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88

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Export performance, technological upgrading and foreign direct investment strategies in the Asian newly industrializing economies

With special reference to Singapur

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Contents

Boxes

Figures

Abstract

This paper analyses the competitiveness and technological structure of manufactured exports by leading Latin American and Asian economies for 1980-97. It explains East Asian performance with reference to the strategies adopted for technological development, focusing on foreign direct investment strategies. It particularly draws on the experience of Singapore, the countgry that has used FDI to promote industrial growth and technological upgrading more effectively than any other developing country. The paper starts by analysing the nature of technological activity in developing countries and the significance of the technological structure of exports. It presents data on global export trends that show that technoloy—intensive manufactures are growing considerably faster than other categories, and that East Asia dominates export performance in the developing world. Latin America lags in high technology exports, though Mexico's maquiladoras improve the region's overall performance. It goes on to analyse the competitive base of leading Latin American And Asian economies, presenting information on strategies, skill formation, R&D activity and attraction of FDI.

Success in attracting export—oriented high—technology FDI has been a major determinant of competitive success in all developing economies with the exception of Korea and Taiwan. The paper presents the results of cluster analysis to show different groups of countries according to broad competitive strategy. It then analyses FDI strategies in East Asia and particularly Singapore, and provides economic reasons why such strategies are necessary.

Introduction

This paper analyses the competitiveness and technological structure of manufactured exports by the Asian NIEs in the period 1980-97.[1] It compares their performance to that of other regions, developing and developed, in terms of growth rate and technological composition. It explains East Asian performance with reference to the strategies adopted for technological development. In particular, it focuses on the FDI (foreign direct investment) attraction and targeting strategies, with special reference to the experience of Singapore.

The perspective of the analysis is technological. Economists generally accept the role of technology in trade and growth in advanced industrial countries. They tend to neglect it in developing ones. It is generally assumed that advanced industrial countries innovate and create the technological advantages—developing countries merely import and (passively) use the technologies suited to their factor endowments. Once created, technologies are taken to move across countries and enterprises without cost, risk, effort or externalities. This makes the use of technologies an easy, and economically trivial, process. As such, technology per se (and technological effort) does not affect the comparative advantage of developing countries or differentiate their trade patterns (since they all have equal access to technology). Technology is a passive factor that adapts to the real determinants of comparative advantage: factor endowments.

[1] I am grateful to the World Bank for providing the UN Comtrade export data used here, and to Manuel Albaladejo for his help in analysing the data and carrying out the econometric analysis. The Asian NIEs include the mature 'Tigers' (Hong Kong, Korea, Singapore and Taiwan) and the 'new Tigers' (Indonesia, Malaysia, Philippines and Thailand).

However, the empirical literature that deals with micro-level technology development and efficiency in industrial firms—call it the ‘technological capability’ approach—suggests that these assumptions are over-simplified and misleading (Lall, 2000). The technological capability approach, drawing upon the evolutionary theories of Nelson and Winter (1982) and the pioneering work of Katz (1987) in Latin America, argues that firms operate with imperfect knowledge of technological alternatives. They need time and conscious effort to master the tacit elements of new technologies (new, that is, to them rather than to industry at large). New technologies cannot be simply imported and deployed at ‘best practice’ levels. Finding technologies is a difficult process. More important, once a technology is imported, there is a complex process of learning to use it efficiently. The process is often costly, prolonged, risky and unpredictable. It involves externalities and coordination problems, and may face failures in information, capital, skill and other markets. The risks are particularly large for skills and technology, with markets prone to widespread information deficiencies, uncertainty and externalities (Stiglitz, 1996).

The learning process is highly differentiated by technology. Some technologies are more difficult to master than others because the learning process is longer and more uncertain, involving greater effort and more externalities and coordination problems. At the same time, more difficult technologies also tend to offer greater potential for further learning and have greater scope for the application of new knowledge. Some complex technologies, particularly in generic activities like machinery or electronic manufacture, have strong linkage and spillover effects, acting as ‘hubs’ for technical progress and diffusion. As countries grow and wages rise, comparative advantage has to shift from simpler to more complex technologies and from simpler to more difficult functions within given technologies. Otherwise, competitiveness would erode with rising wages and exports would stagnate. This is the essence of the case for analysing the technological structure of exports.

