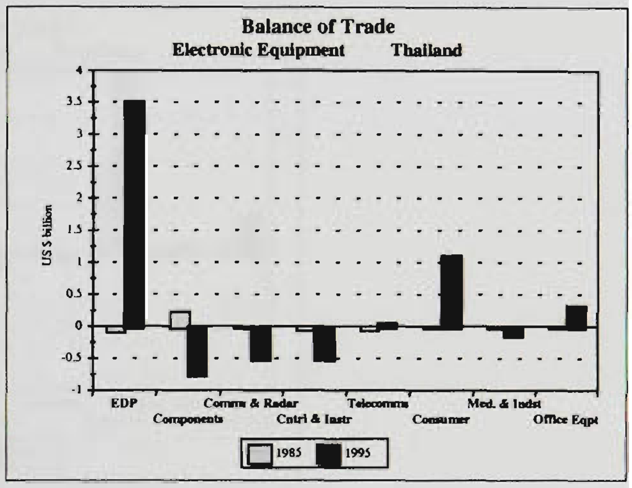
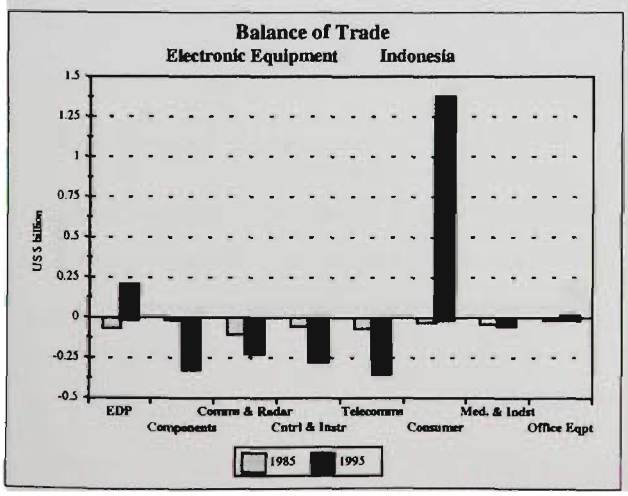
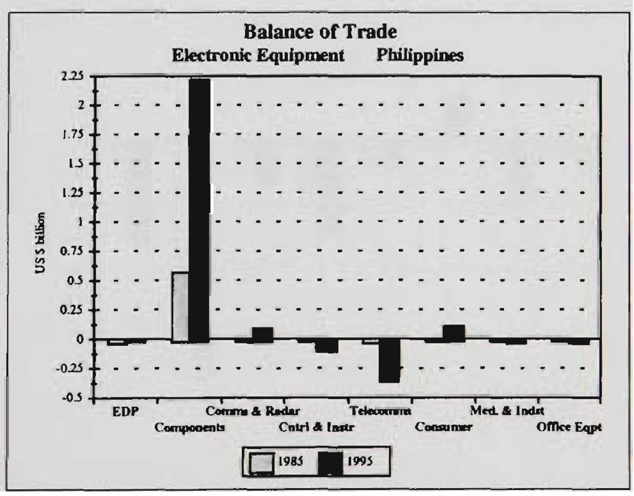
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
1985
1995

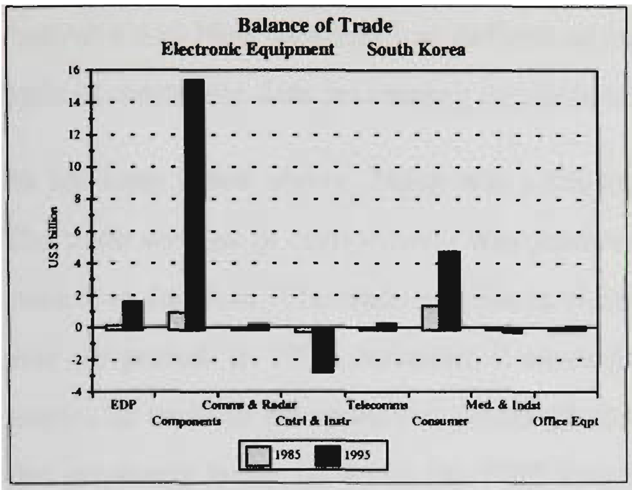

Balance of Trade
Electronic Equipment Malaysia
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
1985
1995

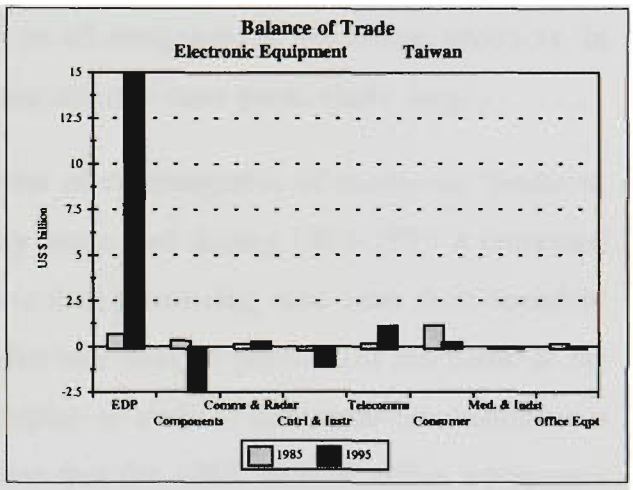

Balance of Trade
Electronic Equipment Thailand
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
1985
1995

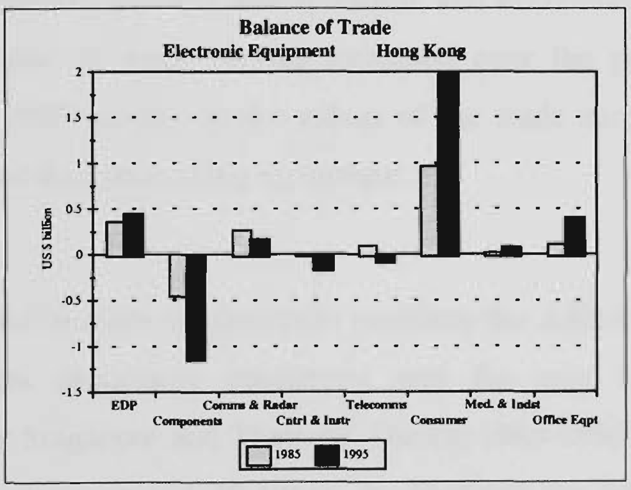

Balance of Trade
Electronic Equipment Indonesia
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
1985
1995

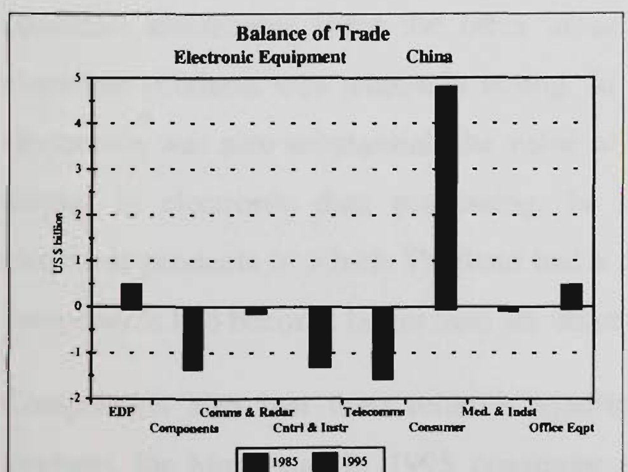

Balance of Trade
Electronic Equipment Philippines
US $ billion
EDP
Components
Comms & Radar
Cntrl & Instr
Telecomms
Consumer
Med. & Indst
Office Eqpt
1985
1995

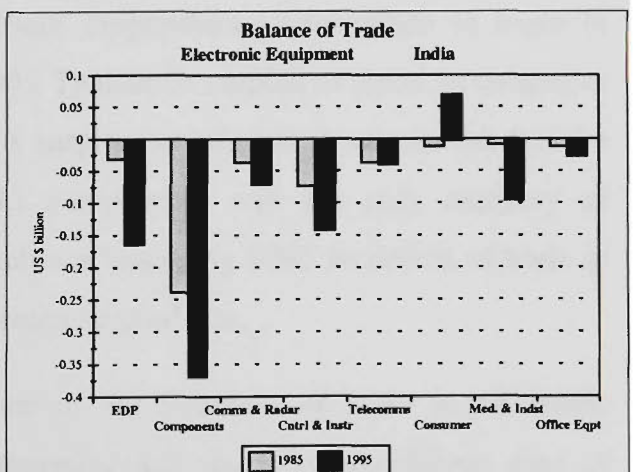
Continued











Source: Based on World Electronics Data 1997.

Ireland had the largest, and growing, deficit of trade. However, in 1995 surplus of trade in data processing equipment was more than 2.5 times greater than the deficit in components.

Australia and New Zealand had deficits of trade in all categories of electronic products. In trade in electronic data processing equipment these deficits were particularly large.

As has been noted above, Japan was a net exporter of all categories of electronic products. The trade surplus in components was particularly large, and during 1985-1995 it increased more than fourfold. The trade surplus in electronic data processing rose more than threefold over the period. In 1995, however, it accounted for less than 40 per cent of the value of the surplus of trade in components. Although the surplus of trade in consumer electronics was also relatively large, its value for 1995 was below that for 1985. In both office equipment and communications and radar equipment, the value of the surplus also declined. For each of control and instrumentation, medical and industrial, and telecommunications equipment, on the contrary, the value of trade surplus increased over the period. However, they remained quite low in 1995 relative to the values of the trade surpluses in components, consumer electronics, and data processing equipment.

ASEAN

In terms of specialisation in trade in electronic products the ASEAN economies differed from one another. Data processing equipment was the area of particularly strong performance in trade for Singapore and Thailand. During 1985-1995 for Singapore surplus of trade in these products increased 30 times. In Thailand the deficit of trade in data processing equipment in 1985 changed into a substantial surplus by 1995. Components and consumer electronics were the other areas where Singapore's performance in trade in electronic products was relatively strong. In 1995 Thailand's surplus of trade in consumer electronics was also substantial: the value of this surplus constituted about one third of the surplus in electronic data processing. In 1985 components was the only category of electronic products in which Thailand had a surplus of trade. By 1995 its deficit of trade in components had become larger than for other electronic products.

Components also lost their relative significance in the structure of trade in electronic products for Malaysia. In 1995 consumer electronics was the most significant area of specialisation in trade. The surplus of trade in consumer goods was about 2.5 times greater than in components and almost double that in electronic data processing. The balance of trade in telecommunications also was positive in 1995; however, the value of surplus in telecommunications accounted for just 12.5 per cent of the value of the surplus in consumer electronics.

Indonesia in 1985 had negative trade balances for all types of electronic products. By 1995 the balances of trade in three categories of electronic goods were positive: electronic data processing, office equipment and consumer electronics. The surplus of trade in consumer electronics was the largest, with the value more than six times greater than the value of the surplus in electronic data processing and significantly greater than that in office equipment.

The specialisation of the Philippines in trade in components was pronounced. Over the period 1985-1995 the value of the surplus of trade in components rose fourfold. In 1995 the surplus in components was more than 20 times greater than in consumer electronics and about 25 times greater than in communications and radar equipment.

All ASEAN economies had deficits of trade in control and instrumentation, and in medical and industrial equipment. Moreover, these deficits rose during 1985-1995. Thus, the deficit of trade in control and instrumentation equipment in more that fivefold in Thailand, Malaysia, the Philippines, Indonesia and Singapore. The deficit of trade in medical and industrial equipment rose in most ASEAN countries, and Malaysia was the only country of the ASEAN region where the deficit of trade in medical and industrial equipment declined over the period.

East Asian NICs

Patterns of specialisation in trade in electronic products differed considerably across the NICs. Components were the major area of specialisation for South Korea. In 1985 the surplus of trade in consumer electronics was about 1.5 times greater than the value of surplus in components. By 1995 the situation became dramatically different: the surplus of trade in components was more than three times greater than in consumer electronics. Electronic data processing was another area where the performance of South Korea in trade was relatively strong. However, in 1995 the surplus of trade in electronic data processing equipment amounted to only one tenth of the surplus in components.

In Taiwan in 1985 consumer electronics was also the major area of specialisation in trade in electronic products. The surplus of trade in consumer goods was 1.7 times greater than in electronic data processing. Over the period 1985-1995 the trade surplus in data processing equipment rose almost 22 times, while surplus in consumer electronics declined. In 1995 the trade surplus in electronic data processing was 66 times greater than the surplus in consumer goods. Telecommunications emerged as the second major area of specialisation in trade in electronic products of Taiwan. However, in 1995 the surplus in telecommunications constituted just 7.5 per cent of the value of the surplus in data processing equipment.

During 1985-1995 in Hong Kong consumer electronics was the major area of specialisation in trade. In 1985 surplus of trade in these products was 2.7 times greater than in electronic data processing equipment, which was the second most significant type of electronic products in the composition of trade of Hong Kong. By 1995 the surplus of trade in consumer electronic goods became more than four times the value of the surplus in data processing equipment. Office equipment was also significant, and the trade surplus in these products rose 3.7 times over the period.

In the contrast to South Korea, in 1995 Taiwan and Hong Kong both had negative balances of trade in components. Moreover, the trade deficits in these products were increasing over time. In Taiwan in 1985 the balance of trade in components was positive. By 1995 it had changed into a deficit, seven times greater than the magnitude of the initial surplus. In Hong Kong the trade deficit in components was already relatively large in 1985. Over the period the value of trade deficit increased 2.5 times. In 1995 the magnitude of the trade deficit in components was equal to 58 per cent of the surplus of trade in consumer electronics.

As for the ASEAN economies, all the NICs had deficits of trade in control and instrumentation, and the value of these deficits were growing over time. By 1995 in South Korea the trade deficit in control and instrumentation was particularly large.

In 1995 China was a net exporter of consumer electronics, data processing equipment and office equipment and a net importer of components, control and instrumentation, medical and industrial, communications and radar, and telecommunications equipment. Consumer electronics was of a particular importance in the composition of trade in electronic products of China. The surplus of trade in consumer electronic goods was about ten times larger than the surpluses in electronic data processing and office equipment. The value of trade deficit were highest in telecommunications, components and control and instrumentation equipment.

Conclusion: Pronounced Product Segmentation in Global Electronic Production and Trade

The analysis undertaken in this chapter has shown that over the 1985-1995 period the pattern of product segmentation of global electronic production and trade in electronic products became clearly defined.

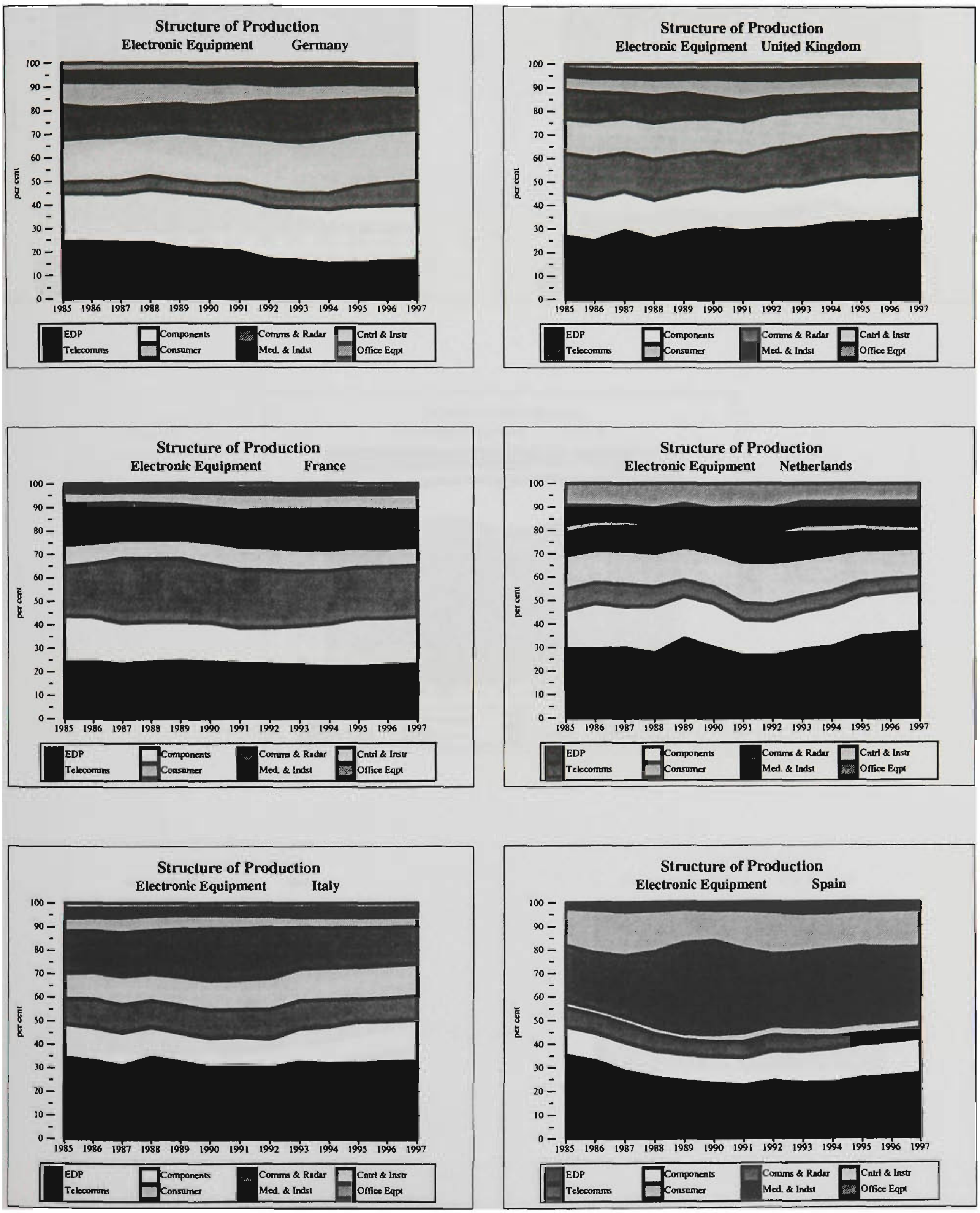
Most countries of ASEAN region and the NICs were specialised in producing electronic goods characterised by high global demand, such as electronic data processing equipment and components. Consumer electronics was also important in the composition of electronic production in many Asian economies. It is also worth noting that the differences between particular ASEAN economies and the NICs in terms of their specialisation in electronic production were quite marked. Countries of the ASEAN region were mostly specialised in the production of consumer electronics and components, and although structural significance of electronic components was declining, data processing equipment emerged as a new area of specialisation. Consumer electronics was the major area of specialisation of the East Asian NICs, although the relative significance of these products declined dramatically; components became structurally significant in South Korea and data processing equipment in Taiwan.

The role of electronic products of high global demand in the structure of electronic production of developed non-Asian countries, except Ireland, was relatively modest. Most developed non-Asian countries were specialised in production of control and instrumentation, industrial and medical, communications and radar, and telecommunications equipment.

The pattern of distribution of global electronic production across countries was reflected in their specialisation in trade in particular categories of electronic products. Most developed non-Asian countries had a surplus of trade in control and instrumentation, communications and radar, medical and industrial and telecommunications equipment, and deficit in electronic data processing, office equipment, consumer electronics, and components. Most East Asian economies, except Japan, had a surplus of trade in electronic data processing, office equipment, consumer electronics and components, and a deficit in control and instrumentation, communications and radar, medical and industrial and telecommunications equipment. Japan was net exporter of all categories of electronic products, in electronic components, office, and medical and industrial equipment the position of Japan was especially strong.

Appendix: Chapter 8

Chart 8.A1



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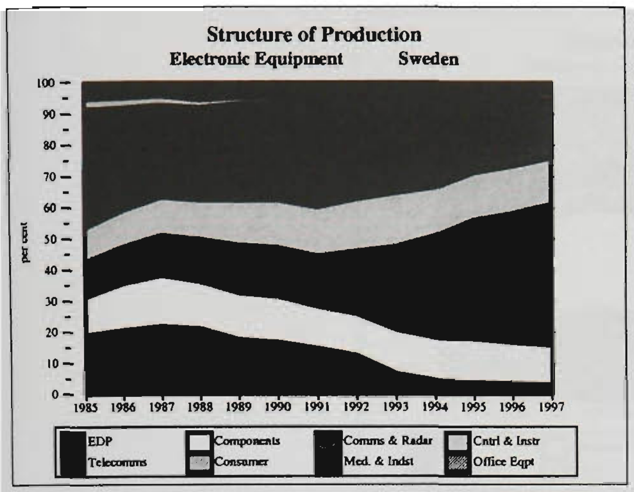
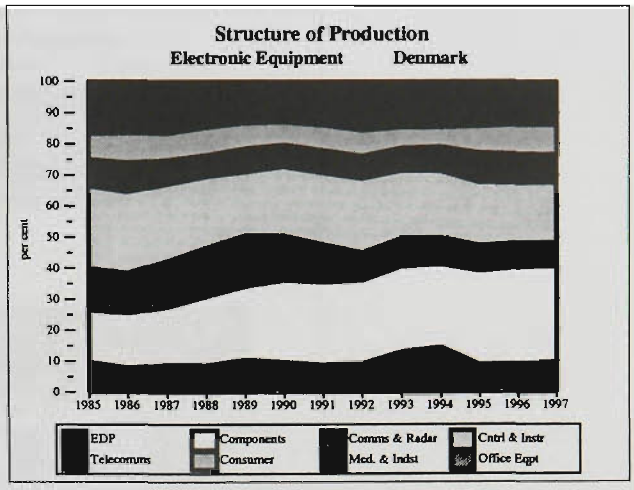

Structure of Production
Electronic Equipment Sweden
per cent
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt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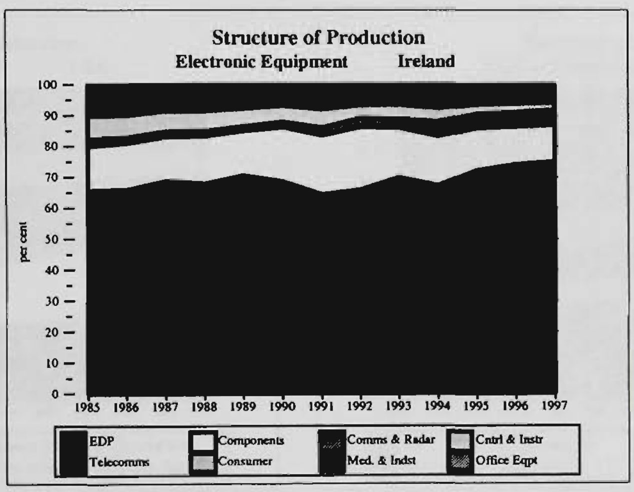
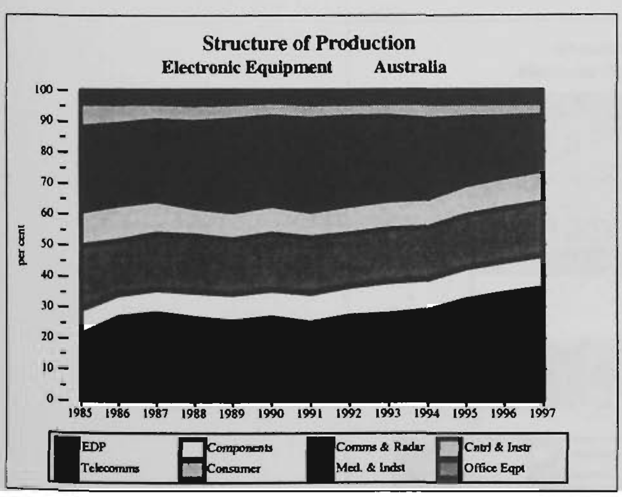
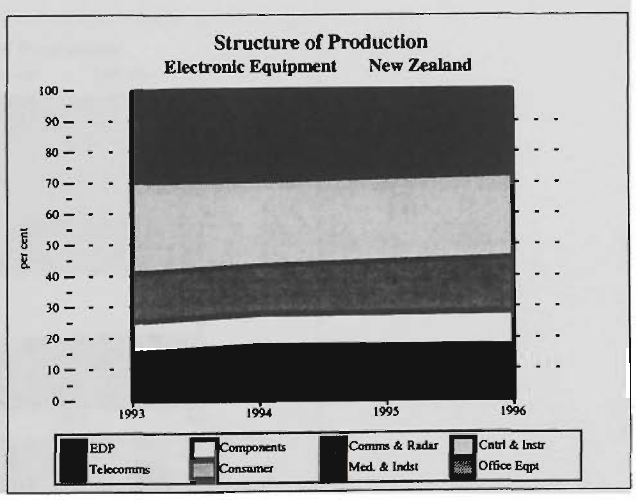
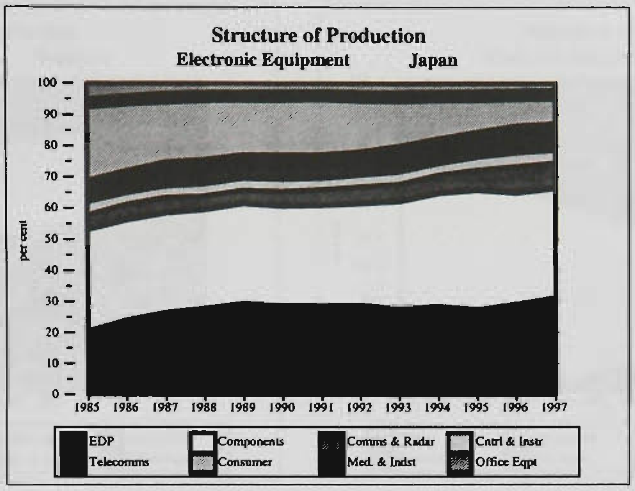
Electronic Equipment Denmark
per cent
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt

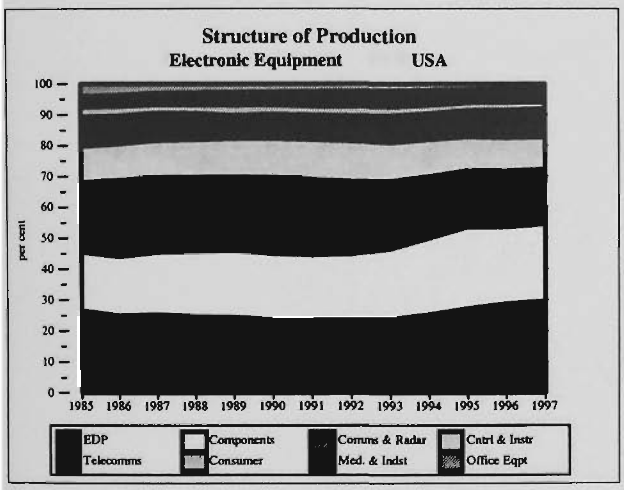

Structure of Production
Electronic Equipment Ireland
per cent
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt

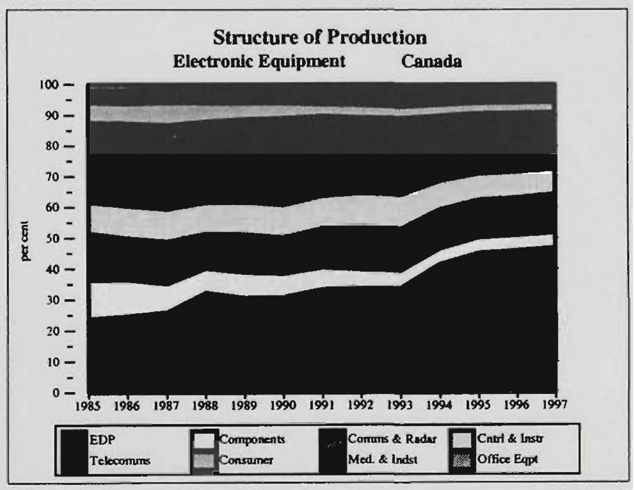

Structure of Production
Electronic Equipment Australia
per cent
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment New Zealand
per cent
1993 1994 1995 1996
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt

Continued


Structure of Production
Electronic Equipment Japan
per cent
100
90
80
70
60
50
40
30
20
10
0
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment USA
per cent
100
90
80
70
60
50
40
30
20
10
0
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment Canada
per cent
100
90
80
70
60
50
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30
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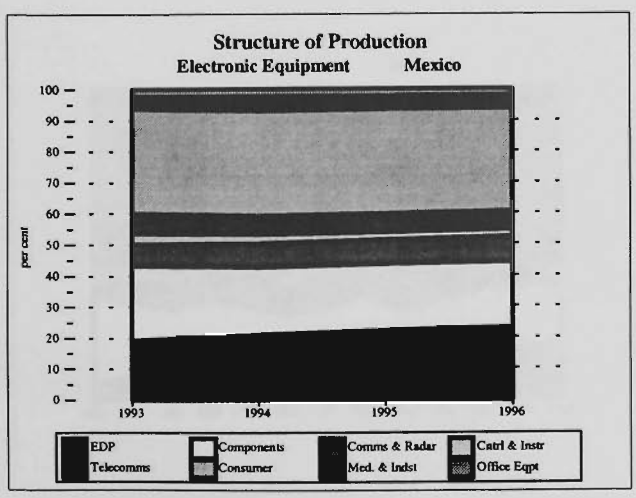
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment Mexico
per cent
100
90
80
70
60
50
40
30
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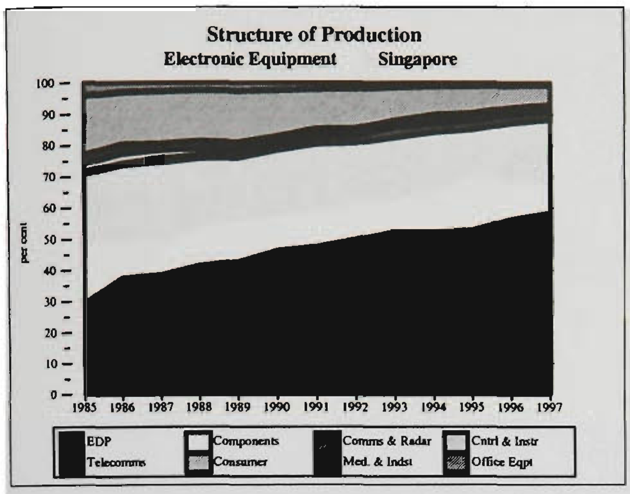
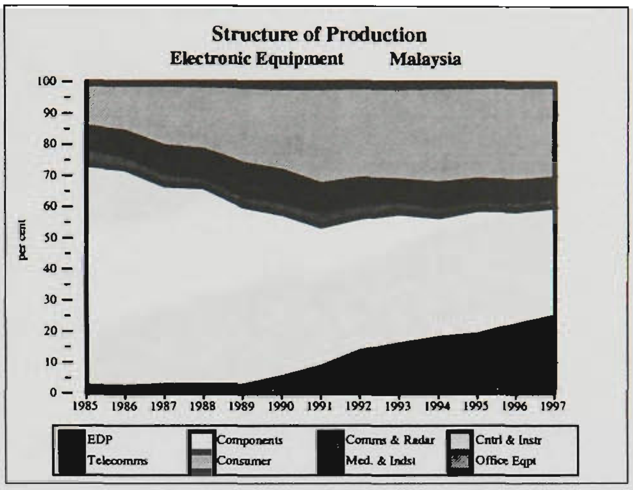
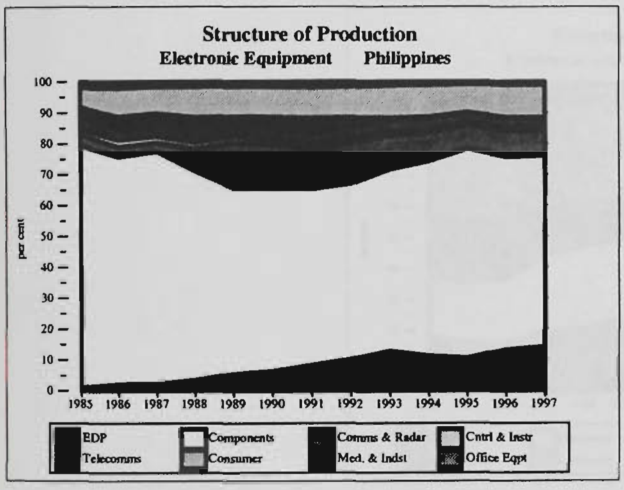
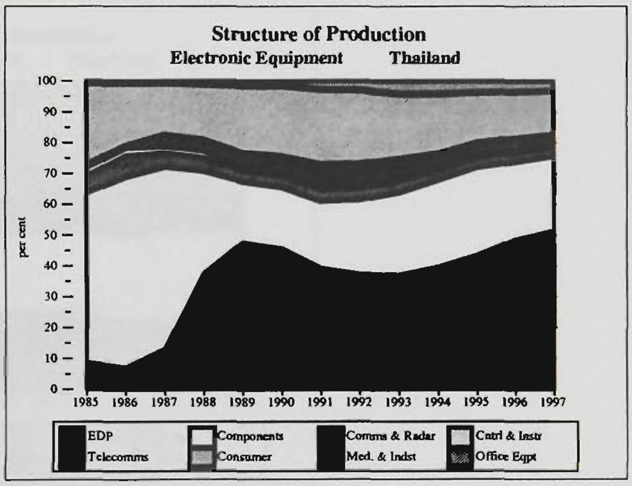
0
1993 1994 1995 1996
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt

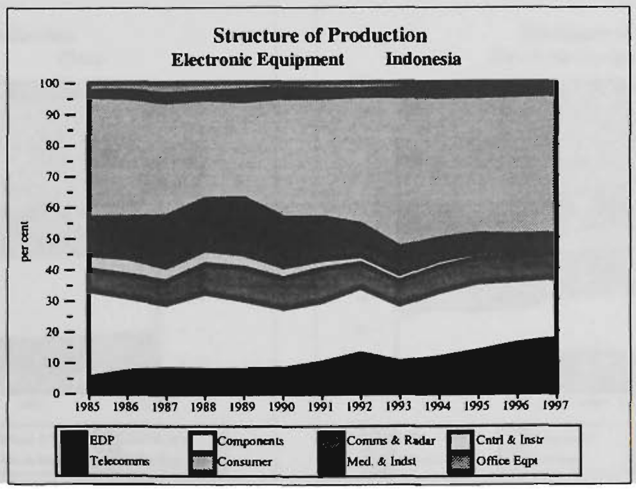
Continued


Structure of Production
Electronic Equipment Singapore
per cent
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment Malaysia
per cent
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment Philippines
per cent
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment Thailand
per cent
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt


Structure of Production
Electronic Equipment Indonesia
per cent
EDP
Telecomms
Components
Consumer
Comms & Radar
Med. & Indst
Cntrl & Instr
Office Eqpt

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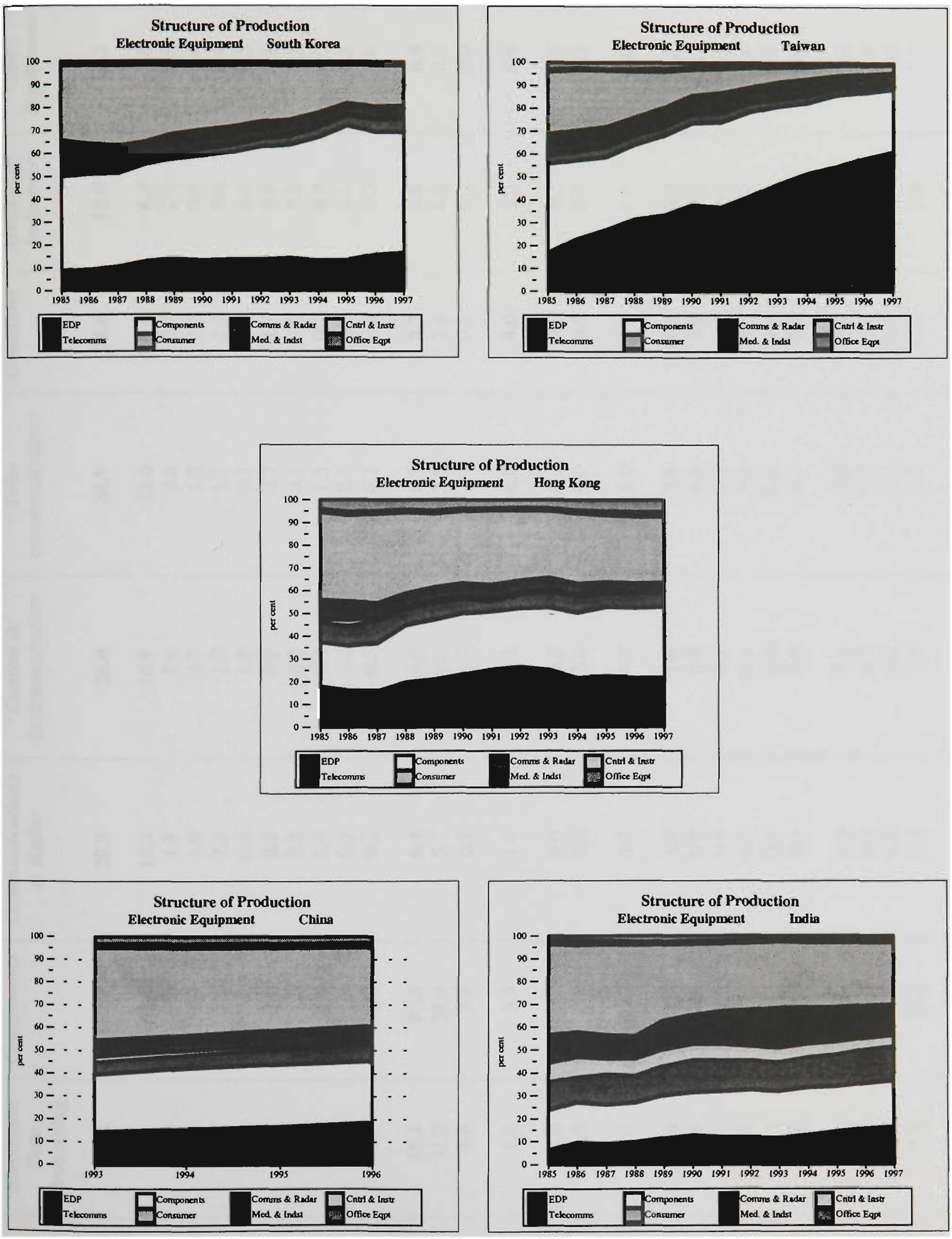


Source: Based on World Electronics Data 1996, 1997.

Table 8.A1 Exports of Electronic Products, US $ billion, Selected Regions and Countries, 1994

	Electronic Data Processing	*Components*	*Communications & Radar*	*Control & Instrumentation*	*Tele-communications*	*Consumer*	*Medical & Industrial*	*Office Equipment*	*All Electronic Goods*
Total (50 countries)	**172.2**	**187.1**	**29.9**	**35.0**	**34.9**	**78.6**	**15.8**	**11.3**	**564.8**
West Europe	**50.1**	**37.5**	**10.2**	**16.9**	**13.0**	**15.8**	**6.4**	**3.8**	**153.7**
Germany	8.0	10.8	1.8	5.6	3.6	2.7	2.3	0.6	**35.4**
United Kingdom	12.2	7.8	1.9	2.7	1.2	2.3	0.6	0.4	**29.1**
France	5.8	5.5	2.5	1.7	1.7	1.7	0.6	0.4	**19.9**
Netherlands	4.0	2.4	0.3	1.2	0.7	0.7	0.5	0.3	**9.9**
Italy	8.7	3.2	0.2	0.9	0.7	1.3	0.8	1.8	**17.6**
Ireland	5.5	1.0	0.2	0.2	0.3	0.0	0.0	0.0	**7.2**
Sweden	0.6	0.8	1.4	0.7	1.5	0.2	0.3	0.0	**5.5**
Spain	1.2	0.7	0.1	0.4	0.7	0.7	0.1	0.1	**4.0**
Denmark	0.5	0.6	0.2	0.5	0.2	0.2	0.3	0.0	**2.5**
North America	**35.4**	**27.3**	**6.4**	**9.8**	**6.7**	**2.7**	**4.8**	**0.5**	**93.5**
USA	31.0	24.6	5.7	9.0	5.0	2.6	4.6	0.5	**83.0**
Canada	4.4	2.7	0.7	0.7	1.7	0.1	0.2	0.0	**10.5**
Mexico	1.8	3.9	1.0	0.3	0.6	4.0	0.5	0.4	**12.5**
Australia	1.0	0.2	0.0	0.2	0.3	0.0	0.1	0.0	**1.9**
New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
Japan	27.8	40.2	4.7	4.7	6.0	17.2	2.4	3.5	**106.5**
ASEAN	**30.4**	**35.3**	**1.9**	**1.0**	**2.6**	**15.1**	**0.3**	**1.0**	**87.5**
Singapore	21.6	18.0	0.8	0.8	0.9	5.8	0.1	0.5	**48.5**
Malaysia	4.7	11.5	0.6	0.1	1.1	6.5	0.1	0.1	**24.8**
Thailand	3.7	3.4	0.1	0.1	0.4	1.5	0.0	0.4	**9.4**
Indonesia	0.2	0.3	0.1	0.0	0.1	1.1	0.0	0.0	**1.8**
Philippines	0.2	2.0	0.3	0.0	0.1	0.2	0.0	0.0	**2.9**
NICs	**21.3**	**36.2**	**4.5**	**1.1**	**3.3**	**17.6**	**0.6**	**1.6**	**86.2**
South Korea	3.3	14.7	0.9	0.3	0.7	4.9	0.1	0.2	**24.9**
Taiwan	12.6	8.1	0.5	0.2	1.3	0.9	0.1	0.2	**23.9**
Hong Kong	5.4	13.5	3.1	0.6	1.3	11.8	0.4	1.3	**37.4**
China	2.0	4.3	0.4	0.2	1.1	5.0	0.2	0.5	**13.7**
India	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	**0.4**

Source: Estimates based on World Electronics Data 1996, 1997.

