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ABSTRACT

Two central facts dominate the history of the world economy over the past two decades - the revolution in computing and communications and the rise of East Asia and ASEAN - although their conjunction is normally regarded as casual rather than causal. Over the same period one key theme in the intellectual history of economics has been the re-examination of the role of innovation and of the creation of new goods in generating growth, these aspects having been excluded by the assumptions of the standard neoclassical models which prevailed for several decades. The revolution in computing and communications has surely led to the most rapid process of creation of new goods that the world has seen, while the sustained pace of economic development in East Asia and ASEAN also has no obvious parallel. This paper attempts to link these two phenomena, and to explore them in the context of new theories of growth based on the intentional creation of new goods. Our aim is to throw some light both on the diverse patterns of growth in East Asia and ASEAN and on the relevance of these new growth theories to the contemporary growth experience.

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DIVERSE PATHS TO INDUSTRIAL DEVELOPMENT IN EAST ASIA AND ASEAN[1]

Two central facts dominate the history of the world economy over the past two decades - the revolution in computing and communications and the rise of East Asia and ASEAN - although their conjunction is normally regarded as casual rather than causal. Over the same period one key theme in the intellectual history of economics has been the re-examination of the role of innovation and of the creation of new goods in generating growth, these aspects having been excluded by the assumptions of the standard neoclassical models which prevailed for several decades. The revolution in computing and communications has surely led to the most rapid process of creation of new goods that the world has seen, while the sustained pace of economic development in East Asia and ASEAN also has no obvious parallel. This paper attempts to link these two phenomena, and to explore them in the context of new theories of growth based on the intentional creation of new goods. Our aim is to throw some light both on the diverse patterns of growth in East Asia and ASEAN and on the relevance of these new growth theories to the contemporary growth experience.

1. Computing, Communications and the East Asian Miracle

Our two central facts need little introduction, having been extensively described in both scholarly and popular literature. The initial transistors of the 1970s were objects of household scale, but today millions of transistors are packed onto a chip the size of a finger nail. The competitive race is on to produce transistors commercially at the known physical limits, which is transistors only 300-400 atoms wide, and this is likely to be achieved in the early part of next century (Mayo 1994; Chaudhuri 1994). Reflecting these changes, the price/performance ratio for information processing fell by a factor of 10,000 between 1975 and 1995, and continuing reductions at a similar pace are inevitable in the future (World Bank 1995). The quantum leaps which have occurred in the capabilities of integrated circuits have led to the digitisation of products, processes and services, not only in the communications industry but in many other industries as well, and this trend is being facilitated both by increased availability of almost unlimited bandwidth at low and falling prices and by advances in digital compression techniques. Central to the actual application of these radically new computing and communications systems have been parallel advances in technologies related to the capture,

Table 1: GDP Growth Rates - Selected Countries, 1960-2005

(Derived from data in US$ billion, at constant 1990 purchasing power parity values)

	Average Growth Rates of Real GDP		
	1960-1979	*1979-1995*	*1995-2005*
	(Per cent per annum)		
United States	3.8	2.4	2.4
Selected East Asian and ASEAN Countries			
China	5.5	9.6	8.9
Japan	7.5	3.2	2.8
South Korea	12.3	7.8	6.4
Taiwan	9.6	6.7	7.0
Hong Kong	10.2	6.5	5.1
Malaysia	6.8	6.8	7.5
Indonesia	5.7	6.2	6.9
Thailand	7.6	7.8	7.9
Singapore	8.5	7.6	6.6
India	3.4	5.3	7.0
Australia	4.3	3.0	3.4

Source: Compiled by Ainsley Jolley, Centre for Strategic Economic Studies and Harrow Pines, from forecasts surveyed by Consensus Economics. Purchasing power parity estimates are based on the Penn World Tables (Summers and Heston 1992). See also Jolley (1995).

storage and use of information in digital form, including scanning and imaging technologies, memory and storage technologies, display systems and copying technologies.

These escalating capabilities of computing and communications systems on the hardware side are vital enabling technologies, but without effective software development they remain impotent. Thus the past decade has seen a major swing to software development, including emphasis on attempts to create and extend sophisticated tools for the development of software. They also give rise to basic core competencies,

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which can be used to underpin competitiveness in a wide range of business and consumer product areas, and to drive the creation of new products in such areas (Prahalad and Hamel 1994).

In 1960 the total GDP of the nine East Asian and ASEAN countries shown in Table 1, measured in purchasing power parity in constant 1990 US dollars, amounted to 33 per cent of that of the USA. By 1995 their total GDP had exceeded that of the USA and, on the basis of the first set of long-term forecasts compiled by Consensus Economics for this region, it is projected to be more than 50 per cent above that of the USA by 2005. While Japan’s growth has slowed markedly after the 1970s, each of the other countries achieved real growth in the 6-10 per cent range over the sixteen year period from 1979 to 1995, and similar rates are projected for the next decade.

2. New Goods and the Theory of Growth

It is now regularly argued that fundamental changes have taken place over the past decade or so in economic theory (e.g. Hahn 1989; Krugman 1993; Romer 1994a; Stiglitz 1995). These changes are held to result from a recognition that one or more of the assumptions of the basic Arrow-Debreu model (Debreu 1959) on which modern neoclassical theory is based are unrealistic, together with a demonstration that this theory is not robust in relation to its assumptions, so that a variation in a particular assumption substantially affects the conclusions of the theory. Perhaps the most widely known, if not the most fundamental, aspect of this theoretical reappraisal has been the rise of new growth theory. Whereas in the received theory, growth was seen as driven by exogenous technological change impacting on competitive markets, in the new models growth emerges from endogenous technological, learning or other processes in markets which often do not meet the conditions of pure competition.

The literature on new growth theory is already massive, with a vast array of different models having been created and new variants emerging on a regular basis. It is not our purpose in this paper to attempt to survey or analyse these new models. Romer (1989) provided an early survey of a range of new growth models, Grossman and Helpman (1991) have given a detailed analysis of the implications of a central set of these models and Barro and Sala-i-Martin (1995) have recently provided a definitive review of key aspects of this literature. Other surveys are to be found in Hammond and Clare (1993), Sheehan (1993) and the essays in the Winter 1994 issue of the *Journal of*

Economic Perspectives. However, it may be useful to make a number of points about these models, each of which suggests a reason for taking these models seriously in understanding the process development in general and the emergence of East Asia in particular.

Firstly, many of the new models involve formalisation of important ideas which have recurred in the history of economics and of development economics, and hence serve to re-introduce a conceptual richness into contemporary economic theory. Examples from the economic literature include the idea, deriving from Adam Smith, that growth arises from the division of labour in the context of an expanding market; the idea that growth is linked to externalities, spillovers and increasing returns associated with the application of new technology, and Schumpeter's concept that it is the creation and destruction of technologies and firms in an environment of monopolistic competition which is the engine of growth. On the development economics side, formal models are also now available which capture to at least some degree Lewis's concept of the dual economy, Rostow's stages of growth, Rosenstein-Rodan's influential argument that growth can be achieved by a coordinated expansion of many sectors of the economy simultaneously (the Big Push) and Hirschman's emphasis on the rapid development of leading sectors with strong linkages to other sectors as the key to growth. This point has been emphasised by Krugman (1993).