The technological capability approach has important implications for export and industrial strategy. Countries with similar ‘endowments’ and openness to technology flows can have different kinds of comparative advantage and different patterns of evolution over time, depending on the national learning system. Traditional determinants of comparative advantage do remain relevant – but through their effects on learning, when their assumptions conform to technological realities. For instance, H-O explains trade patterns when the activities concerned have low scale-economies, simple skills, short learning periods, limited externalities and undifferentiated products. In these conditions, wage cost differences per se can be important determinants of competitiveness. Since these are also activities that developing countries tend to start with, H-O seems to ‘explain’ a substantial part of their exports. However, even here a simple version of H-O can misrepresent reality. There may be large differences between countries in competence, dynamism and depth in these simple, labour-intensive technologies, expected in the capability approach but not explicable by H-O. There are in fact significant variations in export performance between low wage countries in simple manufactures—these can be explained only by differences in national learning.

It is therefore important to understand the determinants of ‘national learning systems’. Such systems are the outcome of a complex interaction of many factors. The most important are trade and industrial policies, macroeconomic conditions, location and resource endowments, human capital, technological effort and nature of factor markets and institutions (Lall, 1996). From the technological perspective, the critical ones relate to how enterprises access, master and improve upon new (and increasingly difficult) technologies. There are two broad approaches: fostering learning by domestic firms (autonomous), and depending on FDI to drive technological upgrading. Both entail the extensive use of foreign technologies, but the different agents for learning involve different strategies to import, absorb and build upon new technologies.

These broad strategies have sub-strategies: nationalistic strategies with pervasive import substitution versus those with strong export-orientation, and FDI-based strategies with strategic targeting of investors and activities versus those without such targeting. It is the latter distinction that is of most interest to this analysis. In practice, the distinction between them may be blurred. Many countries combine different strategies, and change their relative weight over time. In recent years, the spread of liberalisation has led to growing convergence towards market—oriented, less interventionist strategies. The pace of technical change and the spread of global production networks has also reduced the scope for autonomous strategies. Nevertheless, we can understand export competitiveness in the Asia NIEs only with reference to past strategies. As we see below, not only did different strategies lead to different export patterns, they produced very different competitive bases.

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I. Technological structure of manufactured exports

Under standard trade theory, export structures are incidental. Developing countries specialize in resource based or labour-intensive, low skill, low technology activities. Over time, they switch to more capital, skill or technology-intensive activities as in response to changing factor endowments. The export structure per se does not matter—it simply reflects factor prices and adjusts automatically and without lags. No structure is more desirable than is another, since there are no externalities or dynamic learning effects that lead social returns to diverge from private returns. In the absence of scale economies, agglomeration effects, technological learning, externalities and so on, shifts between activities are costless. Export structures thus do not raise any economic or policy issues.

A more realistic analysis of how firms in developing countries develop technological competence, however, suggests that export structures do matter. There are three steps in the reasoning.

Each country has a distinct technological structure of exports.

Structures are path dependent and difficult to change. They are the outcome of accumulated (technological, managerial and other) capabilities, developed by slow, incremental learning processes. They are not, however, rigid; they change in response to market signals, new technologies and external catalysts (like FDI), different policies and the accumulation of new capabilities. Even so, structural change takes time and effort. FDI can provide new technologies and skills rapidly, but their effective use needs complementary factors (once technologies move beyond simple assembly activities). As the industrial sector matures, therefore, there is likely to be a strong element of structural stability in exports.

Maintaining competitiveness in any technological structure needs technical upgrading and effort. Given the need for improved technology, different technological structures can face different prospects for growth and offer different opportunities for further learning and development.