Table 8.A2 Imports of Electronic Products, US $ billion, Selected Regions and Countries, 1994

	Electronic Data Processing	*Components*	*Communications & Radar*	*Control & Instrumentation*	*Tele-communications*	*Consumer*	*Medical & Industrial*	*Office Equipment*	*All Electronic Goods*
Total (50 countries)	**168.5**	**181.3**	**24.0**	**35.4**	**29.3**	**68.5**	**13.8**	**11.4**	**532.3**
West Europe	**72.2**	**52.3**	**6.9**	**14.0**	**9.5**	**23.0**	**5.0**	**5.1**	**188.1**
Germany	15.1	12.7	1.1	2.9	2.5	6.0	1.3	1.0	**42.4**
United Kingdom	14.2	11.1	1.2	2.1	1.5	3.1	0.6	0.6	**34.2**
France	9.2	6.7	1.3	2.0	0.8	3.2	0.7	0.7	**24.5**
Netherlands	4.6	4.7	0.7	1.6	0.7	2.2	0.4	0.4	**15.2**
Italy	10.1	3.8	0.4	1.0	0.7	2.1	0.5	1.4	**20.0**
Ireland	3.1	1.8	0.0	0.2	0.2	0.1	0.1	0.0	**5.5**
Sweden	2.4	1.9	0.5	0.7	0.5	0.7	0.2	0.1	**7.0**
Spain	2.6	1.8	0.2	0.8	0.5	1.4	0.2	0.2	**7.8**
Denmark	1.3	0.7	0.1	0.2	0.3	0.4	0.1	0.1	**3.3**
North America	**51.2**	**40.6**	**4.8**	**6.4**	**7.7**	**20.1**	**4.2**	**3.1**	**138.1**
USA	44.2	35.0	3.9	4.6	6.6	18.4	3.8	2.7	**119.1**
Canada	7.0	5.6	1.0	1.8	1.2	1.8	0.4	0.3	**19.0**
Mexico	2.0	6.2	1.0	0.8	0.7	1.5	0.3	0.2	**12.8**
Australia	3.4	1.1	0.6	0.9	0.4	0.9	0.2	0.2	**7.8**
New Zealand	0.5	0.2	0.1	0.1	0.1	0.3	0.0	0.0	**1.4**
Japan	8.8	10.2	1.6	2.4	1.2	3.2	0.8	0.3	**28.6**
ASEAN	**12.7**	**28.9**	**2.1**	**2.5**	**2.3**	**4.8**	**0.5**	**0.6**	**54.5**
Singapore	9.2	14.9	0.4	1.2	0.8	4.0	0.2	0.4	**31.0**
Malaysia	1.7	9.1	0.7	0.6	0.3	0.4	0.1	0.1	**13.0**
Thailand	1.3	3.8	0.5	0.4	0.5	0.4	0.1	0.1	**7.1**
Indonesia	0.1	0.6	0.2	0.2	0.3	0.0	0.1	0.0	**1.6**
Philippines	0.3	0.6	0.2	0.1	0.4	0.1	0.0	0.0	**1.6**
NICs	**8.8**	**29.8**	**3.6**	**3.9**	**2.0**	**10.8**	**0.8**	**1.1**	**60.8**
South Korea	2.1	5.2	0.6	2.2	0.4	0.3	0.3	0.1	**11.2**
Taiwan	1.7	9.8	0.2	1.0	0.4	0.7	0.1	0.1	**13.9**
Hong Kong	5.0	14.8	2.8	0.7	1.3	9.8	0.4	1.0	**35.7**
China	1.8	5.8	0.7	1.3	2.5	0.9	0.4	0.1	**13.5**
India	0.3	0.4	0.0	0.1	0.1	0.0	0.1	0.0	**1.0**

Source: Estimates based on World Electronics Data 1996, 1997.

CHAPTER 9

CASE STUDIES:
VIDEO CASSETTE RECORDERS AND TAPE RECORDERS

The analysis undertaken in the previous chapter has shown that product segmentation was the dominant feature of the pattern of distribution of global electronic production and trade in electronic products among different countries. The major areas of specialisation in the electronic production of most developed economies were control and instrumentation, industrial and medical, communications and radar, and telecommunications equipment, while most countries of ASEAN region and the NICs were specialised in production of electronic data processing equipment, components and consumer electronics. The main objective of this chapter is to investigate whether global electronic production was also segmented in terms of the functional complexity and quality of the electronic goods produced in different countries, and whether this segmentation can provide an explanation for changes in the regional distribution of global electronic production.

It is notoriously difficult to find appropriate economic indicators of the functional sophistication and quality of different products, including electronic products. By quality we understand the design, reliability and durability of products. Only thorough laboratory tests of particular technical characteristics can provide the reliable information necessary and sufficient for differentiating the functional sophistication and quality of products that belong to the same category according to commodity classifications. However, in this chapter we will attempt to investigate differentiation between similar electronic products, in terms of functional complexity and quality, on the basis of the analysis of unit prices. The results of such analysis can be considered as tentative only: factors other than the quality of the products, such as costs incurred in the process of production and the marketing strategies of particular companies, can affect price settings. Nevertheless, in our view, a comparison between the unit prices of similar products produced in different countries can provide useful information that may help to shed some light on the functional sophistication and quality of those products.

It is far beyond the scope of this research to undertake a cross-country comparison of the unit prices, for different countries and regions, of all the computing and electronic products that have been considered in the previous chapter. Here we will confine the analysis to particular case studies. Two different electronic products, video cassette recorders and pocket-size cassette players, have been selected for the case studies. The material that will be presented in this chapter can be broadly subdivided into two parts: the justification for selecting these particular electronic goods and the analysis of unit prices of these products for different countries and regions. In the first section of this chapter the structural significance of video and audio electronic equipment will be considered. In the second and the third sections production and trade in video cassette recorders and tape recorders will be analysed, followed by the analysis of the unit prices of video recorders and pocket-size cassette players.

9.1 Production of Video and Audio Equipment

As has been discussed in the previous chapter, by the end of the 1985-1995 period developed non-Asian countries were mostly specialised in production of and trade in control and instrumentation, medical and industrial, communications and radar, and telecommunications equipment. In most East Asian countries the major areas of specialisation were in electronic components, consumer electronics and, to a lesser degree, electronic data processing and office equipment. As our interest is in understanding the nature and implications of changes in industrial structure, it is appropriate to select, for the case studies, product areas in which global markets are growing rapidly. Given the argument above, such electronic products would belong to the major areas of specialisation of the newcomers to the global electronic production, such as China, rather than to those of the countries with a traditionally high reputation as producers and exporters of electronic goods. An analysis of production and import unit prices of such electronic products can help us to understand the changes in the regional distribution of global production of particular categories of electronic goods. Besides this, a selection of electronic products within the areas of specialisation of the newcomers to global electronic production will provide a broader base for a cross-country comparison of unit prices, in terms of the availability of the relevant production and trade data.

Consumer electronics was of a particular importance in the composition of trade in electronic goods of China, Hong Kong, and Indonesia. In Thailand and South Korea the trade surpluses in these products were quite substantial. Singapore's performance in trade in consumer electronics was also strong. Although consumer electronics was not among the major areas of specialisation of the developed economies, in Western Europe and North

America the value of production of electronic goods in this category increased over the 1985-1995 period (see Table 8.2, Chapter 8). In 1994 the value of exports of consumer electronic products generated by countries of these regions remained substantial (see Table 8.A1 in the Appendix, Chapter 8). Thus, in our view, it is reasonable to select particular consumer electronic products as a base for a cross-country comparison of production and import unit prices.

Consumer electronic products include consumer video, consumer audio, and consumer personal products. Consumer video products include colour and monochrome television sets, video recorders, video cameras and combinations, tuners and satellite receivers. Consumer audio products include portable radios and radio recorders, main radios and combinations, car radios and combinations, tape recorders and decks, record players and decks, compact disk players. Consumer personal products include electric/electronic watches and clocks, and electronic flashlights (see also Section 8.1.1, Chapter 8).

In 1985-1995, in most developed and East Asian economies, video and audio equipment constituted the major part of overall consumer production (Table 9.1). In terms of the relative significance of video and audio equipment the difference between developed and Asian economies is more marked. Audio electronic goods were relatively more important in the composition of consumer electronic production in East Asian countries than in the developed economies (see also Table 9.2). In 1995 in most developed countries audio equipment accounted for less than 30 per cent of consumer electronic goods. In Malaysia, the Philippines and Taiwan, for, example, audio equipment accounted for more than 45 per cent of all consumer electronic goods produced, in China for almost 40 per cent, and in Singapore, Hong Kong and Indonesia for more than 30 per cent.

Changes in relative significance of video and audio products in the composition of consumer electronic production of Asian countries are also of interest. In Malaysia, Singapore, Thailand, South Korea and Taiwan the structural significance of video products was growing over time, while the significance of audio electronic products was diminishing. In Hong Kong the picture was the opposite. In the Philippines the structural significance of both types of electronic products was growing over time.

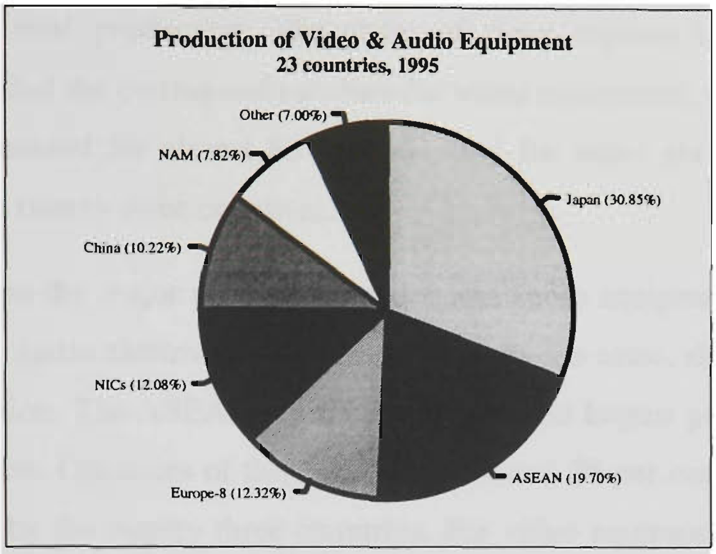
Chart 9.1 and Table 9.2 present the shares of major regions and countries in the total production of video and audio equipment of the twenty three countries considered in this section, taken as a whole.

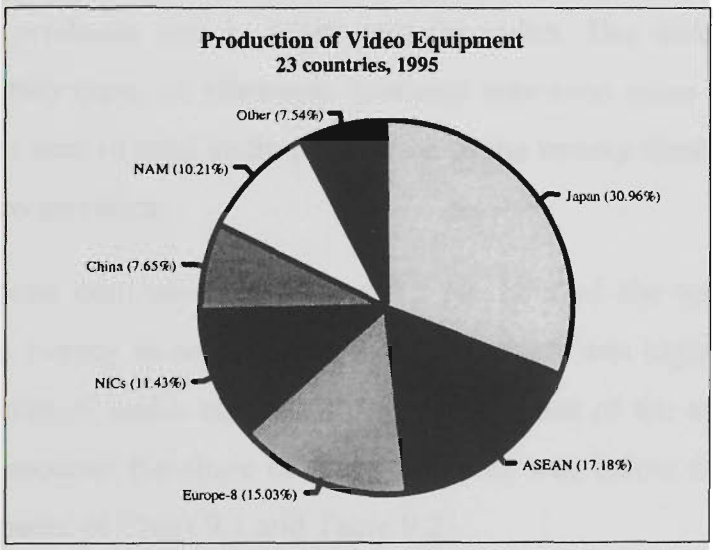
Table 9.1 Production of Video and Audio Equipment, Shares of Production of Consumer Equipment, Selected Countries, 1985-1995

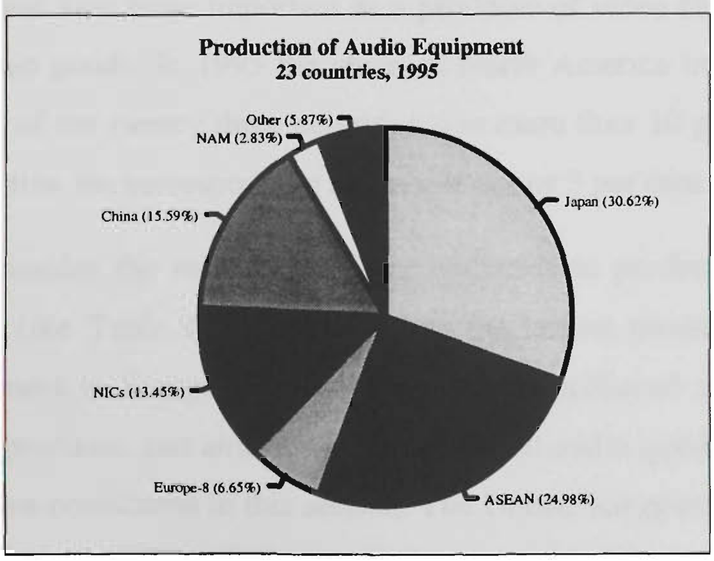
	Video & Audio Equipment Shares of Consumer Equipment % (in current US $)			*Video Equipment Shares of Consumer Equipment % (in current US $)*			*Audio Equipment Shares of Consumer Equipment % (in current US $)*		
	1985	**1990**	**1995**	**1985**	**1990**	**1995**	**1985**	**1990**	**1995**
Germany	90.6	90.7	89.9	70.5	69.0	70.3	20.1	21.7	19.5
United Kingdom	97.7	98.3	98.4	89.8	93.9	86.9	7.9	4.3	11.5
France	83.2	88.5	90.2	69.7	73.3	68.1	13.5	15.2	22.2
Italy	79.8	93.4	88.6	72.0	91.7	87.3	7.8	1.8	1.3
Netherlands	77.5	64.6	82.1	56.2	51.5	37.9	21.4	13.1	44.2
Ireland	94.4	90.0	91.7	16.7	30.0	62.5	77.8	60.0	29.2
Sweden	98.3	98.0	na	98.3	94.0	na	na	4.1	na
Spain	100.0	100.0	100.0	93.7	96.6	98.1	6.3	3.4	1.9
Denmark	99.5	99.3	97.9	66.1	62.2	51.7	33.4	37.1	46.2
USA	83.3	83.4	84.0	70.0	76.0	74.5	13.3	7.4	9.5
Canada	92.4	94.7	94.7	69.9	76.9	77.5	22.5	17.8	17.2
Mexico	na	na	98.3	na	na	70.2	na	na	28.1
Australia	96.6	91.9	90.9	70.7	67.1	73.5	25.9	24.9	17.4
Japan	91.5	91.1	90.9	65.3	61.5	61.7	26.3	29.5	29.2
Singapore	99.2	99.6	99.1	35.6	42.9	61.9	63.6	56.8	37.2
Malaysia	99.8	100.0	99.3	27.7	35.5	49.7	72.1	64.5	49.5
Thailand	76.3	89.5	91.8	55.7	77.3	84.7	20.5	12.3	7.1
Indonesia	67.0	79.7	91.4	48.1	57.1	56.9	18.9	22.6	34.5
Philippines	49.1	80.1	90.4	24.5	45.9	42.9	24.5	34.2	47.5
South Korea	92.5	94.4	92.8	58.3	60.1	69.0	34.1	34.3	23.8
Taiwan	93.0	86.5	88.8	42.0	34.6	43.3	51.0	51.9	45.5
Hong Kong	37.3	33.5	35.7	4.0	6.1	0.7	33.4	27.4	35.0
China	na	na	80.5	na	na	40.7	na	na	39.7
India	97.5	89.2	86.3	77.0	69.5	66.4	20.5	19.7	19.9

Source: Estimates based on World Electronics Data 1996, 1997.

Chart 9.1







Source: Estimates based on World Electronics Data 1996, 1997.

In 1995 most of video and audio electronic production was undertaken in East Asian countries. The combined share of Japan, ASEAN, the NICs, and China was equal to almost 73 per cent of total production. The share of these regions and countries for audio equipment exceeded the corresponding share for video equipment: for audio these countries and regions accounted for almost 85 per cent, and for video about 67 per cent, of total production in the twenty three countries.

In 1995 Japan was the major producer of video and audio equipment. The shares of Japan for video and for audio electronic goods were virtually the same, slightly above 30 per cent of world production. The ASEAN region was the second largest producer of both types of electronic products. Countries of this region contributed 25 per cent of all audio electronic goods produced by the twenty three countries. For video equipment the share of ASEAN was significantly lower, 17 per cent. The shares of the NICs were equal to 13.5 per cent for audio electronic products, and 11.4 per cent for video. The difference between China's shares for these two types of electronic products was even more marked. In 1995 China produced 15.6 per cent of total audio production of the twenty three countries, and less than 8 per cent of video products.

The eight European countries contributed 15 per cent of the total production of video equipment of the twenty three countries in 1995, which was higher than the share of the NICs. In production of audio equipment the contribution of the eight European countries was much more modest: the share of these countries was below those of the NICs and of China (the third panel of Chart 9.1 and Table 9.2).

North America was also more important as a producer of video electronic equipment than of audio electronic goods. In 1995 the share of North America in the total production of video equipment of the twenty three countries was more than 10 per cent, while for audio electronic production the corresponding share was below 3 per cent.

Let us briefly consider the role of particular countries as producers of video and audio electronic goods (see Table 9.2). Germany was the largest producer of video and audio electronic equipment in Europe. In 1995 this country produced about 30 per cent of all video electronic products, and almost 40 per cent of all audio goods, produced in the eight European countries considered in this section. The United Kingdom was the second largest producer of electronic video equipment in Europe, and France was the second largest European producer of audio electronic equipment.

Table 9.2 Production of Video and Audio Equipment, Selected Regions and Countries, 1995

	Production of Video & Audio Equipment					
	current US $ million			*Shares of Total 23 countries %*		
	Video & Audio	*Video*	*Audio*	*Video & Audio*	*Video*	*Audio*
Germany	3012.6	2358.0	654.5	3.77	4.36	2.53
United Kingdom	2552.4	2254.0	298.4	3.19	4.16	1.15
France	1941.9	1464.9	477.0	2.43	2.71	1.84
Spain	1007.5	988.0	19.5	1.26	1.83	0.08
Italy	818.4	806.7	11.7	1.02	1.49	0.05
Netherlands	282.6	130.4	152.2	0.35	0.24	0.59
Denmark	203.9	107.7	96.2	0.25	0.20	0.37
Ireland	35.5	24.2	11.3	0.04	0.04	0.04
Europe-8	**9854.8**	**8134.0**	**1720.8**	**12.32**	**15.03**	**6.65**
USA	5898.0	5230.0	668.0	7.37	9.66	2.58
Canada	362.0	296.4	65.7	0.45	0.55	0.25
NAM	**6260.0**	**5526.4**	**733.7**	**7.82**	**10.21**	**2.83**
Mexico	4234.0	3024.0	1210.0	5.29	5.59	4.67
Australia	147.4	119.3	28.1	0.18	0.22	0.11
Japan	24686.5	16758.8	7927.7	30.85	30.96	30.62
Malaysia	8290.4	4154.4	4136.0	10.36	7.68	15.98
Singapore	3278.2	2047.2	1231.0	4.10	3.78	4.76
Indonesia	2008.0	1250.0	758.0	2.51	2.31	2.93
Thailand	1803.6	1663.6	140.0	2.25	3.07	0.54
Philippines	386.0	183.0	203.0	0.48	0.34	0.78
ASEAN	**15766.2**	**9298.2**	**6468.0**	**19.70**	**17.18**	**24.98**
South Korea	7569.0	5631.0	1938.0	9.46	10.40	7.49
Taiwan	1092.1	532.9	559.2	1.36	0.98	2.16
Hong Kong	1003.9	20.1	983.8	1.25	0.04	3.80
NICs	**9665.0**	**6184.0**	**3481.0**	**12.08**	**11.43**	**13.45**
China	8177.0	4140.0	4037.0	10.22	7.65	15.59
India	1221.3	939.8	281.5	1.53	1.74	1.09
Total	**80012.2**	**54124.4**	**25887.8**	**100**	**100**	**100**

Source: Estimates based on World Electronics Data 1996, 1997.

The USA dominated the production of video and audio electronic equipment in North America. In 1995 the USA was the third major producer of video equipment among the twenty three countries, contributing almost 10 per cent of the total video electronic production of these countries. However, as a producer of audio equipment the contribution of the USA was relatively minor: in 1995 the share of the USA in the total audio production of the twenty three countries was equal to 2.6 per cent, which was below the corresponding share of Indonesia.

Japan was the absolute leader as a producer of both video and audio electronic equipment, contributing more than 30 per cent of the total production of the twenty three countries for both types of electronic goods. South Korea was the second largest producer of video electronic equipment following Japan. Malaysia occupied the fourth position among the twenty three countries, after the USA, and China was the fifth in the list of the major producers of video electronic equipment. Malaysia was the second largest and China was the third largest producer of audio electronic equipment among the twenty three countries considered in this section. South Korea followed China; however, the value of audio production of South Korea constituted less than a half of the corresponding value of production of China. The contribution of other East Asian countries to the total production of video and audio electronic equipment was less significant.

Conclusions

Three main conclusions can be derived on the basis of the analysis undertaken in this section. First, over the 1985-1995 period and for most countries, video and audio equipment constituted the major part of the overall consumer production. Second, in terms of the relative significance of video and audio equipment the difference between developed and Asian economies was quite marked: audio electronic goods were relatively more significant in the composition of consumer electronic production in East Asian countries than in the developed economies. Third, by the end of the period the major part of total production of video and audio equipment in the twenty three countries occurred in East Asian countries (Japan, ASEAN, the NICs, and China).

These findings justify the selection of the examples of video and audio electronic equipment for the case studies for a cross-country comparison of unit prices, in the context of our interest in changes in industrial structure. Such an analysis can be useful in explaining the observed trends in the patterns of specialisation in electronic production and trade across countries (see Chapter 8).

9.2 Case Study: Video Cassette Recorders

9.2.1 Production of Video Cassette Recorders

In this section we will analyse the role of video cassette recorders in the composition of production of video electronic equipment in different countries, to set the foundation for the analysis of the unit prices of this particular type of video electronic products.

Table 9.3 presents information on production of video cassette recorders (VCRs) and on the shares of the production of these products in the overall production of video equipment, in selected countries and regions. Countries of particular regions are listed in descending order according to the value of production for 1995. It is worth noting that the definition of the commodity group that includes video recorders varies slightly across the national classification systems (see the notes, Table 9.3). Although the differences are relatively minor, the aggregate totals for the regions should be considered only as indicative values, not as exact ones. Further, in Section 9.3, we will supplement the analysis based on production data by incorporating more accurately defined trade statistics derived directly from Customs declarations.

As has been noted in Section 9.1, consumer video products include colour and monochrome television sets, video recorders, video cameras and combinations, tuners and satellite receivers. The structural significance of video recorders in the overall production of video equipment differed substantially across regions and countries (Table 9.3). In the NICs in 1989 specialisation in production of video recorders was significantly higher than in other regions. Although the structural significance of production of video recorders was diminishing over time, in 1995 the role of these products in the NICs was still greater than in other regions with their share of total video equipment production being equal to 37.4 per cent. In ASEAN, on the contrary, the share of VCRs in the total production of video equipment was growing over time. By 1995 specialisation in production of VCRs in ASEAN was almost at the same level as in the NICs. In the European countries the significance of video recorders in the production of video equipment was decreasing during the 1989-1995 period. By the end of the period the share of VCRs in the overall output of

Table 9.3 **Production of Video Recorders, Shares of Production of Video Equipment, Selected Countries and Regions, 1989-1995**

	*Video Recorders** numbers (thousands)				*Video Recorders** current US $ million				*Video Recorders** Shares of Video Equipment % (in current US $)			
	1989	*1991*	*1993*	*1995*	*1989*	*1991*	*1993*	*1995*	*1989*	*1991*	*1993*	*1995*
Germany	3623	3729	2673	2969	1100.0	1104.2	718.2	797.9	43.1	39.3	35.4	33.8
United Kingdom	1436	1500	950	1400	496.7	617.5	373.1	507.9	35.7	26.0	24.0	22.5
France	318	1706	1204	962	105.0	334.2	247.3	260.5	10.9	20.4	18.4	17.8
Spain	190	340	500	550	81.8	109.5	124.9	135.0	10.0	9.3	15.0	13.7
Italy	150	158	30	30	43.8	46.0	6.4	8.0	4.5	4.1	0.9	1.0
Europe-5	**5717**	**7433**	**5357**	**5911**	**1827.4**	**2211.5**	**1469.9**	**1709.3**	**27.3**	**24.2**	**22.6**	**21.7**
USA	340	90	50	125	76.0	50.0	50.0	100.0	1.5	1.1	1.1	1.9
Canada	200	120	50	46	59.3	43.5	20.2	19.0	16.8	16.7	8.8	6.4
NAM	**540**	**210**	**100**	**171**	**135.3**	**93.5**	**70.2**	**119.0**	**2.5**	**1.9**	**1.4**	**2.2**
Australia	120	100	100	100	39.7	39.1	34.0	34.1	42.4	42.7	42.4	28.6
Japan	32015	30699	19993	16115	8224.6	7696.3	5387.4	4048.9	42.1	34.1	29.8	24.2
Malaysia	274	2270	6320	10500	47.2	349.1	1040.9	1728.0	11.8	31.0	43.5	41.6
Singapore	330	1043	2913	5100	76.9	204.0	531.5	904.9	9.5	24.2	42.4	44.2
Indonesia	55	140	2580	3200	13.0	30.0	355.0	455.0	9.8	8.2	40.8	36.4
Thailand	699	1729	2690	3400	111.5	271.7	332.0	360.0	32.7	29.3	25.1	21.6
Philippines	62	72	80	100	16.0	19.0	22.0	26.0	25.0	26.4	17.7	14.2
ASEAN	**1420**	**5254**	**14583**	**22300**	**264.6**	**873.8**	**2281.4**	**3473.9**	**15.2**	**26.2**	**38.2**	**37.4**
South Korea	8861	10110	10773	13035	1797.0	1770.0	1796.0	2121.0	47.7	42.1	41.2	37.7
Taiwan	1501	773	615	847	323.8	208.0	184.1	199.1	33.3	31.7	35.7	37.4
NICs-2	**10362**	**10883**	**11388**	**13882**	**2120.8**	**1978.0**	**1980.1**	**2320.1**	**44.8**	**40.7**	**40.6**	**37.6**
China	na	na	600	2195	na	na	67.0	251.0	na	na	2.0	6.1
India	75	120	60	120	45.6	61.2	21.5	37.0	4.2	8.9	3.0	3.9

Notes: AUS, CAN, FRA, DEU, IND, IDN, ITA, MYS, SGP, ESP, TWN, THA – video recorders, CHN, KOR – video recorders & disc players, PHL – video recorders inc. cameras, JPN - video recorders (inc. kits), GBR, USA - video recorders/players.

Source: Estimates based on World Electronics Data 1996, 1997.

video equipment accounted for 21.3 per cent, which was slightly below the corresponding share for Japan. In North America video recorders were not of high structural significance: in 1995 these products constituted 2.2 per cent of the total output of video electronic equipment.

Among countries, in 1995 specialisation in the production of video cassette recorders was the highest in Singapore. During 1989-1995 the share of these products in the overall production of video equipment rose from 9.5 to 44.2 per cent in this country. In Malaysia the increase in the structural significance of VCRs was also quite remarkable: in 1989 these products accounted for 11.8 per cent of the total output of video equipment, but by 1995 their share reached 41.6 per cent. In Indonesia the corresponding share rose from 9.8 to 36.4 per cent over the period. In other countries of the ASEAN region, Thailand and the Philippines, video recorders were becoming less significant in the structure of production of video electronic equipment.

In South Korea the structural significance of VCRs for the total production of video electronic equipment diminished during the period; however, in 1995 specialisation in production of video recorders remained higher than in most other countries. VCRs accounted for 37.7 per cent of the overall output of video electronic products in South Korea. In Taiwan the share of video recorders in total video equipment production increased over the period, approaching the value of the corresponding share for South Korea.

In most developed countries the shares of VCRs in the overall output of video equipment were decreasing during the period of 1989-1995. However, in some countries, for example, Germany, Australia, Japan and the United Kingdom, video recorders remained quite significant.

Let us consider the distribution of production of video cassette recorders, in terms of the values and the numbers produced, across different regions and countries. In 1989 Japan was the major producer of video recorders. Japan produced 32 million video recorders, or nearly twice the number produced in the five European countries, North America, ASEAN, and the NICs, taken together. However, over the 1989-1995 period the numbers of video recorders produced in Japan decreased, and in 1995 Japan produced only 16.1 million video recorders.

Growth in the numbers of video recorders produced in ASEAN was remarkable. In 1989 the number of VCRs produced in ASEAN was only about 5% of the number produced in Japan. By 1995 ASEAN has become the world's leader in terms of the number of video cassette recorders produced. In terms of the value of production, however, the picture is different. In 1995 the value of Japan's production of video recorders was still about 20% greater than the value of production of VCRs in ASEAN, even though ASEAN produced a considerably greater number of units. Over the 1989-1995 period the numbers of VCRs produced in the NICs, South Korea and Taiwan, increased by 34 per cent. However, values of production increased only by 9.4 per cent over the period.

In the five European countries the numbers produced increased marginally, while the value of production decreased over the period. In North America, although both the numbers produced and the overall value of production of VCRs decreased, the reduction in the value of production was less marked than in the number of units produced. In 1995 the value of production of VCRs was 88 per cent of the 1989 level, while the number of video recorders produced was 32 per cent of the 1989 level.

In summary, over the 1989-1995 period in East Asian economies video cassette recorders gained structural significance in the production of video electronic equipment. By the end of the period Japan remained the world leader in production of video recorders, while the position of South Korea was also quite strong. Three ASEAN economies – Malaysia, Thailand and Indonesia – emerged as major producers of VCRs. In most developed countries the share of video recorders in the production of video equipment was decreasing over time. However, in some developed countries, such as Germany, the United Kingdom and France, VCRs still accounted for substantial proportions of video electronic production. Moreover, the observed differences between the trends in growth in the number of units produced and in the value of production of video recording equipment in different regions and countries are indicative of disproportionate changes in average unit prices over time in different economies.

9.2.2 Video Recorders – Unit Values in Production

As can be seen from Table 9.3, for some countries the relative ranks defined according to the numbers of VCRs produced differed from their ranks determined according to the value of production. Thus, for 1989 the relative positions of Taiwan, the USA, Singapore, Italy, and Australia defined in terms of units exceeded their relative ranks defined in terms of value of production. For the United Kingdom, Spain and Italy the picture was the opposite. For 1995 Thailand, Indonesia, China and the Philippines the unit ranks were higher than the value ranks, while for Germany, the United Kingdom, France, and Australia the value ranks were higher than the unit ranks. These results are indicative of quite significant degree of variation in the average unit prices of VCRs produced in different countries. Analysis of the shares of individual countries in the total volume and the value of gross output of the eighteen countries, provided in Table 9.3, can also be used to document these marked differences between countries.

The shares of particular countries in the total number of VCRs produced and in the total value of production in the eighteen countries for 1995 are shown on Chart 9.2. The eighteen countries are subdivided into two groups according to the relative value of their shares. Countries in which the share in terms of numbers exceeded their shares in terms of the total value of production are presented on the first panel of Chart 9.2. Countries for which the reverse is true are presented on the second and the third panels of the chart.

The differences between most East Asian countries and the developed economies are quite marked. In South Korea, Malaysia, Singapore, Thailand, Indonesia and China the unit shares exceeded the value shares, while in Japan, Germany, France, Spain, the USA, Australia, Canada, and Italy, by contrast, the value shares were higher. In Taiwan, India, and the Philippines, higher relative value shares were observed, as for the developed countries.

As can be seen from formula 9.1, the ratio of a country's share of total production of all countries expressed in terms of value to that expressed in terms of its share in the total number of units produced is equal to the ratio of the average unit price of production of this country to the average unit price of the total production of all countries.

$$\left(P_v^i / \sum_{i=1}^{n} P_v^i\right) \Big/ \left(P_q^i / \sum_{i=1}^{n} P_q^i\right) = \left(P_v^i / P_q^i\right) \Big/ \left(\sum_{i=1}^{n} P_v^i / \sum_{i=1}^{n} P_q^i\right) \qquad (9.1)$$

where P – gross output,

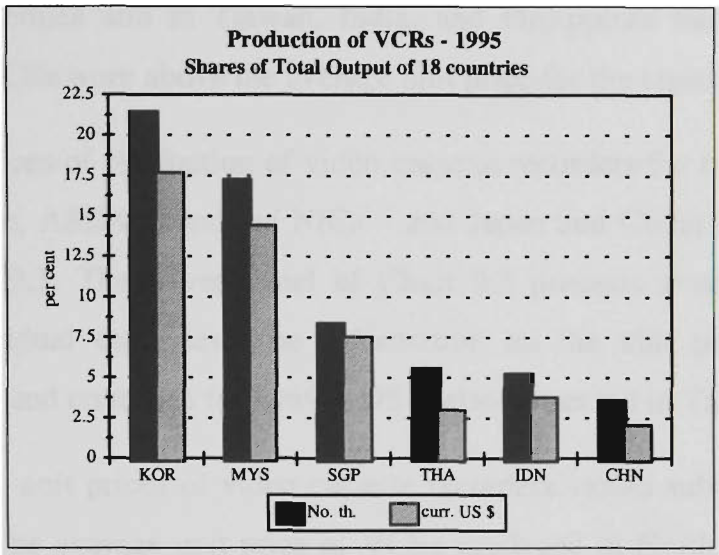
v - value,

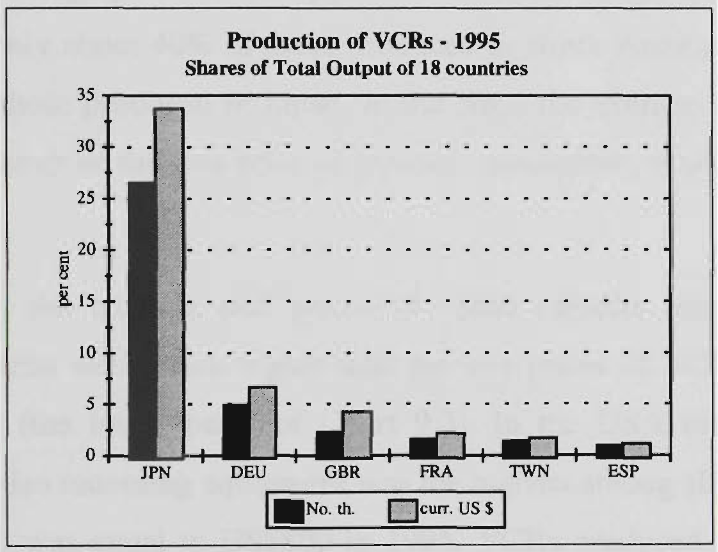
q – quantity (volume),

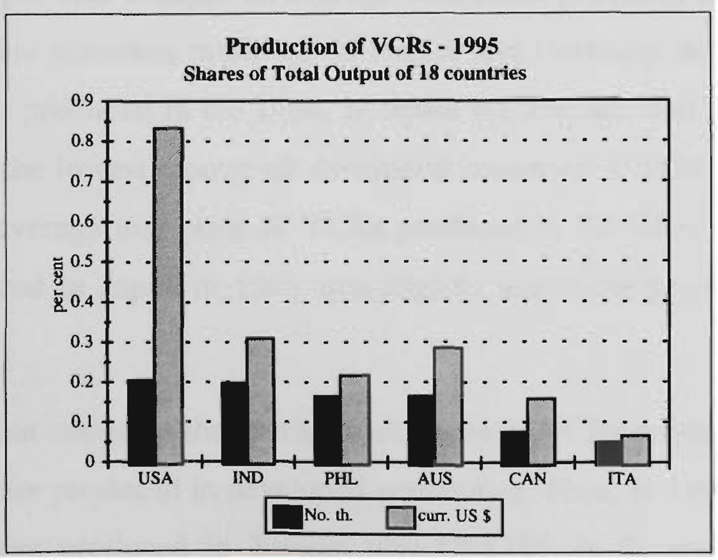
i - a particular country,

n – total number of countries.

Chart 9.2







Source: Estimates based on World Electronics Data 1996, 1997.

Thus, in 1995 in most East Asian countries the average unit prices of production of VCRs were below the average unit price of the total production of the eighteen countries. In developed economies and in Taiwan, India, and Philippines the average unit prices of production of VCRs were above the average unit price for the eighteen countries.

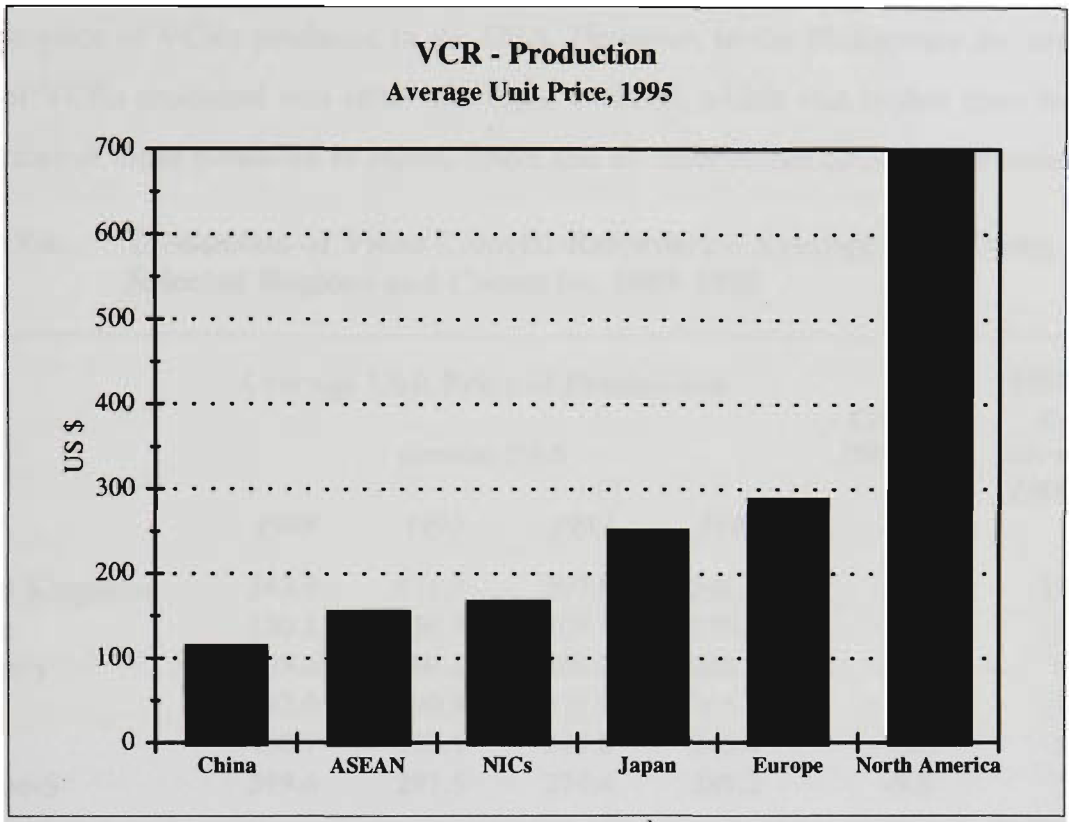
Average unit prices of production of video cassette recorders for the major region – North America, Europe, ASEAN, and the NICs – and Japan and China are shown on the upper panel of Chart 9.3. The lower panel of Chart 9.3 presents average unit prices for the seventeen individual countries. The information on the unit prices of production for selected regions and countries for 1989-1995 is also presented in Table 9.4.

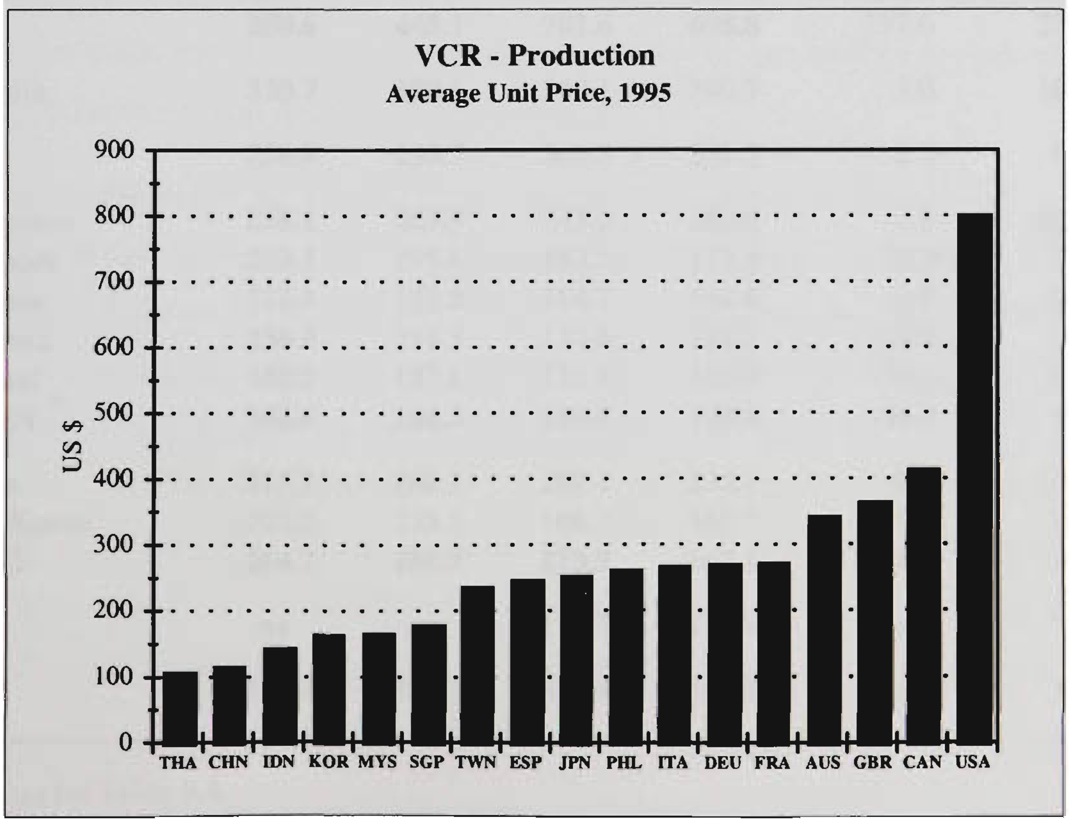
In 1995 average unit prices of video cassette recorders varied substantially across regions and countries. The average unit price of VCRs produced in North America was six times higher than the average price of those produced in China. The unit value of VCRs produced in Europe was only about 40% of those produced in North America, but 15 per cent more expensive than those produced in Japan. In the NICs the average unit price of production was about two thirds of the unit price of Japanese production, while for ASEAN the figure was 62 per cent.

More generally, the average unit prices of video cassette recorders produced in the developed countries were much higher than the unit prices of VCRs produced in the East Asian countries (the lower panel of Chart 9.3). In the USA the average unit price of production of video recording equipment was the highest among all countries considered in this section, and was equal to US$800 in 1995. VCRs produced in the United Kingdom were almost 55 per cent cheaper on average than those produced in the USA. The average unit price of video recorders produced in France and Germany accounted for less than 34 per cent of those produced in the USA. In Spain the average unit price of video recording production was the lowest among all developed countries: US$245, or little more than 30 per cent of the average unit price of VCRs produced in the USA. The unit price of video recorders produced in Japan in 1995 was slightly above the price level of production of Spain.

In most East Asian countries the average unit prices of VCRs produced were lower than the unit prices of those produced in developed economies. Thus, in 1995 the average unit price of video recorders produced in Taiwan was US$235, in Singapore it was US$177, in Malaysia US$164, and in South Korea US$162.

Chart 9.3





Source: Estimates based on World Electronics Data 1996, 1997.

Unit prices of VCRs produced in China and Thailand were especially low. In China the average unit price was only 14.3 per cent, and in Thailand only 13.2 per cent, of the average price of VCRs produced in the USA. However, in the Philippines the average unit price of VCRs produced was relatively high, US$260, which was higher than the average unit prices of those produced in Japan, Spain and all other Asian countries considered here.