Secondly, the basic condition for endogenous growth in most of these models is that the marginal product of capital (or of the several forms of reproducible capital taken together if more than one form is used) is bounded away from zero. With multiplicative production functions and at least one non-reproducible factor of production, this implies increasing returns to the factors of production taken as a whole. Various strategies are employed to handle these increasing returns in a modelling context. One is to ignore non-reproducible factors, and so return to constant returns. Another is to use the Marshallian device of increasing returns internal to the industry but external to the firm, so that the basic structures of competitive analysis can be retained even though the competitive solution will not be optimal for the economy as a whole. A third is to model increasing returns internal to the firm by using the various constructions of monopolistic competition, and in particular the approach based on product diversity derived from Dixit and Stiglitz (1977). When a firm undertakes R&D activities directed at innovative products, this might involve either the search for products which meet existing needs more effectively, i.e. which are of higher *quality*, or which service new needs or functions, hence extending the *variety* in consumption or the specialisation in production. Both of these avenues have been extensively explored although, as Grossman and Helpman (1991) have shown, their implications for growth models are in the end very similar. Models making use of complementarities at the level of strategies rather than pay-offs, which relate to the extensive recent Keynesian literature in macroeconomics based on coordination failures, are also a important recent development (see Cooper and John 1988; Durlauf 1993). Thus the new growth theory models attempt to grapple, at least in a preliminary way, with some key facts which many economists have for decades seen as central to the development process.

For our present purposes, the aspect of these models which is most important is that concerned with the creation and utilisation of new goods. The introduction of new goods and services into the production process is central to economic development, whether this be in the case of an advanced country, where the new goods have to be invented, or in the case of a less developed country, where the goods to be introduced exist in other parts of the world. Most new growth models are based on general equilibrium assumptions, using dated and state contingent goods and assuming perfect foresight and complete markets. Hahn pointed out some time ago the difficulties that new goods pose for standard general equilibrium theory - markets cannot exist and foresight cannot be perfect in relation to goods not yet even envisaged (Hahn 1984). Many of the issues which this observation raises for new growth theories, which are typically perfect foresight models involving either infinite horizon optimisation or an overlapping generations structure, have not been adequately addressed. Nevertheless, Romer has recently emphasised the role which new goods play both in the process of economic development and in some new growth theories (Romer 1994b). Focusing on a developing economy rather than a technologically advanced one, he argues that when new goods are included in the analysis policy interventions can have first order effects, for either good or ill, and in particular that tariffs on productive inputs can lead to large reductions in national income.

Romer's model is one in which final output is undertaken by domestic firms in an environment of pure competition, and is a function of the number of inputs to production. New inputs are provided by foreign firms, which must incur a fixed cost to supply that input. Because the domestic firms compete in pure competition and are hence zero profit firms, the foreign firms cannot capture all of the increase in value created by the new good, over and above the standard monopoly price. If the use of capital and the return to capital are taken as fixed for the domestic firms, the increase in value generated by the new goods is reflected in the marginal product of labour and hence, given competitive assumptions, in the real wage. Thus a tariff which prevents the foreign firm from recovering their fixed costs, and which hence blocks the introduction of the new good, will have not only the usual efficiency losses but also the much larger losses associated with foregoing the increase in the real wage. Hence 'the assertion that an equilibrium is not first-best Pareto optimal does not validate any arbitrary intervention. It just raises the stakes' (p. 8). In particular 'trade restrictions are a little bit harmful in the usual model of free markets. They are very harmful in the second-best world with fixed costs . . .' (p. 8).

Romer's model can of course be taken in various other directions. For example, if it is assumed that domestic labour is in unlimited supply and hence that wage rates do not change with the increased marginal product of labour using the new good, or if the overseas supplier is vertically integrated and so can appropriate the benefits down to the consumer goods, then the overseas supplier can capture all of the benefits of the new goods. In this case either a tariff, or perhaps an industry policy designed to encourage the domestic production of the new good or of industries using the new good, could have substantial first order effects. In general, in such a model focusing on the introduction of new goods with associated fixed costs, policy interventions affecting the timing, context and conditions of the introduction of new goods may have a first order impact on economic development, whether for good or for ill. Anchorduguy's classic study *Computers Inc.: Japan's Challenge to IBM*, catalogues an extended series of interventions by the Japanese bureaucracy directed at precisely this issue, viz. the terms on which computers would be introduced throughout the Japanese economy (Anchorduguy 1989).

3. The Argument

It is notoriously difficult to find data pertaining to the role of new goods in the economy, especially the type of time series data covering a range of countries on a comparable basis which would be necessary to examine rigorously some of the theoretical propositions noted above. This is not a reason for avoiding empirical investigation of these issues, but for using other strategies and broader concepts of what constitutes relevant data (Romer 1994a).

In this paper we make two central assumptions in setting up an empirical analysis. The first is that the prevalence of new goods in a particular industry is indicated by the level of business expenditure on research and development (R&D) in that industry in the developed countries, so that if (say) the ratio of R&D to the value of production is relatively high in a given industry in the countries of the Organization for Economic Development and Cooperation (OECD), this is indicative of a relatively high emphasis on new goods in that industry. Much of R&D is of course devoted to process rather than product innovation, especially in developing countries, but our assumption is that the distribution of R&D spending as a share of the value of production across industries in the OECD countries can be taken as a reasonable proxy of the distribution of product innovation across industries. The second is that, particularly in the countries of East Asia and ASEAN, manufactured exports have been a driving force in growth (World Bank 1993), and hence that to some degree issues about the role of new goods in growth can be approached through analysis of the composition of manufactured exports. The relevance of these two assumptions to our research strategy will be apparent. For they allow us to apply some of the techniques and data used in the literature on science and technology and on international trade to be brought to bear on this question, and in particular to make use of the very detailed data available on trade and to supplement these data by other information, such as that on R&D, patents and foreign investment.

The analysis of these data is used to provide tentative evidence for four propositions, as follows:

<u>Proposition 1</u>: *Over the past two decades the knowledge intensity of East Asian and ASEAN manufactured exports has increased very substantially, at rates well above the world average, with rapid growth in high tech exports and increased specialisation in knowledge intensive products.*

<u>Proposition 2</u>: *This increase in the knowledge intensity of exports in East Asia and ASEAN has been dominated above all by exports of computing and electronics products, such exports growing at rates well above the world average for these products and also well above the averages for these regions for all manufactured products.*

Proposition 3: *Thus the rapid growth in East Asia and ASEAN over the past two decades or so has been driven to a substantial degree 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.*

Proposition 4: *Several different paths to high growth based on capturing these new goods are apparent, ranging from the case of Japan, which has taken a leading role in creating these products (high R&D and patents activity, low inwards foreign investment and indeed massive net investment outflows), to that of Malaysia and Singapore, which have built large scale export bases on foreign investment and the importation of technology. Some high growth countries, such as Indonesia, have only recently participated to a substantial degree in export driven growth based on computing and communications products.*

In the next section, Section 4, the data and the analytical methods to be employed are outlined in more detail, while the evidence for these four propositions is assembled in Sections 5-7. Several implications of this analysis, and our conclusions, are drawn together in Section 8.