With some caveats, we may argue that technology-intensive structures are more beneficial for export growth and industrial development. This is so for the following reasons:

- Activities with the rapid product innovation generally enjoy faster growing demand vis à vis less dynamic activities.[2] Similarly, activities with rapid process innovation can take market shares from others because they are better able to lower costs or raise quality.
- Technology-intensive activities are less vulnerable to entry by competitors compared to low technology activities where scale, skill and technology requirements are low. To the extent that technology-intensive exports reflect genuine domestic capabilities, countries with more advanced export structures will tend to have higher barriers to entry from countries lower on the scale. A low-technology export structure is clearly the best starting point for a labour-surplus economy, but over time, as wages rise, it can sustain growth only by taking shares from other low technology (possibly lower wage) exporters. In relatively slow—growing markets, this is possible but relatively difficult.[3]
- O ver time, technology-intensive activities also offer higher learning and productivity potential as well as greater spillover benefits to other activities, as compared to simple activities. Thus, ceteris paribus, the former lead to faster growth in capabilities, greater diffusion and higher quality capabilities. A technology-intensive production and export structure is likely to offer greater systemic benefits in terms of learning and innovation (Guerrieri and Milana, 1998).
- Capabilities in technology-intensive activities are more attuned to technological and market trends, giving the ability to respond more flexibly to changing conditions.

While we argue that in general technologically advanced export structures are more conducive to growth, we must note important caveats. At the empirical level, we are obliged by the nature of the trade data to use broad (SITC three-digit) categories, and to classify technological levels by general R&D levels. The most notable qualifications are:

- The propositions relating to technology-intensive export structures apply over the long term and to countries that have achieved a certain level of industrial development. It is clearly unrealistic (and undesirable) for countries at low levels of industrial development to aim for technology-intensive exports. What is relevant, however, is that all countries exporting manufactures must upgrade their export structures as they grow. A competitive edge based

[2] Evidence on the faster growth of technology intensive industries and exports in 68 economies is provided in NSF (1998). "The global market for high-tech goods is growing at a faster rate than that for other manufactured goods, and economic activity in high-tech industries is driving national economic growth around the world. Over the 15-year period examined (1980-95), high-tech production grew at an inflation-adjusted annual average rate of nearly 6 per cent compared with a rate of 2.4 per cent for other manufactured goods… Output by the four high-tech industries – those identified as being the most research-intensive – represented 7.6 per cent of global production of all manufactured goods in 1980; by 1995, this output represented 21 per cent." (Chapter 6)

[3] For instance, in garments, entry into high quality, brand-conscious segments needs considerable technical effort and high levels of design and marketing skill – the tacit element of competitiveness is large and very difficult to acquire. In fact, it may be more difficult than upgrading technologies in more complex products where it is easier to automate in response to rising wages. This is borne out by the East Asian experience, where rising wages have led to the reduction (with overseas relocation) of low technology activities (no country has been able to 'do an Italy' in fashion products) while it has led to deepening of complex activities like electronics.

on cheap unskilled labour is unsustainable (though an essential starting point); the ability to move into more complex products has to be developed from the start.

- The technological categories used are broad and have inherent aggregation problems – some low-technology products enjoy rapid technical progress, some high-technology ones may be stagnant. The aggregation problems can be partly remedied by more detailed technological classifications, but this is impossible given the nature of the data. Moreover, there are clearly exceptions to the generalisation that rapid market growth follows from rapid product innovation.
- Even if we classify products correctly by technology, we must distinguish the process involved. The same product can use very different processes in different locations, exploiting different sources of competitive advantage. For instance, semiconductor exports may involve complex design and fabrication in one country (and so be genuinely high technology) and only assembly and packaging in another (and so be low technology). Many ‘high—tech’ exports by developing countries are based on the relatively simple, labour-intensive assembly of imported components. The available data cannot distinguish process characteristics; the best we can do is to qualify on the basis of country-specific knowledge.
- The data also do not allow us to assess technological upgrading within activities, clearly a vital source of new competitive advantages. Again, trade data do not allow us to analyse technology upgrading at the detailed product level. It still remains true, nevertheless, that upgrading quality within slow growing exports is unlikely to yield as much growth as within dynamic products; the arguments on learning potential and spillovers also continue to apply.
- The case for export growth via technological upgrading overlooks the possibility that there can be rapid export growth in low technology activities with slow-growing markets, driven by the relocation of production from high to low wage countries. This has been the case with clothing, footwear or toys: as we see later, some of these products are among the fastest growing in world trade. Relocation can also accelerate export growth in technologically dynamic activities, in cases where these have separable labour-intensive processes. In fact, the combination of technological dynamism and relocation can provide the most powerful engine of export growth for developing countries.