Table 9.4 Production of Video Cassette Recorders – Average Unit Prices, Selected Regions and Countries, 1989-1995

	Average Unit Price of Production *current US $*				*Change 1989-1995 %*	*1995 Unit Price, per cent of 1989 level*
	1989	*1991*	*1993*	*1995*		
United Kingdom	345.9	411.7	392.8	362.8	4.9	104.9
France	330.2	195.9	205.4	270.8	-18.0	82.0
Germany	303.6	296.1	268.7	268.7	-11.5	88.5
Italy	292.0	290.9	211.8	265.8	-8.9	91.1
Spain	430.7	322.1	249.8	245.4	-43.0	57.0
Europe-5	**319.6**	**297.5**	**274.4**	**289.2**	**-9.5**	**90.5**
USA	223.5	555.6	1000.0	800.0	257.9	357.9
Canada	296.6	362.3	403.1	412.6	39.1	139.1
NAM	**250.6**	**445.1**	**701.6**	**695.8**	177.6	277.6
Australia	330.7	390.6	340.1	340.7	3.0	103.0
Japan	256.9	250.7	269.5	251.2	-2.2	97.8
Philippines	258.1	263.9	275.0	260.0	0.8	100.8
Singapore	233.1	195.6	182.5	177.4	-23.9	76.1
Malaysia	172.4	153.8	164.7	164.6	-4.5	95.5
Indonesia	236.4	214.3	137.6	142.2	-39.8	60.2
Thailand	159.5	157.1	123.4	105.9	-33.6	66.4
ASEAN	**186.4**	**166.3**	**156.4**	**155.8**	**-16.4**	**83.6**
Taiwan	215.7	269.1	299.4	235.1	9.0	109.0
South Korea	202.8	175.1	166.7	162.7	-19.8	80.2
NICs-2	**204.7**	**181.7**	**173.9**	**167.1**	**-18.3**	**81.7**
China	na	na	111.7	114.4	na	na
India	607.4	510.3	358.5	308.6	-49.2	50.8

Notes: as for Table 9.3.

Source: Estimates based on World Electronics Data 1996, 1997.

As has been noted in the introduction to this chapter, unit prices of production can be affected by a number of factors, including the functional complexity and quality of products produced and the costs incurred in the process of production. Proper laboratory tests and reliability trials of components used in the process of production, and of the final products, are required to provide sufficient information for a comparison of the technical characteristics and quality of products that belong to the same category in a commodity classification. As noted earlier, it is beyond the scope of this research to incorporate the analysis of technical characteristics of particular electronic products. The information on unit prices of production analysed above can, however, shed some light on differentiation across products, in terms of functional complexity and quality. Even if we accept that costs of production influence price settings, this factor alone can hardly justify such marked differences in unit prices across countries. As has been shown in Chapters 6 and 7, the significance of hi-tech products, and of electronic goods in particular, in the composition of international trade flows was growing over time. If higher production costs in developed countries were the only cause of higher prices of produced and traded goods, such production could not be sustained in an increasingly open global environment. Thus it must be the case that unit prices reflect technical characteristics and quality of the products to a substantial degree, rather than simply costs incurred in the process of production. Production costs, and in particular labour costs, can not be accepted as the sole explanation of the differences in unit prices across the countries.

The observation that in the Philippines the average unit price was higher than in many other countries, including Japan, provides a ground to support this view. In the early 1990s the labour costs incurred in the process of production of electronic goods in Philippines were much lower than, for example, in Japan, Singapore and South Korea (see Table 10.5, Chapter 10). The higher unit prices in the Philippines must be supported by higher functional complexity and quality, or these unit prices could not be supported in global markets. Thus, the results of a cross-country comparison of average production unit prices of video recording equipment allow us to conclude that there were significant differences across countries in terms of functional complexity and quality of VCRs produced.

Nevertheless, unit prices of production may be affected by price factors specific to individual countries, including factors related to domestic markets and to the characteristics of the export markets for different countries. The degree of openness to foreign trade (global competition) can vary across countries. In relatively closed economies production prices may not necessarily reflect technical characteristics and the quality of the products – high prices on the domestic markets of closed economies may reflect insufficient supply of particular products rather than high technical standards and quality. In our view, it would be useful to supplement the analysis of production unit prices by a cross-country comparison of unit prices of products exported to the same country, in order to eliminate the effects of price differentials in different national markets. In the next section we will consider unit prices of video cassette recorders imported from different countries into two developed countries, the USA and Australia.

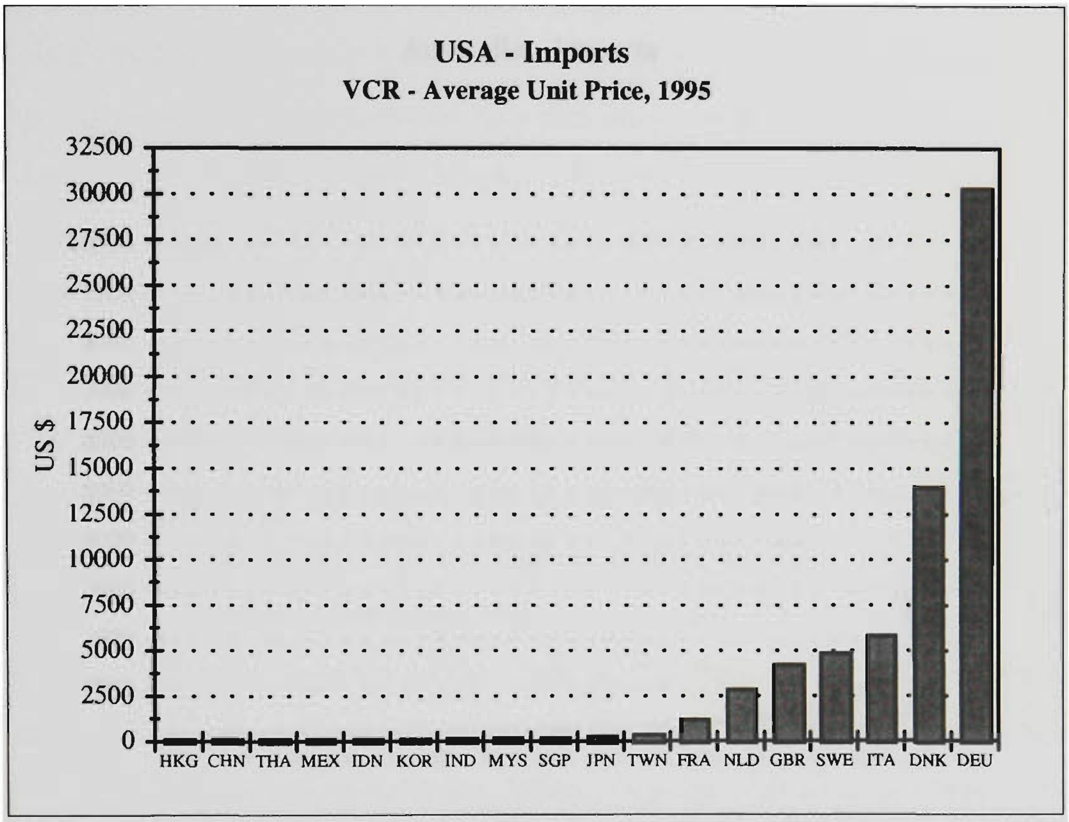
9.2.3 Video Recorders – Unit Values in Trade

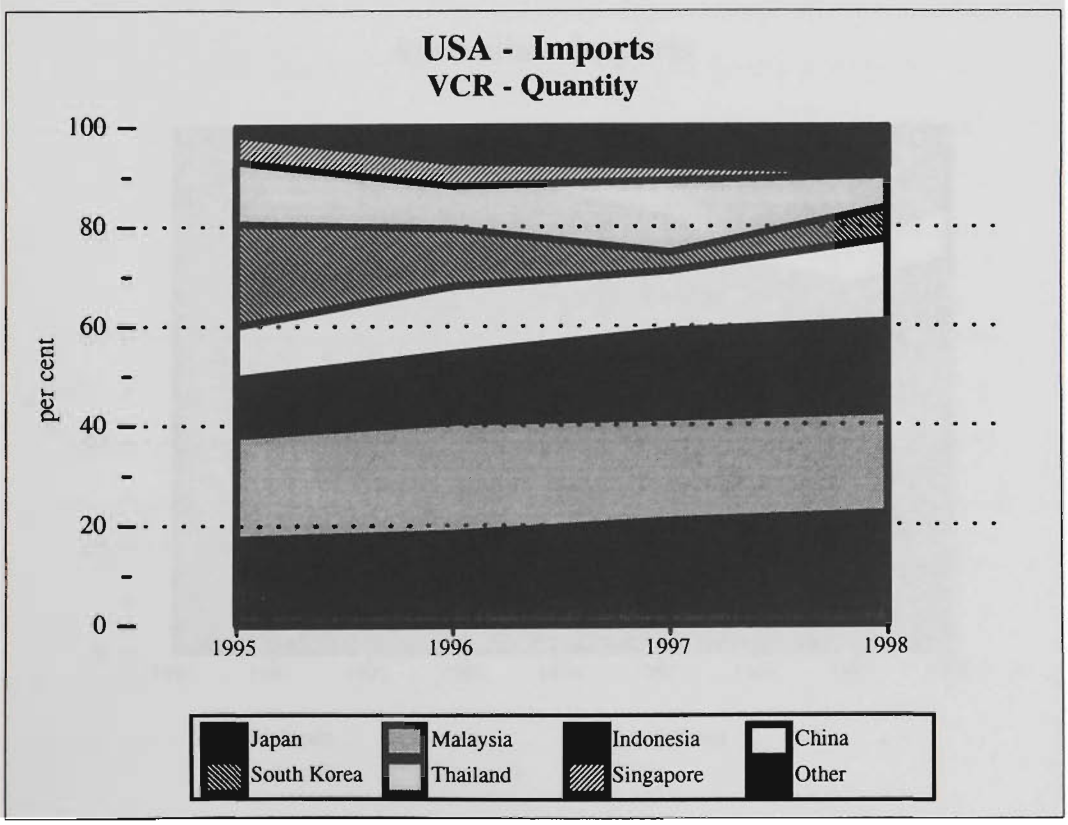
In this section we will analyse the information on imports of VCRs to the USA and Australia in terms of the contribution of particular exporting countries and in terms of the average unit prices of the products imported from different countries. The data, necessary for this analysis, have been accessed through the TradeData system at the Centre for Strategic Economic Studies, Victoria University. This system provides reliable trade statistics, derived directly from Customs declarations and provided by national statistical agencies, for a number of countries, on a comparable basis and at a high level of dissagregation. In this section we have used the data on imports of VCRs defined as magnetic tape-type video recording or reproducing apparatus, whether or not incorporating a video tuner, code 852110, Harmonised Trade Classification.

Import unit prices of video recorders for 1995 are presented in the first panels of Charts 9.4 and 9.5 for the USA and Australia, respectively. Trends in the shares of particular countries, the major exporters of VCRs, in total imports of these products of the two countries are shown on the second panels of the charts, for the 1995-1998 period for the USA and for the 1990-1998 period for Australia. The periods are determined by the availability of the data.

In 1995 the average unit prices of video cassette recorders again varied substantially across countries exporters. In most cases the average unit prices of VCRs imported from developed countries were higher than the prices of the VCRs imported from East Asian countries. Thus, for the imports to the USA (the first panel of Chart 9.4), the average unit price of the VCRs imported from Germany was the highest, US$30,300. The average unit price of VCRs imported from France was the lowest among all the unit prices of video recorders imported from developed non-Asian countries, US$1,200.

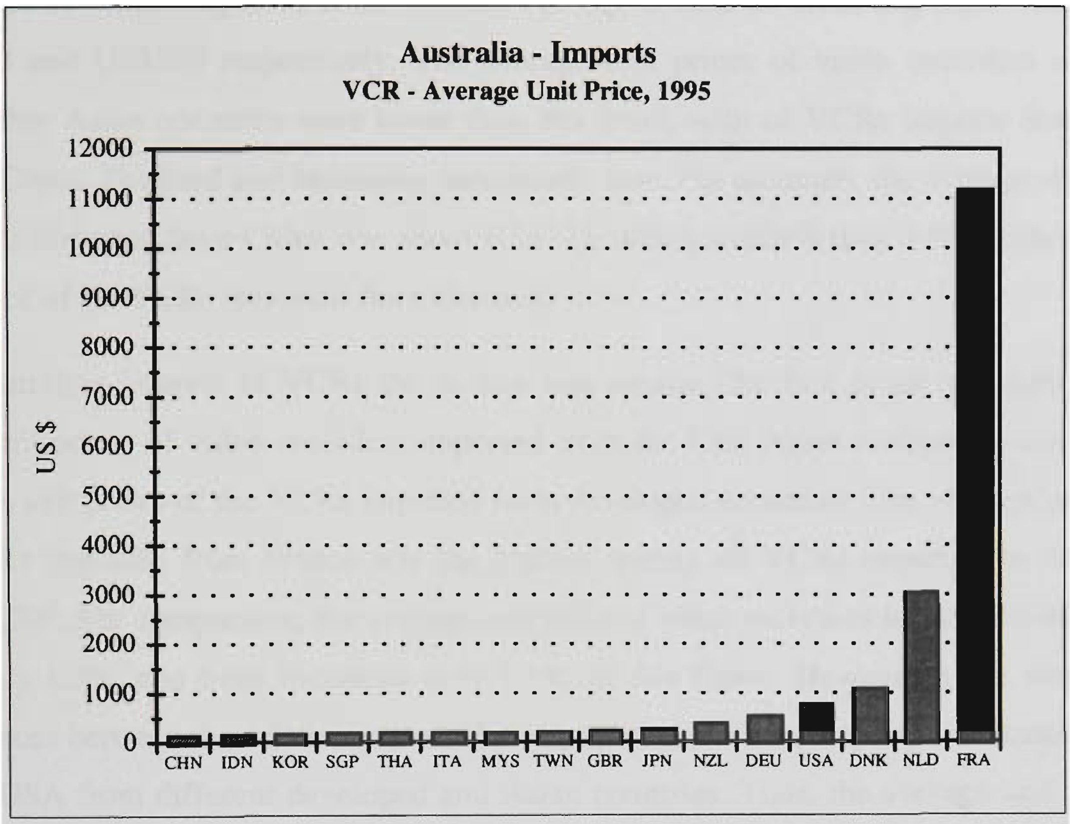
Chart 9.4

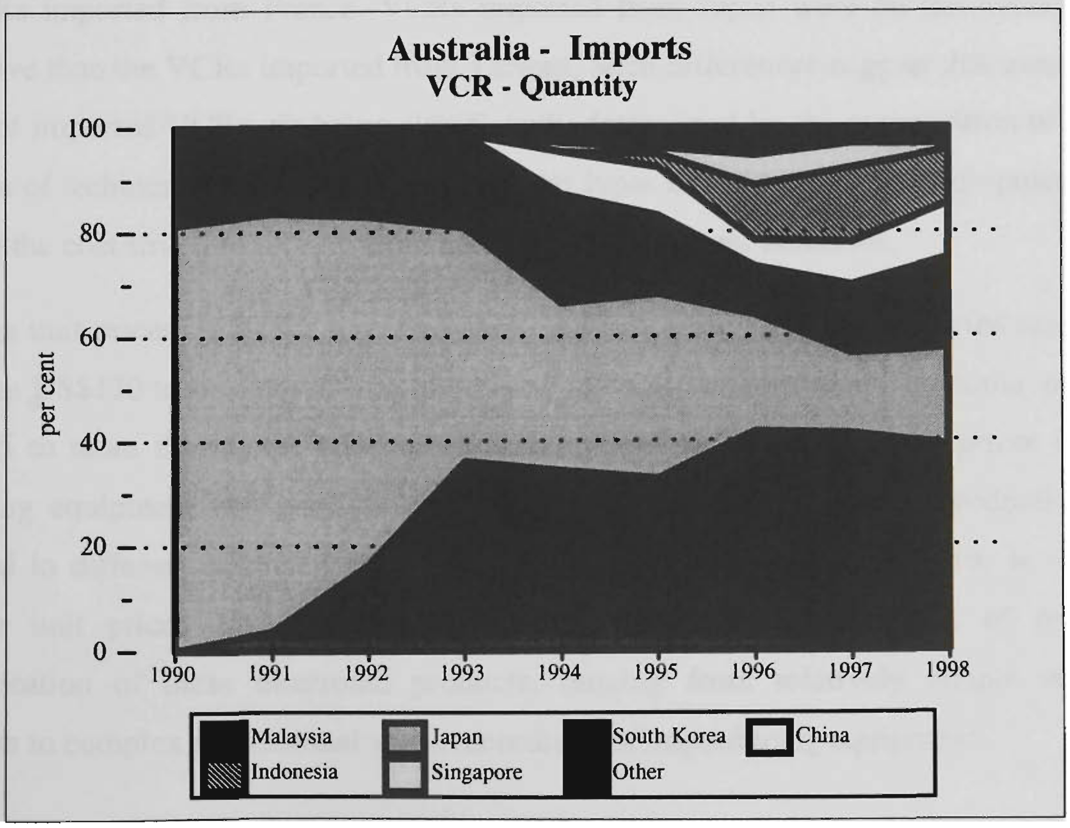




Source: Estimates based on Trade Statistics accessed through TradeData, CSES, VUT.

Chart 9.5





Source: Estimates based on Trade Statistics accessed through TradeData, CSES, VUT.

The average unit price of VCRs imported from Japan was lower than the average unit prices of those imported from other developed countries. It is worth noting that the average unit price of VCRs imported from Taiwan was higher than of those imported from Japan, US$333 and US$270 respectively. The average unit prices of video recorders imported from other Asian countries were lower than this level, with of VCRs imports from Hong Kong, China, Thailand and Indonesia particularly low. For example, the average unit price of VCRs imported from China was about US$125, which was less than 0.5% of the average unit price of the VCRs imported from Germany.

For Australian imports of VCRs the picture was similar (the first panel of Chart 9.5). In 1995 unit prices of video recorders imported from the East Asian economies were lower than the unit prices of the VCRs imported from developed countries. The average unit price of VCRs imported from France was the highest among all VCRs imported to Australia, US$11,200. For comparison, the average unit price of video recorders imported from China was only 1.3%, and from Indonesia only 1.5%, of this figure. However, there were some differences between the relative values of unit prices of products imported to Australia and to the USA from different developed and Asian countries. Thus, the average unit price of video recorders imported to Australia from Germany was lower than the average unit price of VCRs imported from France. VCRs imported from Japan were on the average more expensive than the VCRs imported from Taiwan. Such differences suggest that average unit prices of imported VCRs are being significantly determined by the composition of imports in terms of technical characteristics of particular types of video recording equipment rather than by the cost structure of electronic production of different countries.

Average unit prices of VCRs imported into the USA from different countries range from less than US$120 to more than US$30,000 and of VCRs imported into Australia vary from US$135 to more than US$10,000. Such differentials in the average unit prices of video recording equipment can hardly be explained by differences between production costs incurred in different countries or in the pricing policies of particular firms. In this case average unit prices of VCRs are rather likely to reflect the degree of functional sophistication of these electronic products, ranging from relatively simple consumer products to complex professional video recording and reproducing equipment.

Changes over time in the shares of major exporting countries in total VCR imports to the USA and to Australia are shown in the second panels of Charts 9.4 and 9.5. Two important observations can be made on the basis of the information presented.

First, East Asian countries were the major exporters of video recording equipment to the USA and to Australia.

Second, the shares of countries that exported VCRs characterised by lower unit prices were growing over time. Thus, over the 1995-1998 period, growth in the share of Indonesia and of China in the composition of imports of VCRs to the USA was the most pronounced. The share of Indonesia rose from 11.5 per cent to more than 18 per cent and the share of China increased from 10.5 per cent to 16.5 per cent. With respect to changes in the composition of Australian imports of VCRs, the overall picture was similar to that of the USA. In 1990 Malaysia, China and Indonesia contributed less than 1 per cent each to imports of video recorders to Australia. By 1998 the share of Malaysia accounted for almost 40 per cent, while the shares of China and of Indonesia exceeded 10 per cent. The contribution of Japan to imports of video recorders to Australia diminished significantly over the period. In 1990 the share of Japan constituted more than 80 per cent, in 1998 it was less than 20 per cent. The share of Japan in imports of VCRs to the USA rose only moderately during the 1995-1998 period, from 17 per cent to 22 per cent.

We can conclude that the analysis of the average unit prices of video recording equipment imported to the USA and Australia has again revealed that in the 1990s there were marked differentials between developed and East Asian economies in terms of the functional complexity and quality of video recording equipment produced and exported. The market shares of different countries reflected the differentials between the unit prices of VCRs they exported in inverse order: higher market shares corresponded to lower unit prices. The East Asian economies produced and exported relatively simple video recording products that corresponded to consumer quality standards in domestic markets in the USA and Australia. As a result, these economies were getting higher market shares. Developed countries exported VCRs characterised by high unit prices, which are likely to involve professional functionally sophisticated video recording and reproducing equipment of high quality but of moderate demand. Thus, the case study of video recording equipment suggests that segmentation, in terms of technical sophistication and quality of products, was a dominant feature of the global electronic production of video electronic equipment.

In order to verify that segmentation across countries in terms of the functional complexity and quality of the products was not specific only to video electronic equipment, but a prevailing feature of electronic production more generally, in the next section we will consider another case, that of audio electronic equipment.

9.3 Case Study: Tape Recorders – Pocket-size Cassette Players

The information on production of tape recorders in selected countries regions for the 1985-1995 period is presented in Table 9.5. The shares of production of tape recorders in the overall production of audio equipment are also presented. Countries of particular regions are listed in descending order according to the value of production for 1995. The definition of the commodity group that includes tape recorders varies somewhat across national classification systems (see the notes, Table 9.5). Therefore, the values of the shares of tape recorders in total audio production and the average unit prices calculated on the basis of this information can be considered as indicative only. Further, in this section we will supplement the analysis based on production data by incorporating a case study of pocket-size cassette players based on more accurately defined trade statistics, derived directly from Customs declarations.

As has been noted in Section 9.1, consumer audio products include portable radios and radio recorders, main radios and combinations, car radios and combinations, tape recorders and decks, record players and decks, compact disk players.

The structural significance of tape recorders in the overall production of audio equipment differed substantially across countries. In most East Asian economies tape recorders constituted higher proportions of total audio production than in developed countries. For, example, in Thailand in 1995 the share of tape recorders in total production of audio electronic equipment was the highest among all countries presented in Table 9.5. Over the 1985-1995 period this share increased from 11 per cent to more than 70 per cent. In developed economies, except Spain and Ireland, the share of tape recorders in the overall production of audio electronic equipment were not high.

In terms of the numbers produced East Asian countries were the major producers of tape recorders. In 1995 the number produced in China exceeded the number produced in all other countries presented in Table 9.5, taken together. Malaysia was the second largest producer of tape recorders. Over the 1985-1995 period the number of tape recorders

Table 9.5 Production of Tape Recorders, Shares of Production of Audio Equipment, Selected Countries, 1985-1995

	*Tape Recorders** numbers (thousands)				*Tape Recorders** current US $ million				*Tape Recorders** *Shares of Audio Equipment* % (in current US $)			
	1985	*1990*	*1993*	*1995*	*1985*	*1990*	*1993*	*1995*	*1985*	*1990*	*1993*	*1995*
Germany	42	28	14	26	21.8	35.2	17.0	28.0	5.0	3.6	2.7	4.3
United Kingdom	5	21	53	65	1.3	1.8	9.0	12.7	1.8	1.8	5.9	4.3
Spain	49	33	20	70	8.2	6.9	3.1	9.6	36.2	20.6	16.7	49.4
Denmark	29	21	18	25	5.7	9.2	6.2	8.9	20.4	17.2	11.0	9.3
Ireland	42	50	45	70	1.1	5.0	2.9	4.8	7.1	50.0	40.0	42.9
Italy	254	90	35	6	9.4	5.0	2.5	0.6	23.7	21.4	16.7	5.3
USA	107	831	700	1300	11.0	18.0	22.0	60.0	1.5	3.9	4.8	9.0
Mexico	na	na	1600	2949	na	na	130.0	243.0	na	na	12.6	20.1
Australia	160	150	130	150	2.8	5.5	4.1	4.4	10.5	16.3	20.7	15.8
Japan	na	5805	3292	2053	na	744.8	441.4	265.7	0.0	7.9	4.6	3.4
Malaysia	422	5500	9500	12700	8.9	161.1	323.0	600.0	4.9	12.8	13.3	14.5
Indonesia	744	1050	2700	8700	29.0	26.0	55.0	150.0	58.0	23.4	15.8	19.8
Thailand	70	2882	3200	4500	3.7	47.9	53.4	100.0	11.0	50.1	57.9	71.4
Philippines	285	2049	1800	1900	4.0	35.0	48.0	65.0	30.8	70.0	38.4	32.0
Singapore	2060	1608	1069	1400	34.1	51.9	41.4	42.3	7.2	4.2	3.8	3.4
South Korea	na	11610	6000	3500	527.0	641.0	487.0	224.0	74.0	29.6	26.6	11.6
Hong Kong	2631	6370	6150	6700	27.0	92.6	64.7	71.2	5.8	12.9	7.5	7.2
Taiwan	15539	6413	2022	1323	68.8	82.5	46.9	49.7	8.7	9.2	8.0	8.9
China	na	na	45000	59328	na	na	250.0	361.0	na	na	10.0	8.9

Notes: AUS, IDN, MEX – tape recorders, DNK, DEU, IRL, ESP, GBR, USA - tape recorders & decks, CHN - tape recorders & players, JPN - tape decks, MYS - record players & tape recorders, TWN - cassette decks, HKG, SGP - cassette recorders, PHL - radio recorders, KOR - radio recorder/players other, ITA - record players & decks, THA - other audio equipment.

Source: Estimates based on World Electronics Data 1996, 1997.

produced in Malaysia increased from 422,000 to 12.7 million, a figure almost ten times greater than the number of tape recorders produced in 1995 in the USA. The relative positions of Indonesia, Hong Kong, Thailand, and South Korea in terms of the number of units produced of production of tape recorders were also quite strong.

A comparison between trends in unit production and in the value of production of tape recorders of different countries indicates that there were quite marked variations in the unit prices of tape recorders across the countries. Thus, in Germany, Denmark, Australia and Singapore the numbers produced decreased over the 1985-1995 period, while the value of production increased. In Ireland, Italy, Malaysia, Philippines, Hong Kong and Taiwan the growth of the value of production of tape recorders exceeded growth in unit production. In the United Kingdom, Spain, the USA, Indonesia and Thailand, by contrast, production was growing more rapidly in terms of units than in terms of value.

The average unit prices of production of tape recorders for selected countries for the 1985-1995 period are presented in Table 9.6. Several observations can be made on the basis of this information.

First, the average unit prices of tape recorders varied substantially across countries, ranging in 1995 from US$6 in China to more than US$1000 in Germany. Such pronounced differences between the unit prices in different countries are indicative of the marked differences across countries in terms of the technical characteristics and quality of the tape recorders produced.

Second, in Asian countries the average unit prices of production of tape recorders were lower than in most developed economies. This fact implies that Asian countries were specialising in production of relatively simple tape recording equipment, presumably for the consumer market. High unit prices of tape recorders produced in developed countries, such as Germany, Denmark and the United Kingdom, indicate that this audio recording equipment was of higher functional complexity, most likely for professional and semi-professional applications.

Third, there were marked differences across countries in terms of the changes in the unit prices of tape recorders over time. For, example, in Germany, Denmark, Ireland, Italy, Australia, Malaysia, Philippines, Singapore and Taiwan the average unit price increased during the 1985-1995 period. In the United Kingdom, Spain, the USA, Indonesia, Thailand

and Thailand there was a decrease in the unit value of production. This fact indicates that there were changes in terms of functional sophistication of particular types of audio recording equipment produced in different countries. However, other factors such as changes in the cost structure of production, in the demand conditions of domestic markets in different economies and in the price policies of particular firms might also have some effects. Besides this, as has been noted above, the definition of the commodity group that includes tape recorders varies somewhat across national classification systems, and thus production statistics used in this analysis could incorporate a wide range of audio recording and reproducing equipment.

Table 9.6 Production of Tape Recorders – Average Unit Prices, Selected Countries, 1985-1995

	Average Unit Price of Production *current US $*				*Change 1985-1995 %*	*1995 Unit Price, per cent of 1985 level*
	1985	*1990*	*1993*	*1995*		
Germany	518.3	1256.6	1212.1	1075.8	107.6	207.6
United Kingdom	259.7	85.0	169.0	195.4	-24.8	75.2
Spain	167.1	208.2	157.1	137.5	-17.7	82.3
Denmark	195.2	438.5	342.9	357.1	83.0	183.0
Ireland	25.3	100.0	65.4	69.1	172.9	272.9
Italy	37.1	55.6	72.6	102.2	175.6	275.6
USA	102.8	21.7	31.4	46.2	-55.1	44.9
Mexico	na	na	81.3	82.4	na	na
Australia	17.5	36.5	31.4	29.6	69.5	169.5
Japan	na	128.3	134.1	129.4	na	na
Malaysia	21.0	29.3	34.0	47.2	124.7	224.7
Indonesia	39.0	24.8	20.4	17.2	-55.8	44.2
Thailand	53.0	16.6	16.7	22.2	-58.1	41.9
Philippines	14.0	17.1	26.7	34.2	143.8	243.8
Singapore	16.5	32.3	38.7	30.2	82.4	182.4
South Korea	na	55.2	81.2	64.0	na	na
Hong Kong	10.2	14.5	10.5	10.6	3.6	103.6
Taiwan	4.4	12.9	23.2	37.6	748.7	848.7
China	na	na	5.6	6.1	na	na

Notes: as for Table 9.5.

Source: Estimates based on World Electronics Data 1996, 1997.

Below we will consider a case study of a homogeneous audio electronic product, the pocket-size cassette player, imported from different countries into the two developed economies, the USA and Australia. As in the case of video recorders, this approach will allow us to eliminate the effects of price differentials across different national markets.

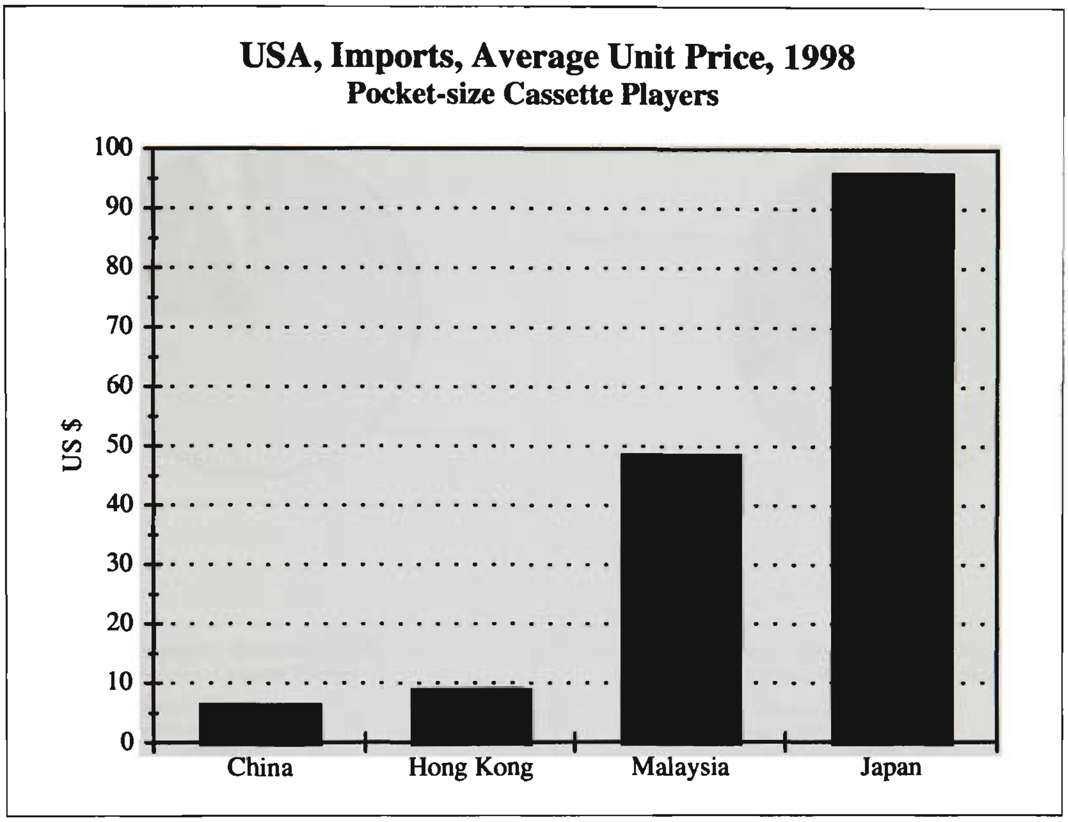
The data on imports to the USA and to Australia have been provided by TradeData, as noted above. In trade statistics for the USA pocket-size cassette players are identified by the code 8519920000 of the Harmonised Trade Classification. For Australia pocket-size cassette players with sound reproducing apparatus, not incorporating a sound recording device, are classified by the code 8519920057 of the same classification.

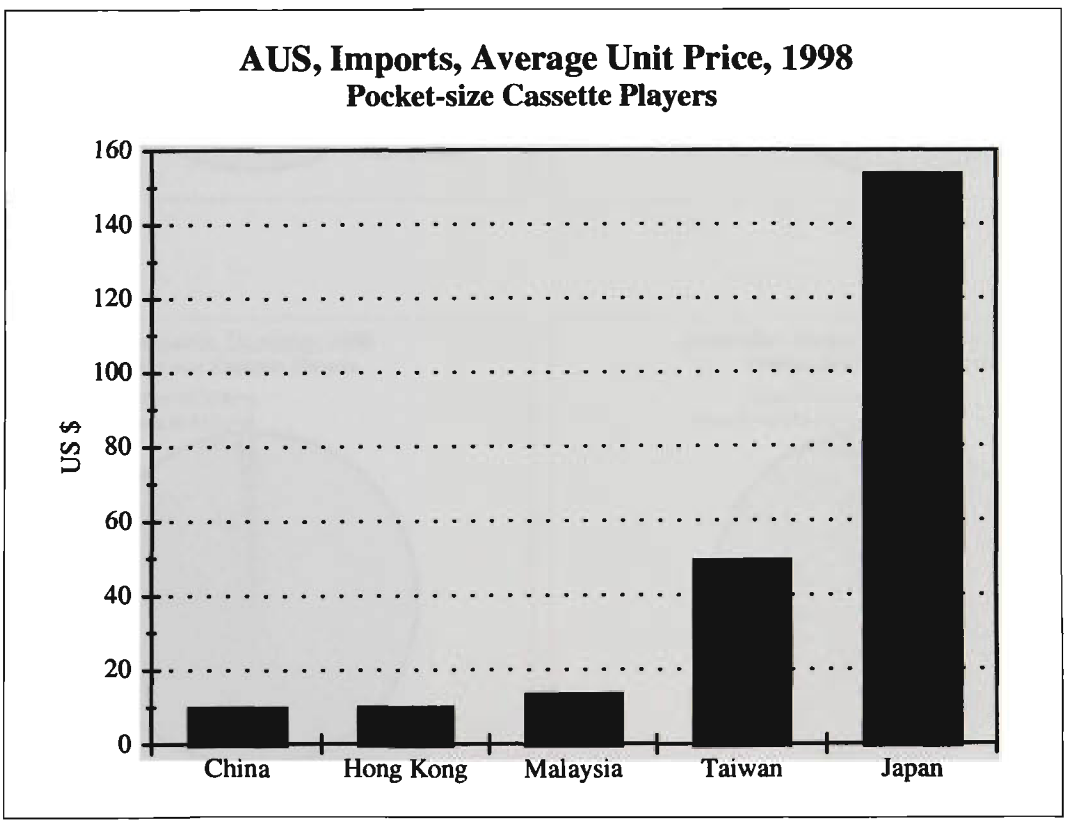
Import unit prices of pocket-size cassette players for 1998 are presented on Chart 9.6, on the first panel for the USA and on the second panel for Australia. Trends in the shares of particular countries, the major exporters of pocket-size cassette players, in total imports of these electronic devices of the two countries, for the 1996-1998 period, are shown on Chart 9.7.

East Asian economies were the major exporters of pocket-size cassette players to the USA and to Australia. In 1998 the average unit price of pocket-size cassette players varied substantially across the exporting countries. The average unit price of cassette players imported from Japan was significantly higher than the unit prices of similar electronic products imported from other Asian economies. Thus, in the case of imports to the USA (the first panel of Chart 9.6) the average unit price of Japanese-made pocket-size cassette players was for US$96. The average unit price of cassette players imported from Malaysia was only about half this figure, and the unit price of such devices imported from China was only US$6.40, which was only about 6% of the unit price of Japanese exports. In the case of imports to Australia (the second panel of Chart 9.6) the difference between the unit prices of cassette players imported from different Asian economies was even more marked. The average unit price of Japanese exports amounted to US$154, the unit price of the players imported from Taiwan was more less than one third of this and from China only about 6% of this figure.

Marked differentials in the average unit prices of pocket-size cassette players imported to the USA and Australia indicate that even for this, relatively homogeneous, electronic product the degree of variation in technical characteristics (and quality) was quite high.

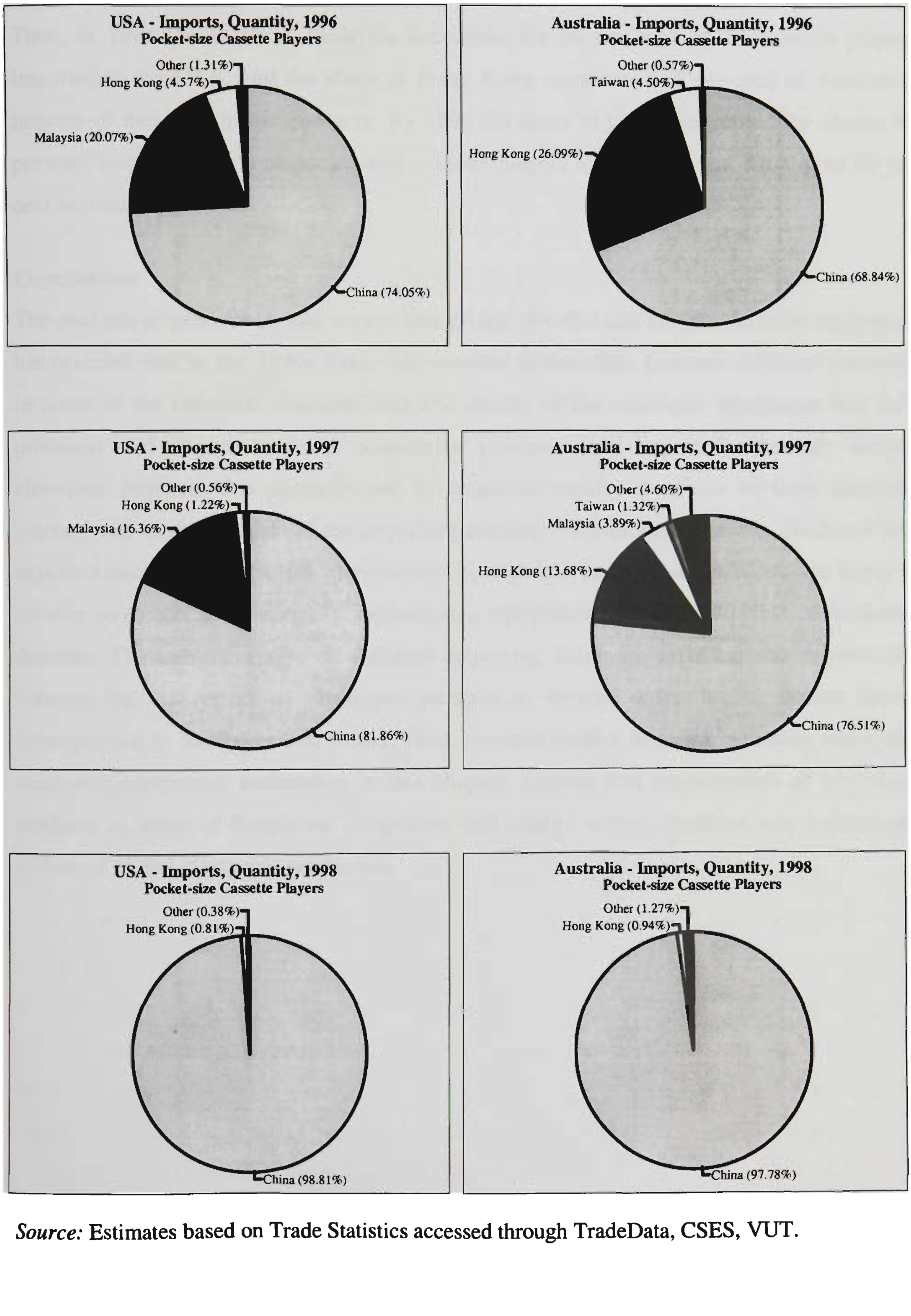
Chart 9.6





Source: Estimates based on Trade Statistics accessed through TradeData, CSES, VUT.

Chart 9.7



Source: Estimates based on Trade Statistics accessed through TradeData, CSES, VUT.

Changes in the shares of the major countries exporting pocket-size cassette players to the USA and to Australia over time (Chart 9.7) confirm that the market shares of countries that exported electronic products characterised by lower unit prices were growing over time. Thus, in 1996 the share of Malaysia accounted for 20 per cent of all cassette players imported to the USA, and the share of Hong Kong constituted 26 per cent of Australian imports of these electronic products. By 1998 the share of China accounted for almost 99 per cent of total imports of pocket-size cassette players in the USA and for almost 98 per cent in Australia.

Conclusions

The analysis of production and import unit prices of video and audio electronic equipment has revealed that in the 1990s there were marked differentials between different countries in terms of the technical characteristics and quality of the electronic equipment that they produced and exported. Asian economies produced and exported relatively simple electronic products that corresponded to consumer quality standards in their domestic markets and in the markets of the importing countries. Developed countries produced and exported electronic equipment characterised by high unit prices. Such products are likely to involve professional functionally sophisticated equipment of high quality but of moderate demand. The market shares of different exporting countries reflected the differentials between the unit prices of electronic products in inverse order: higher market shares corresponded to the lower unit prices. Thus, the case studies of video recording and audio electronic equipment, undertaken in this chapter, suggest that segmentation of electronic products in terms of functional complexity and quality across countries was a dominant feature of global electronic production.

PART D

THE NATURE OF COMPUTING AND ELECTRONIC PRODUCTION AND NATIONAL INCOME

The fourth group of chapters (Chapters 10-12) extends the analysis of the nature of computing and electronic production further, with the objective of exploring the extent to which the high income generating potential of the computing and electronics industries was actually realised in different countries. Productivity, labour costs and the income generated in the selected countries are analysed both in the computing and electronics and in other industries. These chapters also explore the broader linkages between the changes in industry structure, through growth in the computing and electronics industries, and convergence in levels of GDP per capita. The conclusion is that, for some East Asian countries, the computing and electronics industries exhibit few of the characteristics associated with high income potential, and show little difference from other industries in terms of value added, productivity, labour costs and income of employees. Thus, for these countries, to the extent to which the shift in industrial structure contributed to rapid growth, this would have to be due to the high growth characteristics of these industries rather than to their status as advanced industries.