4. Analytical Methods and Data

Knowledge becomes incorporated in productive activities in many different ways, ranging from learning by doing by operators on the shop floor to formal processes of knowledge generation and application, of training and of investment in advanced equipment. Here we focus on the main formal means of developing new products and applying new knowledge, viz. corporate expenditures on research and development. Following the approach developed by the OECD Secretariat, the knowledge intensity of an industry is measured by the average level of business expenditure on R&D (BERD) per unit of production in that industry in a central group of the OECD countries taken as a whole. Table 2 provides this ratio for 22 industries for the period 1987-89. That is, for each industry this table shows the ratio of business sector R&D expenditure to the value of production, averaged across all of the OECD countries and for the three year period shown. More specifically:

> The R&D intensity ratio (BERD divided by production) is calculated for 22 manufacturing sectors and 13 countries (OECD-13) which, taken together,

account for more than 95 per cent of the industrial R&D performed in the OECD area. For each industry, the ratio has been weighted by each countries share in the total output of the 13 countries using purchasing power parities to convert to a common currency. (OECD 1994a, p. 229)

Table 2: R&D Intensity of Production in the OECD, 1987-89

	R&D/ Production		*R&D/ Production*
High	(%)	Medium-High	(%)
Aerospace	20.2	Instruments	4.8
Computers	12.4	Motor vehicles	3.5
Electronics	10.8	Chemicals	3.4
Pharmaceuticals	10.3	Elec. machinery	3.2
Medium-Low		Low	
Machinery	2.1	Ferrous metals	0.7
Other transport equipment	1.9	Fabricated metals	0.6
Shipbuilding	1.4	Food drink and tobacco	0.3
Petroleum refining	1.1	Paper and printing	0.2
Stone, clay and glass	1.1	Textiles and clothing	0.2
Other manufacturing	1.0	Wood and furniture	0.1
Rubber and plastics	1.0		
Non-ferrous metals	0.9		

Source: OECD, *Science and Technology Policy, Review and Outlook 1994*, (1994a).

This table can be used to illustrate a central aspect of increasing knowledge intensity in manufacturing, viz. the dramatic differences in R&D intensity between industries, ranging from the aerospace industry with an average ratio of 20.2 per cent in 1987-89 to the wood and furniture industry with a ratio of 0.1 per cent in that period. If, as has occurred over recent decades, the high R&D intensity industries grow more rapidly than those with lower intensity, the composition of output or trade will become more knowledge intensive, for given industry rates. Thus rising knowledge use *within* industries and the changing composition of overall activity *across* industries are important elements of this fundamental structural shift in the nature of the modern economy.

It is important to be clear about the implications of using the average OECD R&D ratios for a given industry for say 1987-89 as measures of the knowledge intensity of that industry. This measure, and the analytical tools used below derived from it, classify activities in a given industry at any time and place only in terms of the average R&D intensity of production in that industry in the major OECD countries as a whole in the late 1980s. Developments in individual countries and at diverse times are viewed through this particular lens. In any given country, whether in the OECD or not, the actual R&D intensity of production or trade may be quite different, reflecting the particular conditions of that country at that time. Thus this measure must be seen only as classifying activities in particular countries in an international framework, e.g. classifying production or trade activity by OECD average knowledge intensity, rather than measuring the actual R&D intensity of activities *in that country*. Classifying individual country activities in a common framework is of analytical value, but it is not to be mistaken for measuring the actual knowledge intensity of activities in each country.

Related to this is the fact that a high level of production in an R&D intensive industry may be achieved in various ways. In one case, the firms in a country may invest heavily in R&D, develop new products with their associated patents, and commercialise these products entirely from their own resources. Here the character of national production reflects the innovative activities of national firms and other institutions. At the other extreme, a country may provide facilities for firms from other countries to undertake investment and production within its borders with only minimal linkages with the domestic economy, e.g. through free trade zones, tax holidays and other arrangements. These foreign firms may then undertake high technology production within the country, to take advantage of cheap skilled labour, access to markets and so on, without undertaking any significant local R&D or drawing to any degree on local technology and without providing any substantial technology transfer. In both cases production and export will be categorised as high technology, but the relation to domestic processes for the generation and application of knowledge will be fundamentally different. For many countries, aspects of each of local R&D, foreign investment and technology transfer will be involved in most industries.

As outlined above, in this paper we follow the OECD Secretariat in using the ratio of R&D to production as the basis for classifying industries by technology level. Our analysis of the changing science and technology intensity of international trade is based on the analysis of the detailed UN trade data for a range of countries. The data forming the basis of this analysis is obtained from the International Economic Database (IEDB) at the Australian National University, and the classification of the trade data by industry (ISIC) category has been undertaken by the ANU group. Three forms of analysis are applied to these data, as noted below.

Technology Intensity Categories

Following the OECD classification system outlined in Table 2, export and import data for the various countries are classified into the *four technology intensity categories*, allowing analysis of country specific trends in the composition of trade across these categories.

Index of Specialisation

Adapting a standard measure from the literature on specialisation in trade (e.g. Balassa 1965; Drysdale 1988; Vollrath 1991; Chow and Kellman 1993), we define the *index of specialisation* for a given technology intensity category for a particular country and trade flow. Thus the index of specialisation of exports in a given category is given as

$$RXA_a^i = (X_a^i \;/\; X_t^i) \,/\, (X_a^w \;/\; X_t^w)\ ,$$

where a - any specific category defined over industries,
t - all industries,
i - a particular country,
w - the world.

The index measures the degree of a country's specialisation in exporting the output of a particular industry or a group of industries, and the higher the value of the index, the higher the specialisation. Thus, for example, the index of specialisation of country *i* in high tech exports is the ratio of the share of *i*'s exports which are in the high tech category to the share of world exports in that category. Consequently, this index will be equal to 1 if the share of *i*'s exports which are high tech is the same as for the world as a whole, and less than 1 if it has a proportionately lower share in the high tech area and a higher share in other areas.