There are many ways to categorise products by technology. The simplest and most common one is to distinguish between high and low technology activities (based on R&D intensity, the proportion of scientists and engineers in R&D, and so on, all giving very similar rankings). While relatively easy to implement, this measure is highly aggregated, and some finer distinctions would be useful. An alternative measure is to distinguish between resource-based, labour-intensive, scale-intensive, differentiated and science-based manufactures. This is more difficult to use because the analytical distinctions are unclear and there are large overlaps between categories. The scheme used here combines both the methods, and extends them to take account of product groups or clusters of particular export interest to the developing world.

Table 1

TECHNOLOGICAL CLASSIFICATION OF EXPORTS

• Classification	• Examples
Primary products	Fresh fruit, meat, rice, cocoa, tea, coffee, wood, coal, crude petroleum, gas
Manufactured products	
• Resource based manufactures	
Agro/forest based products	Prepared meats/fruits, beverages, wood products, vegetable oils
Other resource based products	Ore concentrates, petroleum/rubber products, cement, cut gems, glass
Low technology manufactures	
Textile/fashion cluster	Textile fabrics, clothing, headgear, footwear, leather manufactures, travel goods
Other low technology	Pottery, simple metal parts/structures, furniture, jewellery, toys, plastic products
• Medium technology manufactures	
Automotive products	Passenger vehicles and parts, commercial vehicles, motorcycles and parts
Medium technology process industries	Synthetic fibres, chemicals and paints, fertilizers, plastics, iron, pipes/tubes
Medium technology engineering industries	Engines, motors, industrial machinery, pumps, switchgear, ships, watches
High technology manufactures	
Electronics and electrical products	Office/data processing/telecom equip, TVs, transistors, turbines, power generating equipment
Other high technology	Pharmaceuticals, aerospace, optical/measuring instruments, cameras
• **Other transactions**	Electricity, cinema film, printed matter, 'special' transactions, gold, art, coins, pets

Source: Comtrade database, classified by author.
Note: Special transactions like electric power, art works, gold bullion, miscellaneous transactions and so on are not shown here.

There is a degree of judgement involved in assigning particular products to particular categories, but this is unavoidable. In general, the classification used here conforms to most analysts' conception of what constitutes technology intensive and non-technology intensive products.

Primary products and special transactions need little analysis in terms of comparative advantage, and we largely ignore them in our analysis of export structures. Within manufactured exports, the general technological features of the various categories are as follows:

- **Resource based** (RB) products tend to be simple and labour-intensive (e.g. simple food or leather processing), but there are segments using capital, scale and skill-intensive technologies (e.g. petroleum refining or modern processed foods). Since competitive advantages in these products arises generally—but not always—from the local availability of natural resources, they do not raise particularly interesting issues for competitiveness and are not considered in great detail. We draw a distinction between agriculture/forest-based products and others, mainly mineral-based.
- **Low technology** (LT) products tend to have stable well-diffused technologies mainly embodied in capital equipment, with low R&D expenditures and simple skill requirements. Labour costs tend to be a major element of cost and barriers to entry are relatively low. The market as a whole tends to grow slowly, with income elasticities generally below unity (though there are exceptions). There are particular consumer products with high quality segments where brand names, skills, design and technological competence are very important. However, products of major interest to developing countries are in the lower quality segments, based on simple technologies and price rather than quality competition. We distinguish between the textile, garment, footwear ('fashion') cluster and other low

technology products. The former has undergone massive relocation from developed to developing areas, with the simpler assembly operations shifted to low wage sites and complex design and manufacturing functions retained in advanced countries. This relocation has been the engine of export growth for many countries, though the location of sites in textiles and clothing has been influenced not just by cost but by market access (under MFA, offshore assembly provisions, regional trade agreements like NAFTA and so on). Other low technology exports have not benefited from this active a relocation process (toys are the exception).