A cross-country analysis of labour productivity, value added and the structure of production, and the output of R&D activities in the computing and electronics industries is undertaken in Chapter 10. One of the conclusions of this chapter is that, in developed countries, structural change in domestic manufacturing production towards a greater proportion of industries of high income generating potential, such as computers and electronics, was positively correlated with growth in value added and productivity and negatively correlated with employment growth. In Asian countries structural change in manufacturing value added was positively correlated with growth of employment, but there was no statistical evidence about the correlation between structural change in domestic manufacturing production and growth in value added and productivity. In most Asian economies productivity in the computing and electronics industries was significantly below the productivity levels achieved in the developed countries. In South Korea, Singapore and Hong Kong, however, the growth of productivity was quite pronounced, and the productivity levels approached the levels achieved in some developed economies. Another conclusion of this chapter is that in many countries the levels of productivity in the computing and electronics and in the textiles and clothing industries were similar. This implies that the income generating potential of the computing and electronics industries was not fully realised. The analysis of the structure of production indicates that knowledge-intensive production activities, generating high value added and high earnings, did not play a significant role in the computing and electronic industries in most Asian countries. The analysis of patent data has confirmed this conclusion: in Asian countries, except Japan, South Korea and Taiwan, R&D activities did not generate results in any way comparable with those of the developed countries. The overall conclusion is that the high income generating potential, that characterised computing and electronics industries according to global benchmark indicators, was not fully utilised in many countries in East Asia.

Chapter 11 further investigates the nature of production activities in the computing and electronics sectors of different economies, through an analysis of whether the computing and electronics industries generated strong economic returns to employees in the form of wages or, alternatively, whether production activities were mainly based on low labour costs. One of the conclusions of this chapter is that, in the developed countries, structural change in domestic manufacturing production towards a higher income generating potential was positively correlated with the growth of wages and wages per employee and negatively with employment growth. In East Asian countries structural change in manufacturing value added was positively correlated with growth of employment, but there was no statistical evidence about the correlation between structural change and the growth of wages and wages per employee. Another conclusion of this chapter is that there were distinct differences across Asian economies in terms of labour costs per unit of employment in the computing and electronics industries, and these differences became more pronounced over time. In Hong Kong, Singapore and South Korea labour costs in the computing and electronics industries were converging towards the levels reached in the developed economies, while in other East Asian countries such a trend was not observed. In all East Asian countries, except Japan, labour costs were substantially lower than in the developed economies. A cross-industry comparison between the trends in growth of wages per employee has revealed marked differences between developed and East Asian economies. In most developed non-Asian economies wages per unit of employment in the computing and electronics industries were higher than, and were growing at a higher rate than, wages in the total manufacturing sector. In Singapore, South Korea, Malaysia and the Philippines wages per employee in total manufacturing were growing more rapidly than in the computing and electronics industries. In the 1990s in Singapore and South Korea wage costs in overall manufacturing production were higher than in computing and electronics and in Malaysia wages per employee in these two sectors were exactly the same. Another conclusion of this chapter is that there is no statistical evidence of a correlation between the structure of electronic production, evaluated in terms of relative global demand for different electronic products, and wages per employee. However, the output of national technological innovation, expressed by the number of patents granted, is positively correlated with wages per employee and the change in the number of patents is positively correlated with growth of wages per employee. The overall conclusion of this chapter is that low wage rates remained an important element in the expansion of the computing and electronics industries in East Asian up to the 1990s. The findings thus provide confirmation that the high income generating potential of the computing and electronics industries, in the form of the generation of strong economic returns to employees in the form of wages, was not fully utilised in East Asian economies.

The review and summary of the findings of the thesis are presented in the concluding Chapter 12, in an attempt to give answers to the general and specific questions of the topic of research. In terms of the impact of increased activity in these industries on growth and improved competitiveness in the East Asian countries, the overall conclusion is that the fact that many countries in East Asia experienced a pronounced shift in industrial structure towards a higher proportion of the computing and electronics industries did indeed contribute to their rapid growth over the 1970-1995 period. But for many of these countries, particularly Malaysia, Thailand, the Philippines and Indonesia, the relevant characteristic of these industries was their rapid global growth rather their advanced technology status. Other than the stimulus to demand and to the balance of payments, little has yet been contributed to a broader national competitiveness that would allow these countries to approach and sustain the living standards of the developed countries. As a result, these East Asian economies remain vulnerable to shifts in the pattern of global sourcing of computing and electronics products. For other countries – such as South Korea and Singapore – the situation is somewhat different. While the nature of their products and production processes did remain limited by the standards of the developed countries over the period studied, there was serious involvement with the advanced technology aspects of the computer and electronics industries. In these industries, the output of R&D was relatively strong, and production activities were increasingly focused on high quality products and high value added processes. As a result, those effects of industrial structure on growth and competitiveness linked to the advanced nature of these industries - direct, high value effects and spillovers to other industries - are likely to have become increasingly important in these countries.

These conclusions allow us to give partial answers to the two more general questions of the thesis. The first of these concerned whether, at the current stage of technological development, a high level of production capability in the computing and electronics industries is either a necessary or a sufficient condition for a high level of national competitiveness. In terms of the sufficiency condition, our answer is clear. Possession of an advanced industrial structure is not sufficient for high levels of competitiveness. Genuine participation in the advanced industries, such as the computers and electronics, at an advanced level is also required. The issue of the necessity condition for a particular economy should be considered in relation to the existing competitive strengths of this economy, in terms of both natural and created comparative advantages. Thus, to derive an exact answer to the question of which industrial structure is the most conducive to economic growth in a particular economy, extensive country-specific research is required. This would investigate, inter alia, to what degree the income generating potential of advanced industries can be utilised in given national conditions. Such country-specific analyses are beyond the scope of this thesis. However, the conclusions reached in this study indicate that such research is worth pursuing.

In relation to the more general question of the link between advanced industrial structure and national competitiveness, we can conclude that specialisation in economic activities characterised by high income generating potential, or in other words, an industrial structure conducive to income generation, is not a sufficient condition for improving substantially the living standards of the population and for achieving high levels of national competitiveness by international standards. As the experience of many East Asian countries has demonstrated, it is possible to move rapidly to an apparently advanced structure, without either the products made, or the processes by which they are made, reflecting the advanced nature of these industries. While there are good reasons to believe that an advanced industrial structure, with its potential fully realised, will contribute greatly to national competitiveness, it is necessary for the high income generating potential of that industrial structure to be realised for this to be achieved.

CHAPTER 10

COMPUTERS AND ELECTRONICS: PRODUCTIVITY, VALUE ADDED AND THE STRUCTURE OF PRODUCTION

In the previous chapters we have considered production of and trade in computing and electronic equipment from a number of perspectives. In Chapters 6 and 7 the performance of different countries and regions in trade in products of computing and electronics industries has been evaluated. In Chapters 8 and 9 the segmentation of global electronic production across countries has been analysed in terms of particular areas of specialisation in computing and electronic goods and in terms of case studies relating to the functional complexity and quality of specific electronic equipment produced in different economies. In this chapter we will extend the analysis of electronic production further, with the objective of discovering the extent to which the high income generating potential of the computing and electronics industries was actually realised in different countries. First, we will analyse whether structural change in the manufacturing sector was correlated with manufacturing productivity growth in different economies. Second, the patterns of the change in productivity growth across manufacturing industries in different countries will be considered. Third, a cross-country comparison between trends in productivity in the computing and electronics industries and in other manufacturing industries will be undertaken. Fourth, the structure of computing and electronic production in different economies will be analysed. Finally, patenting activities in the computing and electronics in different countries will be considered.

10.1 The Correlation between Structural Change in the Manufacturing Sector and Performance Variables

As has been suggested in Chapter 4, manufacturing industries differ to a large extent in terms of their potential to generate economic wealth. Thus, the higher the proportion of industries characterised by a high income generating potential in the composition of a given manufacturing sector the higher the potential of that sector to generate income. That potential may not, of course, be realised. The objective of this section is to find out whether changes in the composition of the manufacturing sector towards high income generating potential were associated with the growth in productivity and income, generated by the manufacturing sector, in different countries.

For this purpose, we will test whether there is a positive correlation between structural change in manufacturing value added and the growth of manufacturing value added, employment and productivity. It is not intended through these tests to determine causality between the variables; nor do we imply that structural change of manufacturing value added is the only factor associated with the dependent variables. The purpose of the panel regression analysis, the results of which are discussed below, is to establish whether there is a positive correlation between the variables and, if so, whether such a positive correlation is the prevailing situation for different groups of countries.

The results of the panel regression tests between structural change in domestic manufacturing value added and the growth of manufactured value added, employment and productivity are presented in Table 10.1. The Index of the Long Run Income Potential of manufacturing value added has been used as the independent variable, and manufacturing value added, employment and value added per employee (productivity) are the dependent variables in the various regressions. All variables are in logarithmic form. The data set covers thirteen countries (see the notes, Table 10.1) for the period 1981-1995. The data are unbalanced, the number of observations for individual countries depends on the availability of the data. The sample is subdivided into two sub-samples: the first covers four Asian countries, India, South Korea, the Philippines and Singapore, and the second incorporates nine developed countries (see the notes, Table 10.1).

A fixed effects model has been used. This assumes a homogeneous slope and heterogeneous intercepts across sections, in our case representing particular countries. Application of this model allows us to test whether the slope coefficients for individual countries constituting a sample are similar, and, if so, to determine whether there is a correlation between the variables. Thus, by applying a fixed effects model we can define subsets of countries that exhibit similar coefficients between the variables. Analysis of covariance, based on an F-test, is used to test the acceptance of the restriction of homogeneity of the relevant regression coefficients. A value of F exceeding the critical value indicates that the assumption of a common slope coefficient is not valid. In this case a single least-squares regression using all observations of the cross-sectional units through time may be seriously biased, and the pooled least-square estimates may lead to false inferences (see, for example, Hsiao 1986, pp. 5-18).

Table 10.1 Regression Results of the Effects of Structural Change in Manufacturing Value Added on Growth of Manufacturing Value Added, Employment, and Productivity

Independent variable – ln of values of the Index of Long Run Income Potential of Manufacturing Value Added

	Coeff-t	t-ratio	R-sq. adj.	Number of observations	SEE	F test $(A_i, B = A_i, B_i)$	Critical F value
Value Added	*Dependent variable – ln of values of Manufacturing Value Added (bill. curr. $ US)*						
All countries (13)[1]	12.06	9.94	0.967	155	12.81	3.09	5.13
Asian countries excl. Japan (4)[2]	11.64	7.63	0.887	50	5.46	9.06	3.70
Other countries incl. Japan (9)[3]	14.40	5.05	0.957	105	7.28	1.08	4.63
Employment	*Dependent variable – ln of values of Manufacturing Employment (mill.)*						
All countries (13)[1]	1.39	3.57	0.993	155	1.31	5.43	5.13
Asian countries excl. Japan (4)[2]	2.30	3.95	0.988	50	0.80	2.36	3.70
Other countries incl. Japan (9)[3]	-3.68	-7.32	0.998	105	0.23	2.27	4.63
Productivity	*Dependent variable – ln of values of Manufacturing Value Added per Employee (th. curr. $ US)*						
All countries (13)[1]	10.68	9.60	0.919	155	10.74	3.56	5.13
Asian countries excl. Japan (4)[2]	9.34	8.02	0.935	50	3.18	9.85	3.70
Other countries incl. Japan (9)[3]	18.08	6.49	0.626	105	6.96	1.32	4.63

Notes: 1. AUS (81-85, 87-91), CAN (81-95), DEU (81-93), ESP (81-92), GBR (81-92), ITA (89-91), SWE (81-94), USA (81-95), IND (81-92), JPN (85-95), KOR (81-94), PHL (83-92), SGP (81-94);

2. IND (81-92), KOR (81-94), PHL (83-92), SGP (81-94);

3. AUS (81-85, 87-91), CAN (81-95), DEU (81-93), ESP (81-92), GBR (81-92), ITA (89-91), SWE (81-94), USA (81-95), JPN (85-95).

Source: Estimates based on Production Statistics, from IEDB database.

The regression results for the sample incorporating all thirteen countries show a positive correlation between structural change and the growth of manufacturing value added. The results of the panel regression for the data sample covering four Asian countries should be rejected on the basis of F test. These results indicate that there is a significant variation in individual countries' coefficients. Another panel test, for developed countries, has led to statistically significant results, indicating a positive correlation with a coefficient on the dependent variable higher than the coefficient derived on the basis of testing the aggregated sample, namely 14.4 in comparison with 12.06.

In terms of the correlation between the structural change of manufacturing value added and changes in the numbers of employed in manufacturing sector, the results are quite different to those described above. The results of the regression, for all thirteen countries, show no common coefficient, on the basis of F-test. Disaggregation of the data set into two groups, however, leads to statistically significant results for both sub-samples. For Asian countries the coefficient is positive, equal to 2.3, while for developed countries it is negative, minus 3.68. These results indicate that the structural change in manufacturing production towards a high income generating potential embodied in the industrial structure is positively correlated with employment growth for four Asian countries and negatively correlated for the developed economies.

The results of panel regressions between the structural change and productivity growth are similar to the results of the first set of tests. There are statistically significant results for the aggregated data sample, covering all thirteen countries, and for the second disaggregated sample, incorporating nine developed countries. Both coefficients are positive, and the coefficient of the regression for developed countries is higher than the coefficient for the aggregated sample, 18.08 as against 10.68 respectively. The results of the first regression, covering four Asian countries, do not allow us to draw any conclusion about the correlation between the variables. The results should be rejected on the basis of F test, thus indicating significant variation in individual countries' coefficients.

The panel regression tests have shown a marked difference between developed economies and four Asian countries included in the data sample. For developed countries structural change in domestic manufacturing production towards a high income generating potential embodied in the industrial structure is positively correlated with the growth of generated value added and productivity and negatively with employment growth. For four Asian countries the structural change of manufacturing value added is positively correlated with the growth of employment. However, the panel regression results do not allow us to draw any conclusion about the correlation between structural change and the growth of value added and productivity, thus indicating that there are significant differences between the individual countries.

10.2 The Structure of Manufacturing Productivity Growth

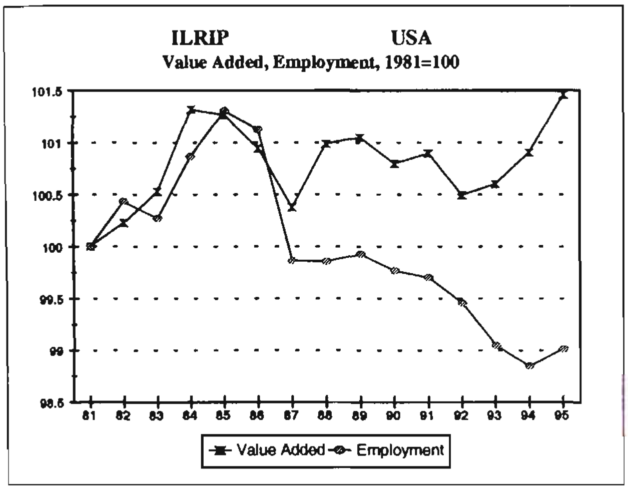
In this section we will study the pattern of changes in productivity growth across manufacturing industries in different countries.

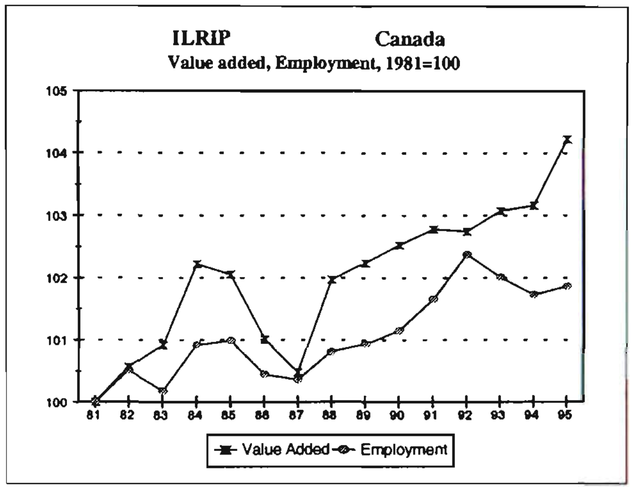
The changes in the composition of manufacturing value added and employment for selected countries are shown on Chart 10.1. Manufacturing structure is evaluated in relation to the income generating potential embodied in industrial structure. Higher values of the Index are associated with greater proportions of industries characterised by a high income generating potential. Being applied to value added generated in the manufacturing sector as a whole, high values of the Index indicate that the value added generated in industries of high income generating potential constitute high proportions of total manufacturing value added. Similarly, being applied to manufacturing employment, high values of the Index indicate that persons employed in industries of high income generating potential constitute high proportions of the total number of employed in manufacturing sector. Thus, by comparing the values of the Index for value added with the corresponding values for employment we can estimate the differences between the industrial composition of manufacturing value added and the industrial composition of manufacturing employment.

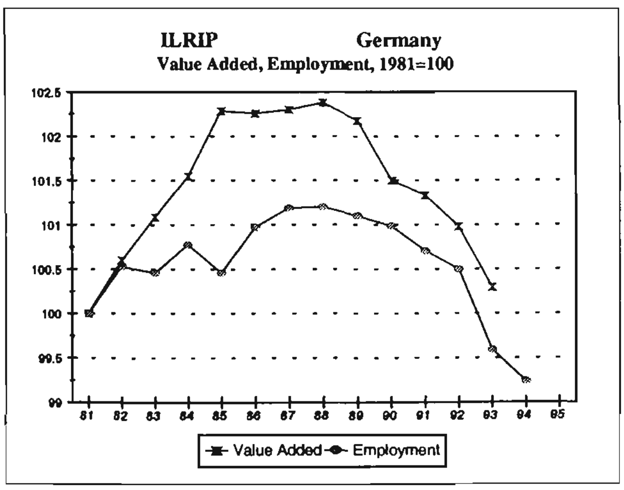
The values of the Index of Long Run Income Potential (ILRIP) are presented in Chart 10.1 with the value of the ILRIP for 1981 equal to 100. Because of data limitations 1983 has been used as the base year for Philippines and 1985 for Japan. Original values of the Index for Long Run Income Potential, that enable a cross-country comparison between the structural composition of manufacturing value added relative to the composition of employment, for these countries are shown on Chart 10.A1 in the Appendix.

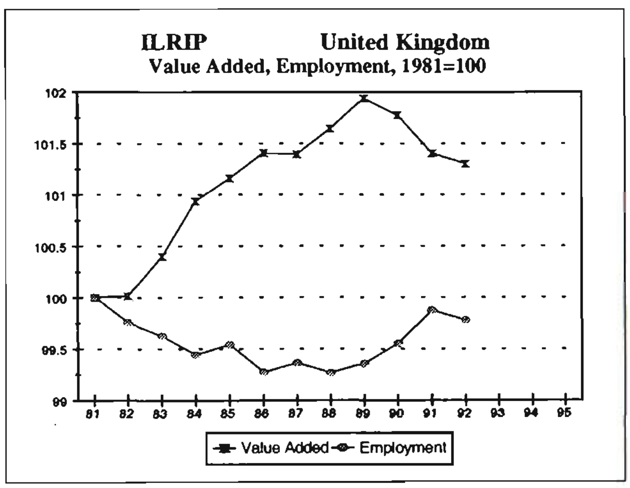
An increasing gap between the trends for the values of the Index for value added and for employment was a common feature for most non-Asian developed countries, at least at particular periods of time (Chart 10.1). The widening gap between the values of the Index for value added and employment indicates that while value added generation was

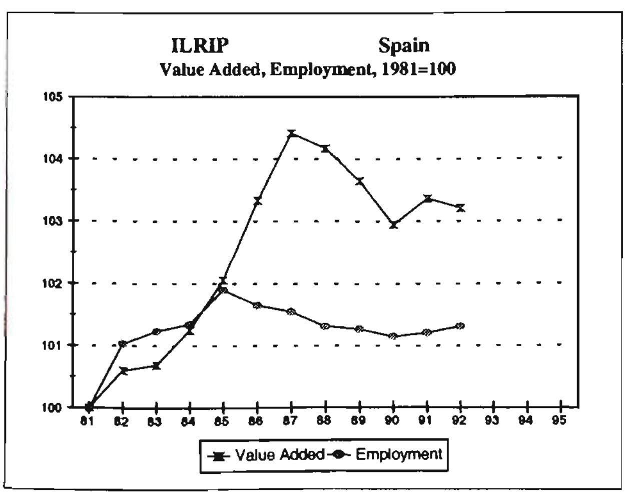
Chart 10.1

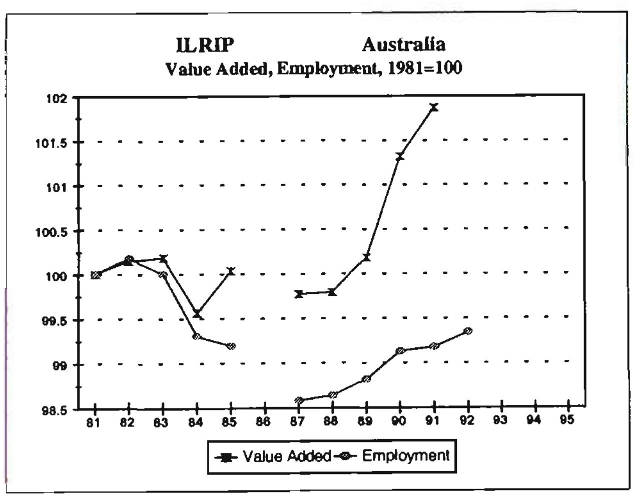












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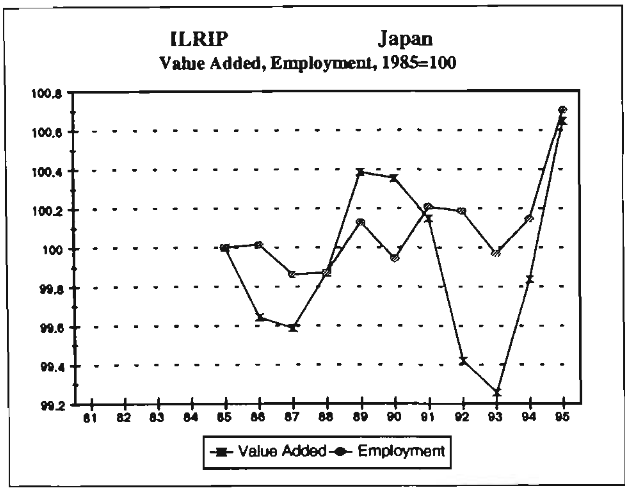
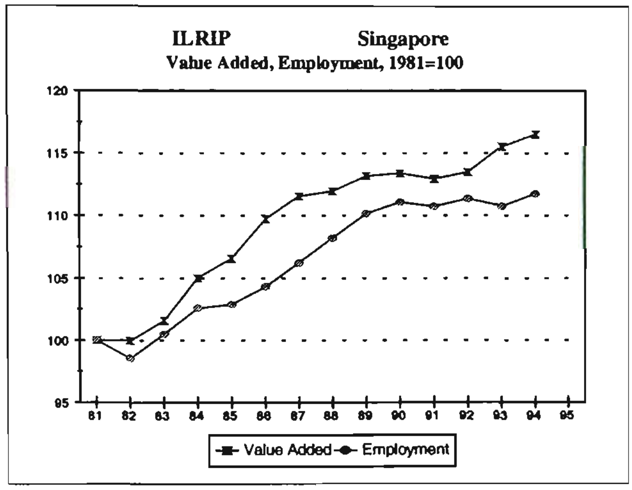
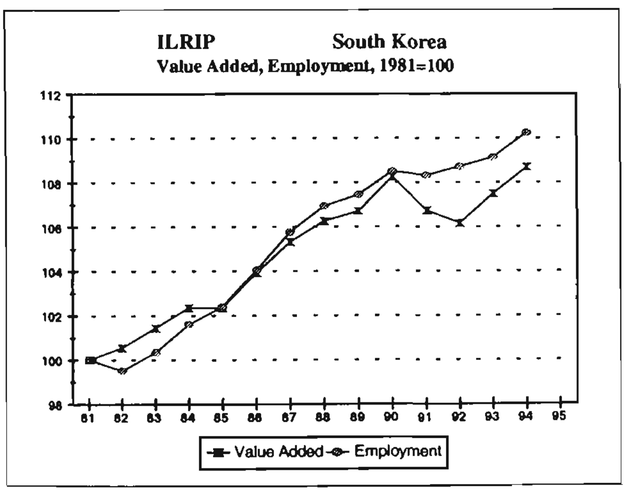
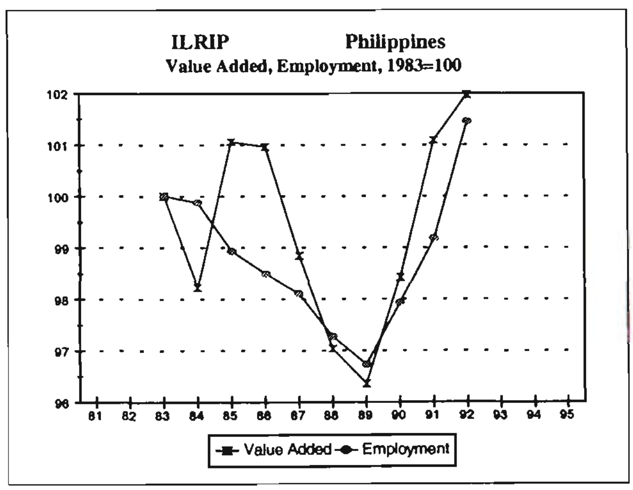
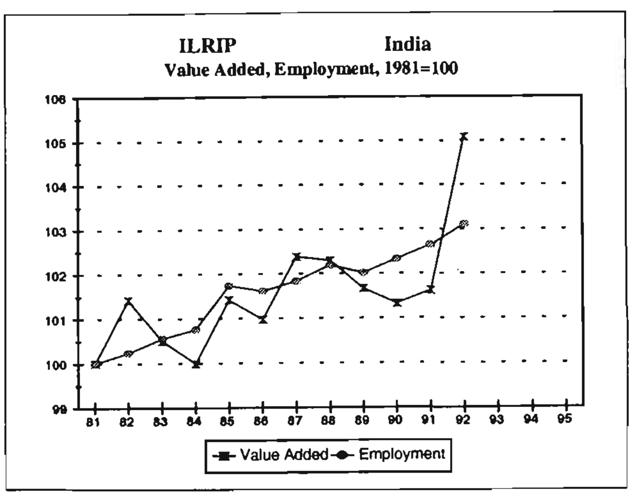










Source: Estimates based on Production Statistics, from IEDB database.

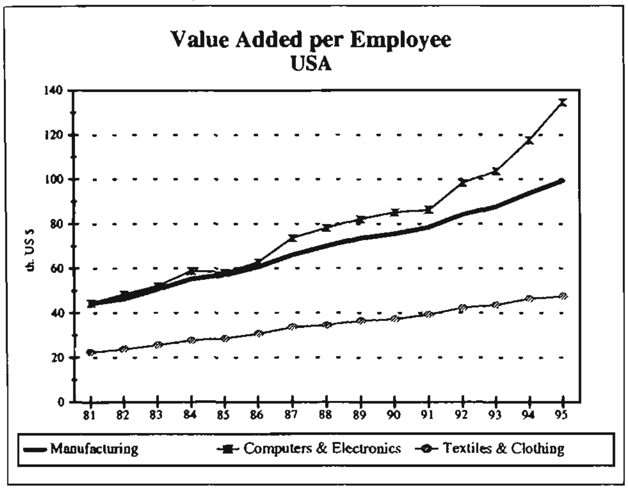
increasingly concentrated in industries of high income generating potential, the contribution of these industries to manufacturing employment was diminishing over time. This implies a disproportionate pattern of productivity growth across manufacturing industries, with higher value added per unit of employment (productivity) in industries of high income generating potential. For example, in the USA this trend was most pronounced from the late 1980s, mostly due to changes in the composition of manufacturing employment towards a low income generating potential. In Canada the values of both indexes exhibited an overall upward trend. However, because of the differences between the slopes of the trends from the late 1980s, the gap between the two trends increased. In Germany the gap between the values of the indexes for value added and employment was widening in the first half of the 1980s. In the United Kingdom the widening gap between values of the two indexes was quite pronounced in the 1981-1989 period.

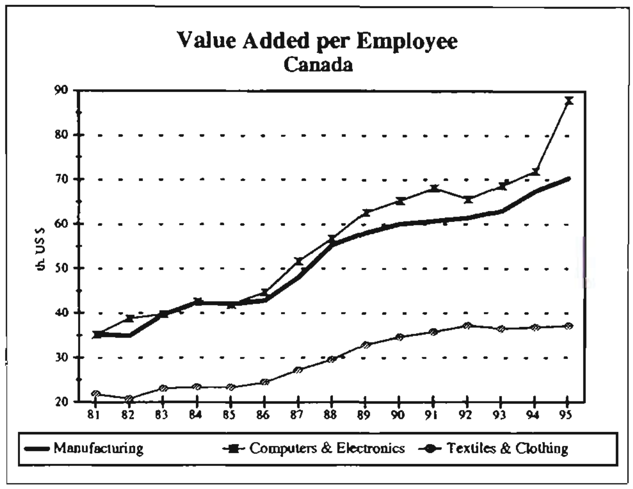
The pattern of distribution of productivity growth in most Asian countries was dramatically different to that in developed non-Asian countries. Singapore was the only country, among Asian economies considered here, for which the gap between the values of the Index of Long Run Income Potential for value added and for employment was widening. In South Korea, in the second half of the 1980s and in the early 1990s, industries of high income generating potential were gaining significance in the composition of employment at a higher rate than in the structure of manufacturing value added. In Japan, the Philippines and India there were no sharp differences between the trends of changes in composition of value added and of employment. So, it is impossible, on the basis of the technique applied here, to state that in these countries productivity growth was disproportionately distributed across manufacturing industries.

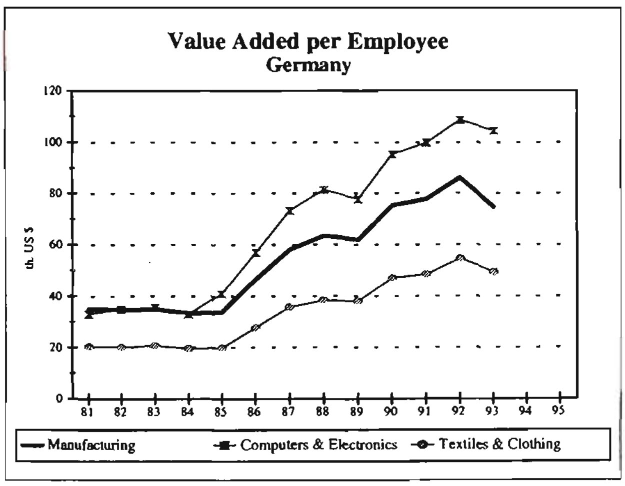
10.3 Productivity in the Computing and Electronics Industries, and in Other Manufacturing Industries

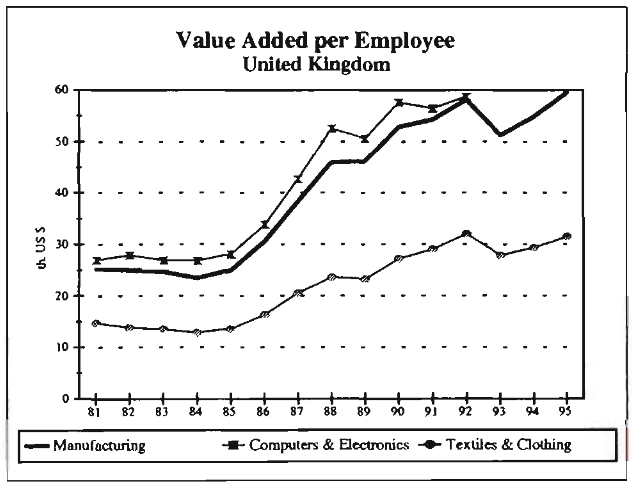
The information presented in Chart 10.2 provides a basis for extending the analysis undertaken in the previous section. In this section changes in productivity in the computing and electronics industries will be compared with the changes in productivity in total manufacturing and in the textiles and clothing industry in different economies. The computing and electronics industries are classified as ones of the highest income generating potential, while the textiles and clothing industry is ranked second to last among the twenty two manufacturing industries (see Table 4.5, Chapter 4). The wood and furniture industry,

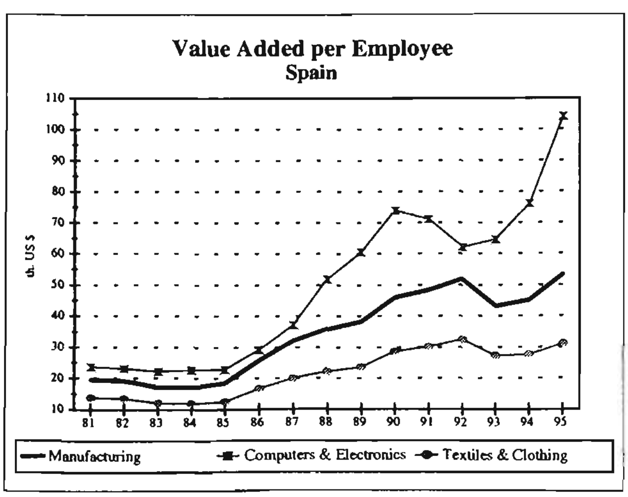
Chart 10.2

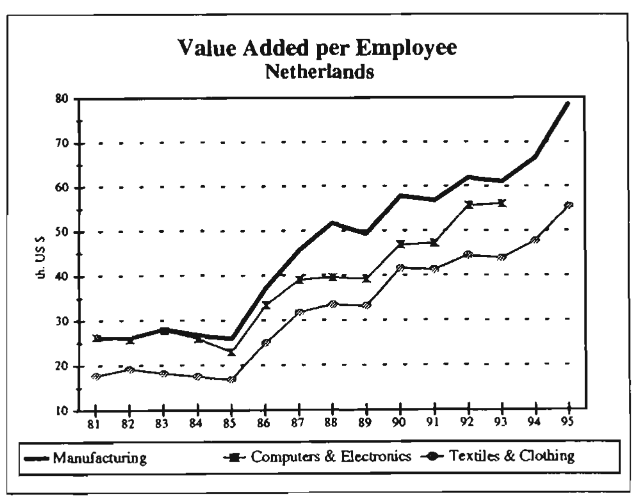












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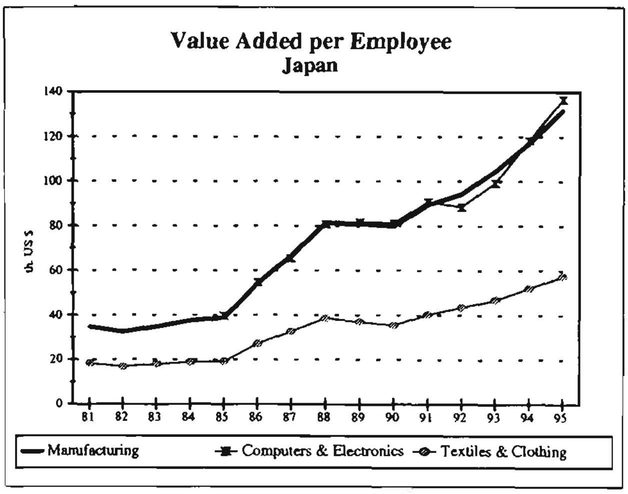
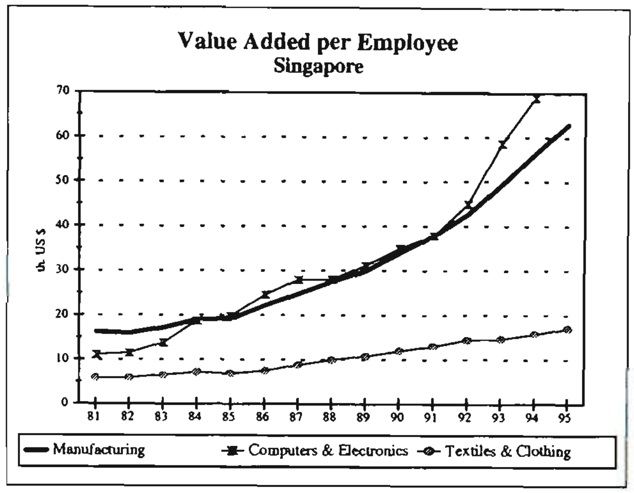
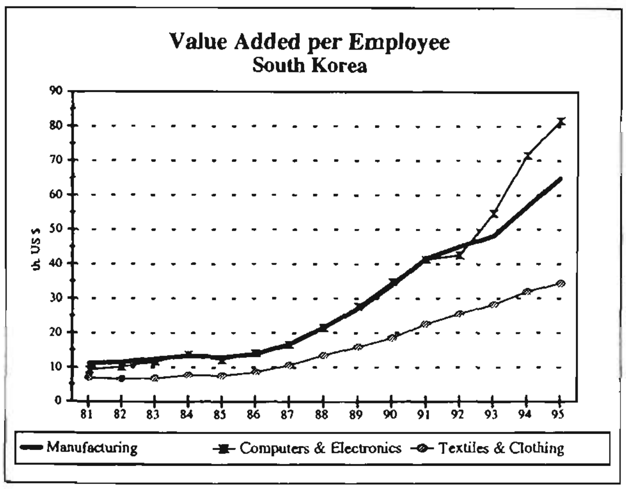
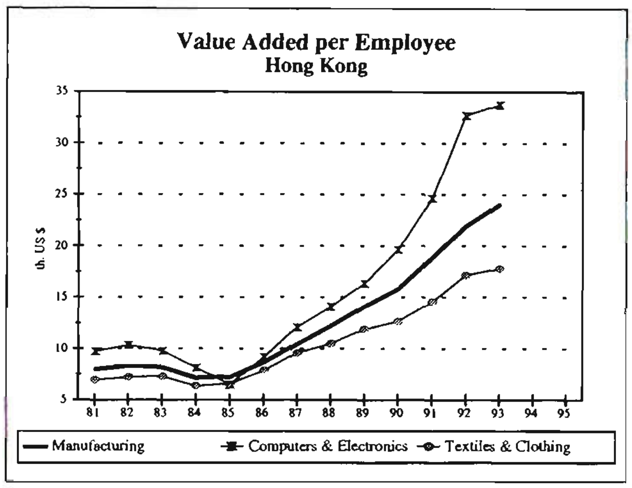
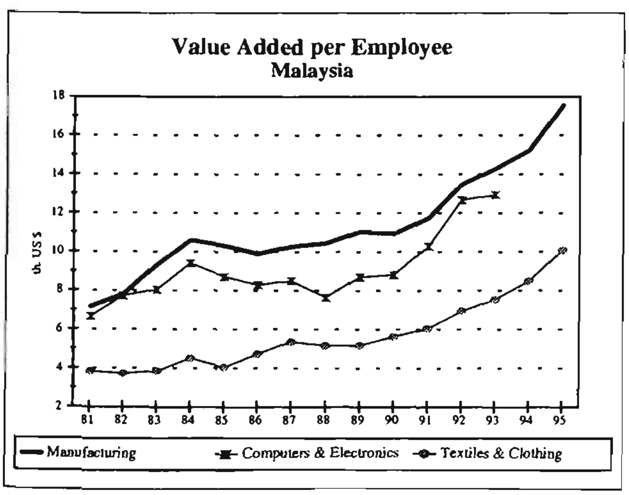
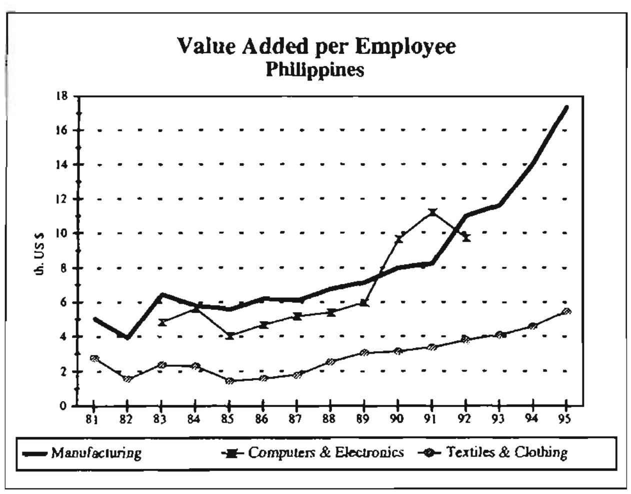












Source: Estimates based on Production Statistics, from IEDB database.

ranked last in the list of manufacturing industries, could also been used for contrasting the differences in the productivity levels across manufacturing industries. However, textiles and clothing has been preferred because of its relatively high significance for international trade, on the one hand, and its lower ranks according to value added and wage per employee indicators on the other (see Table 4.4, Chapter 4). Besides this, textiles and clothing is a traditional area of specialisation in many countries, especially Asian countries. A comparison between the productivity levels achieved in the computing and electronics and in the textiles and clothing industries can provide a useful technique for determining whether the high income generating potential of the computing and electronics was actually realised in different countries. Total manufacturing productivity provides a benchmark of the average productivity level achieved in different countries.

In most countries for which data are presented in Chart 10.2, productivity in textiles and clothing was growing at lower rates than productivity in computers and electronics and in total manufacturing. This contributed to the widening gap between the levels of productivity across manufacturing industries over time. In terms of the relative rates of productivity growth in the computing and electronics industries and total manufacturing the differences between countries were quite marked.

Over the 1981-1995 period in most of developed non-Asian countries, for example in the USA, Canada, Germany, Spain and to a lesser extent in the United Kingdom, the rate of productivity growth in the computing and electronics industries exceeded the rates of growth of productivity in total manufacturing.

Among the East Asian countries covered in Chart 10.2, Hong Kong was the only economy for which productivity achieved in the computing and electronics industries was consistently above that in the overall manufacturing sector, as was the case with most developed countries.

In Japan during 1985-1991 value added per employee in the computers and electronics closely replicated manufacturing productivity.

In Singapore in 1981 productivity in the computing and electronics industries amounted to less than 70 per cent of manufacturing productivity. By 1985 the value added per employee achieved in the computing and electronics industries exceeded that in overall manufacturing. By 1994 productivity in the computing and electronics industries in Singapore was about 20 per cent higher than total manufacturing productivity.

In South Korea the situation was similar to that of Singapore. In 1981 productivity in the computers and electronics amounted to 82 per cent of the average manufacturing level. From the mid 1980s to the early 1990s productivity in the computing and electronics industries was virtually the same as total manufacturing productivity. Since 1992 the rate of growth of value added per employee in the computing and electronics has exceeded the growth rate of manufacturing productivity, and by 1995 productivity in the computing and electronics was 25 per cent higher than that in manufacturing.

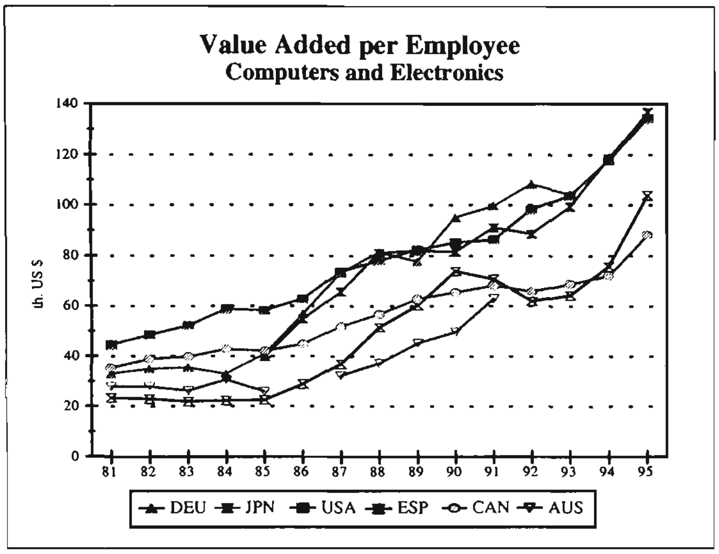
In Malaysia productivity in the computing and electronics industries was below the level achieved in total manufacturing. In 1992 productivity in the computing and electronics industries accounted for almost 94 per cent of the manufacturing productivity. In the Philippines in the 1980s productivity in computers and electronics industries was below the average manufacturing benchmark, in the early 1990s productivity it became higher than in the overall manufacturing sector. But in 1992, the last year for which the data are available, it was 12 per cent below the manufacturing productivity.