Index of Knowledge Composition of Exports

Thirdly, we develop an *index of knowledge composition* for country *i*'s (manufactured) exports by weighting *i*'s exports in industry *j* by the average OECD R&D/production ratio for industry *j* for the period 1987-1989 from Table 2, and dividing by total manufactured exports multiplied by the average R&D weight. Thus

$$CI^{i} = \frac{\sum_{j}^{n} \left(X_{j}^{i} \cdot I_{j} \right)}{\left(\sum_{j}^{n} X_{j}^{i} \right) \cdot CI_{0}},$$

where i - a country,
j - an industry,
I - the relevant R&D intensity ratio, and

$$CI_{0} = \frac{\sum_{j}^{n} I_{j}}{n}.$$

The index of knowledge composition of exports is a measure of the overall R&D intensity of country *i*'s manufacturing exports, *on the basis of the average R&D intensities by industry in the OECD for a particular period*. If a hypothetical economy had exports equally divided across each of the 22 industries then its index of composition would be equal to 1, whereas if its exports were concentrated in industries with high R&D intensity the index would be greater than one, and less than 1 for concentration in industries with low R&D intensities.

5. Knowledge Intensity, Specialisation and the Composition of Trade

A summary of the results of these three types of analysis is provided for key countries and regions in three sources here: Table 3, which shows the average annual rate of growth of exports by technology level for the period 1980-1994; Table 4, which shows the level of and changes in the index of specialisation in high tech exports for the period 1970-1994 and Table 5 and Chart 1, which show the index of knowledge composition of exports for those regions for four selected years over the period 1970 to 1994.

Table 3: Growth in Merchandise Exports, 1980-94, by Technology Intensity
(Based on data in current US$)

	Average annual rates of growth by category, 1980-94				
Technology Level	*High*	*Med High*	*Med Low*	*Low*	*All Manufacturing*
USA	9.0	7.3	5.0	6.3	6.9
EEC7	9.3	6.2	3.8	5.3	5.6
East Asia	19.2	16.4	14.0	11.6	14.0
ASEAN	23.2	18.7	8.7	12.1	14.6
Japan	12.7	8.6	8.2	2.5	8.3
World	12.0	7.8	5.1	6.1	7.1

Source: UN Trade Data, accessed through International Economic Data Bank, ANU.

These data again provide evidence of a general and worldwide shift to greater knowledge intensity in manufacturing industry trade. Over the period 1980-1994 total world exports of high technology products grew by 12 per cent per annum, increasing almost fivefold from US$130 billion in 1980 to US$635 billion in 1994. While these products still account for less than 20 per cent of total manufacturing trade, they constitute by far the most dynamic section of that trade, exports of medium low and low tech products growing by about 5.5 per cent per annum over the period. These changes are also reflected in the index of composition, which for total world exports (and, equally, imports) rose from 0.71 in 1970 and 0.75 in 1980 to 1.01 in 1994. This shift to greater knowledge intensity is clearly a major and continuing feature of world commodity trade.

Table 4: Index of Specialisation - High Tech Exports
(Based on data in current US$)

	1970	*1980*	*1986*	*1994*	*% change 1970-1994*
USA	2.28	2.21	2.15	1.56	-31.7
EEC7	1.01	0.96	0.86	0.83	-18.5
East Asia	0.86	1.20	1.10	1.19	38.5
ASEAN	0.34	1.60	1.81	2.36	603.5
Japan	1.63	1.61	1.73	1.50	-8.2

Source: UN Trade Data, accessed through International Economic Data Bank, ANU.

The pattern of response to this overall trend has been varied across the major regions of the world, and in some cases the response has indeed been different in the period of slow growth in world trade between 1980 and 1986 and in the more rapid expansion since 1986. For the major developed countries, key factors influencing that response have been strong domestic R&D capabilities, declining cost competitiveness in many industries relative to newly emerging economies, fluctuations in exchange rates and in some cases the movement of domestic production offshore to take advantage of changing competitive conditions.

In the USA, for example, the first half of the 1980s saw a massive deterioration in the deficit on manufacturing trade, with manufactured exports growing by only 0.5 per cent per annum and imports by 12.7 per cent per annum. While high tech exports grew more rapidly than total exports, high tech imports grew by 20 per cent per annum and America's traditional trade surplus on manufactured exports was obliterated. Following the massive devaluation of the US dollar in the mid 1980s, the position on manufactured trade improved somewhat over the next eight years, with exports growing at 1.5 times the rate of imports. But between 1986 and 1994 exports at the lower tech end showed somewhat more rapid growth than high tech exports, and both the high tech specialisation index and the index of composition of US manufactured exports fell. The overall result has been substantial erosion of the position of the US as a major net exporter of high and medium high tech manufactured goods, with a change from a *surplus* for these two categories of US$ 21 billion or 34 per cent of imports in 1980 to a *deficit* of US$ 68 billion or 28 per cent of exports in 1994.

Table 5: Index of Knowledge Composition of Exports, Selected Countries and Regions
(Based on data in current US$)

	1970	*1980*	*1986*	*1994*	*% change 1970-1994*
USA	1.27	1.29	1.57	1.47	16.1
EEC7	0.73	0.76	0.86	0.96	30.8
East Asia	0.39	0.58	0.70	0.92	134.1
ASEAN	0.29	0.69	0.97	1.53	430.2
Japan	0.80	0.96	1.22	1.32	64.1
World	0.71	0.75	0.90	1.01	43.3

Source: UN Trade Data, accessed through International Economic Data Bank, ANU.

Trends in Japan show some similarities but many sharp contrasts with those in the USA. Building on developments in the 1970s, growth in Japanese manufactured exports was concentrated at the more advanced technology level between 1980 and 1986, high tech exports for example growing by 16.1 per cent and low tech exports declining marginally in US dollar terms over the period. The Japanese trade surplus on high and medium high technology products rose as a consequence from US$52.4 billion in 1980 to $108.8 billion in 1986, this constituting the major part of a total manufacturing trade surplus of US$145 billion in 1986. The magnitude of these figures and their continuing increase inevitably put in train exchange rate and other responses, a central aspect of which was large scale foreign investment by Japanese companies in offshore capacity after the mid 1980s, in North America, Asia and Europe. This led to a slower relative rate of growth of Japanese advanced technology exports after 1986, and faster rates of growth of imports of these products. For Japanese exports the index of high tech specialisation fell, and the index of composition ceased to increase, after 1988. But Japan remains unique among major countries, both developed and rapidly developing, in having a low technology composition of imports. By 1994 the trade surplus on high and medium high tech products was US$178 billion, still the major component of Japan’s overall manufacturing trade surplus of US$203 billion.

Developments in Western Europe have been less dramatic than in either the USA or Japan, with trends in the EEC7 countries closely mirroring those in the world as a whole. Over the period 1980 to 1994, high tech exports from the EEC7 grew more rapidly than other categories of their exports, and the index of composition of both exports and imports rose steadily in line with world trends. The index of high tech specialisation of EEC7 exports fell slowly after 1982, as the growth of their high tech exports was a little below that of the world as a whole. The EEC7 countries taken together remain net exporters of advanced technology products, with a surplus of US$50 billion in 1980 and US$76 billion in 1994 on trade in high tech and medium high tech products. But this surplus has been declining substantially relative to overall trade over time, falling from 30 per cent of imports of these products in 1980 to only 16 per cent in 1994.