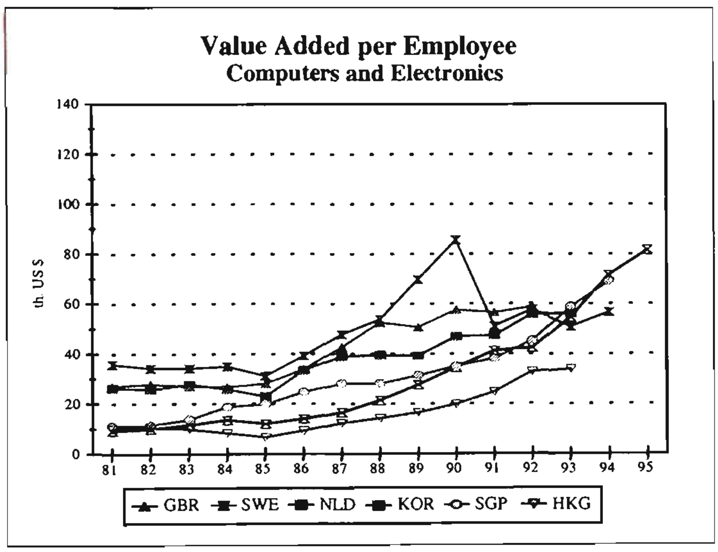
To summarise, in most developed non-Asian countries productivity in the computing and electronics industries was growing more rapidly than in total manufacturing sector, and the difference between the achieved levels was increasing over time. In most East Asian economies the difference between the levels of productivity achieved in the computing and electronics industries and in the overall manufacturing sector was significantly less marked.

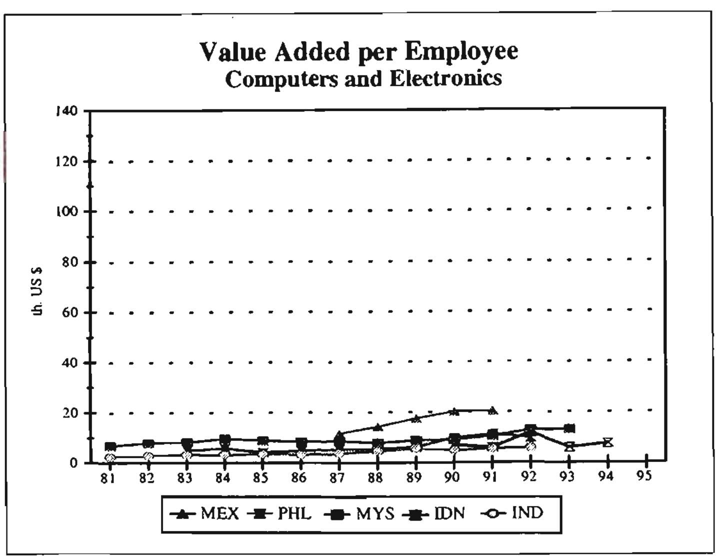
The levels of productivity achieved in the computing and electronics industries in different countries are shown on Chart 10.3. Seventeen countries are sorted in descending order according to the level of productivity achieved in 1991, the last year for which the data are available for all countries. The differences across countries in terms of the changes in productivity and the levels achieved by the end of the period are immense.

At the beginning of the period the highest productivity in the computing and electronics industries was achieved in the USA. At the end of the period Germany and Japan occupied the leading positions, followed by the USA. Spain, Canada, and Australia also belonged to the group of the six leading countries.

Chart 10.3







Source: Estimates based on Production Statistics, from IEDB database.

Among the countries of the second group, in South Korea and Singapore productivity growth in the computing and electronics industries was the most spectacular. In 1981 productivity in the computing and electronics industries in South Korea amounted to 20 per cent, and in Singapore to 25 per cent, of the US level. By the end of the period productivity in this sector of production in Singapore reached almost US$70,000 per employee, or almost 60 per cent of the productivity level achieved at that time in the USA. Productivity in the computing and electronic industries in South Korea was even higher than in Singapore. In 1995 value added per employee generated in electronic sector of South Korea exceeded US$80,000. In Hong Kong productivity increased 3.5 times over the 1981-1993 period. However, in 1993 the productivity of electronic production in Hong Kong accounted for only about 60 per cent of the South Korean level.

In the countries of the third group productivity growth in the computing and electronics industries was also quite evident. For example, in the Philippines and in Malaysia productivity in electronic production almost doubled over the period. However, because of the low initial levels, at the end of the period productivity in these countries was still far below the levels achieved in the developed countries.

Thus, although in the 1980s and early 1990s productivity in the computing and electronics industries increased in all countries, in the 1990s the difference between the developed countries and East Asian economies in terms of the achieved levels was marked. Among Asian economies, in South Korea, Singapore and Hong Kong the growth of productivity was quite pronounced, and the levels approached the levels achieved in some developed economies. In other East Asian countries considered here, productivity levels remained significantly below those of the developed economies.

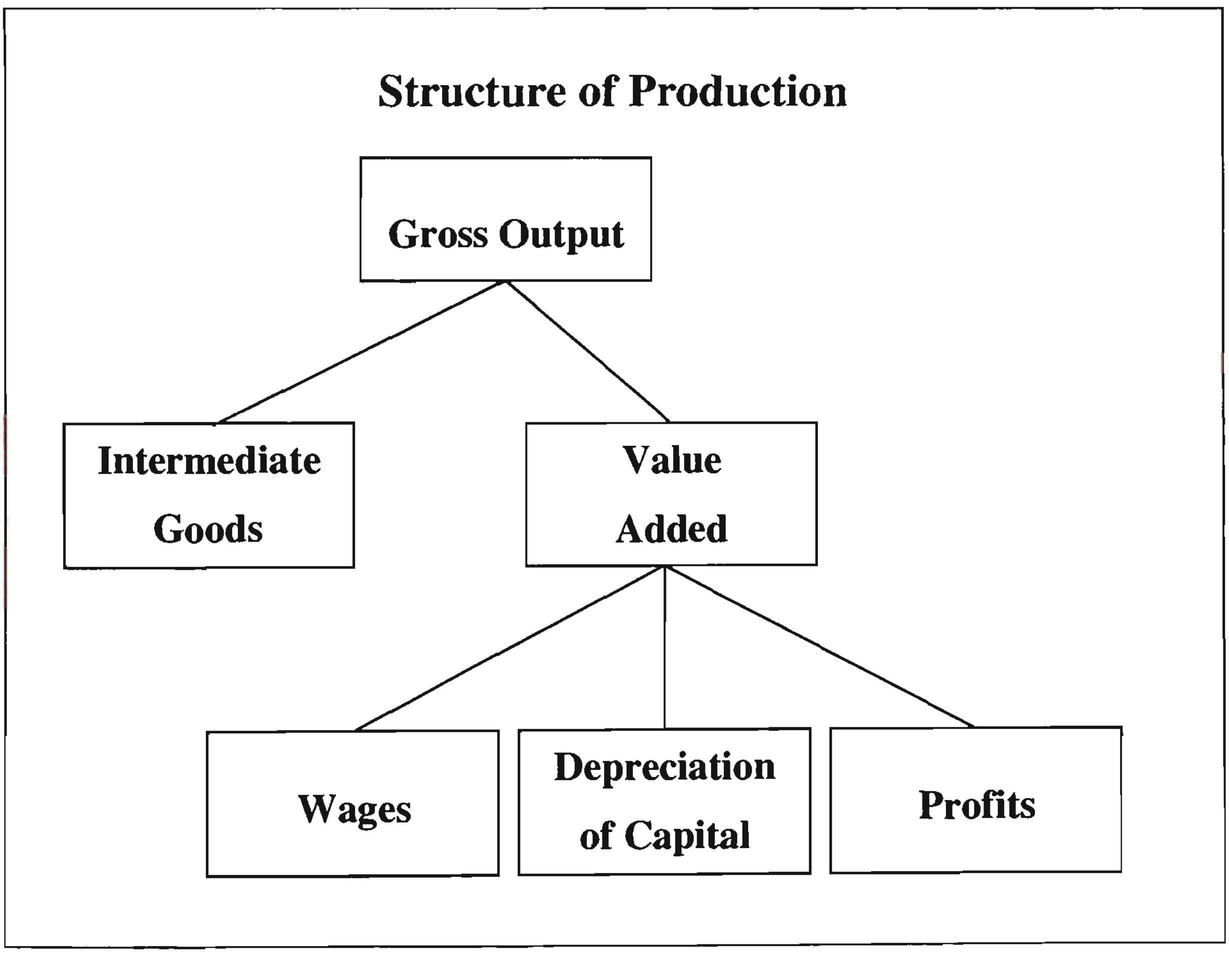
Another important fact can be derived from the information presented on Chart 10.2 and Chart 10.3. In spite of the marked differences across countries in terms of productivity growth and the levels achieved, the relative levels of productivity in the computing and electronics and in the textiles and clothing industries, and the relative trends in those levels, were similar in most countries.

In some countries, and in many East Asian countries in particular, there was no marked difference between the productivity levels in the computing and electronics industries and in the overall manufacturing sector. Besides this, in these countries productivity levels in computers and electronics were very low. These facts imply that the income generating potential of the computing and electronics industries was not fully realised in these countries. This, in turn, implies that changes in the structure of manufacturing production towards a greater proportion of industries characterised by high income generating potential, according to the world's benchmark, is not a sufficient condition for achieving high levels of competitiveness, defined in terms of high sustainable living standards. Further analysis can shed more light on these issues.

10.4 The Structure of Production in the Computing and Electronics and in Other Manufacturing Industries

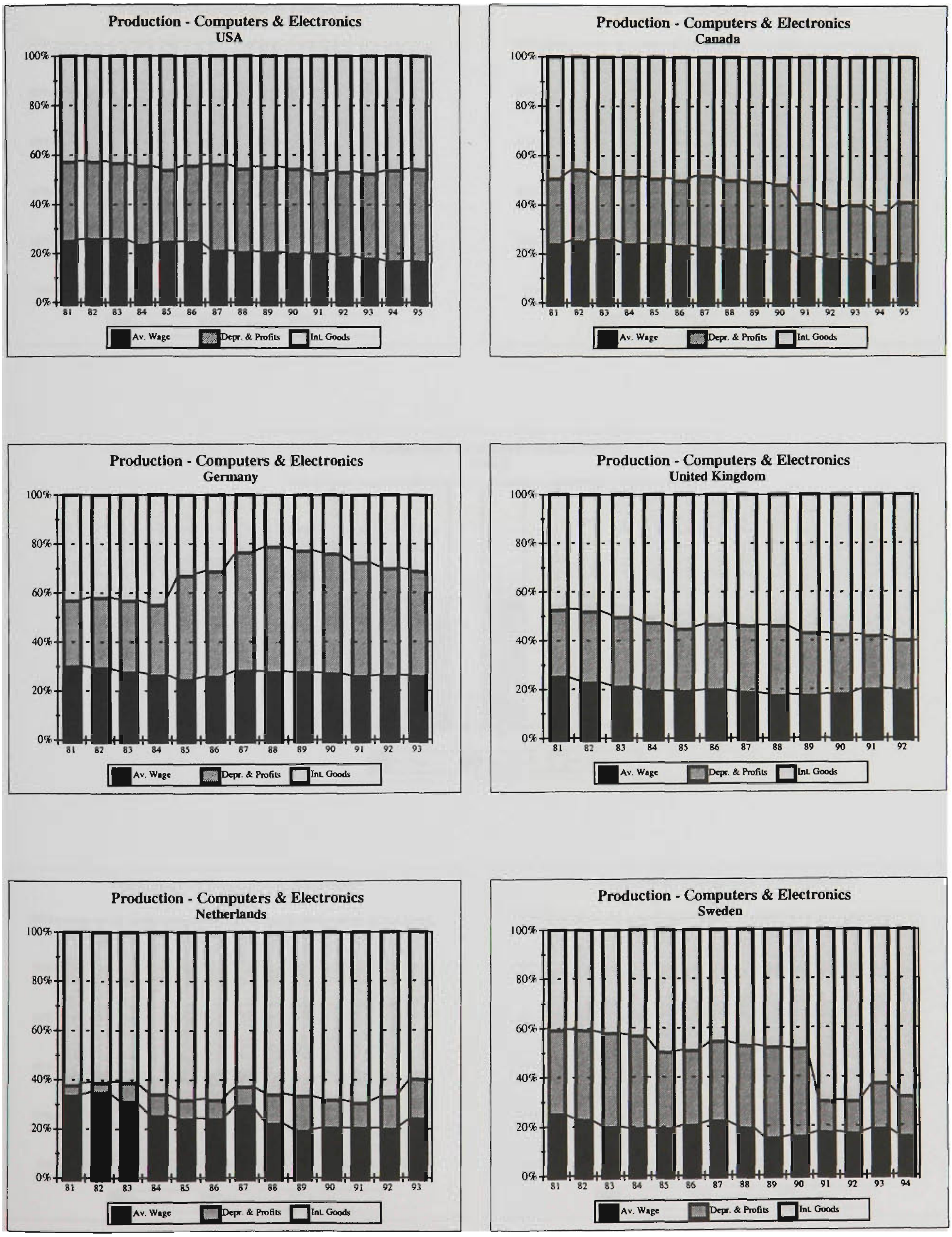
As shown in Chart 10.4, the value of overall production (gross output) consists of the two following components: the value of intermediate goods used and the value added to them. Value added can in turn be broken up into wages, the depreciation of capital and profits.

Chart 10.4



Changes in the structure of computing and electronic gross output in different countries, in terms of the relative significance of the components of gross output, are shown on Chart 10.5. Several observations can be made on the basis of the analysis of this information.

Chart 10.5



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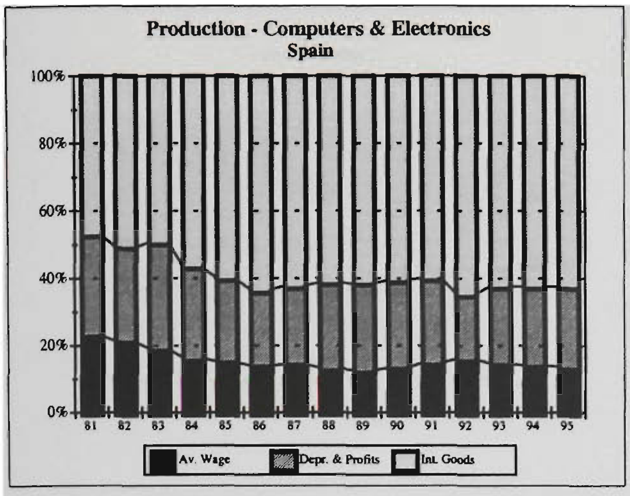
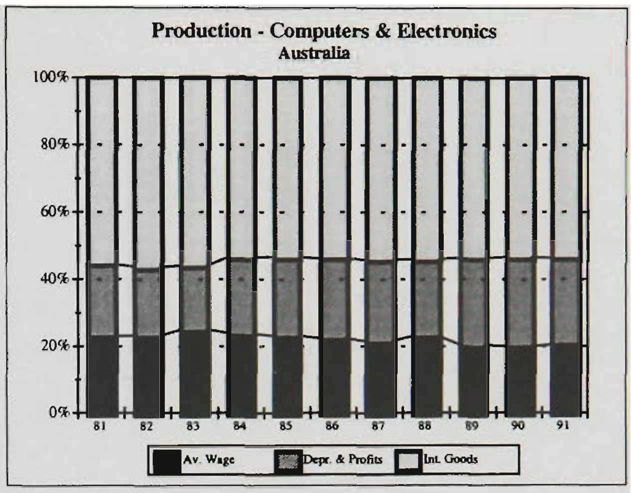
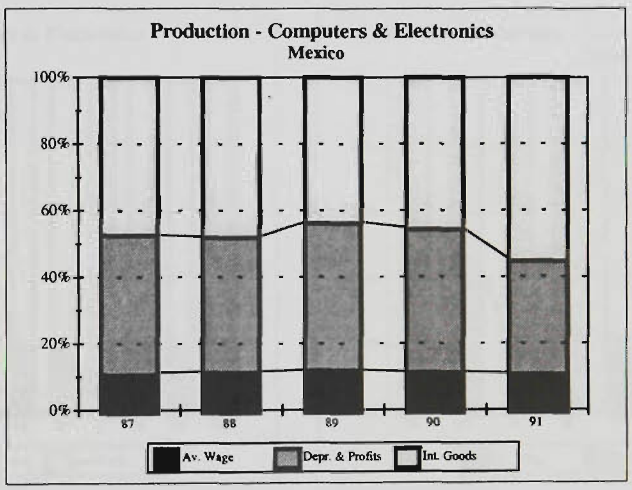
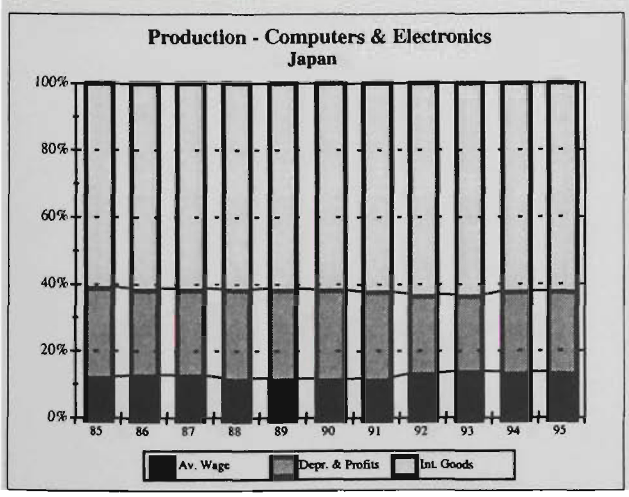
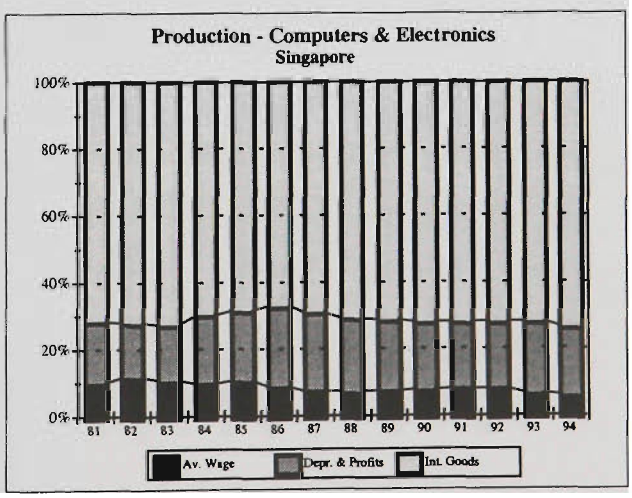

Production - Computers & Electronics
Spain
100%
80%
60%
40%
20%
0%
81 82 83 84 85 86 87 88 89 90 91 92 93 94 95
Av. Wage
Depr. & Profits
Int. Goods


Production - Computers & Electronics
Australia
100%
80%
60%
40%
20%
0%
81 82 83 84 85 86 87 88 89 90 91
Av. Wage
Depr. & Profits
Int. Goods


Production - Computers & Electronics
Mexico
100%
80%
60%
40%
20%
0%
87 88 89 90 91
Av. Wage
Depr. & Profits
Int. Goods


Production - Computers & Electronics
Japan
100%
80%
60%
40%
20%
0%
85 86 87 88 89 90 91 92 93 94 95
Av. Wage
Depr. & Profits
Int. Goods


Production - Computers & Electronics
Singapore
100%
80%
60%
40%
20%
0%
81 82 83 84 85 86 87 88 89 90 91 92 93 94
Av. Wage
Depr. & Profits
Int. Goods

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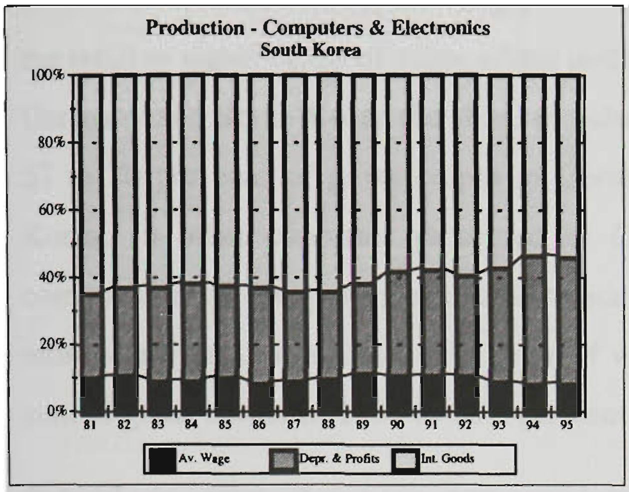
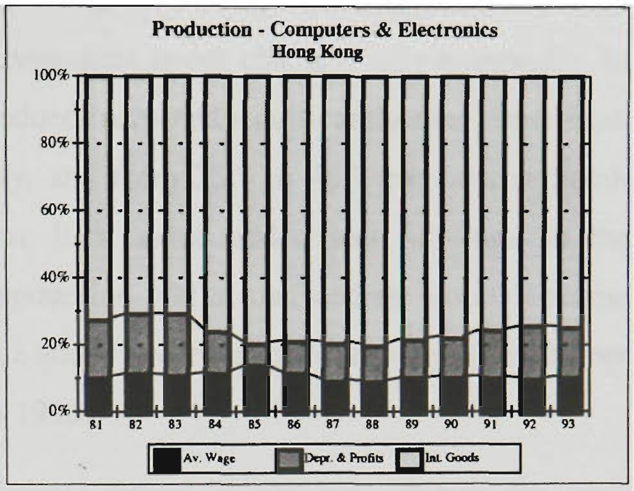
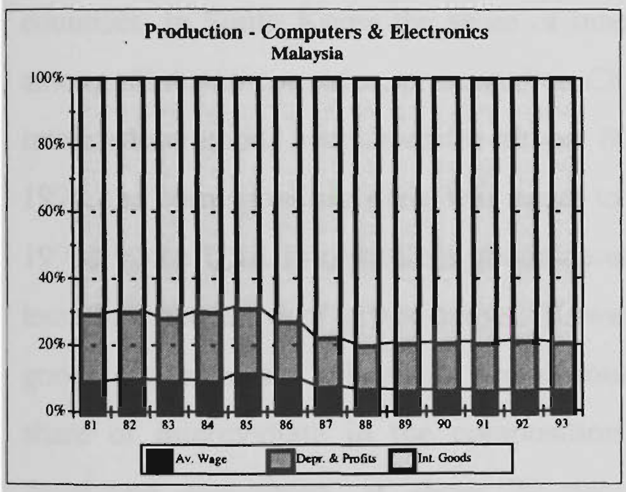
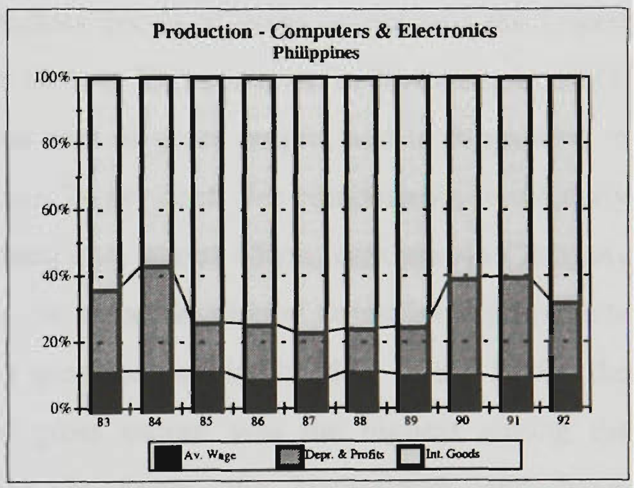
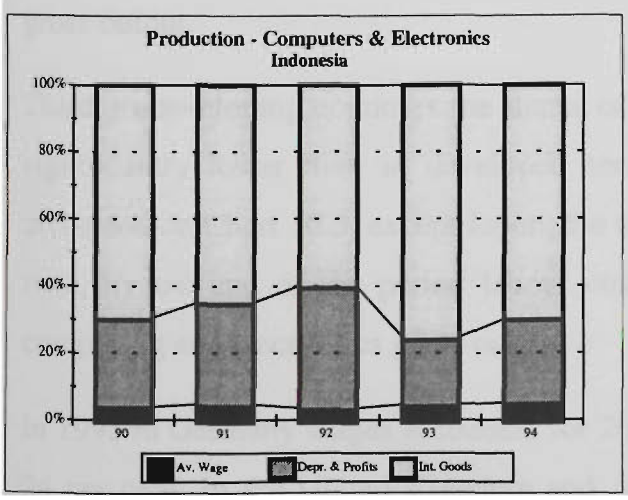
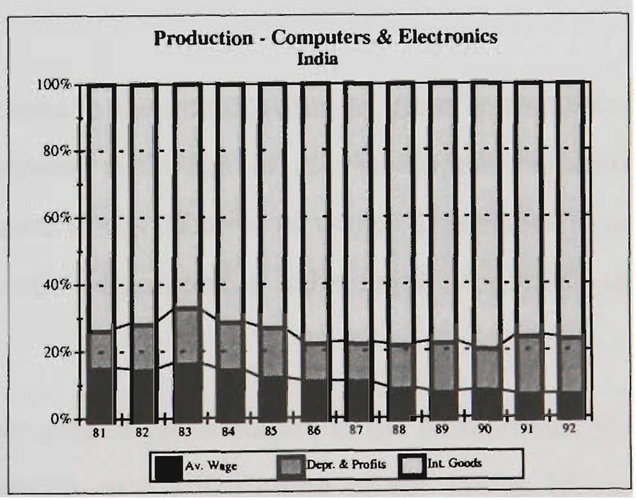












Source: Estimates based on Production Statistics, from IEDB database.

First, in some countries there were no dramatic changes in the composition of gross output, while in others the structural changes were quite pronounced. Thus, in the USA, the Netherlands, Australia, Japan, Singapore, Hong Kong, the Philippines, Indonesia, and India the relative significance of value added and intermediate goods changed only marginally. In Germany and South Korea the share of value added increased significantly over time: from 57 to 70 per cent of gross output in Germany, and from 35.7 to 46.7 per cent in South Korea. In other countries presented in Chart 10.5, value added lost its share in the composition of computing and electronics production while intermediate goods became more significant. In Malaysia the share of value added decreased substantially: from 30 per cent of gross output in 1981 to 20.8 per cent in 1993.

Second, in most Asian countries covered intermediate goods were relatively more important in the structure of computing and electronics production than in the developed countries. In South Korea the share of intermediate goods of gross output was the lowest among all Asian countries, presented on Chart 10.5, at 53.3 per cent. In Malaysia, in 1993, intermediate goods accounted for almost 80 per cent of gross output, and in Singapore, in 1994, the corresponding share was equal to about 74 per cent. For comparison, in the early 1990s in the USA intermediate goods constituted only about 45 per cent and in Germany less than one third of gross output. However, in some developed countries intermediate goods accounted for substantial proportions of gross output. In Sweden, in the 1990s, the share of intermediate in the composition of gross output was the highest among the developed economies, at about 70 per cent. In Spain, the Netherlands and Japan intermediate goods were also quite significant, they accounted for more than 60 per cent of gross output.

Third, in developing countries the shares of wages in the composition of gross output were significantly lower than in developed economies. Although in all developed countries presented on Chart 10.5, except Japan, the structural significance of wages diminished over time, by the end of the period labour costs still constituted a substantial proportion of computing and electronics gross output.

In 1993 in Germany wages accounted for 26 per cent of gross output, in the Netherlands for 24 per cent. In the United Kingdom and Australia, at the beginning of the 1990s, labour costs constituted about 20 per cent of gross output. In the USA by 1995 it diminished to about 17 per cent. In Canada, Sweden, Spain and Japan the values of the shares of wages were slightly lower, at about 15 per cent of gross output.

For Asian countries, in Hong Kong and South Korea the shares of wages of gross output were relatively high, although significantly lower than in the developed countries. In Hong Kong in 1993 wages accounted for almost 11 per cent. In South Korea at the beginning of the 1990s the share of wages reached 11.3 per cent, but by 1995 it had diminished to 9 per cent. In the Philippines, over the 1983-1992 period, the share of wages fell from 11.4 to 9.7 per cent. In Singapore, Malaysia and India the decline in shares of wages in the composition of electronic production was quite marked. In Singapore and in Malaysia in the early 1980s labour costs accounted for about 10 per cent of gross output, but in the 1990s the shares of wages in both countries diminished to 6 per cent. In Indonesia in the 1990-1994 period, the only one for which data are available, labour costs constituted 4-5 per cent of the overall value of computing and electronic production.

The reduction in the share of wages in the composition of overall computing and electronic production over time was a common trend for most countries considered in this section. However, in the 1990s in many Asian countries labour costs constituted exceptionally low proportions of gross output in comparison with the shares of wages in developed economies. In the next chapter we will undertake further analysis of the trends in wages in different countries. In this chapter we will compare the structure of gross output in the computing and electronics industries with the composition of gross output in total manufacturing and in the textiles and clothing.

The shares of value added and wages in the composition of gross output of the computing and electronics, the textiles and clothing, and total manufacturing for 1991 are presented in Table 10.2. The order of countries in the list is determined according to the value of the shares of wages in gross output in the computing and electronics industries.

A cross-industry comparison shows distinct similarities for most countries. The proportions of the components of gross output for the computing and electronics, total manufacturing, and the textiles and clothing industries were similar in most countries. Germany and the USA, however, present examples in which there are significant differences in the component shares across the three industry groups. In these countries the share of intermediate goods in the gross output of the computing and electronics industries was significantly lower than in total manufacturing and in the textiles and clothing. Or, alternatively, value added generated in the computing and electronic production in Germany and, to a lesser degree, the USA constituted significantly higher proportions of gross output than in other industries. Thus, the computing and electronics in these countries can be characterised as high value added generating industries.

Table 10.2 Value Added and Wages – Shares of Gross Output per Employee, Computing & Electronics, Manufacturing and Textiles & Clothing, Selected Countries, 1991

	Shares of Gross Output *per cent* *(in current US $)*					
	Value Added			**Wages**		
	Computers & Electronics	*Total Manufac-turing*	*Textiles & Clothing*	*Computers & Electronics*	*Total Manufac-turing*	*Textiles & Clothing*
Germany	72.7	49.2	41.5	26.1	20.4	19.4
Italy	35.1	30.6	31.5	23.9	21.0	20.6
Netherlands	31.0	29.4	34.8	20.5	15.4	19.6
Australia	46.4	42.0	43.0	20.5	16.8	21.1
United Kingdom	42.4	44.1	47.5	20.4	19.6	25.1
USA	53.2	46.5	46.2	20.3	16.5	19.4
Canada	41.2	37.2	44.8	19.2	17.9	24.3
Sweden	30.4	29.1	35.0	17.8	15.1	19.8
Spain	40.1	34.1	37.7	14.9	14.0	17.7
Japan	37.9	40.0	45.1	11.9	13.3	20.7
South Korea	43.1	41.9	42.9	11.3	11.0	16.2
Mexico	45.2	38.0	43.4	10.9	8.3	16.4
Hong Kong	24.7	29.2	27.6	10.7	15.3	17.7
Philippines	39.8	35.4	40.2	9.2	8.2	17.6
Singapore	28.0	31.4	30.4	8.1	10.3	17.9
India	24.6	17.4	17.7	7.0	6.9	9.2
Malaysia	20.9	25.9	30.7	6.4	7.0	12.5
Indonesia	34.9	34.7	29.8	4.7	5.0	7.1

Source: Estimates based on Production Statistics, from IEDB database.

In Italy and Australia the share of value added in gross output in the computing and electronics industries was also higher than in the textile and clothing and total manufacturing. In the Netherlands, Canada, Sweden and Spain value added generated in the computing and electronics industries constituted a higher proportion of gross output than in total manufacturing but a lower proportion than in textiles and clothing. In Japan the share of value added in gross output in the computers and electronics was lower than in total manufacturing and significantly lower than in the textiles and clothing.

In South Korea, Indonesia, India and Mexico the share of value added in computing and electronics production was higher than the corresponding shares for textiles and clothing and for total manufacturing. In the Philippines it was above the corresponding share for total manufacturing but below the share for the textiles and clothing, while in Singapore and Hong Kong it was lower than in the other two industry groups.

To summarise, in all developed countries considered in this section, except the United Kingdom and Japan, value added generated in the computing and electronics industries constituted higher proportions of gross output than in total manufacturing. In Mexico, South Korea, Philippines, Indonesia and India the situation was similar in this respect to that in most developed countries. In Hong Kong, Singapore, and Malaysia the shares of value added in gross output in the computers and electronics were below the corresponding shares in total manufacturing.

A comparison between the shares of value added in gross output generated in computing and electronics and in textiles and clothing industries has shown that there were marked differences between countries in the relative values of these shares. In Germany, the USA, Australia, Spain, Italy, Mexico, South Korea, Indonesia and India the share of value added in overall computing and electronics production was higher than the corresponding shares in the textiles and clothing. In the Netherlands, the United Kingdom, Canada, Sweden Japan, Hong Kong, Philippines, Singapore and Malaysia the situation was the opposite. This fact raises some serious doubts about whether the high income generating potential of the computing and electronics industries, defined according to the global benchmark indicators, was actually utilised in these countries.

A combination of high values of the shares of intermediate goods and low values of the shares of wages in the composition of gross output provides a reason for making a conclusion that knowledge-intensive, generating high value added and high earnings, production activities did not play a significant role in the computing and electronic production of most Asian countries. In our view, it would be rather reasonable to presume that assembly of final products and highly automated production of electronic components were the most typical types of production activities in these countries. This result provides one more reason to infer that the high income generating potential that characterises particular industries, such as the computers and electronics, according to global benchmark indicators, is not necessarily an essential feature of these industries in all countries.

10.5 Patenting Activities in the Computing and Electronics

Information on the output of R&D activities in the computing and electronics industries can provide some additional evidence to support the conclusion we have reached above. Patents granted in the US Patent and Trademark Office have been used as an indicator of the results of R&D. As has been stated in the OECD Patent Manual, "... the special proximity of patents to the output of industrial R&D and other inventive and innovative activities means that there is no other equivalent indicator for this purpose" (OECD 1994b, p. 16). The US Patent and Trademark Office has been used as a source of patent data. The USA is a large market and, thus, registration of inventions in the US Patent and Trademark Office may be an important component of the marketing strategy of firms located in different countries. Besides this, "... the US laws require a very detailed disclosure of the invention", and the procedure of granting a patent "... can sometimes take as long as five years" (p. 22), which, in our view, can provide an assurance of the quality of the registered inventions. The country of origin of patents is determined by the residence of the inventor (US Patent and Trademark Office 1994, p. 1). In the Fractional Count Report, which has been used as the source of data, multiple patent counts among product field categories are eliminated (p. 2). The only problem that may arise in using data from the US Patent and Trademark Office for cross-country analysis of the numbers of patents granted is related to possible over-representation of the USA. As has been noted in the OECD Patent Manual, inventors usually apply for a patent to his own country's patent office (OECD 1994b, p. 42). For this reason, although the numbers of patents granted by the US inventors have been presented in Table 10.3, we will confine the analysis to the numbers of external patents registered by non-residents of the USA.

The numbers of patents granted in the computing and electronics by the US Patent and Trademark Office to inventors from twenty five countries (including the USA) for the 1970-1995 period are shown in Table 10.3. The second panel of this table also shows the

Table 10.3 Patents Granted by the United States Patent Office, Computers & Electronics, Selected Countries, 1970-1995

	Patents Granted					*Shares of All External Patents Granted %*				
	1970	**1980**	**1985**	**1990**	**1995**	**1970**	**1980**	**1985**	**1990**	**1995**
USA	6809	4945	5984	8091	12343					
Japan	456	1352	2972	5652	8297	21.73	43.94	56.64	65.09	65.79
Germany	433	473	721	756	767	20.64	15.37	13.74	8.71	6.08
South Korea	0	0	4	89	651	0.00	0.00	0.08	1.02	5.16
France	241	320	398	519	578	11.49	10.40	7.59	5.98	4.58
United Kingdom	377	281	328	464	525	17.97	9.13	6.25	5.34	4.16
Taiwan	0	6	17	93	414	0.00	0.19	0.32	1.07	3.28
Netherlands	132	164	203	294	268	6.29	5.33	3.87	3.39	2.12
Canada	112	97	156	247	247	5.34	3.15	2.97	2.84	1.96
Sweden	64	48	76	65	134	3.05	1.56	1.45	0.75	1.06
Italy	62	81	85	144	125	2.96	2.63	1.62	1.66	0.99
Australia	11	17	26	46	53	0.52	0.55	0.50	0.53	0.42
Singapore	0	1	1	7	24	0.00	0.03	0.02	0.08	0.19
Ireland	2	2	6	12	23	0.10	0.06	0.11	0.14	0.18
Hong Kong	0	4	4	9	13	0.00	0.13	0.08	0.10	0.10
Denmark	14	14	11	8	13	0.67	0.45	0.21	0.09	0.10
China	0	0	0	6	12	0.00	0.00	0.00	0.07	0.10
India	0	0	0	3	7	0.00	0.00	0.00	0.03	0.06
Spain	1	3	3	7	6	0.05	0.10	0.06	0.08	0.05
New Zealand	0	2	2	2	3	0.00	0.06	0.04	0.02	0.02
Mexico	5	2	1	2	2	0.24	0.06	0.02	0.02	0.02
Thailand	0	0	0	0	1	0.00	0.00	0.00	0.00	0.01
Malaysia	0	0	0	1	1	0.00	0.00	0.00	0.01	0.01
Philippines	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Indonesia	0	0	0	1	0	0.00	0.00	0.00	0.01	0.00
Total (external patents)	2098	3077	5247	8684	12612	100.0	100.0	100.0	100.0	100.0

Source: US Patent and Trademark Office.

shares of patents originated from particular countries in the total number of external patents. Countries in the list are sorted in descending order according to the number of patents granted in 1995.

During the 1970-1995 period most of the patents granted to inventors resident outside the USA originated from Japan. In 1970 Japanese inventors registered almost 22 per cent of all external patents. By 1995 this share rose to more than 65 per cent. Germany followed Japan. In 1995 the number of patents granted to German inventors was 1.8 times greater than in 1970. However, over the period the share of Germany decreased dramatically, from more than 20 to 6 per cent of all external patents. Shares of other developed countries exhibited similar trends. Thus, for example, the share of France decreased from 11.5 to 4.6 per cent, the share of the United Kingdom fell from 18 to 4 per cent, and the share of the Netherlands fell from 6.3 to 2.1 per cent.

The numbers of patents granted to inventors from Asian countries, by contrast, increased. The most remarkable is the case of South Korea. In 1970-1980 no patents were registered by South Korean inventors. In 1985 they were granted four patents, in 1990 eighty nine, and by 1995 this number reached 651, which accounted for more than 5 per cent of all external patents. The number of patents originated from Taiwan also rose dramatically over the period. In 1970 Taiwan's inventors had no patents registered in the USA. During 1980-1990 the number of patents granted to Taiwan exceeded the number of South Korean patents. In 1990 patents granted to inventors from Taiwan accounted for 1.07 per cent of all external patents, while the share of South Korea was equal to 1.02. In the 1990s, however, in spite of marked growth in the numbers of patents generated in Taiwan, from 93 patents for 1990 to 414 for 1995, Taiwan lost its leading position among Asian countries other than Japan. In 1995 Taiwan's patents constituted 3.3 per cent of all external patents, which was below the share of South Korea.

In Singapore in the 1990s there was a significant increase in patenting activity. In 1990 inventors from Singapore registered seven patents, in 1995 twenty four, which was, however, less than half the number of patents originated from Australia. In 1995 Hong registered 13 patents and China 12 patents. The number of patents granted to other Asian countries was very small. Thus, in 1995 Thailand and Malaysia had one patent granted each. The Philippines and Indonesia had no patents registered in that year.

We can conclude that the analysis of patent data has shown that in Asian countries, except Japan, South Korea and Taiwan, R&D activities did not generate results comparable with those in developed countries, such as Germany, France, the United Kingdom, the Netherlands, Canada, Sweden and Italy. This finding confirms the conclusion that has been made earlier: that high value added and high earnings production activities, such as R&D, did not play a significant role in the computing and electronic production in most Asian countries.

10.6 Conclusions

Several conclusions can be made on the basis of the analysis undertaken in this chapter:

1. Panel regression tests have shown a marked difference between developed economies and the four Asian countries included in the data sample. For developed countries structural change in manufacturing towards a greater proportion of industries of high income generating potential, such as the computers and electronics, is positively correlated with growth of value added and productivity and negatively correlated with employment growth within the manufacturing sector. For the four Asian countries structural change is positively correlated with growth of employment, but the panel regression results do not allow us to draw any conclusion about correlation with growth of value added and productivity. This indicates that there are significant differences between individual Asian countries.

2. For all non-Asian developed countries considered in this chapter, industries of high income generating potential exhibited higher rates of productivity growth than other manufacturing industries, at least at some periods of time. The pattern of distribution of productivity growth in Asian countries considered here, except for Singapore, was dramatically different to that in developed non-Asian countries. In South Korea, in the second half of the 1980s and the early 1990s, industries of high income generating potential were gaining significance in the composition of employment at a higher rate than in the structure of manufacturing value added. In Japan, the Philippines and India there were no sharp differences between the trends for value added and for employment, indicating that there were no marked differentials in productivity growth across manufacturing industries.

3. Although in the 1980-1990s productivity in the computing and electronics industries increased in all countries, in the 1990s the difference between the developed countries

and East Asian economies in terms of the achieved productivity levels was marked. Among Asian economies, in South Korea, Singapore and Hong Kong the growth of productivity was quite pronounced, and productivity levels approached the levels achieved in some developed economies. In the other Asian countries considered here, productivity levels remained significantly below those of the developed economies. In some countries, and in many East Asian countries in particular, there was no marked difference between the productivity levels in the computing and electronics industries and in the overall manufacturing sector. Besides this, in these countries productivity levels in computers and electronics were very low. These facts imply that the income generating potential of the computing and electronics industries was not fully realised in these countries. Thus, changes in the structure of manufacturing production towards a greater proportion of industries characterised by high income generating potential, according to the world's benchmark, is not a sufficient condition for achieving high levels of competitiveness, defined in terms of high sustainable living standards.