However, the most important feature of these data is the dramatic shift towards greater knowledge intensity in manufacturing trade in the East Asian and ASEAN regions (excluding Japan), which is illustrative of our *Proposition 1* above. For the ASEAN countries, the period since 1980 has been one of rapid growth in manufactured exports across the board, but with particularly high rates of growth in the high tech and medium high tech categories. High technology exports from the ASEAN countries increased by 23.2 per cent per annum in US dollar terms between 1980 and 1994, growing from US$5 billion to US$92 billion, accounted for more than 40 per cent of their manufactured exports by 1994 and generated a trade surplus of US$13.7 billion in that year. Medium high tech exports also grew rapidly, increasing at 18.7 per cent per annum from US$2 billion in 1980 to US$23 billion in 1994, although this remained an area of substantial trade deficit for the ASEAN countries, with a deficit of US$27 billion in 1994. With much lower growth in medium low and low tech exports, the ASEAN index of high tech specialisation as jumped from 0.34 in 1970 - the lowest of the groups shown in Table 4 - to 2.36, the highest of those shown in the table, well exceeding that of the previous leader, the United States. The ASEAN index of knowledge composition of exports (Table 5) also increased more than fivefold between 1970 and 1994, exceeding the US level in 1994.

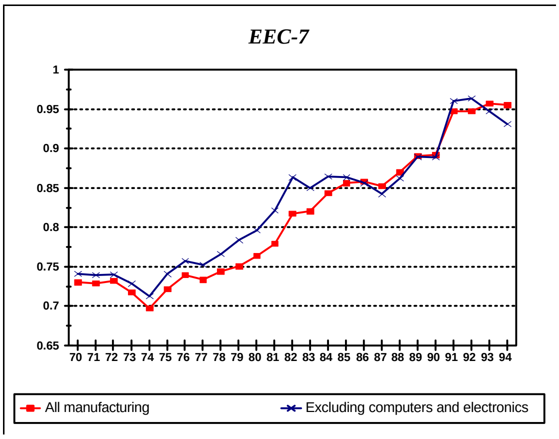
These ASEAN trends can only be described as remarkable, and as a striking vindication of part of *Proposition 1*. The situation in the developing countries in East Asia, here defined as South Korea, Taiwan, China and Hong Kong, is similar but more complex, if only because of the diverse nature of the group. East Asian high tech exports have also grown strongly - by 24.9 per cent per annum between 1970 and 1994 - and their knowledge composition has more than doubled over this period, although their relative degree of specialisation in such exports declined a little after 1980.

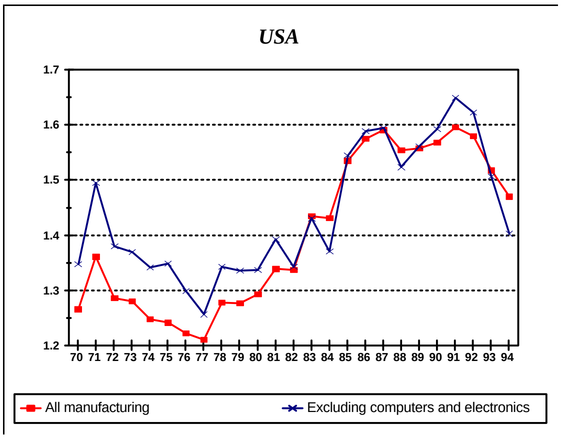
These trends are vividly illustrated in the overall indexes of composition in Chart 1. Since 1985 there has been no increase in the knowledge composition of US manufactured exports, while the composition of EEC7 exports has continued to increase at a modest pace, as has that of Japan, in spite of large scale shifting of capacity offshore. The index of composition of ASEAN exports was rising from about one quarter of the US level in 1970 and exceeded the US level in 1994, while the East Asian index has gone from being a little over half the EEC level in 1970 to being close to that level in 1994. In spite of the various complexities, there seems little doubt that *Proposition 1* is true.

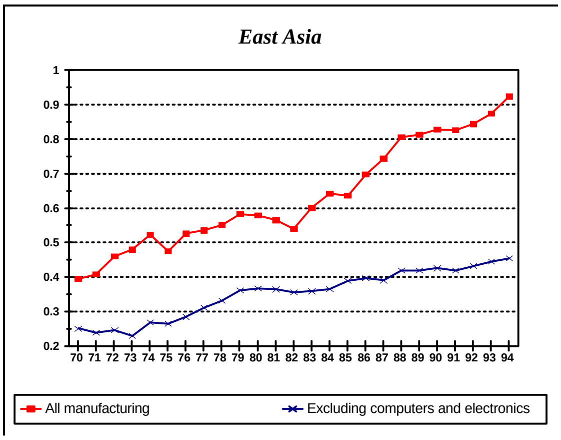
6. The Central Role of Computing and Electronics

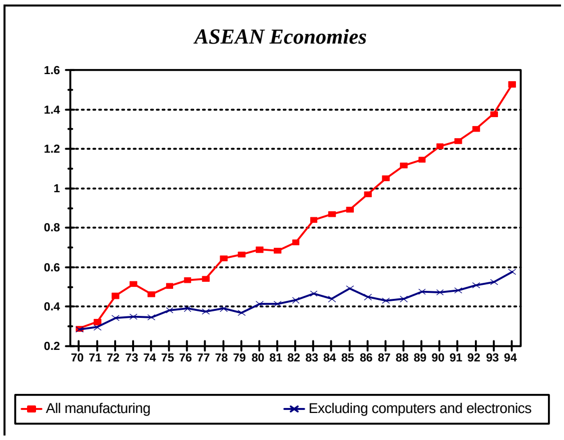
Two themes, one of similarity and one of difference, are central to further understanding of changes in the knowledge intensity of trade in the Asian region. The common theme is the importance of computing, electronics and communication equipment (for which the abbreviated designation ‘computers and electronics’ is used throughout this paper) in the export performance of the emerging Asian economies. The transformation of the export base of these countries (defined here as covering South Korea, Taiwan, China, Hong Kong and the ASEAN countries) was heavily dependent on the fact that they captured the lion’s share of the worldwide explosion in trade in these products after 1970, and especially after 1980. In one of the most remarkable market penetration exercises ever seen, their share of the world export markets for these new products jumped from only 3.4 per cent in 1970 to more than 30 per cent by 1994,

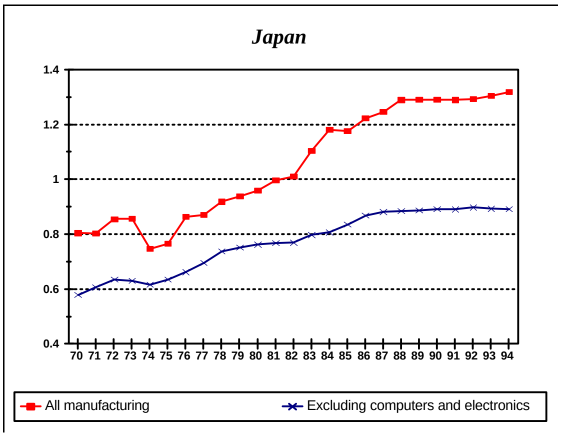
Chart 1: Index of Knowledge Composition of Manufactured Exports, Selected Countries and Regions











while their share of export markets for all other products rose in a more subdued manner, from 3.3 per cent in 1970 to 14 per cent in 1994. If Japan is included, the share of world export markets for computing, electronics and communications equipment held by ASEAN and East Asian economies was 54.4 per cent in 1994, by comparison with a share of all other manufactured exports markets of 23.5 per cent.

Some further detail on the central position of these industries in the ASEAN and East Asian export surge is provided in Tables 6 and 7. During the period of rapid expansion of world trade in the 1970s these industries were still in their infancy, total trade was growing only a little faster than manufacturing trade and the relative position of the Asian economies in these industries was improving only slowly. It was in the 1980s, as these industries became more established, that they both became increasingly important in world trade and increasingly dominated by the Asian suppliers. Thus between 1980 and 1994, total world trade in these information technology products grew by 13.2 per cent per annum while trade in other manufacturing goods grew by only 6.4 per cent, while the East Asian and ASEAN economies achieved export growth of 21.5 per cent by comparison with growth in exports of these products from the rest of the world of 11 per cent. Over this fourteen year period, the share of world markets for these products held by these countries excluding Japan rose from 12.7 per cent to 33.8 per cent, and the share of these products in the total manufactured exports of the East Asian and ASEAN countries more than doubled.

Another way of examining the importance of computing, electronics and communications equipment in the trading position of the Asian economies is to examine the impact of these products on the index of composition of their exports. As noted above, the index of composition measures the knowledge intensity of a given trade flow, by weighting industry elements by the average R&D intensity of that industry in the OECD economies over the period 1987-89. The various panels in Chart 1 show the index of composition of exports for the East Asian and ASEAN regions and for the EEC7, USA and Japan on two bases - one for total manufacturing and one for all manufacturing excluding computer and electronic equipment. In both cases the index is re-based to ensure that if a country’s exports were equally distributed across all industries covered, then the index would be equal to one.

Table 6: The Role of Computing and Electronics Exports, Selected Countries and Regions
(Based on data in current US$)

	Computing and Electronics Exports					All Other Manufacturing Exports	
	1970	*1980*	*1994*	*Average Annual Per Cent Change*		*Average Annual Per Cent Change*	
				1970-80	*1980-94*	*1970-80*	*1980-94*
	(US $ billion)			(%)		(%)	
East Asia	0.4	6.6	79.1	33.3	19.5	27.3	13.0
ASEAN	0.1	4.4	88.3	53.5	23.8	26.6	11.6
Japan	2.6	19.2	101.7	22.3	12.6	20.9	7.2
Total	**3.0**	**30.3**	**269.1**	**26.0**	**16.9**	**23.2**	**9.9**
USA	3.4	19.3	78.0	18.9	10.5	16.8	6.3
EEC7	5.9	32.2	116.3	18.5	9.6	19.1	5.3
World (1)	**9.8**	**56.4**	**225.7**	**19.2**	**10.4**	**18.4**	**5.6**

Notes: (1) Excluding East Asia, ASEAN and Japan.
Source: UN Trade Data, accessed through International Economic Data Bank, ANU.

Again the message is striking. For the USA and the EEC the value of the index as at 1994 is effectively unchanged by the inclusion or exclusion of computing and electronics, and there is only modest differences in the long term trend. But it is clear from the charts that by 1994 the exclusion of computing and electronic equipment from exports substantially lowers the index for the two Asian regions and Japan, and heavily influences the trend for the first two in all cases shown. This is particularly so of the ASEAN economies, 80 per cent of the increase in the knowledge intensity of their exports since 1970 being attributable to these products, and also of the East Asian group, more than two thirds of the post 1970 increase in knowledge intensity being due to computers and electronics. These facts do, in our view, establish *Proposition 2* - that the increase in knowledge intensity in East Asian and ASEAN exports has been dominated by computing and electronics.

However, *Proposition 3* - that the rapid growth in East Asia and ASEAN over the past two decades or so has been substantially driven by their success in capturing the new goods arising from the information technology revolution - may seem a good deal.

Table 7: Export Shares and Specialisation in Computers and Electronics, Selected Countries and Regions

Share of Computers and Electronics in Total Manufactured Exports				
	1970	*1980*	*1986*	*1994*
		(per cent)		
USA	9.9	11.6	17.0	18.4
EEC7	5.9	5.6	7.6	9.5
East Asia	7.1	10.8	14.1	20.9
ASEAN	2.3	13.9	23.1	40.9
Japan	13.8	15.1	23.0	26.3
World	5.4	6.4	10.0	14.0
Index of Specialisation in Exports of Computers and Electronics				
	1970	*1980*	*1986*	*1994*
USA	1.82	1.81	1.71	1.31
EEC7	1.09	0.88	0.76	0.67
East Asia	1.31	1.69	1.42	1.49
ASEAN	0.43	2.18	2.32	2.91
Japan	2.54	2.37	2.31	1.87

Source: UN Trade Data, accessed through International Economic Data Bank, ANU.

more fanciful. In outline our argument is simple. It is widely accepted that this growth was heavily influenced by the explosion in manufactured exports, and this growth was dominated by computing and electronics products. As we have noted, the share of world computing and electronics exports held by the countries of East Asia and ASEAN (excluding Japan) rose from 3.4 per cent in 1970 to more than 30 per cent in 1994, whereas their share of other manufactured exports rose from 3.3 per cent to 14 per cent. For the ASEAN countries, computing and electronics exports accounted for 40.9 per cent of manufactured exports in 1994, by comparison with 2.3 per cent in 1970. Capability in these technologies, whether of a production or of a developmental type, also undoubtedly assisted competitiveness and growth in other industries. Thus it seems highly likely that capturing, in one way or another, leading edge productive capacity in these new goods has been central to the success of these countries.

7. Diverse Paths in East Asia and ASEAN Growth

As Romer's discussion cited above indicates, there are two polar cases with new goods and economic development - countries may invent the new goods, through domestic R&D, or they may import the technology lying behind the new goods, perhaps through foreign investment and associated technology transfer, or simply by importing producer goods embodying the new technology. In practice, of course, there is a continuum of possibilities here, and there are a number of quite distinct patterns to be observed among the East Asian and ASEAN nations along this continuum (*Proposition 4*). These patterns involve different combinations of the importation and imitation of foreign technology, the use of foreign direct investment and the development of domestic innovation capabilities. They are briefly noted here, drawing on data on foreign investment and on patents granted in the US, in addition to the analysis of the trade data used above extended to a country by country basis (Table 8 and Chart 2). For the patent analysis we confine our attention to patents granted in the US classified by industry of the invention and by country of residence of the inventor, using data from the US Patent Office, and compare the share of patents granted by country and industry with the share of total world exports achieved by country and industry (Tables 9 and 10). This is regarded as an acceptable approach in the relevant literature because of the role of the United States as the dominant market for advanced technology products. Basic data on foreign direct investment inflows by country, drawn from the IMF Balance of Payments Statistics and expressed as a percentage of GDP, are also used (Table 11).