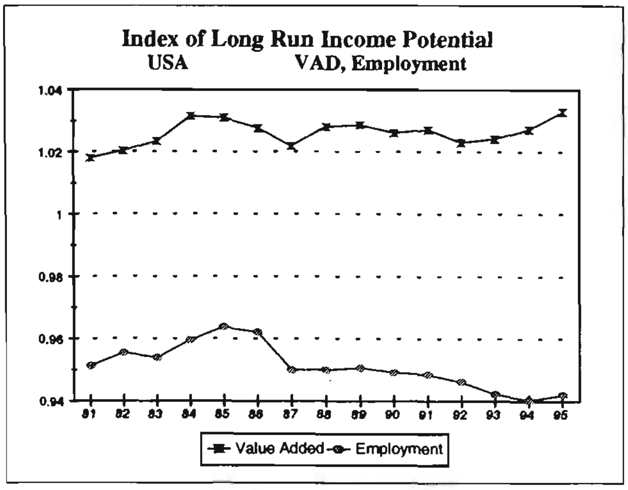
4. A combination of high values of the share of intermediate goods, and low values of the share of wages, in the composition of gross output generated in the computing and electronics industries provides a basis for making a conclusion that knowledge-intensive, generating high value added and high earnings, production activities did not play a significant role in the computing and electronic production of most Asian countries. It is rather reasonable to presume that assembly of final products and highly automated production of electronic components were the most typical types of production activities in these countries.

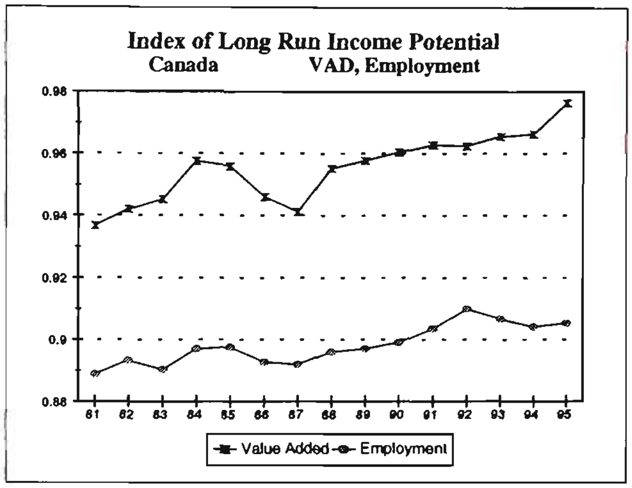
5. The analysis of patent data has shown that in Asian countries, except Japan, South Korea and Taiwan, R&D activities did not generate results comparable with those in developed countries, such as Germany, France, the United Kingdom, the Netherlands, Canada, Sweden and Italy. This finding confirms the conclusion that high value added and high earnings production activities, such as R&D, did not play a significant role in the computing and electronic production in most Asian countries.

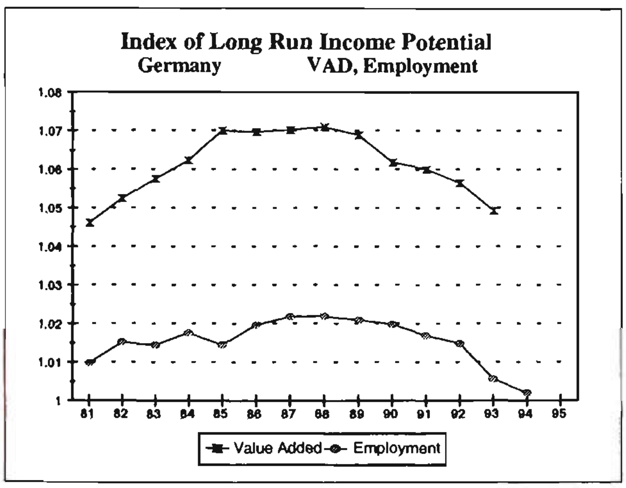
We can conclude that the analysis undertaken in this chapter has provided a basis to infer that high income generating potential, which characterises the computing and electronics industries according to global benchmark indicators, was not fully realised in many countries, and particularly in the East Asian countries. In the next chapter we will extend the research by incorporating a cross-country comparison of wages earned by employees in the computing and electronics, the textiles and clothing and total manufacturing industries.

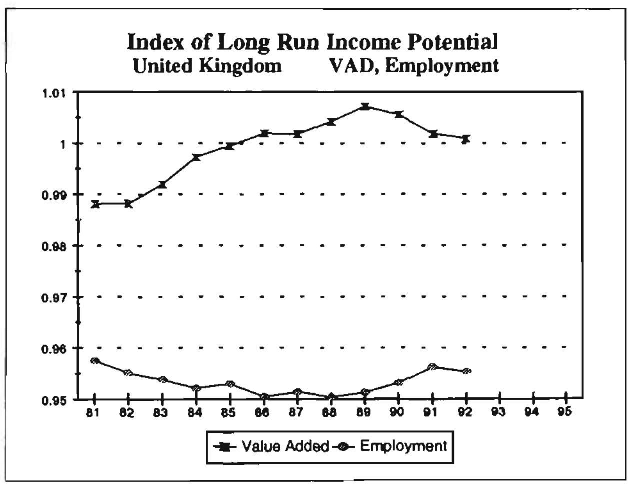
Appendix: Chapter 10

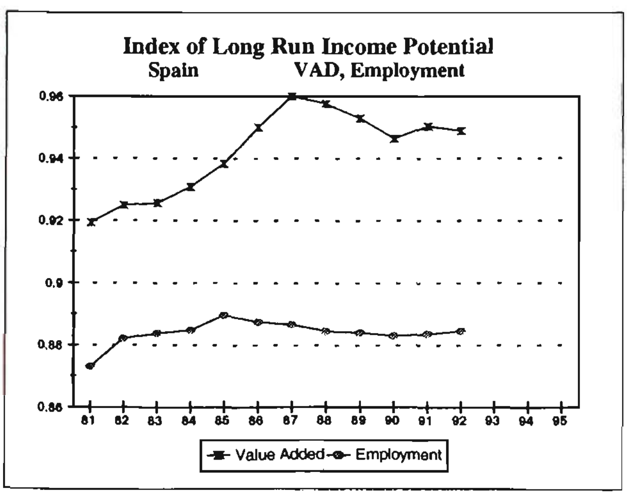
Chart 10.A1

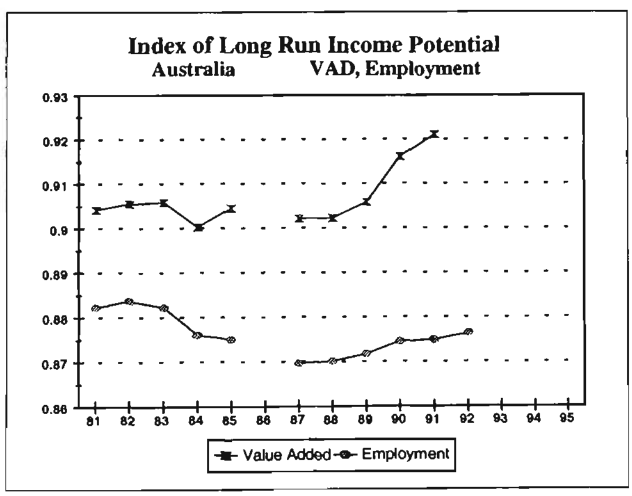












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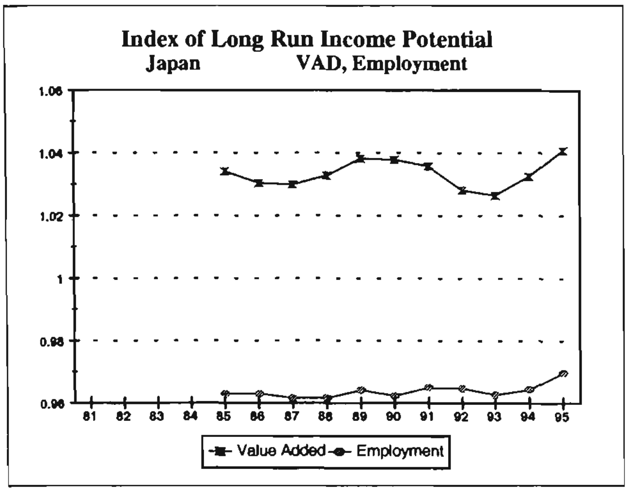
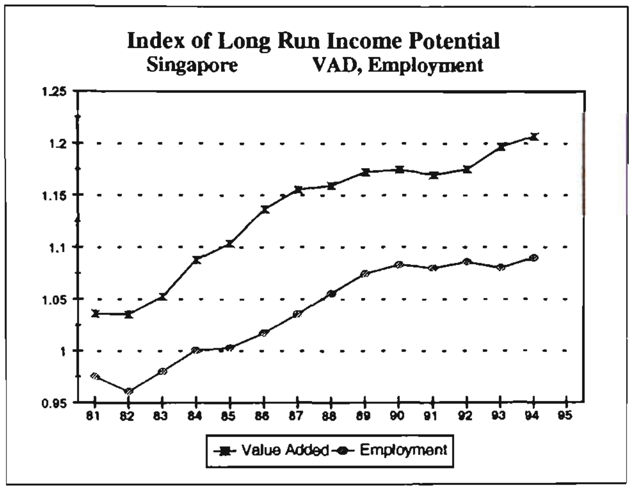
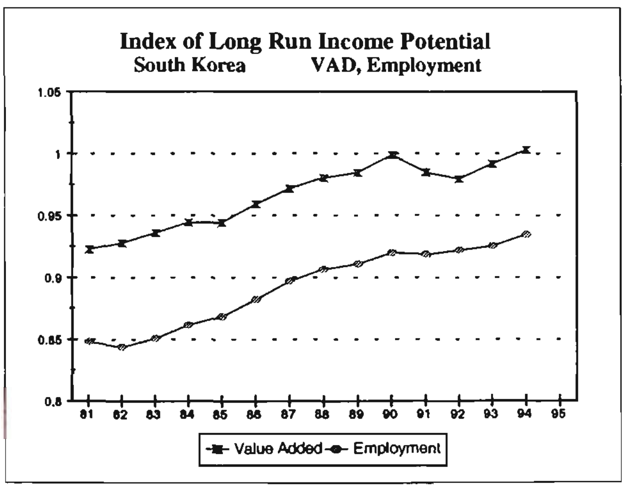
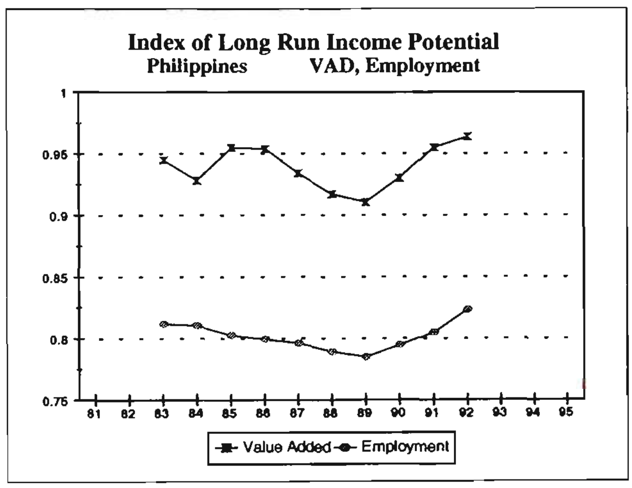
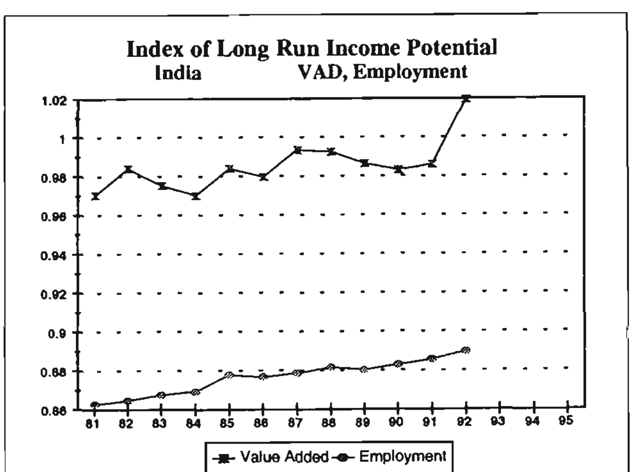










Source: Estimates based on Production Statistics, from IEDB database.

CHAPTER 11

COMPUTERS AND ELECTRONICS: CROSS-COUNTRY ANALYSIS OF DYNAMICS IN LABOUR COSTS

The analysis of productivity, value added and the structure of production, undertaken in the previous chapter, has indicated that the high income generating potential of the computing and electronics industries was not fully utilised in many countries, and in particular was not fully utilised in East Asian economies. In this chapter we will analyse to what extent a relatively high potential of the computing and electronics industries to transfer the generated economic wealth to the employees in the form of wages was realised in different economies. This will also relate to the question of the extent to which the expansion of the computing and electronics industries relied on low wages rather than other competitive factors.

The data on wages per employee, which are used in this chapter, are expressed in current US dollars and, thus, represent labour costs incurred in manufacturing production in different countries on a comparable basis. A cross-industry and a cross-country analysis based on information on wages per employee, measured in current US dollars, can help to get a better understanding of the implications of production activities in particular manufacturing sectors of different economies.

First we will analyse whether structural change towards an industrial structure of a higher income generating potential in the manufacturing sector was positively correlated with the earnings of employees in different economies. In the second section a cross-country comparison between the trends in wages per employee earned in the manufacturing sectors will be undertaken. In the next section, the analysis will be extended by testing the hypothesis that manufacturing labour costs have been converging across developed and East Asian economies. In the fourth section the pattern of change in the composition of manufacturing wages and employment over time will be considered. Such an analysis can provide information whether earnings growth was more pronounced in industries of high income potential, in different economies. In the fifth section this analysis will be supplemented by an assessment of the relative rates of growth of wages per employee across manufacturing industries. In the sixth section we will analyse whether wage costs in the computing and electronics industries differed from wage costs in other manufacturing sectors. Finally, in the seventh section, we will test whether wages per employee in the computing and electronics sectors of different countries were correlated with the structure of electronic production and with the output of technological innovation. The results of the research undertaken in this chapter are pulled together in the last section.

11.1 The Correlation between Structural Change in Manufacturing and Wage Growth

Manufacturing industries differ significantly in terms of their potential to generate economic wealth and to transfer this wealth to employees in the form of wages (see Chapter 4). The objective of this section is to investigate whether structural changes towards a high income generating potential in manufacturing were associated with growth in the wages of employees in the manufacturing sector in different economies. For this purpose, we will test whether there is a positive correlation between structural change in domestic manufacturing production (value added) and growth of wages, employment and wages per employee. It is not our aim to determine causality between the variables, nor do we imply that the dependent variables are the only factors with which structural change in manufacturing value added is associated. The purpose of the panel regression tests, undertaken in this section, is to find out whether the variables are positively correlated and, if it is so, whether such a positive correlation is the prevailing situation for different groups of economies.

Table 11.1 presents the results of panel regression tests between structural change of domestic manufacturing production (value added) and growth of wages, employment (see also Table 10.1, Chapter 10) and wages per employee in manufacturing sector. A fixed effects model has been used (for a description see Section 5.2.1, Chapter 5). The values of the Index of the Long Run Income Potential of manufacturing value added, in logarithmic form, have been used as an independent variable, and logarithms of the values of manufacturing wages, employment, and wages per employee as dependent variables. The data set used for these tests is exactly the same as the one that has been used in earlier panel regressions, testing for correlation between structural change in manufacturing and value added, employment and productivity (see Chapter 10). The data set covers thirteen countries for the period 1981-1995.

The data are unbalanced, the number of observations for individual countries depends on the availability of the data (see the notes, Table 11.1). The sample is subdivided into two sub-samples: the first consists of four Asian countries, India, South Korea, the Philippines

Table 11.1 Regression Results of the Effects of Structural Change on Growth of Manufacturing Wages, Employment and Wages per Employee

Independent variable – ln of values of the Index of Long Run Income Potential of Manufacturing Value Added

	Coeff-t	t-ratio	R-sq. adj.	Number of observations	SEE	F test $(A_i, B = A_i, B_i)$	Critical F value
Wages	*Dependent variable – ln of values of Manufacturing Wages (bill. curr. $ US)*						
All countries (13)[1]	10.95	9.00	0.969	155	12.86	3.24	5.13
Asian countries excl. Japan (4)[2]	10.80	6.69	0.883	50	6.11	10.16	3.70
Other countries incl. Japan (9)[3]	11.80	4.30	0.956	105	6.74	0.69	4.63
Employment [4]	*Dependent variable – ln of values of Manufacturing Employment (mill.)*						
All countries (13)[1]	1.39	3.57	0.993	155	1.31	5.43	5.13
Asian countries excl. Japan (4)[2]	2.30	3.95	0.988	50	0.80	2.36	3.70
Other countries incl. Japan (9)[3]	-3.68	-7.32	0.998	105	0.23	2.27	4.63
Wages per Employee	*Dependent variable – ln of values of Manufacturing Wages per Employee (th. curr. $ US)*						
All countries (13)[1]	9.57	8.65	0.929	155	10.61	3.46	5.13
Asian countries excl. Japan (4)[2]	8.50	6.85	0.910	50	3.61	11.75	3.70
Other countries incl. Japan (9)[3]	15.48	5.70	0.576	105	6.61	0.98	4.63

Notes: 1. AUS (81-85, 87-91), CAN (81-95), DEU (81-93), ESP (81-92), GBR (81-92), ITA (89-91), SWE (81-94), USA (81-95), IND (81-92), JPN (85-95), KOR (81-94), PHL (83-92), SGP (81-94);

2. IND (81-92), KOR (81-94), PHL (83-92), SGP (81-94);

3. AUS (81-85, 87-91), CAN (81-95), DEU (81-93), ESP (81-92), GBR (81-92), ITA (89-91), SWE (81-94), USA (81-95), JPN (85-95);

4. As presented in Table 10.1.

Source: Estimates based on Production Statistics, from IEDB database.

and Singapore, and the second consists of nine developed countries (see the notes, Table 11.1).

The results of the regression tests between structural change in manufacturing value added and growth in employment are exactly the same as those presented in Table 10.1. The results of panel regression tests between structural change in manufacturing and growth in wages and in wages per employee are similar to the results reported in Table 10.1 for structural change and growth in value added and productivity. The regression results for the sample consisting of all thirteen countries show a positive correlation between structural change in domestic manufacturing production and growth in manufacturing wages. The results of panel regression for the data sample covering four Asian countries should be rejected on the basis of F test. These results imply that there is a significant variation in individual countries' coefficients. The results of another panel test, for developed countries, are statistically significant. These results indicate a positive correlation between the variables, with a coefficient on the dependent variable higher than the coefficient obtained on the basis of testing the aggregated sample, namely 11.8 by comparison with 10.95.

The results of the panel regressions which test for correlation between structural change and wages per employee, show that there are statistically significant coefficients for the aggregated data sample, covering all thirteen countries, and for one smaller sample, incorporating nine developed countries. Both coefficients are positive, and the coefficient on the dependent variable for developed countries is higher than the coefficient for the aggregated sample, namely 15.48 and 9.57 respectively. The results of the regression for four Asian countries should be rejected on the basis of F test, and, thus, do not allow us to draw any conclusion about the correlation between the variables.

To summarise, the panel regression tests have shown a marked difference between the developed economies and the four Asian countries included in the data sample. For the developed countries structural change in domestic manufacturing production towards a structure with high income generating potential is positively correlated with growth of wages and wages per employee, and negatively correlated with employment growth. For four Asian countries structural change in manufacturing value added is positively correlated with growth in employment, while the results do not allow us to draw any conclusion about the correlation between structural change and growth in wages and in wages per employee.

In the next section we will undertake a cross-country comparison of trends in earnings of employees in the manufacturing sector.

11.2 Trends in Manufacturing Labour Costs in Different Economies

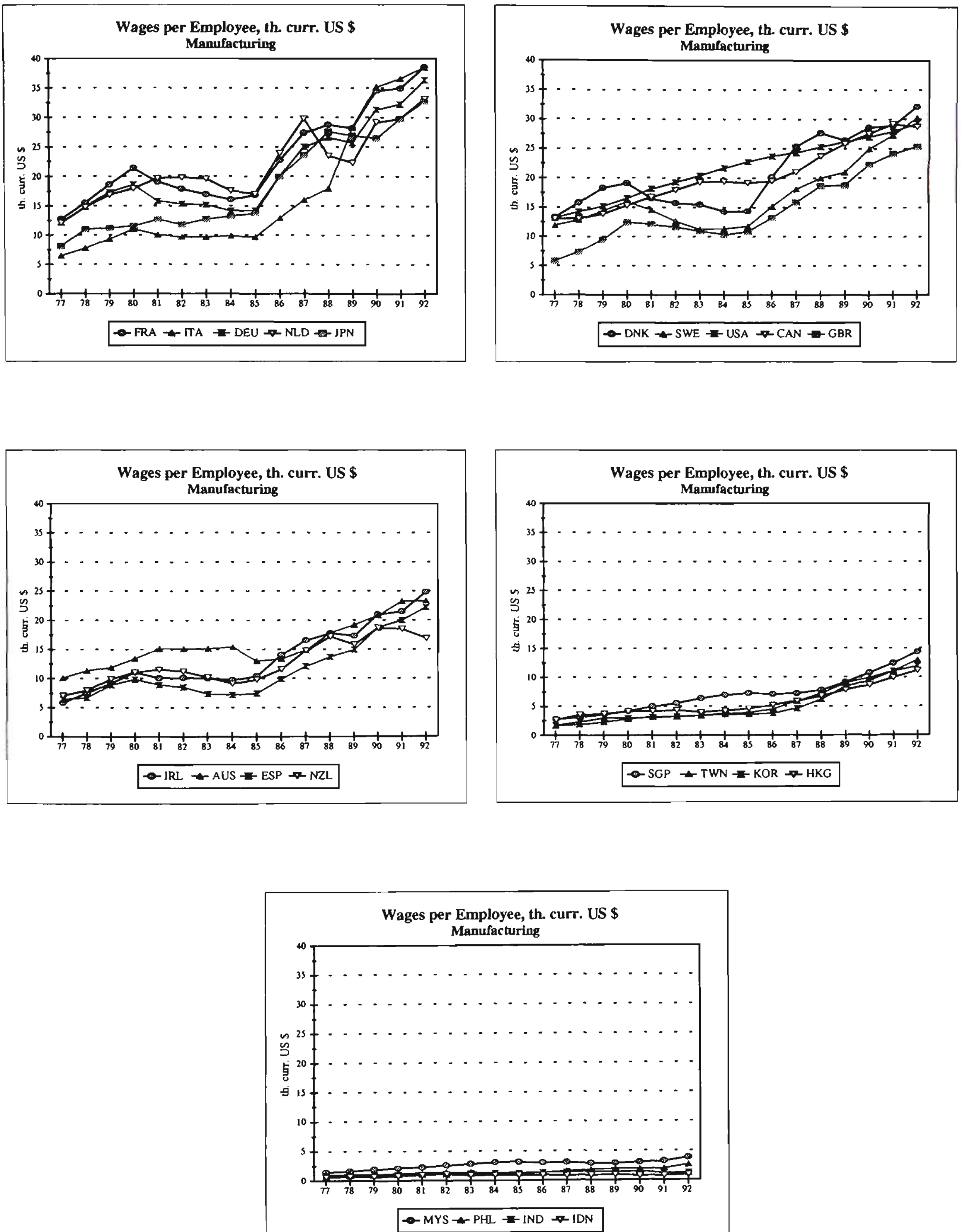
Chart 11.1 presents trends in wages per employee, expressed in current US dollars, in the manufacturing sector for twenty two countries for which the data on wages and employment are available, over the period 1977-1992. Countries in the list are sorted in the descending order, according to the value of wages per employee for 1992, and allocated into five groups. The differences between the developed countries and the Asian countries, excluding Japan, in terms of the level of wages per employee were quite marked. Fourteen developed countries, including Japan, belong to the first three groups, while the Asian countries are concentrated in the fourth and the fifth groups.

In 1992 in France the average wage per employee was the highest among all twenty two countries. In Italy over 1977-1992 wages per employee grew at an average annual rate of 12.7 per cent, reaching by the end of the period almost the same level as in France. In Germany and the Netherlands manufacturing labour costs were also high, accounting to 94 and to 86 per cent respectively of the highest level in 1992. In Japan wages per employee increased more than fourfold over the period, and in 1992 were slightly lower than in the Netherlands.

At the beginning of the period in Denmark wages per employee were the highest among all countries. By 1992 Denmark occupied the sixth position, followed by Sweden. In the USA and Canada wages per employee decreased relative to the levels of some other developed countries. In 1985 wages per employee in the USA were the highest of all countries, but the influence of the devaluation of the US$ after 1984 is evident in the rise of wage levels in many other countries relative to the US from 1985. The average wage per employee in manufacturing production in the United Kingdom was moderately high. In 1992 the United Kingdom occupied the tenth position among the twenty two countries.

In Ireland during the 1977-1992 period wages per employee were growing at an average annual rate of 10.2 per cent, although from a relatively low base. In 1977 the average wage per employee was equal to US$5,800, which was 44 per cent of the average wage in the USA at that time. In 1992 the average wage in the manufacturing sector of Ireland amounted to 85 per cent of the US average wage.

Chart 11.1



Source: Estimates based on Production Statistics, from IEDB database.

In Australia the average wage more than doubled over the period, reaching US$23,200 by 1992. In Spain at that time labour costs were slightly below than in Australia. In New Zealand in 1992 the average wage accounted for less than 58 per cent of the US average wage.

All Asian countries considered in this section, except Japan, belong to the fourth and the fifth groups. During the 1977-1992 period the highest wage per employee among these countries was earned in the manufacturing sector of Singapore. However, in 1992 the average wage in this country accounted for only 37.3 per cent of the average in France. In Taiwan, South Korea and Hong Kong average wages were also significantly higher than in the Asian countries of the fifth group, but lower than in the developed economies. Thus, in 1992 in Taiwan the average manufacturing wage was 14.7 times higher than in Indonesia, but only one third of that in France. In South Korea and in Hong Kong the average manufacturing wage was close to, but a little lower, than that in Taiwan.

In some countries of the fifth group manufacturing wages per employee were growing at relatively high rates during the period, comparable with the rates of growth in the developed countries. Thus, in the Philippines the average manufacturing wage was growing at a rate of 7.1 per cent per annum and in Malaysia at 6.8 per cent per annum. However, the levels reached in these countries by 1992 remained far below the levels of wages in the developed economies. In Malaysia the average manufacturing wage amounted to 10.4 per cent, in the Philippines 7 per cent, in India 3.1 per cent and in Indonesia 2.4 per cent of the average wage in Germany at that time.

In summary, during the 1977-1992 period the differences between labour costs in the manufacturing sectors of the developed and of Asian countries, excluding Japan, were marked. Labour costs in the manufacturing sectors of Malaysia, the Philippines, India and Indonesia were particularly low. In Taiwan, South Korea and Hong Kong average wages were significantly higher than in other Asian countries, considered in this section, but lower than in the developed economies. The disparities between the labour costs in manufacturing sectors of the developed and of Asian countries were growing over time. In the next section we will test these findings statistically.

11.3 Tests of Convergence in Manufacturing Labour Costs: Developed and Asian Countries

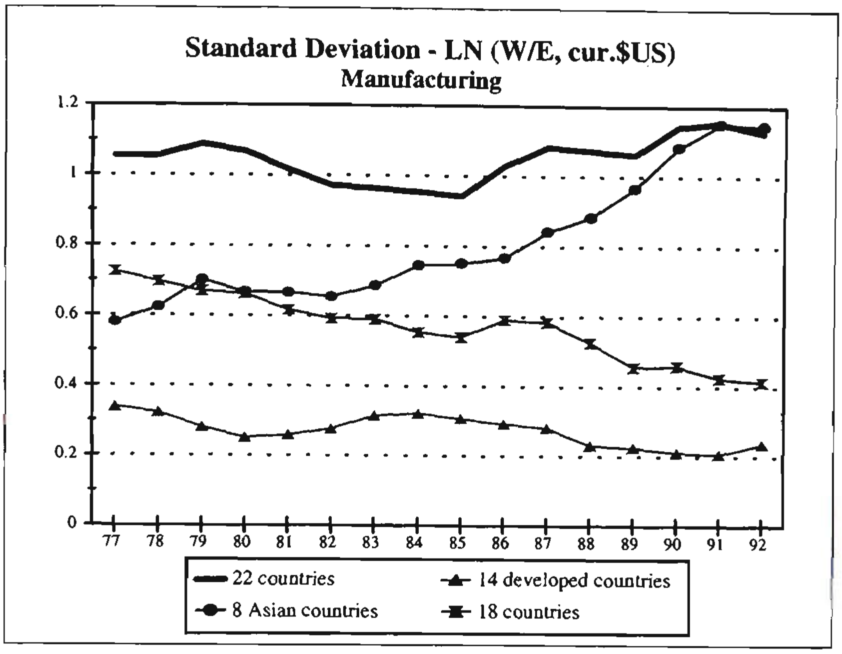
Chart 11.2 shows the standard deviation of logarithms of wages per employee for the 1977-1992 period. This information provides a basis for analysing changes in cross-country disparities in the labour costs of manufacturing production. The sample consists of the twenty two countries for which the data on wages and employment are available. Trends in the standard deviation for disaggregated samples, consisting of fourteen developed countries, eight Asian countries, and eighteen countries (the fourteen developed and four Asian countries: Hong Kong, South Korea, Singapore, and Taiwan) are also shown on the first panel of Chart 11.2. The second panel of the chart presents the trends for the eight Asian countries and for two further disaggregated samples.

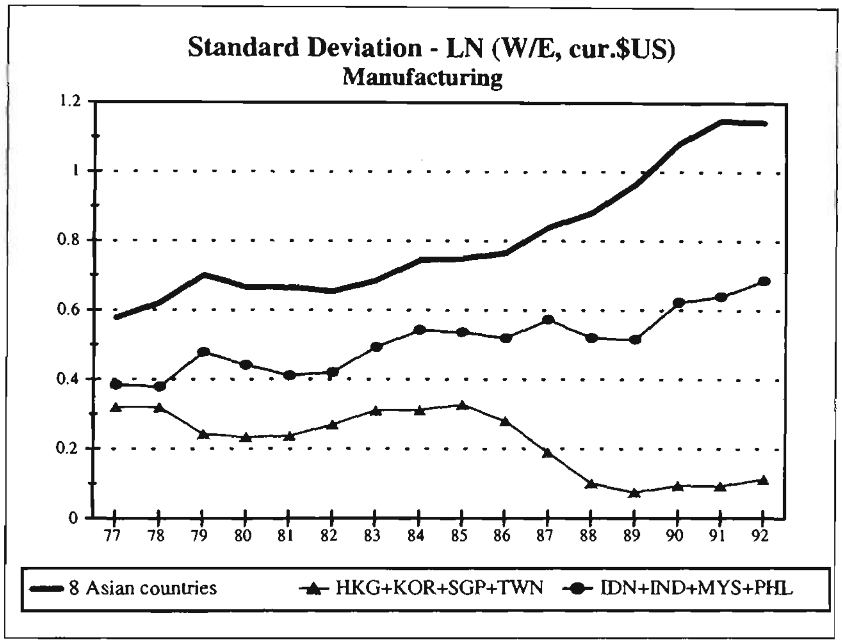
The trend in the values of the standard deviation for the complete sample indicates that in the first half of the 1980s there was a marked tendency to convergence of labour costs across the twenty two countries (standard deviation declining). However, since 1985 the trend was reversed, with a tendency to divergence became quite evident. The value of the standard deviation for 1992 exceeded the initial value for 1977. Thus, there was no convergence of labour costs of manufacturing production across the twenty two countries over the full period.

The trend in the standard deviation for the fourteen developed countries indicates overall convergence between manufacturing labour costs in these countries, although at a slow pace. The labour costs of the eight Asian countries were diverging. Growing disparities between manufacturing wages per employee in these countries was especially marked in the late 1980s and early 1990s.

The lower panel of Chart 11.2 shows trends in the standard deviation of the logarithms of wages per employee for the sample consisting of the eight Asian countries, and for two more disaggregated samples. The first of these samples consists of Hong Kong, South Korea, Singapore and Taiwan, and the second of Indonesia, India, Malaysia and the Philippines. The values of the standard deviation for the first sample exhibited a downward trend, thus indicating convergence of labour costs across the four countries. The trend for the second sample indicates divergence of wages per employee over time. The gap between the trends for the two disaggregated samples was widening, particularly for the late 1980s and early 1990s. The growing disparity in labour costs between the two groups of countries

Chart 11.2





Notes: 22 countries: AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, NLD, NZL, SWE, USA, JPN, HKG, IDN, IND, KOR, MYS, PHL, SGP, TWN;

14 developed countries: AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, NLD, NZL, SWE, USA, JPN;

8 Asian countries: HKG, IDN, IND, KOR, MYS, PHL, SGP, TWN;

18 countries: AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, NLD, NZL,SWE, USA, JPN, HKG, KOR, SGP, TWN.

Source: Estimates based on Production Statistics, from IEDB database.

was reflected in a relatively steep upward of the trend for the sample consisting of all eight Asian countries.

Downward trends in the values of the standard deviation for the samples consisting of eighteen countries, fourteen developed and four Asian countries (Hong Kong, South Korea, Singapore and Taiwan) are indicative of convergence of labour costs across these countries (see the first panel, Chart 11.2). In 1992 the value of the standard deviation for the eighteen country sample was greater than for the fourteen developed country sample, indicating that the disparity between labour costs across the eighteen countries was greater than that across the fourteen countries. However, the diminishing gap between the two trends over time implies that wages per employee in the four Asian countries (Hong Kong, South Korea, Singapore, and Taiwan) were converging with the levels in developed economies.

In summary, the tests of convergence of manufacturing wages per employee for the period 1977-1992 have confirmed that there was no convergence across all twenty two countries and across the eight Asian countries considered in this section. In Indonesia, India, Malaysia and the Philippines there was also no convergence of manufacturing labour costs. The tests for the other samples, consisting of fourteen developed countries, four Asian countries, Hong Kong, South Korea, Singapore, and Taiwan, and the combined sample incorporating the former two samples, exhibited convergence. Thus, manufacturing wages per employee in these four Asian countries were converging with the levels in the developed economies.

11.4 Analysis of the Pattern of Changes in the Composition of Manufacturing Wages and Employment

In this section changes in the composition of manufacturing wages and employment across industries in different countries will be considered. The same technique will be applied here as has been used for analysing changes in relative productivity across manufacturing industries (see Section 10.2, Chapter 10). We will assess changes in the composition of wages relative to those of employment. The manufacturing structure is evaluated according to the income generating potential of industrial structure. Chart 11.3 shows changes in the structure of manufacturing wages and employment for selected countries. The values of the Index of Long Run Income Potential (ILRIP) are presented in index form, with the value for 1981 equal to 100. Because of data limitations, 1983 has been used as the base year for the Philippines and 1985 for Japan. The original values of the Index for Long Run Income

Potential, which are useful for a cross-country comparison between the structural of manufacturing wages relative to that of employment, are shown on Chart 11.A1 in the Appendix.

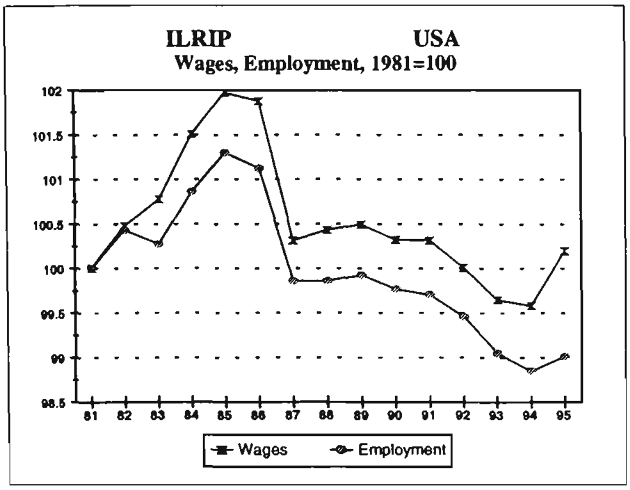
The gap between the values of the Index for wages and for employment was increasing over time for all developed countries presented on Chart 11.3. For some countries this tendency was less pronounced than for value added and employment (see Chart 10.5, Chapter 10). This indicates that the changes in wages per employee across manufacturing industries were disproportionate to the changes in labour productivity. The situation in Asian countries, excluding Japan, was quite complex. Let us briefly consider structural changes in manufacturing wages relative to those in employment in some individual countries.

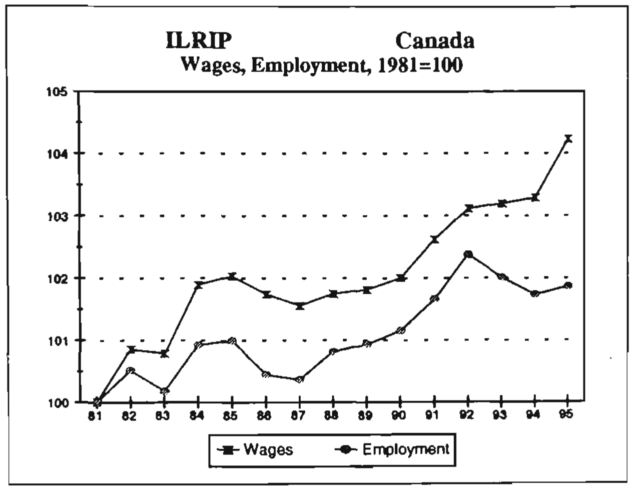
In the USA the gap between the values of the Index of Long Run Income Potential for wages and for employment was widening over time, indicating that wages per employee were growing more rapidly in the industries of high income generating potential than in other manufacturing industries. This is so in spite of the fact that both indexes were falling over time. By contrast, in Canada wages and employment were increasingly concentrated in the industries of high income generating potential. However, this tendency was more marked for wages than for employment, and the gap between the trend was widening over time. In the United Kingdom there was also a disproportionate increase in wages per employee in the industries of high income generating potential, relative to the levels of earnings in other manufacturing industries, and the situation was similar in Spain. In Germany and Sweden the gap between the values of the Index for wages and for employment increased, in spite of marked differences in the direction of structural changes in these countries.

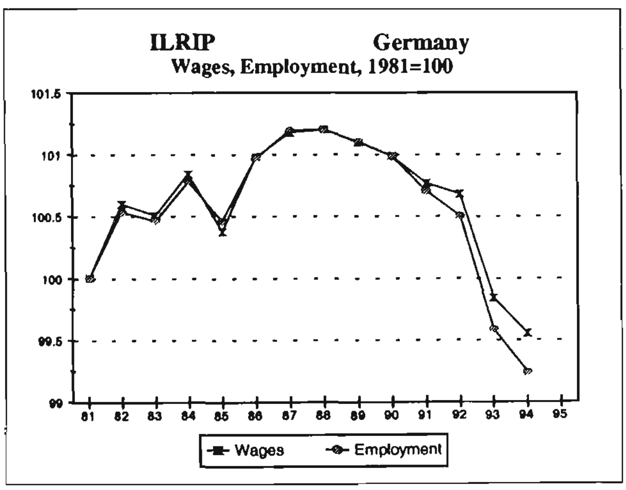
In Japan the situation was similar to that in most other developed countries. Changes in the structure of wages and employment that occurred in the late 1980s and early 1990s largely contributed to the increased gap between the values of the Index for the two indicators.

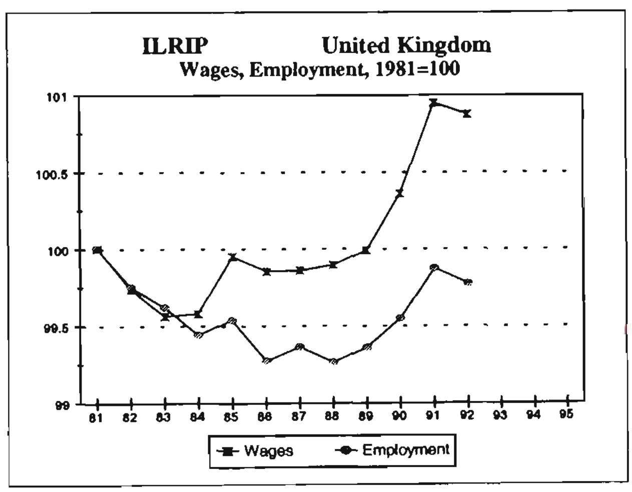
The situation in other Asian countries covered in Chart 11.3 was less uniform than in the developed countries. India was the only country for which the gap between the values of the Index of Long Run Income Potential for wages and employment was widening over time.