Japan

One pattern is evident in the case of Japan, which by 1970 already had a knowledge intensity of manufacturing trade above the world average, which has for much of the subsequent period had a level of R&D spending as a share of GDP above the OECD average and for two decades has had an aggressive and successful record in registering new inventions through the patent system. By 1986, for example, 58 per cent of the patents granted by the US Patent Office in computing, electronics and communications to inventors resident outside the USA were granted to Japanese researchers, and by 1993 this figure had risen to 68 per cent (Table 9). Thus the

Table 8: The Role of Computing and Electronics Exports - East Asian and ASEAN Countries
(Based on data in current US$)

	Computing and Electronics Exports					All Other Manufacturing Exports	
	1970	*1980*	*1994*	*Average Annual Per Cent Change*		*Average Annual Per Cent Change*	
				1970-80	*1980-94*	*1970-80*	*1980-94*
	(US$ billion)			(%)		(%)	
Japan	2.6	19.2	101.7	22.3	12.6	20.9	7.2
South Korea	0.0	1.9	26.1	46.2	20.5	36.3	11.6
Taiwan	0.2	2.7	26.6	31.6	17.7	31.4	9.9
China	0.0	0.1	21.3	38.1	50.2	25.0	19.8
Malaysia	0.0	1.2	25.0	91.3	24.4	21.3	12.8
Singapore	0.1	3.0	50.2	48.2	22.2	29.7	9.2
Thailand	0.0	0.1	9.1	92.5	39.6	29.7	15.7
Indonesia	na	0.1	2.0	na	23.8	na	15.7
Philippines	0.0	0.1	2.0	140.9	28.6	21.0	3.7
Hong Kong	0.2	1.9	5.2	28.5	7.6	20.1	5.0

Source: UN Trade Data, accessed through International Economic Data Bank, ANU.

Japanese innovation system, while still heavily reliant also on international technology transfer, has been generating new and improved products to support increasingly knowledge intensive exports. Indeed, from the mid 1980s Japanese firms have been moving high technology production capacity off-shore, in response to Japan's trade surplus and the strong yen. Both the plateauing of the Japanese index of composition of exports after 1985 and the escalation of the indexes for ASEAN, China and to a lesser extent Taiwan since this time, reflect this transfer of production offshore rather than any slowing in the output of the Japanese innovation system.

Aspects of the Japanese pattern can be made clearer by noting some elements of the European experience. Each of the three European countries for which data is provided in Table 10 (UK, France and Germany) continue to be substantial contributors to the international growth in patents They provide in total 11-15 per cent across

Table 9: External Patents Granted by the United States Patent Office 1980-1993

	Computing and Electronics			All Other Manufacturing		
	1980	*1986*	*1993*	*1980*	*1986*	*1993*
	(Number of patents granted)					
Japan	1343	3181	7193	5781	10028	15099
South Korea	..	3	414	8	42	365
Taiwan	6	17	217	59	326	972
China	..	..	8	1	9	53
ASEAN	..	..	28	6	12	64
Total (1)	3065	5477	10546	21400	27257	34561

Notes: (1) Including countries not included above but excluding the USA, because only *external* patents granted in the USA are considered.
Source: US Patents Office.

Table 10: External Patents and Exports - Selected Countries, 1990-93
(Share of external patents granted in the US and of world exports; average for the four years 1990-1993; per cent)

	High Tech		Medium High Tech		Medium Low and Low Tech	
	US Patents Share	*Exports Share*	*US Patents*	*Exports Share*	*US Patents Share*	*Exports Share*
UK	2.8	8.0	2.9	5.1	2.5	4.8
France	3.1	6.8	3.1	7.1	3.1	6.5
Germany	4.9	9.6	8.7	17.4	8.4	11.9
Japan	32.2	17.0	23.8	14.6	15.4	7.1
South Korea	1.2	3.8	0.3	1.2	0.3	2.6
Taiwan	0.7	3.8	0.6	1.4	1.5	2.7
China	0.03	2.3	0.06	1.5	0.05	5.1
Malaysia	0.01	2.8	0.01	0.3	0.01	0.8
Singapore	0.07	5.6	0.01	0.8	0.01	1.6
Indonesia	..	0.14	..	0.13	0.01	1.0
Thailand	..	1.1	..	0.3	..	1.1
Philippines	..	0.29	..	0.07	0.01	0.24

Note: USA and Canada are excluded from this table, because use of US Patent Office data gives undue weight to these two countries, because of the 'domestic' nature of the patents covered for these countries.
Source: US Patent Office and UN Trade Statistics.

technology intensity categories of all patents granted in the US, with Germany being the greatest contributor, especially in industries other than those in the high tech group. Their share of world exports is consistently higher than their share of US patents, with the ratio close to two for each country in total and also for most of the categories shown in Table 10. Examination of the export share/patent share ratio for the 22 industries outlined in Table 2 shows that this ratio is also reasonably consistent across industries. The European pattern, at least as exhibited by these three major countries, involves a significant level of patenting activity but a share of world exports about twice the patent share. By contrast with the European countries, and all other countries shown, Japanese export shares were lower than their patent shares, indeed with export shares by technology intensity category being about half the patent share. This is indeed quite consistent across industries, with the export share exceeding the patent share only in two industries, viz. other transport equipment and shipbuilding. The Japanese pattern, then, involves a very high level of patent output for a given level of R&D together with a level of exports which, although high, is well below the patent shares, to the extent that the share of exports is only about half the patent share. In the early stages of its rapid development, Japan relied heavily on the importation and imitation of Western technology but for a considerable time now has been a real powerhouse for the creation of new products.

South Korea and Taiwan

South Korea and Taiwan occupy something of an intermediate position. While initially developing their export industries on the basis of foreign technology, and with some foreign direct investment, they have made vigorous and successful efforts to develop indigenous innovation capability, especially but not by any means entirely in the areas of computing and electronics. By 1993 South Korea had achieved a level of R&D spending (2.4 per cent of gross domestic product - GDP) above the average level for OECD countries, and this was heavily concentrated in the computing and electronics area. While research outputs do not yet approach the Japanese level, by 1993 about 4 per cent of external patents granted by the US Patent Office in these areas were to South Korean residents (Table 9). A similar expansion of industrially-based research spending and of research outputs is evident also in Taiwan, without quite as heavy a concentration on computing and electronics. By 1993 Taiwanese inventors received nearly 3 per cent of all external industrial patents granted by the US Patent Office. While these economies drew very heavily on both existing foreign technology and on Western science (including scientists trained in the West) they were more reticent about foreign direct investment. Indeed, gross foreign direct investment into the electric machinery and electronics industries in these two countries in the ten years to 1991 totalled US$774 million and US$653 million for South Korea and for Taiwan respectively, only about 20 per cent of the totals for Malaysia and Singapore, in spite of the much larger size of the East Asian economies (OECD 1994b). Total inward foreign direct investment for both South Korea and Taiwan has averaged less than 0.5 per cent of GDP in recent decades, a small fraction of that for some other Asian countries (Table 11).

Malaysia, Singapore and China

A third pattern is illustrated by some of the ASEAN economies, particularly Singapore and Malaysia, and to a lesser extent Thailand and China. Singapore and Malaysia have as yet only limited industrial R&D capacity and undertake little creation of new industrial products, at least as measured by standard indicators such as international patents applied for or granted. Yet they have by 1993 the highest knowledge composition of manufactured exports of all the developed and developing countries considered in the research for this paper, and the index of composition of China's manufactured exports has doubled between 1984 and 1993. China, Singapore, Malaysia and Thailand between them account for some 12 per cent of world export markets for high tech goods (Table 10) but provide only *one-third of one per cent* of all external patents registered in the US in these industries (Table 9). Their advanced technology exports have been achieved neither by indigenous innovation activities nor by aggressive imitation or importation of foreign technology by local firms, but primarily by the attraction of large scale foreign direct investment, bringing with it leading edge technology. According to information recently compiled by the OECD, total gross foreign direct investment into the computing and electronics industries alone totalled US$4383 million in Malaysia and US$3690 million in Singapore in the ten years ending in 1991, a massive amount in relation to the size of the sectors in these

Table 11: Inward Foreign Direct Investment, as a Share of GDP - Selected Asian Countries

	Singapore	*Malaysia*	*China*	*Philippines*	*Indonesia*	*Thailand*	*Taiwan*	*South Korea*
				(Per cent of GDP)				
1970	4.9	2.2	na	-0.4	0.9	0.6	na	0.7
1971	5.2	2.3	na	-0.0	1.4	0.5	na	0.4
1972	5.5	2.2	na	-0.1	1.8	0.8	na	0.6
1973	8.5	2.1	na	0.5	0.1	0.7	na	0.7
1974	6.6	5.8	na	0.0	-0.2	1.4	na	0.6
1975	5.2	3.6	na	0.7	1.5	0.6	na	0.3
1976	3.9	3.3	na	0.8	0.9	0.5	na	0.3
1977	4.4	3.0	na	1.1	0.5	0.5	0.2	0.3
1978	3.8	3.1	na	0.4	0.5	0.2	0.4	0.2
1979	8.9	2.7	na	0.0	0.4	0.2	0.4	0.1
1980	10.5	3.8	na	-0.3	0.2	0.6	0.4	0.0
1981	12.0	5.1	na	0.5	0.1	0.8	0.3	0.1
1982	10.5	5.2	0.2	0.0	0.2	0.5	0.2	0.1
1983	6.5	4.2	0.2	0.3	0.3	0.9	0.3	0.1
1984	6.9	2.3	0.4	0.0	0.3	1.0	0.4	0.1
1985	5.9	2.2	0.4	0.0	0.4	0.4	0.6	0.3
1986	9.6	1.8	0.5	0.4	0.3	0.6	0.5	0.4
1987	14.0	1.3	0.7	0.9	0.5	0.7	0.7	0.5
1988	14.8	2.1	0.8	2.5	0.7	1.8	0.8	0.5
1989	9.9	4.4	0.8	1.3	0.7	2.5	1.1	0.3
1990	15.9	5.4	0.8	1.2	1.0	2.9	0.8	0.3
1991	12.2	8.5	0.9	1.2	1.3	2.1	0.7	0.4
1992	14.6	8.9	2.2	0.4	1.4	1.9	0.4	0.2
1993	na	7.8	5.3	1.4	1.4	1.4	0.4	0.2

Source: IMF Balance of Payments Statistics.

economies in 1982 (OECD 1994b). Annual foreign investment inflows reached about 5 per cent and 10 per cent of GDP in Malaysia and Singapore respectively in the early 1980s, and in recent years have exceeded even those levels (Table 11).

Other Countries in the Region

While these three patterns are distinctive, a number of other relevant countries have had quite different experiences, in large part reflecting specific local circumstances. Hong Kong has not shown rapid growth in exports of either computing and electronics or other manufactured goods since 1980 (Table 8). These trends are presumably due to the shift of manufacturing into China and to the concentration of the local economy on services. Indonesia has shown a quite different trend in the knowledge composition of its manufactured exports than its neighbours (Chart 2), and has only recently seen the emergence of significant exports in the computing and electronics area. Its growth, however, has been buoyed by strong growth in other manufactured exports over the past two decades. The Philippines has seen a pronounced increase in the knowledge composition of its exports (Chart 2), but this sector remains small and a dominant fact about the Philippines economy from this perspective is the slow growth in other manufactured exports since 1980.

8. Conclusions and Implications

While a more definitive analysis of these important and complex matters is clearly called for, our central conclusion is that there is quite good evidence for our four propositions, viz.

- Over the past two decades the knowledge intensity of East Asian and ASEAN manufactured exports has increased very substantially, at rates well above the world average.
- This increase in the knowledge intensity of exports in East Asia and ASEAN has been dominated above all by exports of computing and electronics products.
- The rapid growth in East Asia and ASEAN over the past two decades or so has been driven to a substantial degree 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.
- Several different paths to high growth based on capturing these new goods are evident, with different roles for domestic innovation, foreign investment and technology transfer.

The implications of these conclusions are diverse and potentially important, and are clearly matters requiring further study. For example, the forward looking implications of this analysis need to be considered in the context of the rapidly changing shape of the computing and communications revolution, in particular the rapid falls in the price of hardware, the continuing shift to software and services as the vital component of revenues for most firms in these industries and the emerging globalisation of service activities (Sheehan et al. 1995). Here we make just four points, as headings for that further study.

Firstly, these conclusions do suggest that capturing, in various ways, the production and trade opportunities associated with new goods lies at the heart of the most important growth phenomenon of our times, the East Asian miracle. It follows that models and theories which emphasise the role of new goods in economic growth should be taken very seriously indeed. Secondly, if capturing new goods is at the heart of the East Asian miracle, the policies that enable those nations to capture those new goods need close examination. Romer has stressed the way in which tariff barriers on productive inputs can hinder access to new producer goods, so that removing those barriers can stimulate growth. But a much broader array of instruments has also been used in East Asia. Emphasising new goods would, for example, enrich the standard interpretations of industry policy (Itoh et al. 1991), which have so far related to policies directed at correcting, or correcting for, market failures. Thirdly, our conclusions may be cautionary for nations planning to attempt to imitate the East Asian miracle, for it suggests the possibility that this may have been connected in a unique way with a particular episode in economic history, namely the emergence of the information technology revolution. Finally, noting the importance of trade in hardware products to many of these countries raises the question of how well they will fare in the globalised service economy which is emerging. Will the continuing shift to services activities erode the basis for East Asian dominance of the growth stakes, or can they adjust to this emerging new environment?

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Chart 2: Index of Knowledge Composition of Manufactured Exports, Selected Asian Countries