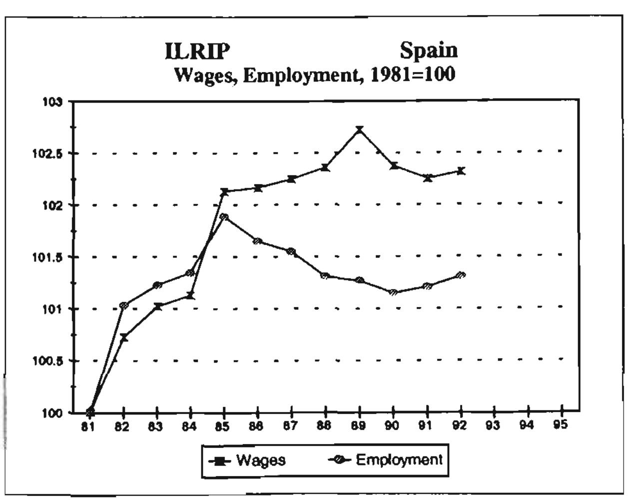
Chart 11.3

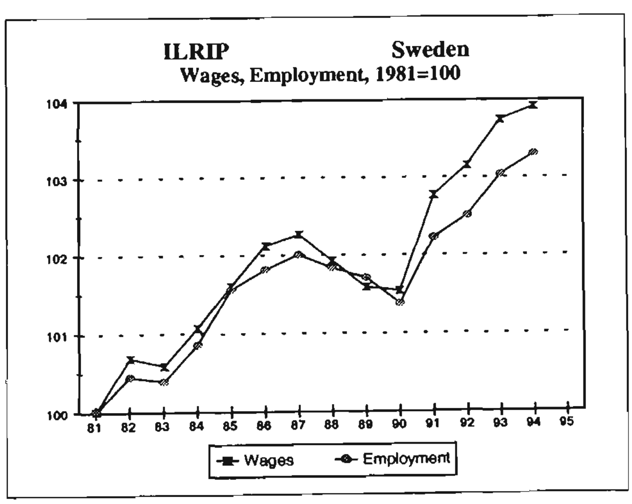












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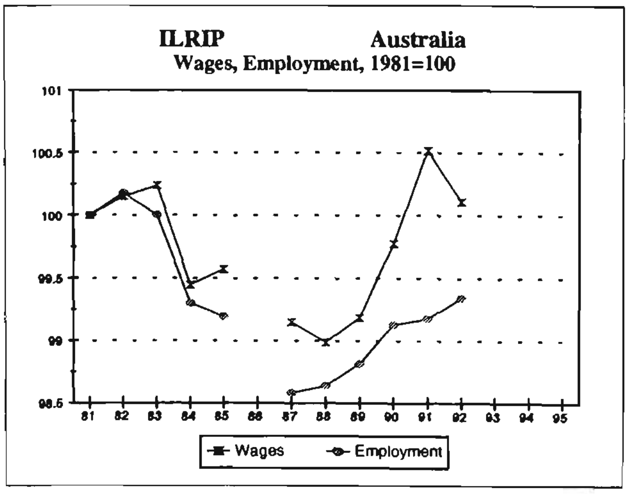
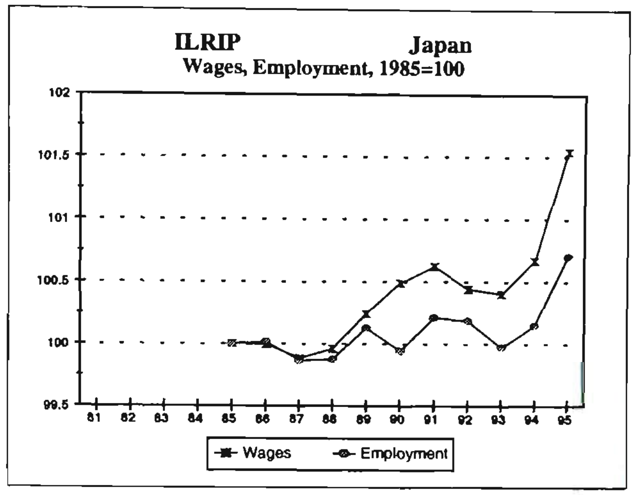
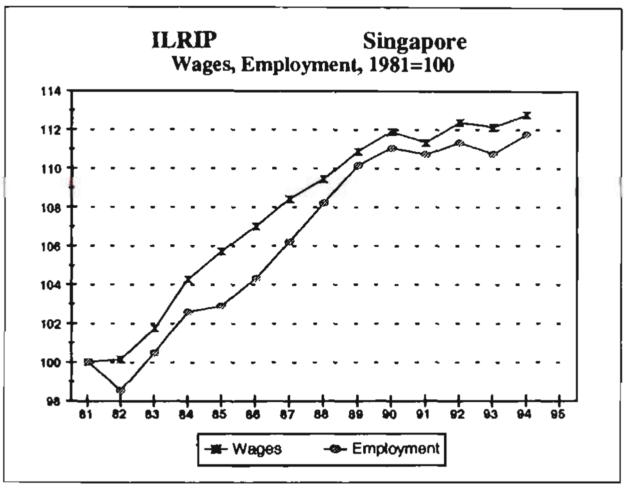
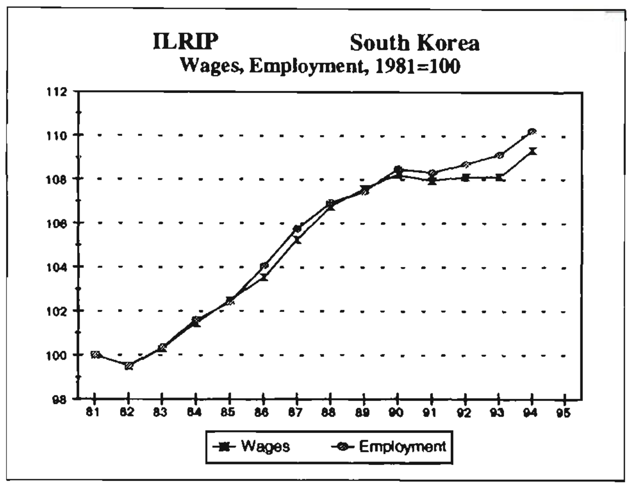
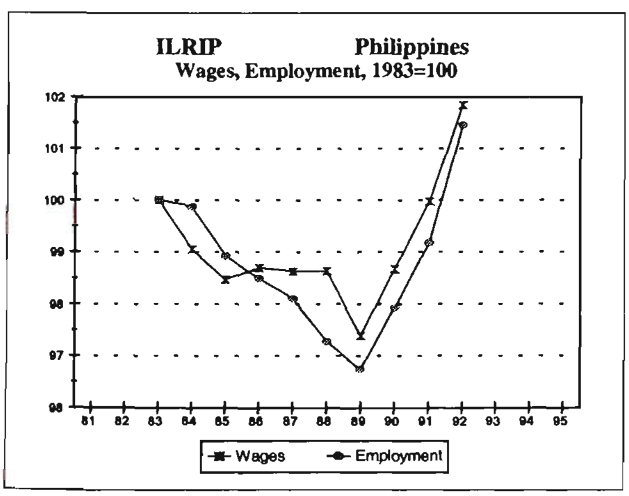
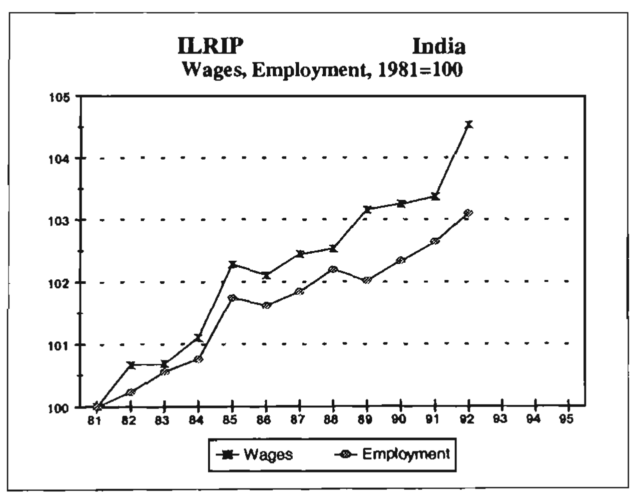












Source: Estimates based on Production Statistics, from IEDB database.

In Singapore, South Korea and the Philippines there were no sharp differences between the trends in the structure of manufacturing wages and employment. However, the differences between these countries were significant. In Singapore there were two periods when the trends for these two variables deviated from each other: in the early 1980s and in the mid 1980s. By 1990 the values of the Index indicating the structure of employment approached the values of the Index for wages, and since that time the gap between the two trends remained virtually unchanged.

In South Korea the situation was different from that in Singapore and very different from that in the developed countries. In the 1980s the trends in structural change in manufacturing wages and employment were virtually identical. In the 1990s the trend for wages deviated from the trend for employment, but in the contrast with the situation in most other countries, the pace of structural change of manufacturing employment exceeded that of wages. This implies that in South Korea wages per employee in the industries characterised by high income generating potential were growing more slowly than in other manufacturing sectors. In the Philippines the value of both structural indicators showed significant fluctuations, but between 1983 and 1992 there was little change in the relative values of the structural indicators for wages and employment.

In summary, an increase in the gap between the values of the Index for wages and employment was a common feature for all developed countries considered in this section. This implies that wages per employee in industries of high income generating potential were growing relatively more rapidly than in other manufacturing sectors. The situations in Asian countries, except Japan, in terms of the changes in the pattern of growth of wages per employee in manufacturing industries, were quite diverse. In India the relative trends for wages and employment were similar to that in the developed countries. In Singapore, the Philippines and South Korea there were no sharp differences between the trends of the Index for wages and employment. This fact indicates that there were no marked differentials in the growth rates of wages per employee across manufacturing industries. However, in Singapore and the Philippines at particular periods of time wages per employee in industries of high income generating potential were growing more rapidly than in other industries. In South Korea, on the contrary, wages per employee in the industries characterised by high income generating potential were growing more slowly than in other manufacturing sectors. In the next section we will extend the analysis of the pattern of relative changes in labour costs across manufacturing industries in different countries by assessing the corresponding growth rates.

11.5 Relative Growth of Wages per Employee in Manufacturing Industries

Growth rates of wages per employee for twenty two manufacturing industries for the 1985-1992 period, for selected countries, are shown on Chart 11.4. The trend lines of the growth rates across industries are also shown. Countries are selected according to the availability of the data and to the statistical significance of the coefficients in the equations for the trend lines. Manufacturing industries are marked (on the horizontal axes) according to the overall composite rank corresponding to the income generating potential of particular industries (see Table 4.4 and Table 4.5, Chapter 4).

For all developed countries presented in Chart 11.4, the trend lines slope down, which indicates that in industries characterised by high income generating potential wages per employee exhibited higher rates of growth than in other manufacturing sectors.

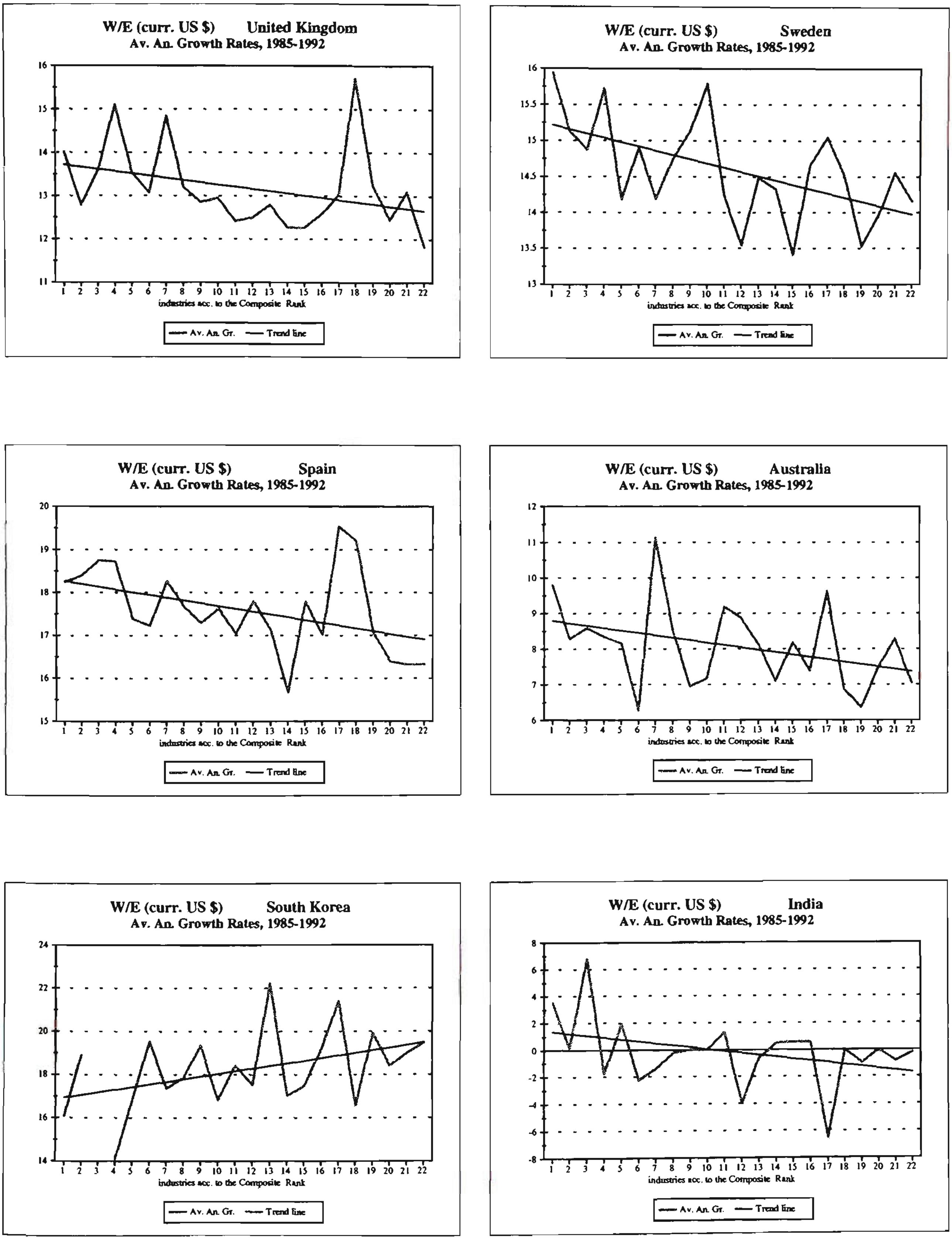
In two Asian countries presented on Chart 11.4, South Korea and India, the situations were very different. The slope of the trend line for India is similar to the slopes of the trend lines for developed countries. For South Korea the trend line is upward sloping, which implies that in South Korea wages per employee in the industries of high income generating potential in South Korea grew less rapidly than those in other manufacturing industries.

These findings confirm, on a more limited sample, the conclusions made in the previous section. In the developed countries wages per employee in the industries characterised by high income generating potential exhibited higher rates of growth than in other manufacturing sectors. In two Asian countries considered in this section, the situations were very different. In the next section we will consider changes in labour costs in the computing and electronics industries relative to other manufacturing sectors of different economies.

11.6 A Cross-Industry Comparison of Wage Costs: Computing and Electronics, Textiles and Clothing, and Total Manufacturing

In this section we will analyse whether the computing and electronics industries contributed to the emergence of the trends in the distribution of wage growth across manufacturing industries described in the previous sections.

Chart 11.4



Source: Estimates based on Production Statistics, from IEDB database.

For this purpose we will analyse the differentials between the levels and growth rates of wages per employee in three manufacturing sectors: computing and electronics, textiles and clothing, and total manufacturing. Information on wages per employee in these manufacturing sectors for sixteen countries for the 1985-1992 period is presented in Table 11.2. Countries are listed in descending order according to the value of wages per employee in the computing and electronics industries in 1992. Several observations can be made on the basis of the information presented.

First, differences between countries according to the relative values of wages per employee in the computing and electronics industries were striking. In 1985 in the USA labour costs in computing and electronics production were the highest among all countries considered here, at US$26,500 per employee, and this level was very much higher than in other countries. In Germany, for example, wages per employee amounted to 57 per cent of the US level, while in the United Kingdom the figure was 45 per cent and in Japan 46.5 per cent. There were also distinct differences across Asian economies in terms of labour costs per unit of employment. In Singapore wages per employee constituted 25 per cent of the labour costs in the computing and electronics sector of the USA while for Hong Kong, South Korea and Malaysia the figures were 16.5 per cent, 13 per cent and 12 per cent respectively. In some Asian countries for which the data are available, labour costs were especially low in comparison with those in the developed economies. Thus, in the Philippines labour costs per unit of employment in electronic production amounted to US$1,800 and in India toUS$1,500, constituting 6.7 per cent and 5.6 per cent of the US level respectively.

By 1992, reflecting currency changes and other factors, the highest labour costs in the computing and electronics industries were in Germany, at more than US$40,000 per employee. In the USA wages per employee were also high, at US$35,000 per employee, although they were much lower relative to other countries than in 1985. In the other developed countries labour costs increased substantially, approaching the highest achieved level. Thus, for example, wages per employee in the United Kingdom amounted to 70 per cent, and in Japan to almost 80 per cent, of German level.

It is quite evident from the information presented in Table 11.2 that, in some Asian countries, wages per unit of employment in the computing and electronics industries were increasing relative to the levels of the developed economies. Thus, in Hong Kong and

Singapore wages per employee accounted for more than 30 per cent, and in South Korea for more than 28 per cent, of the level in Germany in 1992.

Table 11.2 Wages per Employee - Computers & Electronics, Total Manufacturing and Textiles & Clothing, 1985-1992

	Computers & Electronics		Total Manufacturing (*th. current US $*)		Textiles & Clothing		Average Annual Growth Rates *1985-1992* %		
	85	*92*	*85*	*92*	*85*	*92*	**C&E**	**Man.**	**T&C**
Germany	15.0	**40.6**	14.1	36.3	9.8	25.2	15.24	14.42	14.47
USA	26.5	**35.0**	22.7	29.2	13.1	17.4	4.06	3.68	4.16
Netherlands	17.5	**33.9**	17.0	33.2	12.6	25.9	9.94	10.03	10.87
Sweden	11.9	**32.4**	11.7	30.2	9.2	23.9	15.33	14.53	14.55
Japan	12.3	**31.8**	13.6	32.7	8.8	20.3	14.48	13.28	12.71
Canada	19.9	**31.2**	19.2	28.7	12.6	19.4	6.61	5.94	6.36
United Kingdom	11.8	**28.5**	10.8	25.3	7.0	16.5	13.39	12.92	13.10
Spain	8.6	**28.1**	7.4	22.1	5.5	15.7	18.53	17.00	16.32
Australia	12.8	**24.6**	12.9	23.2	10.4	18.2	9.78	8.71	8.29
Hong Kong	4.4	**12.9**	4.6	11.1	4.7	10.3	16.62	13.53	12.07
Singapore	6.6	**12.7**	7.2	14.4	4.3	8.8	9.77	10.30	10.63
South Korea	3.5	**11.5**	3.5	11.8	2.7	9.2	18.70	19.11	18.98
Malaysia	3.2	**3.8**	3.1	3.8	2.1	3.0	2.55	2.92	5.37
Philippines	1.8	**2.9**	1.3	2.5	1.0	1.8	7.48	10.52	9.48
India	1.5	**1.6**	1.1	1.1	1.0	0.9	1.10	-0.08	-0.84
Indonesia	na	**1.1**	0.9	0.9	0.6	0.8	na	-0.73	2.33

Source: Estimates based on Production Statistics, from IEDB database.

But in some other Asian countries labour costs decreased relative to the highest achieved level, and hence remained relatively low. For example, in computing and electronics production in Malaysia wages per employee accounted for less than 10 per cent and in India for less than 4 per cent of the German level. The data for Indonesia for 1985 are not available, so it is impossible to evaluate changes in the relative value of wages per employee over time. But in 1992 in Indonesia labour costs were especially low relatively to those in other countries, at US$1,100 per employee, which was less than 3 per cent of wage costs in the computing and electronics industries in Germany.

Second, in most countries wage costs per unit of employment in computing and electronics production exceeded wage costs in the overall manufacturing sector. However, with respect to the relative values of wage costs in these two sectors, the differences between the developed non-Asian countries and the Asian countries were quite noticeable. Wages per employee in the computers and electronics were 11.5% higher on average than in total manufacturing in the eight developed countries, while in the seven East Asian countries (including Japan) they were 0.6% lower.

In most developed non-Asian economies wages per unit of employment in the computing and electronics industries were higher than in total manufacturing sector. Australia was the only country, among all developed non-Asian economies considered here, where in 1985 wages per employee in total manufacturing were slightly higher than in the computing and electronics industries. In all developed non-Asian countries, except the Netherlands, wages per employee in the computing and electronics industries were growing at a higher rate than in total manufacturing.

In Japan wages per employee in the computing and electronics industries were growing more rapidly than in total manufacturing. However, in 1992, as in 1985, wages per unit of employment in the overall manufacturing sector were higher than in the computing and electronic industries.

A comparison between the wage costs in computing and electronics relative to the overall manufacturing sector in other Asian countries reveals a diverse situation. In 1985 in Hong Kong and in Singapore wage costs in manufacturing were higher than in the computing and electronics. In Hong Kong wages per employee in the computing and electronics industries were growing more rapidly than in total manufacturing, and by 1992 wages per employee in the computing and electronics industries were higher than in total manufacturing. In Singapore the situation was different. Over 1985-1992 the rate of growth of wages per employee in manufacturing was higher than in computing and electronics. However, at the end of the period wages per employee in computing and electronic production remained below the level of earnings in total manufacturing. In South Korea the situation was similar to that in Singapore, except that in 1985 wages per employee in the computing and electronics industries were at exactly the same level as in total manufacturing. In Malaysia and in the Philippines wages per employee in total manufacturing were also growing more rapidly than in the computing and electronics industries. As a result, by the end of the period, in Malaysia earnings per employee in the computing and electronics industries were equal to those in total manufacturing, in spite of being higher in 1985. In the Philippines the average wage per employee in the computing and electronics was below the corresponding level in total manufacturing in 1992, as it was in 1985. Data on wages per employee for the computing and electronics sector in Indonesia are available only for 1992, at which time wages per employee in these industries were higher than in total manufacturing, although they stood at a very low level relative to that of other countries.

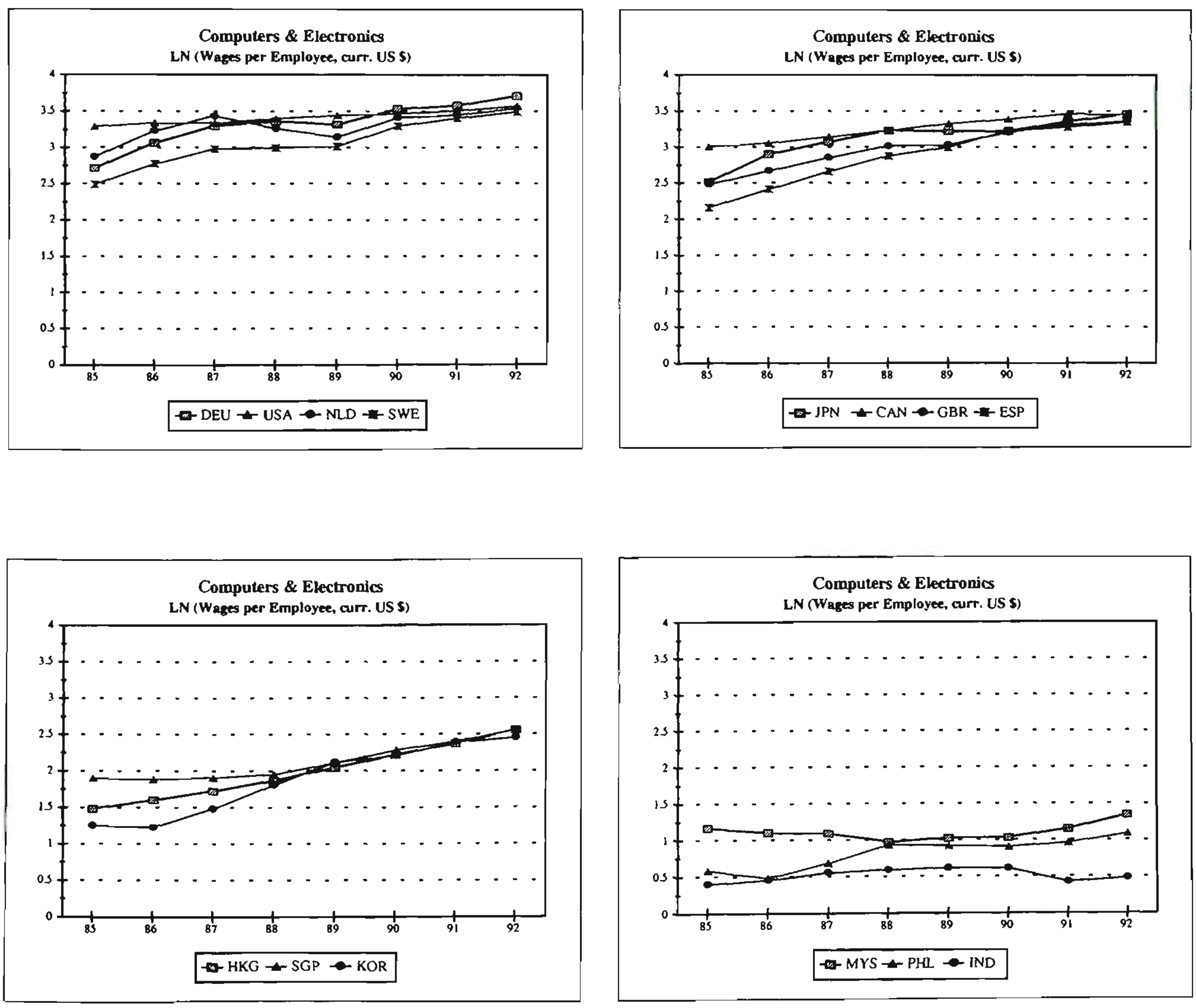
Third, in all countries except Hong Kong, wages per unit of employment in the computing and electronics industries in 1985 were higher than in textiles and clothing. In most developed countries the average annual growth rate of wages per employee in computing and electronics exceeded that in textiles and clothing. In some developed and in most of Asian economies considered in this section (see Table 11.2), wages per employee in the textiles and clothing were growing more rapidly than in the computing and electronics sectors. Thus, for example, in the USA in 1985-1992 in the textiles and clothing wages per employee were growing at 4.16 per cent, while in the computing and electronics at 4.06 per cent per annum. In the Netherlands the corresponding rates were 10.87 and 9.94 per cent respectively.

Wages per employee, in the logarithmic form, for the period 1985-1992 for the computing and electronics industries of the fourteen countries for which the data are available, are shown on Chart 11.5. The countries are listed in the descending order, according to the value of the average wage per unit of employment for 1992, and subdivided into four groups.

There were marked differences between the countries in terms of both the levels and growth rates of wages per employee. In the developed countries (the first and the second panels of Chart 11.5) wages per employee were growing more rapidly in the countries in which the initial level was lower relative to other countries. Thus, convergence in wages per unit of employment was evident across these countries.

For Asian countries, excluding Japan, the picture is not uniform. The trends in wages per employee in the computing and electronics industries for the countries presented on the third panel of the chart differ distinctly from those presented on the fourth panel. Among three Asian countries presented on the third panel, in 1985 wages per employee were lowest in South Korea and highest in Singapore (see Table 11.2). Growth rates of wages per employee in these countries were inversely correlated with the initial relative levels of earnings per unit of employment. Thus, in South Korea the annual rate of growth was the highest, 18.7 per cent, in Hong Kong it was 16.6 per cent and in Singapore the lowest, at 9.8 per cent per annum. Thus there was convergence in wages per employee in these industries across these three Asian economies. Besides this, the high rates of growth achieved in these countries relative to those in many developed economies indicate some convergence of these three Asian economies with the developed countries, in respect to wages per unit of employment in the computing and electronics industries.

Chart 11.5



Source: Estimates based on Production Statistics, from IEDB database.

For other three Asian countries presented on the fourth panel of Chart 11.5 – Malaysia, the Philippines and India – the situation was very different. At the beginning of the period wages per employee in the computing and electronics sectors of these economies were lower than in the countries of the third group. In Malaysia in 1985 the average wage per employee was higher than in the Philippines and India, at US$3,200 (see Table 11.2). The growth rates of wages per employee in the countries of the fourth group were also low in comparison with those achieved in the economies of the third group: 1.1 per cent per annum in India, 2.6 per cent in Malaysia and 7.5 per cent in the Philippines (see Table 11.2). Thus, wages per employee in the computing and electronics sectors in the countries of the fourth group diverged further relative to the three East Asian countries, Hong Kong, Singapore and South Korea, and to most of the developed countries.

In the next section we will analyse the relationship between the wages per employee in the computing and electronics industries and the structure of electronic production and the output of technological innovation in different economies.

11.7 Labour Costs in the Computing and Electronics Industries, the Structure of Electronic Production and Technological Innovation

Various factors, not only economic but also political, social and cultural, can influence relative levels of earnings across different sectors of economies. Here we will consider just some such factors that, in our view, are of the immediate relevance to the topic of the thesis. As has been pointed out earlier, there were marked differences across countries with regard to specialisation in electronic production, technological innovation, and wage costs. Table 11.3 presents the results of two types of panel regression tests: one is of the association between the structure of electronic production (in terms of global demand) and wages per employee, while the other is of the association between the output of technological innovation and wages per employee. Although the issue of the causes of the marked differentials between the wages per unit of employment across countries is complex and deserves to be analysed in further detailed research. However, in our opinion, some tentative evidence presented below can indicate some factors that can be important for explaining the differences in the industry structure of wages per employee across countries.

The first two panel regressions test the relationship between the structure of electronic production and the wages per employee. In the first regression the Index of Relative Global Demand (see Section 8.1.2, Chapter 8) for electronic production has been used as an independent variable, and wages per employee in the computing and electronics industries has been used as the dependent variable. In the second regression the same variables have been used in the logarithmic form. Thus, in this latter case, a relationship between structural change in electronic production and the growth of wages per employee has been tested. The data set covers fourteen countries (see the notes, Table 11.3) for the period 1985-1992.

Table 11.3 Regression Results of the Effects of Structural Change of Electronic Production and R&D Output on Wages per Employee, Computing & Electronic Industries, 14 countries[1], 1985-1992

	Coeff-t	t-ratio	R-sq. adj.	Number of observations	SEE	F test $(A_i,B= A_i,B_i)$	Critical F value
Independent variable - values of the Index of Relative Global Demand of Electronic Production *Dependent variable - Wages per Employee - Computers & Electronics (th. curr. $US)*							
	5.197	0.388	0.816	112	2261.36	5.58	4.71
Independent variable - ln of values of the Index of Relative Global Demand of Electronic Production *Dependent variable - ln of Wages per Employee - Computers & Electronics (th. curr. $US)*							
	2.012	2.007	0.919	112	8.03	10.86	4.71
Independent variable - Numbers of Patents Granted (USPTO) – Computers and Electronics *Dependent variable - Wages per Employee - Computers & Electronics (th. curr. $US)*							
	0.003	3.759	0.839	112	1976.93	3.36	4.71
Independent variable - ln of Numbers of Patents Granted (USPTO) – Computers and Electronics *Dependent variable - ln of Wages per Employee - Computers & Electronics (th. curr. $US)*							
	0.285	6.886	0.924	98[2]	5.07	2.74	4.46

Notes: 1. CAN, DEU, ESP, GBR, NLD, SWE, USA, JPN, HKG, KOR, IND, MYS, PHL, SGP;

2. CAN, DEU, ESP, GBR, NLD, SWE, USA, JPN, HKG, KOR (85-92); IND (86, 89-92), MYS (88, 90-92), PHL (87, 91-92), SGP (85, 88-92);

Source: Estimates based on Production Statistics, from IEDB database.

The results of the first two panel regressions should be rejected on the basis of F test (see for a reference Section 5.2.1, Chapter 5). These results indicate that there is no statistically significant evidence about the correlation between the structure of electronic production (in terms of global demand) and wages per employee, nor between changes in the structure of electronic production and the growth of wages per employee in these industries.

The other two panel regressions test the relationship, for computers and electronics, between the output of national technological innovation and wages per employee. In the first of these regressions the number of patents granted by the US Patent and Trademark Office in the computing and electronics has been used as an independent variable, and wages per employee in the computing and electronics industries is the dependent variable. In the other regression the same variables have been used in logarithmic form. So, in this case a relationship between the changes in the output of research and development activities and the growth of wages per employee in the computing and electronics has been tested. The data set covers again fourteen countries for the period 1985-1992. The data, used for the second regression, are unbalanced, and the number of observations for individual countries depends on the availability of the data (see the notes, Table 11.3).

These two panel tests generate statistically significant results, which indicate a positive correlation between the output of national technological innovation and wages per employee in the computing and electronics industries. This is true both for levels – expressed by the numbers of patents granted and the level of wages per employee – and for growth rates, expressed as changes in the output of research and development activities and the growth of wages per employee.

In summary, the results of the panel regression tests have shown that, for the period of 1985-1992, there is no statistical evidence of correlation between the structure of electronic production, evaluated in terms of relative global demand, and wages per employee in the computing and electronics industries. With respect to the effects of innovation activities there is some preliminary evidence indicating that the output of national technological innovation, expressed by the number of patents granted, is positively correlated with the wages per employee. Changes in the number of patents are also positively correlated with the growth of wages per employee in the computing and electronics industries. These results imply that technological innovation is more likely to be a contributing factor to higher relative wages in the computing and electronics industries than is structural adjustment to global demand shifts.

11.8 Conclusions

There are several main conclusions from the analysis of this chapter. One is that in developed countries structural change in domestic manufacturing production towards a higher income generating potential was positively correlated with the growth of wages and wages per employee and negatively with employment growth. In Asian countries such structural change of manufacturing value added was positively correlated with growth of employment, but there is no statistical evidence about the correlation between structural change of domestic manufacturing production and the growth of wages and wages per employee.

There were distinct differences across Asian economies in terms of wage costs per unit of employment in the computing and electronics industries and these differences became more pronounced over time. In Hong Kong, Singapore and South Korea wage costs in the computing and electronics industries were moving towards the levels reached in the developed economies, while in other Asian countries such a trend was not observed. In all Asian countries, except Japan, wage costs in these industries were substantially lower than in the developed economies.

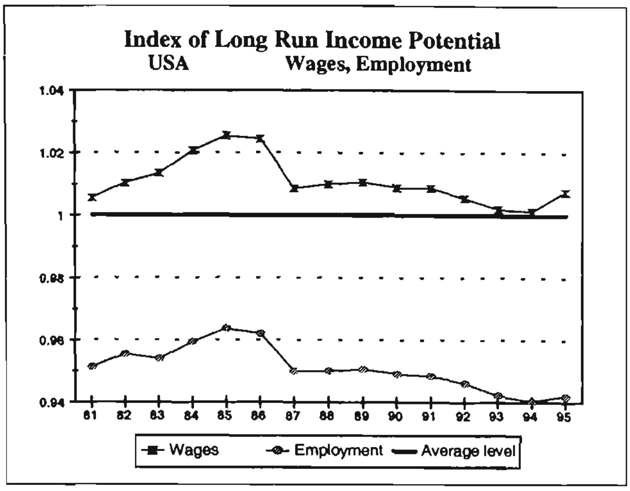
A cross-industry comparison of trends in growth of wages per employee has revealed that in most developed non-Asian economies wages per unit of employment in the computing and electronics industries were higher than, and were growing at a higher rate than, in the total manufacturing sector. But in Singapore, South Korea, Malaysia and the Philippines wages per employee in total manufacturing were growing more rapidly than in the computing and electronics industries. In the 1990s in Singapore and South Korea wage costs in overall manufacturing production were higher than in computing and electronics, and in Malaysia wages per employee in these two sectors were exactly the same.

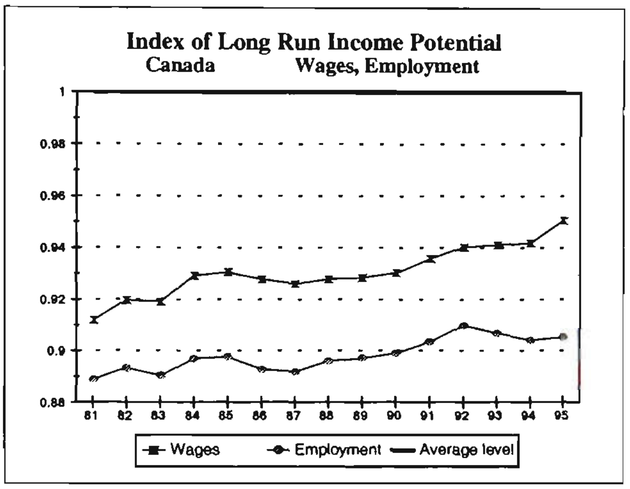
Another conclusion of this chapter is that the output of national technological innovation (expressed both in level and growth terms), rather than structural alignment to global demand trends, is correlated with high and growing levels of wages per employee in the computing and electronics industries.

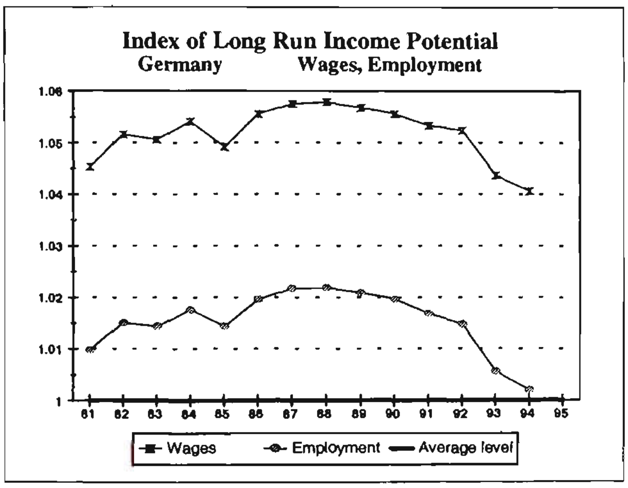
The overall conclusion of this chapter, emerging from the various type of evidence assembled, is that low wage rates remained an important element in the expansion of the computing and electronics industries in East Asian up to the 1990s. The chapter thus provides confirmation of the fact that the high income generating potential of the computing and electronics industries, to generate strong economic returns to employees in the form of wages, was not fully utilised in the East Asian economies.

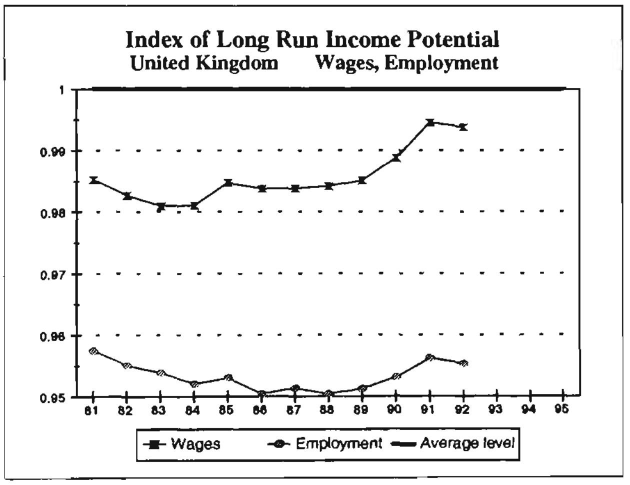
Appendix: Chapter 11

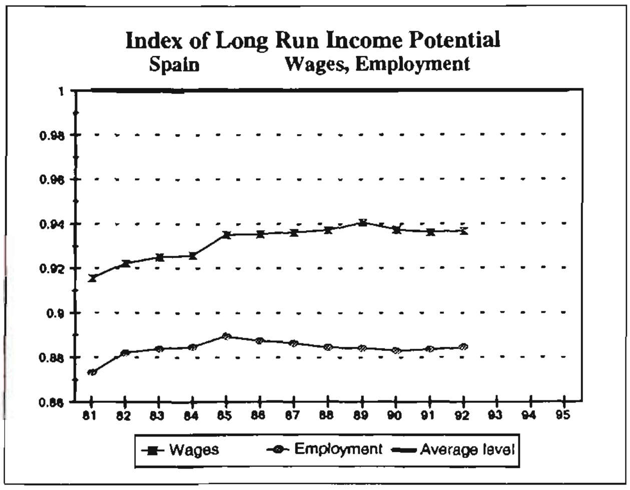
Chart 11.A1

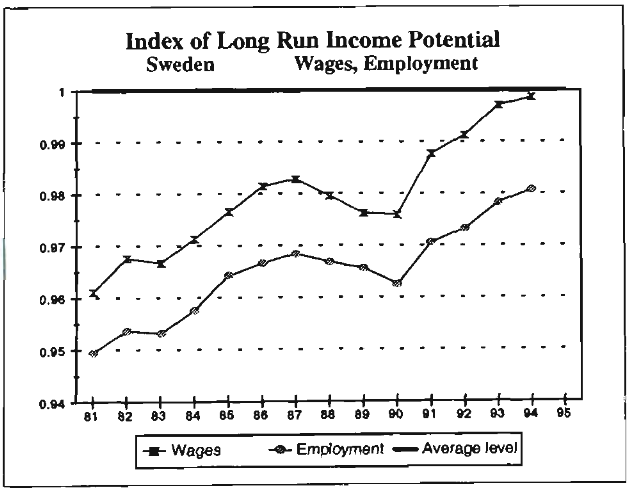












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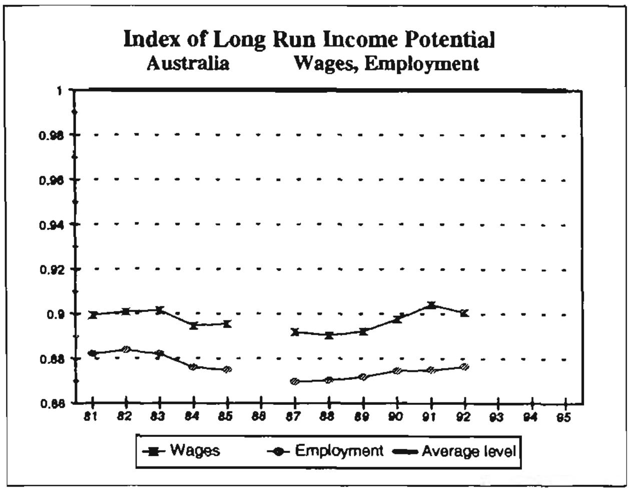
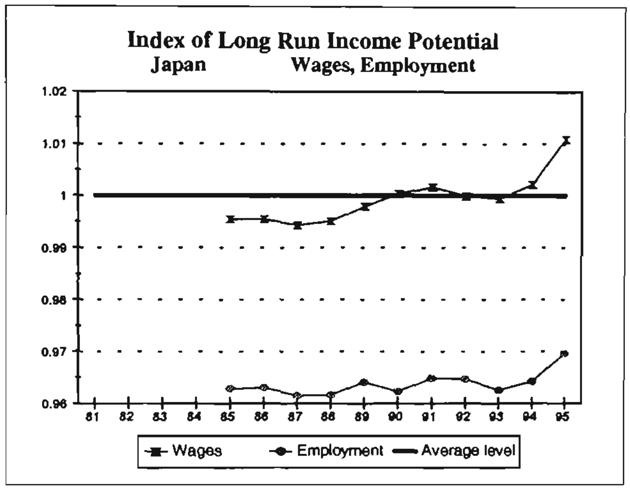
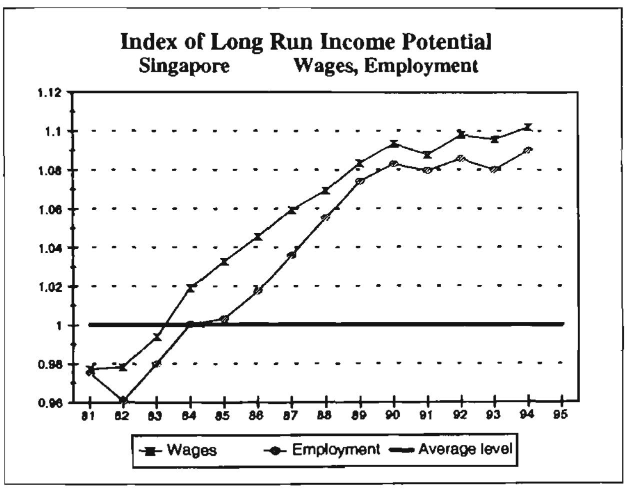
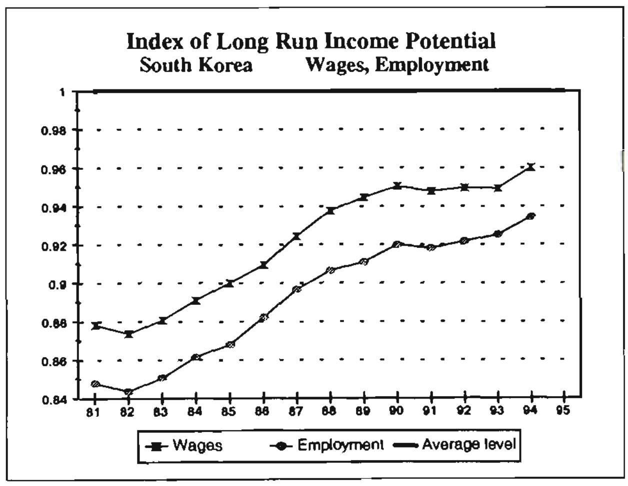
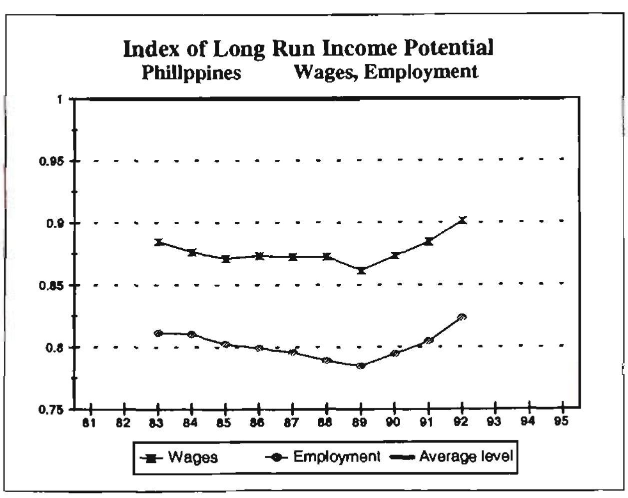
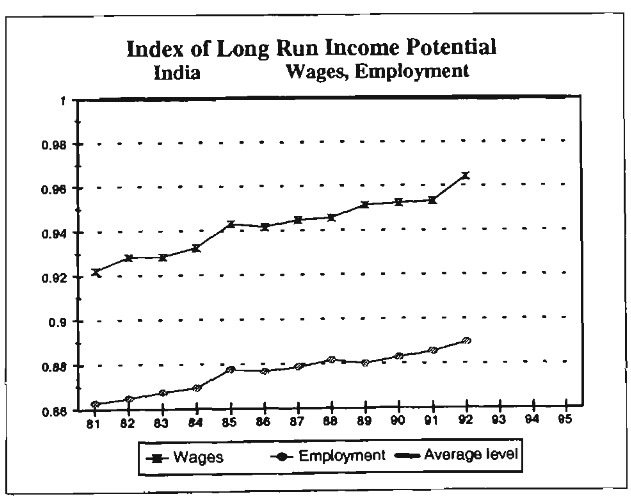












Source: Estimates based on Production Statistics, from IEDB database.

CHAPTER 12

CONCLUSIONS: INDUSTRIAL STRUCTURE, NATIONAL COMPETITIVENESS AND THE COMPUTING AND ELECTRONICS INDUSTRIES

In this concluding chapter we will review and summarise the findings of the previous chapters, and supplement them with some additional empirical analysis, in an attempt to give tentative answers to the general and specific questions that form the topic of this thesis. As has been specified in the Overview, the general questions concern the link between industrial structure and competitiveness. These questions are: *at a given stage of technological development, is there a particular type of industrial structure that is more conducive for the achievement of high levels of national competitiveness and, if so, is such an industrial structure either a necessary or a sufficient condition for high levels of competitiveness?*

The specific questions form the basis for the general questions of the thesis. The specific questions relate to the importance of a high level of performance in the information technology industries (as distinct from competence in applying these technologies in other industries) for growth and competitiveness. In particular, *in the emerging global economy, is a high level of production capability in computing and electronics either a necessary or a sufficient condition for the achievement of high levels of national competitiveness?*

As foreshadowed earlier, the issues concerning the link between the information technology industries and competitiveness have not been approached directly, in all their generality and complexity, in this thesis, but have been addressed through the experience of particular industrialised and developing economies. Central attention is given to considering the role of computing and electronics industries in the growth and competitiveness of East Asian nations over the period 1970-1995. Thus, the specific question with which we have been mainly concerned, in large part for its broader implications, is this: *to what extent, and in what ways, did increased activity in the computing and electronics industries contribute to national competitiveness in different industrialised and developing economies and particularly in the rapidly developing countries of East Asia over the period 1970-95?* Even this question has not been addressed in its full generality. Thus, for example, the thesis does not incorporate the macroeconomic analyses necessary to estimate the indirect effects of specialisation in the computing and electronics industries on improvements in national competitiveness. Rather, this question is approached through the comparative analyses of the structural significance of these industries, and of the nature of production activities undertaken in them in different economies, with the intention of drawing whatever implications are possible from this analysis about issues concerning industrial structure and national competitiveness.

In order to give some answers to the general and specific questions of the topic of the thesis, outlined above, we will summarise the conclusions emerging from this research in the following order. First, the issue of identifying an advanced industrial structure will be considered. Second, the diversity of manufacturing industries will be discussed, with a particular emphasis given to the centrality of the computing and electronics industries and to the shift to an advanced industrial structure that occurred in most countries over the period 1970-1996. Third, the differences across the industrialised and East Asian economies in the utilisation of the income generating potential of an advanced industrial structure, in terms of product segmentation and production process differentials, will be outlined. Fourth, as a preparation for considering the impact of the computing and electronics industries on East Asian competitiveness, a brief cross-country analysis of trends in per capita income will be undertaken. Fifth, the role of the computing and electronics industries in the growth and improved competitiveness of the East Asian economies will be discussed in terms of the four potential effects of industrial structure, specified in the Overview – the direct effects, demand growth and increasing returns, spillover effects on other industries, and balance of payments constraint effects. Sixth, on the basis of these specific conclusions some more general comments concerning the link between the computing and electronics industries and competitiveness will be made. Finally, the question of the relevance of industrial structure for national competitiveness will be considered.

12.1. Identifying an Advanced Industrial Structure

One conclusion of the thesis, on the basis of the analysis of the manufacturing sector, is that it is possible, using economic criteria, to identify the composition of an advanced industrial structure at a particular time and stage of technological development, and to develop methods to compare industrial structures across countries and over time.

A new method for analysing industrial structure, presented in Chapter 4, is based on ranking industries, according to particular industry characteristics germane to income generation, and constructing a weighted index of industrial composition. The overall rationale for this analysis is that the level of sustainable income which can be provided by an industrial structure is related to the level of value added per employee and to the extent to which the benefits of that value added can be transferred to employees in the form of wages per employee, rather than retained by the owners of capital. For a given level of value added or wages per employee, however, the long run potential of an industry structure must also be associated with the extent to which that structure relates to growth and change in the global economy. This element is captured by two aspects of the changing global demand for products of a given industry (the rate of growth of world exports and the industry share of total world manufacturing exports). Knowledge and innovation, particular importance of which is widely acknowledged at the current stage of technological and economic development, are captured by an indicator of the degree of innovation in an industry, R&D intensity. The benchmarking characteristics of the industries are derived on the basis of the performance of major developed economies. Although this approach has been developed for the manufacturing sector, given the topic of the thesis, the suggested methodology could be extended to incorporate other sectors of the economy, given the availability of the relevant data.

An advanced industrial structure, identified according to the methodology developed, will be one which, other things being equal, will tend to generate high levels of valued added and wages per employee in a context of rapid innovation and adjustment to global markets.

12.2 The Diversity of Industries and the Shift to an Advanced Industrial Structure

Another important finding of the thesis is the diversity of industries in terms of their potential to generate income, according to the economic criteria developed. The analysis, undertaken in Chapter 4, also shows that, in the late 1980s and early 1990s, the computing and electronics industries played a central role in an advanced industrial structure, being ranked the highest among all manufacturing industries in terms of the five criteria as a whole. In terms of this composite ranking textiles and clothing and wood and furniture occupied the lowest places.

The thesis demonstrates, especially in terms of the structure of exports, in Chapter 5, that there was a substantial shift towards an advanced industrial structure in most countries over the period 1970-1996. This shift was especially pronounced in many East Asian countries, but is notable that in some other countries as well, particularly Ireland, while Indonesia is a country in which a shift to a more advanced structure of exports did not occur. It is also shown, in Chapter 6, that, the global shift towards an advanced industrial structure of exports was driven substantially by the rise of the computing and electronics industries, in the East Asian economies in particular.

12.3 Differences in the Utilisation of the Income Generating Potential of an Advanced Industrial Structure

As noted above, an advanced industrial structure has been defined on the basis of the performance of major developed economies. The income generating potential of an advanced industrial structure identified in this way may in fact not be realised in a particular country, in one or both of two related ways. One is that the products produced within a given industry may be less complex than those produced in the leading countries, for example because the country specialises in relatively simple final or intermediate goods. The other is that the processes of production used within a given country may be less advanced than in the leading countries. These may, of course, both come together in a particular country, which produces low price electronic products by simple assembly processes based on imported components.

This implies that such a structure is favourable for generating high levels of welfare, but that the actual income levels achieved by different countries will reflect their ability to utilise the potential of manufacturing sectors with high values of the composite rank. It is possible that some countries may have high shares of industries characterised by high values of the composite rank, however, without the underlying industrial performance characteristics. This situation is referred to here as the potential of the industrial structure not being utilised. The analysis of industrial structure and of structural change can provide a good basis for further studies of economic performance in different parts of the world.

The empirical analysis undertaken in the thesis has revealed that a marked segmentation within the computer and electronic industries existed across developed and East Asian economies over the period studied. This segmentation existed both in terms of the types of electronic goods produced and of the production processes used, that is in terms of both product and process segmentation.

Regarding product segmentation, as has been argued in Chapters 8 and 9, the East Asian countries tended to specialise in less sophisticated electronic products, the global demand for which was high and growing rapidly, mostly in the areas of electronic data processing equipment, components and consumer electronics. Developed countries tended to specialise in technically complex electronic products, for which the global demand was more limited and growing more slowly, such as control and instrumentation, industrial and medical processes, and communications electronic equipment.

Concerning the nature of the production processes involved there was, as has been demonstrated in Chapters 10 and 11, a general tendency for production activities in the computing and electronic industries in East Asian economies to involve relatively low levels of productivity, value added and labour costs. This was by comparison with the situation prevailing generally in the developed countries. With the exception of South Korea, Taiwan and to a certain extent Singapore, production activities in these industries in the East Asian countries were not supported to a significant degree by the results of domestic R&D.

12.4 Convergence and Divergence in Per Capita Income

The analysis of industry structure and the characteristics of the computing and electronics industries inherent in the nature of the production activities undertaken in different economies, presented in this thesis, enables some answers to be inferred to the questions concerning the link between the increased activity in the computing and electronics industries and national competitiveness in East Asia. As has been shown in the review of recent tests of the convergence hypothesis (Section 1.2 in Chapter 1), persistent polarisation in per capita income levels is the prevailing situation. However, some countries, especially in East Asia, achieved high rates of economic growth, converging in terms of per capita income with the developed economies. First, in this section (12.4), we will evaluate changes in the relative levels of per capita income across countries with the purpose of finding out in which of the East Asian economies, considered in this study, the improvements in national competitiveness were most marked. Second, the findings of the research, undertaken in the thesis, will then be reviewed (section 12.5) to consider the impact of increased activity in the computing and electronics industries on growth and improved competitiveness in the East Asian countries. This will be undertaken in terms of the four potential effects of industrial structure specified in the Overview – the direct effects, the demand growth and increasing returns effects, spillover effects on other industries, and balance of payments constraint effects.

As has been specified in Chapter 1, the ability to provide high living standards for citizens, relative to the levels achieved in other countries, on a sustainable basis and in an environment of openness to global competition, is an essential prerequisite of a competitive nation. A discussion about the most appropriate indicators of national competitiveness, consistent with the accepted definition, has led to a conclusion that the dynamic development of national competitiveness is reflected by the changes in per capita income, expressed by per capita GDP (PPP), of the national population.

The sustainability of high living standards is a complex issue; numerous factors can affect the national capability to maintain levels of living that are high by international standards. An assessment of national capability to sustain high living standards of the population *in the future* should incorporate an analysis of whether the national environment is conducive to maintaining (or to achieving and then maintaining) a high level of per capita income. An evaluation of sustainability requires complex multi-dimensional methodologies taking into account a range of relevant indicators covering national performance in international trade, the degree of development of financial markets and of infrastructure, an assessment of the role of the government, of the quality of the national scientific and technological base and of the system of education, as well as of labour market conditions and of management. Such studies have been undertaken by the World Economic Forum and the International Institute for Management Development (see Section 1.1.2, Chapter 1).

For a particular period *in the past*, say 1970 to the early 1990s, a cross-country comparison between the levels of per capita income actually achieved, and between the changes in these levels over time, can allow us form judgements about the relative competitive positions of different economies at particular points of time and about changes in national competitiveness over the period. In other words, we can investigate whether living standards in particular countries were improving, and whether high living standards by international standards were achieved and sustained over the period.

Table 12.1 presents information on per capita income, measured by GDP per capita in PPP terms, of the twenty four countries for the period 1970-1992. The countries are listed in the descending order according to the rate of growth of per capita income. The values of real GDP per capita measured in current international prices have been used. This type of GDP measure provides the most appropriate indicator for a direct comparison between the levels of real per capita income across countries. With respect to intertemporal comparability this type of GDP measure is affected by inflation in the numeraire country, the USA. For an evaluation of changes in living standards over time a fixed-base real per capita GDP measure could be regarded as a more appropriate indicator. However, because of the constant base year weights attached to the relative prices, the differences between the values of the fixed-base real per capita GDP and of per capita GDP measured in current international prices can become significant for years remote from the base year. Thus, for such years a cross-country comparison based on the fixed-base real per capita GDP can generate misleading results (Summers and Heston 1991, pp. 334, 343-344). For all countries time series of real GDP per capita measured in current international prices are proportionally affected by inflation in the same numeraire country. Thus, although the values of this indicator are not directly applicable for the analysis of changes in real per capita income over time in individual countries, they adequately reflect the changes in the relative income levels across countries, which is the primary objective of the analysis undertaken in this section.

During the 1970-1992 period in all countries presented in Table 12.1, per capita income increased quite markedly. The growth rates of GDP per capita (PPP) in Asian countries, other than Japan, exceeded the rates of growth for the developed economies. South Korea, Singapore, and Hong Kong achieved particularly high rates of growth. In Japan the rate of growth was the highest among the developed countries. Thus, in East Asian economies there were major improvements in levels of national competitiveness, measured in terms of the per capita income of the population.

However, as can be seen from Table 12.1, in many East Asian countries per capita income was growing from a relatively low base. Let us briefly compare the relative levels of income of the population across different national economies. In the USA in 1970 per capita income was the highest among all countries considered here, and in 1992 the USA maintained its leading position (see the last two columns, Table 12.1). The changes in relative ranks of Canada and Germany indicate significant improvements in the living standards of the population of these countries. Canada moved from fifth to third position, and Germany's relative rank changed from sixth to fourth. The relative rank of France did not change over the period. France occupied the ninth position in the list of the twenty four countries. The relative positions of other developed non-Asian countries deteriorated. In New Zealand this change was most marked. The relative rank of this country changed from seventh to fourteenth.

Table 12.1 GDP per Capita, PPP, Selected Countries, 1970-1992

	GDP per Capita, PPP (th. curr. int. pr.)						*Average Annual Growth Rates 1970-1992 %*	*Rank*	*Rank*
	1970	**1975**	**1980**	**1985**	**1990**	**1992**		*1970*	*1992*
South Korea	0.6	1.2	2.4	4.2	8.3	10.2	13.5	19	17
Singapore	1.2	2.8	5.3	8.6	14.4	16.7	12.8	17	11
Hong Kong	1.6	2.9	6.6	10.6	17.4	21.0	12.4	15	2
Indonesia	0.2	0.5	1.0	1.7	2.3	2.6	11.4	24	21
Malaysia	0.8	1.3	3.0	4.1	6.0	7.2	10.6	18	19
Thailand	0.6	0.9	1.7	2.5	4.3	5.0	10.3	20	20
China	0.3	0.4	0.7	1.3	1.5	1.8	9.5	23	23
Japan	2.8	4.6	7.8	11.8	17.6	19.9	9.3	12	5
Ireland	1.9	3.0	4.9	7.3	11.3	12.3	8.8	14	16
Spain	2.2	3.8	5.7	7.5	11.8	13.0	8.4	13	15
Italy	2.9	4.4	7.9	10.8	15.3	16.7	8.3	11	12
Canada	3.7	6.4	11.1	15.6	20.8	21.0	8.2	5	3
Germany	3.6	5.5	9.3	12.5	18.2	20.2	8.2	6	4
India	0.3	0.4	0.7	1.1	1.5	1.6	8.1	22	24
Mexico	1.5	2.6	4.8	5.6	6.9	7.9	7.9	16	18
France	3.5	5.6	9.1	12.2	17.0	18.2	7.8	9	9
United Kingdom	3.2	4.8	8.0	11.2	15.7	16.3	7.7	10	13
Denmark	3.8	5.6	8.8	13.0	17.2	18.7	7.5	4	6
Netherlands	3.5	5.6	8.8	11.5	16.1	17.4	7.5	8	10
USA	4.9	7.3	11.9	16.6	21.8	23.2	7.3	1	1
Australia	4.1	6.2	9.8	13.6	17.5	18.5	7.1	3	7
Sweden	4.2	6.6	9.7	13.5	18.0	18.4	7.0	2	8
New Zealand	3.6	5.5	8.1	11.4	14.6	15.5	6.9	7	14
Philippines	0.5	0.9	1.4	1.5	2.1	2.2	6.6	21	22

Source: World Bank World Tables, Social Indicators of Development, from IEDB database.

Over the period Japan's position moved seven places up, from twelfth to fifth. Most of the other Asian countries also improved their relative positions. In Hong Kong the changes in relative rank were the most remarkable. Over the period Hong Kong moved thirteen places up, from the fifteenth to the second place in the list. In 1992 per capita income in Singapore was the highest among Asian countries, except Hong Kong and Japan. During 1970-1992

Singapore moved six positions up, however, at the end of the period per capita income in this country was still significantly lower than in many developed economies.

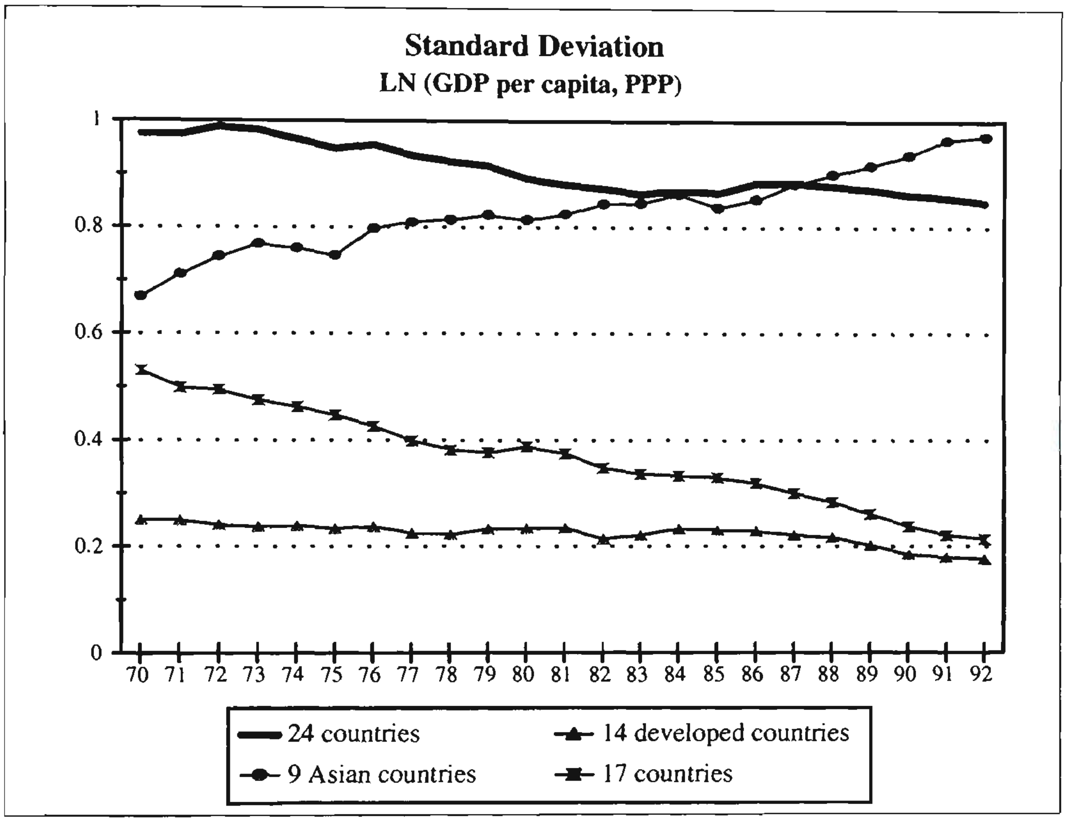
The relative positions of South Korea and Indonesia also improved over the 1970-1992 period, two places up for South Korea and three places up for Indonesia. In 1992 South Korea was the seventeenth and Indonesia was the twenty first among the twenty four countries. The relative positions of Thailand and China did not change. In 1992, as in 1970, Thailand was ranked twentieth, and China twenty third, or second last, among the countries considered in Table 12.1. The relative ranks of Malaysia, Philippines and India deteriorated.

In spite of the relatively high rates of growth of per capita income achieved in most Asian countries, the living standards of the population in these countries remained significantly lower than in developed countries. Among Asian countries, excluding Japan, Hong Kong was the only Asian economy where in 1992 per capita income reached the level of Canada. In Singapore, in 1992, per capita income levels were below the levels achieved in Denmark, Australia, Sweden, France and the Netherlands. In all other Asian countries the income of the population was below the levels of all developed economies considered here. In China and India the levels of per capita income were especially low, accounting for less than 8 per cent of the GDP per capita, PPP, of the USA. We can conclude that although there were substantial improvements in national competitiveness in most East Asian countries, excluding Japan, a cross-country comparison of the levels of per capita income has provided some serious reasons to doubt that these countries can be characterised as competitive.

Below we will test statistically whether per capita income levels in different countries were converging over time. The trends in the standard deviation of logarithms of GDP per capita for the 1970-1992 period are presented on Chart 12.1. The sample consists of the twenty four countries which have considered above (see the notes, Chart 12.1 and also Table 12.1). The complete sample has been subdivided into three sub-samples, which incorporate fourteen developed countries, nine Asian countries, and seventeen countries (the fourteen developed and three Asian countries: Hong Kong, South Korea and Singapore).

The trend in the values of the standard deviation for the complete sample indicates that during the 1970-1992 period income levels in the twenty four countries were converging. However, the trends in the values of the standard deviation for the other samples show that there were marked differences between trends in the levels of per capita income across countries. At the beginning of the period the disparities in GDP per capita, PPP, in the fourteen countries were significantly lower than for other samples. Over the period they diminished even further. In the contrast to the situation in the developed countries, the disparities between the levels of per capita income across the nine Asian countries were growing over time.

Chart 12.1



Notes: 24 countries: AUS, CAN, CHN, DEU, DNK, ESP, FRA, GBR, HKG, IDN, IND, IRL, ITA, JPN, KOR, MEX, MYS, NLD, NZL, PHL, SGP, SWE, THA, USA;

14 developed countries: AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, JPN, NLD, NZL, SWE, USA;

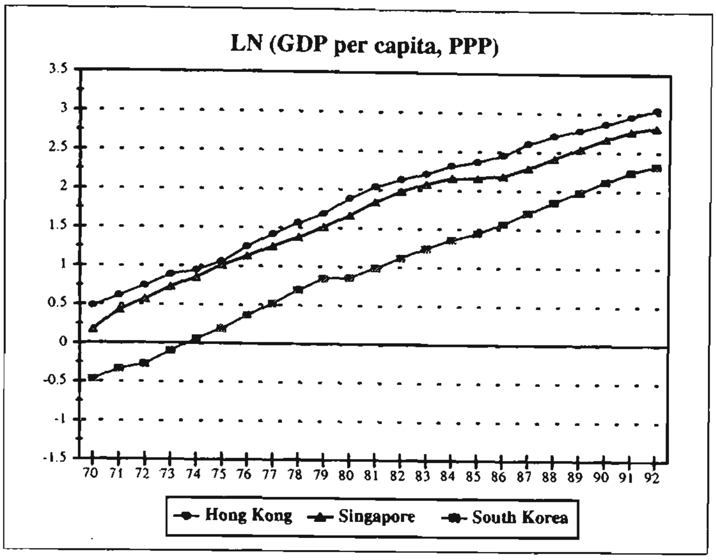
9 Asian countries: CHN, HKG, IDN, IND, KOR, MYS, PHL, SGP, THA;

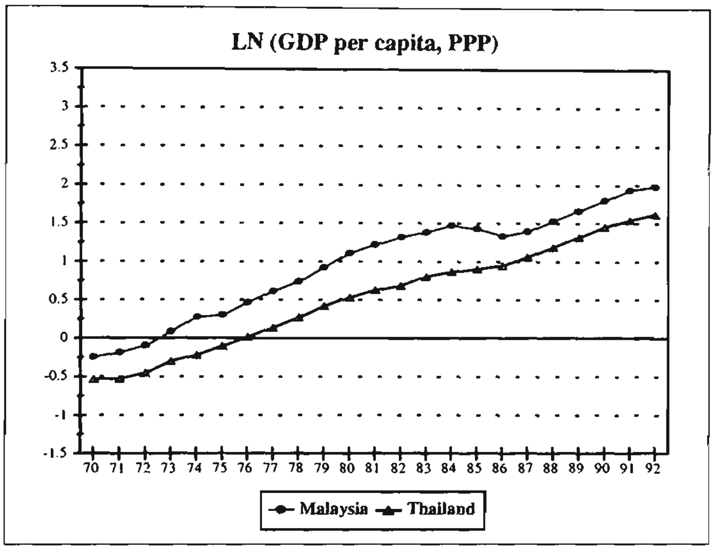
17 countries: AUS, CAN, DEU, DNK, ESP, FRA, GBR, IRL, ITA, JPN, NLD, NZL, SWE, USA, HKG, KOR, SGP.

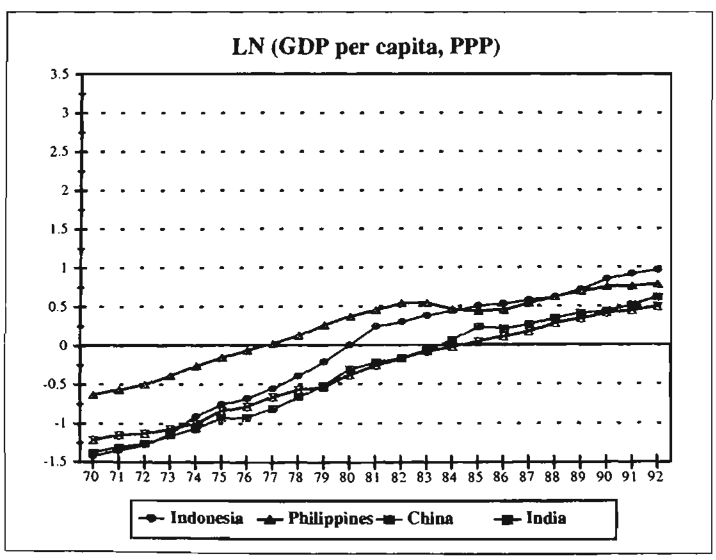
Source: Estimates based on World Bank World Tables, from IEDB database.

Chart 12.2 and Chart 12.3 provide some additional information about the changes in GDP per capita, PPP, in Asian countries. On Chart 12.2 the nine Asian countries are subdivided into three groups according to the per capita income levels, achieved in 1992, in the descending order. The differences between the trends for the countries that belong to

Chart 12.2



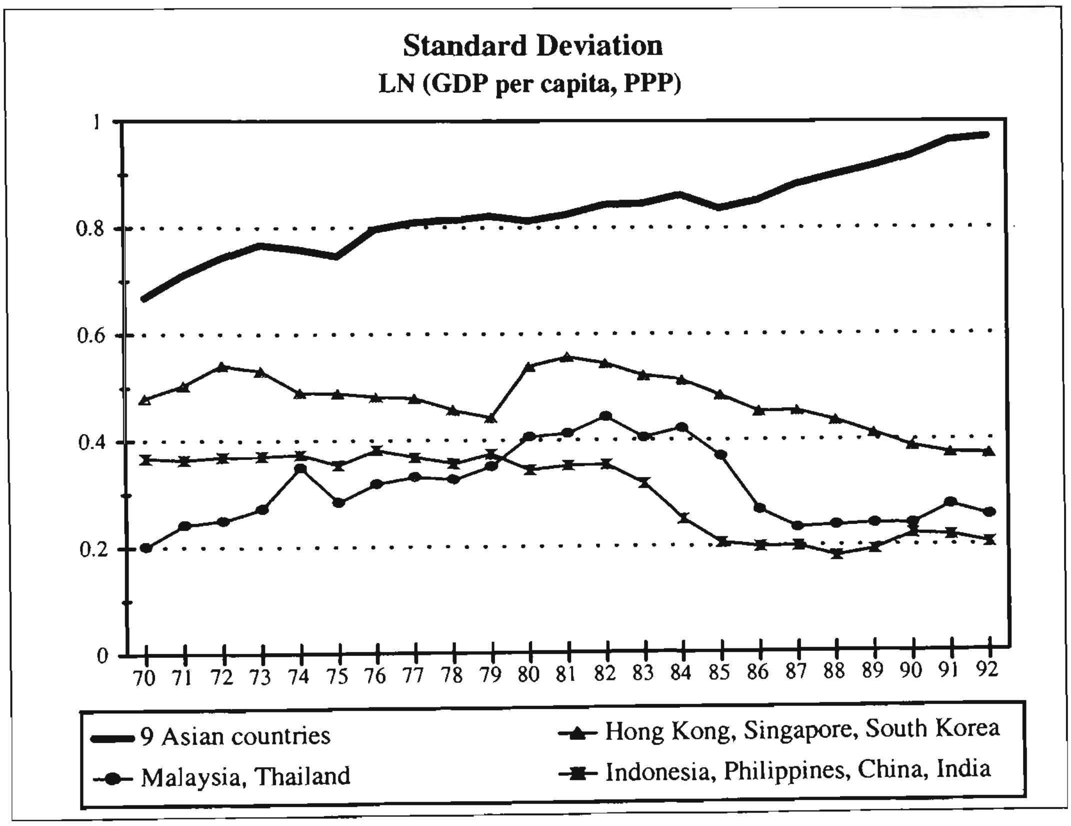




Source: Based on World Bank World Tables, from IEDB database.

different groups are quite marked, while the trends for the countries within the groups are rather similar. So, we would expect convergence between the levels of per capita income within these groups, although, a marked trend of divergence has been observed for the sample of all nine Asian countries. The information presented on Chart 12.3 confirms this observation.

Chart 12.3



Notes: 9 Asian countries: CHN, HKG, IDN, IND, KOR, MYS, PHL, SGP, THA.

Source: Estimates based on World Bank World Tables, from IEDB database.

A downward slope of the trend in the values of the standard deviation for the sample of the seventeen countries (Chart 12.1) indicates convergence in per capita income levels across these countries. The group of the seventeen countries incorporates the fourteen developed economies and the three Asian countries, Hong Kong, South Korea and Singapore, in which per capita income was growing more rapidly than in other Asian economies (see the notes, Chart 12.1). Moreover, a diminishing gap between the values of the standard deviation for the fourteen developed countries and for the seventeen countries is indicative to convergence of per capita income levels in the three Asian economies with the income levels achieved in the developed countries.

We can conclude that although a trend of convergence between per capita income levels across the twenty four countries, considered in this section, has been observed, the differences between the trends for the countries of particular groups were quite distinct. Income levels of the population of the fourteen developed countries were converging, although at a slow pace. The disparities between the levels of per capita income in the nine Asian countries were growing over time. A distinct tendency towards convergence with the developed countries has been observed for Hong Kong, South Korea, and Singapore. The significantly slower pace of per capita income growth achieved in Malaysia and Thailand and, to even a greater extent in Indonesia, Philippines, China, and India, resulted in the overall tendency towards divergence among the nine Asian countries.

12.5 The Computing and Electronics Industries and National Competitiveness in East Asia

In terms of the impact of increased activity in these industries on growth and improved competitiveness in the East Asian countries, considered in the previous section, some conclusions can be reached by considering the four potential effects of industrial structure distinguished earlier.

Direct Effects

In this section the direct contribution of the computing and electronics industries to GDP and to economic growth of different economies will be assessed. Table 12.2 presents the shares of value added generated in the computing and electronics sectors in GDP for twenty countries for the period 1981-1995 (or the latest year available – see the notes, Table 12.2). Because of the notorious difficulties related to obtaining national deflators for value added generated in the computing and electronics sectors, the data expressed in current US dollars have been used. The countries listed are sorted in descending order according to the value of the shares for 1991, the last year for which the data are available for all countries.

The computing and electronics industries were relatively more significant in the structure of GDP in many East Asian countries than in other economies. Besides this, the shares of these industries in GDP increased markedly over time. In Singapore the contribution of these industries to GDP was greater than in other countries. In 1994 these industries provided almost 12 per cent of national domestic income in that country. In Malaysia and South Korea the structural significance of the computing and electronics sectors was also quite high in comparison with most other countries. In Thailand the computing and electronics industries were rapidly gaining significance in the structure of GDP, and by 1991 the share of value added generated in these sectors reached 3.8 per cent of GDP. In the Philippines and Hong Kong at that time the corresponding shares were significantly lower, 1.6 per cent and 1.5 per cent respectively. In Indonesia the share of value added generated in computing and electronics sectors in Indonesia was below the shares for all other countries, except India.

Table 12.2 Value Added – Computing & Electronics Industries, Shares of GDP, Selected Countries, 1981-1995

	1981	*1986*	*1991*	*1995 or the latest available**
		per cent (in current US $)		
Singapore	5.5	9.6	10.5	11.9
Malaysia	2.3	2.6	4.9	6.0
South Korea	2.1	3.7	4.4	6.1
Thailand	na	0.2	3.8	na
Japan	na	3.5	3.6	3.2
Germany	2.6	3.1	2.9	2.5
Netherlands	1.9	2.1	2.0	2.0
USA	2.3	2.3	1.6	2.1
Philippines	na	0.5	1.6	1.3
United Kingdom	1.7	1.8	1.6	1.5
Hong Kong	3.0	1.9	1.5	1.2
Canada	0.8	0.9	0.9	1.1
Sweden	1.4	1.3	0.9	1.1
Denmark	na	na	0.6	na
Spain	0.6	0.4	0.5	0.5
Italy	na	na	0.5	na
Australia	0.4	0.3	0.4	na
India	0.1	0.1	0.3	0.3
Mexico	na	0.4	0.3	na
Indonesia	na	na	0.2	0.4

Notes: Indonesia, Singapore, Sweden – 1994;
Germany, Hong Kong, Malaysia, Netherlands – 1993;
United Kingdom, India, Philippines – 1992.

Source: IMF National Accounts and Production Statistics, from IEDB database.

It is worth noting that in two of the three Asian economies where per capita income levels were converging with the levels achieved in the developed countries, Singapore and South

Korea, the computing and electronics industries were of high and growing significance in the structure of national output. However, in Hong Kong, the only Asian country where per capita income reached the level above those achieved in most developed economies, the computing and electronics industries did not make a significant contribution to GDP. On the other hand, in some East Asian countries where per capita income remained significantly below the levels of the developed countries, the structural significance of value added generated in computing and electronics sectors was relatively high.

In Japan the share of value added generated in computing and electronic production of national domestic income was the highest among the developed countries considered in Table 12.2. In Germany, the Netherlands and the USA the computing and electronics industries were of high significance in the composition of GDP in comparison with many other developed economies. In the United Kingdom in 1992 value added generated in these sectors accounted to 1.5 per cent of GDP. In other developed countries the contribution of the computing and electronics industries to national domestic income was relatively minor: the shares of value added generated in these sectors accounted for about or less than 1 per cent of GDP. Thus, for the developed countries we also have not observed any correlation between per capita income (see for reference Table 12.1) and the structural significance of computing and electronics industries.

The analysis of the contribution of the computing and electronics industries to the growth in GDP leads to similar conclusions (Table 12.3). The contribution of the computing and electronics industries to the growth of GDP for a particular period has been calculated as the ratio of the change in the value added generated in these industries over the period to the change in GDP over the same period and expressed in per cent (formula 12.1).

$$\frac{\Delta VAD^{C\&E}_{t_0-t_1}}{\Delta GDP_{t_0-t_1}} \cdot 100 \qquad (12.1)$$

where VAD – value added,

C&E – computing and electronics industries,

GDP – Gross Domestic Product,

$t_0 - t_1$ – a period of time.

For some Asian countries the shares of these sectors in the change of GDP were much higher than the corresponding shares for the developed countries. In Singapore the direct contribution of the computing and electronics industries to economic growth was especially significant: value added generated in these sectors accounted for 13 per cent of the change in GDP in the 1981-1992 period. During the first half of this period these industries contributed more than 23 per cent of the increment in GDP of this country. In Malaysia during 1981-1992 value added generated in the computing and electronics contributed 7.8 per cent of the increase in GDP. In South Korea in 1981-1986 the computing and electronics accounted for 6.6 per cent of the change in GDP. In 1986-1992 the share of these sectors diminished to 4.2 per cent, however, still remaining higher than the corresponding shares for all countries except Singapore and Malaysia.

Table 12.3 Contribution of Computing & Electronics Industries to Growth of GDP, Selected Countries, 1981-1992

	1981-1986	*1986-1992*	*1981-1992*
		per cent (in current US $)	
Singapore	23.3	11.7	13.0
Malaysia	5.3	8.0	7.8
South Korea	6.6	4.2	4.6
Japan	na	2.6	na
Philippines	na	2.5	na
Germany	4.8	2.2	2.6
Netherlands	3.0	2.1	2.3
United kingdom	3.5	1.1	1.3
Australia	3.1	na	na
USA	2.5	0.4	1.3
Canada	1.2	0.9	1.0
India	0.4	1.4	0.8
Hong Kong	-1.6	1.2	0.8
Sweden	0.7	0.4	0.4
Spain	-0.2	0.3	0.2

Source: IMF National Accounts and Production Statistics, from IEDB database.

In the Philippines during 1986-1992 the contribution of the computing and electronic industries to growth of national income was relatively high, at 2.5 per cent of the increment of GDP. In Hong Kong and India these sectors were not of high significance for economic growth, relative to that in most other countries.

In Japan the contribution of the computing and electronics industries to economic growth was the highest among all developed countries. During the period of 1986-1992, for which the data are available, value added generated in these sectors accounted for 2.6 per cent of the change in GDP.

Among other developed countries the contribution of the computing and electronics sectors was relatively significant to economic growth of Germany and the Netherlands. In the United Kingdom the computing and electronics sectors were also of relatively high importance for economic growth in 1981-1986, but then these industries lost their significance. In the USA the situation was similar to that in the United Kingdom, although the values of the shares were lower. In Sweden and Spain these sectors had little direct effect on economic growth: the shares of value added of these sectors accounted for less than 0.5 per cent of the change in national income.

To conclude, in terms of the direct effects of increased activity in the computing and electronics industries on growth, the analysis has shown that they were substantial in some, but not in all, East Asian countries, and were particularly large in Singapore. But for most East Asian countries they were not large enough to be the dominant reason for growth. For most East Asian countries, the overall conclusion is that the direct effects are substantial but do not alone provide sufficient evidence to support the hypothesis that these industries were the dominant factor in their rapid economic growth.

Demand Growth and Increasing Returns

As detailed in Chapter 6, the extent to which the countries of East Asia captured increasing market share in rapidly expanding global markets in the computing and electronics industries was quite remarkable, and the markets captured were very large relative to the scale of the economies concerned. As has further been shown in Chapters 8 and 9, the segments of these industries in which the East Asian countries were specialised were both large in global terms and growing more rapidly than other segments of these industries. Thus specific segments of the computing and electronics industries provided the East Asian countries with access to large and rapidly growing markets, to greatly supplement domestic demand.

This means that the induced demand effects, and the increasing returns to scale that they generated, may well have been important factors in East Asian growth. It has not been possible, within the scope of the thesis, to explore in detail either the demand linkages arising from export driven expansion of these industries or the returns to scale within the industries, but our analysis suggests that these may well have been important factors in rapid East Asian growth.

Spillover Effects on Other Industries

As has been argued in Part C and Chapters 10 and 11 in Part D, with some exceptions, the products made, and the processes by which they were made, in the East Asian economies were far from the most advanced level internationally, and in many cases were on a par with those of other industries in these countries. The products of high global demand in which they specialised tended to be functional simple products of adequate rather than advanced quality and low unit value. Although there were substantial differences between East Asian countries, in many the processes by which those products were produced tended to involve low levels of value added, capital intensity and technical innovation, and be more of the nature of assembly processes based on low wage costs.

Spillover effects from leading industries on other industries, widely discussed in the literature as driving growth, are typically held to arise from factors such as advanced technology, production knowledge, and design and product creation capabilities. Given the nature of the products made, and the processes by which they were made in many East Asian countries, it seems likely that the growth effects through such spillovers to other industries were limited in those countries. Again, it has not been possible, within the scope of the thesis, to explore in detail the reality of spillover effects from these industries in East Asia, but given the characteristics of the industries documented here, it is unlikely that their impact on overall growth and competitiveness was substantial.

Balance of Payments Constraint Effects

Finally, given the strong export led expansion of the computing and electronics industries in East Asia, and in spite of their heavy reliance on imported capital and intermediate goods, these industries generated substantial trade surpluses. These surpluses could in turn facilitate rapid growth in other, deficit industries without generating a national balance of payments constraint. While our conclusion is qualified by the lack of a detailed analysis of balance of payments constraints on growth in individual countries, it does seem likely that the rapid expansion of the computing and electronics industries in the developing countries of East Asia facilitated rapid growth in many of those countries by lifting the balance of payments constraint.

Conclusion

The overall conclusion is that the fact that many countries in East Asia experienced a pronounced shift in industrial structure towards a higher proportion of the computing and electronics industries did indeed contribute to their rapid growth over the 1970-1995 period. But for many of these countries, particularly Malaysia, Thailand, the Philippines and Indonesia, the relevant characteristic of these industries was their rapid global growth rather their advanced technology status. Catching a wave of growth in the global economy in terms of exports was the key, rather than participating in a technological revolution. Other than the stimulus to demand and to the balance of payments, little has yet been contributed to a broader national competitiveness that would allow these countries to approach and sustain the living standards of the developed countries. As a result these East Asian economies remain vulnerable to shifts in the pattern of global sourcing of computing and electronics products.

For other countries – such as South Korea and Singapore – the situation is somewhat different. While the nature of their products and production processes did remain limited by the standards of the developed countries over the period studied, there was serious involvement with the advanced technology aspects of the computer and electronics industries. In these industries, the output of R&D was relatively strong, and production activities were increasingly focused on high quality products and high value added processes. As a result, those effects of industrial structure on growth and competitiveness linked to the advanced nature of these industries - direct, high value effects and spillovers to other industries - are likely to have become increasingly important in these countries.

12.6 The Computer and Electronics Industries and Competitiveness

These conclusions allow us to give partial answers to the two more general questions with which we began. The first of these concerned whether, at the current stage of technological development, a high level of production capability in the computing and electronics industries is either a necessary or a sufficient condition for a high level of national competitiveness. In terms of the sufficiency condition, our answer is clear. Possession of an advanced industrial structure, characterised by a large role for the computing and electronics industries in terms of output or exports, is not sufficient for high levels of competitiveness. Genuine participation in these industries at an advanced level is also required. The issue of the necessity condition for a particular economy should be considered in relation to the existing competitive strengths of this economy, in terms of both natural and created comparative advantages. Thus, to derive an exact answer to the question of which industrial structure is the most conducive to economic growth in a particular economy, extensive country-specific research is required. This would investigate, inter alia, to what degree the income generating potential of advanced industries can be utilised in given national conditions. Such country-specific analyses are beyond the scope of this thesis. However, the conclusions reached in this study indicate that such research is worth pursuing.

12.7 The Relevance of Industrial Structure for National Competitiveness

Finally, in relation to the more general question of the link between advanced industrial structure and national competitiveness, we can conclude as follows. Specialisation in economic activities characterised by high income generating potential, or in other words, an industrial structure conducive to income generation, is not a sufficient condition for improving substantially the living standards of the population and for achieving high levels of national competitiveness by international standards. As the experience of many East Asian countries has demonstrated, it is possible to move rapidly to an apparently advanced structure, without either the products made, or the processes by which they are made, reflecting the advanced nature of these industries. While there are good reasons to believe that an advanced industrial structure, with its potential fully realised, will contribute greatly to national competitiveness, it is necessary for the high income generating potential of that industrial structure to be realised for this to be achieved.

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