- **Medium technology** (MT) products are the heartland of industrial activity in mature economies, comprising the bulk of skill and scale-intensive technologies in capital goods and intermediates. They generally have complex technologies, with moderately high levels of R&D, and advanced skill needs. Most require lengthy learning periods and considerable interaction between firms to reach 'best practice' technical efficiency. We divide them into three sub-groups. Automotive products are of particular export interest to newly industrialising countries, particularly in East Asia and Latin America. Process industries, mainly chemicals and basic metals, are different in their technological features from engineering products. The former tends to have stable and undifferentiated products and stress the control and optimisation of complex processes. The latter, mainly machinery manufacture, emphasises product design and development as well as extensive supplier and subcontractor networks (SMEs are often important here). Barriers to entry tend to be high where there are large capital needs or strong learning effects in operation, design, and product development. The relocation of particular (labour-intensive) processes to low wage areas is possible but not as widespread as in low technology activities: products are heavy and technological capabilities are needed to meet world standards.

- **High technology** (HT) products have advanced and fast-changing technologies, with high R&D investments and prime emphasis on product design. The most innovative technologies can also require advanced technology infrastructures and close interactions between firms, and between firms and research institutions. However, in certain electronic products final assembly is very labour-intensive, and high value-to-weight ratios can make it economical to place these processes in low wage areas. We separate high technology electronic and electrical products (some of the latter, like turbines or heavy generating equipment are not amenable to easy relocation) from other high-tech products (aircraft, precision instruments, pharmaceuticals, also relatively rooted in economies with high levels of skills, technology and supplier networks).

II. World trade patterns

Table 2 shows the pattern of world exports by sub-periods and technological categories (1995-97 is shown separately to illustrate the effects of the recent economic crisis). We use 1995 as the end year for the analysis of structural factors, since 1997 data are not available for many developing countries, and because the effects of the crisis can lead to a misrepresentation of underlying structural variables. The main trends are as follows:

There was anaemic growth of world trade in 1980-85, a consequence of the second oil shock, followed by five years of rapid expansion and then a slowing down. Manufactured products drove growth throughout the period. There was a sharp fall in the growth rate in 1995, which persisted till 1997 (and hit East Asia particularly hard), with the expansion of manufactured products falling to under one-third of the previous rate and under a quarter of the rate over the past decade. Primary products lost their share of world exports by over one-half over the period.

Of the broad technological categories, the fastest growing set was high technology products, with a rate double that of the slowest growing, resource-based products. High-tech exports maintained their growth best in the recession periods in the early 1980s and mid-1990s. Of the fifty most dynamic products in world manufactured trade in 1985-95, the largest share in 1995 (47 percent) came from HT products, most of them electronics. These fifty products accounted for about 40 percent of total manufactured exports in 1995.

Low and medium technology products grew at fairly similar rates over the period. Medium technology products dominated world trade, and, despite some slippage, remained at around 40 percent of the total. Low technology products kept around 20 percent, while resource based products were the main losers. In the narrower sub-categories of manufactured exports, electronic/electrical products had the highest growth over the whole period, and were the only set to maintain double-digit growth rates during 1990-95. At the other end, the two groups of RB products had the lowest rates. In low technology products, the textile cluster did somewhat better than other products, which were worse hit in the 1995 slowdown. In the MT group, the best overall performer was the automotive industry, largely because of the massive expansion of Latin American auto exports (from Mexico to the USA and by Brazil and Argentina within the Mercosur) since 1985.

Table 2

GROWTH AND DISTRIBUTION OF WORLD EXPORTS (1980-97

(percentage)

	RATES OF GROWTH (% pa)					Percentage distribution		
	1980-85	1985-90	1990-95	1995-97	1980-97	1980	1990	1995
Total exports	1.3	12.7	9.1	2.3	7.0	100	100	100
Primary products	1.1	1.0	5.3	1.5	2.3	23.0	13.1	11.0
Manufactures	1.6	15.2	9.4	2.9	7.9	73.7	83.4	85.5
All manufactured products						100	100	100
Resource based	-0.2	12.3	7.4	1.1	5.7	24.4	19.7	17.9
Agro/forest based	-1.1	14.0	8.9	-1.5	6.1	7.4	6.2	6.1
Other resource based	0.2	11.6	6.6	2.4	5.6	17.0	13.5	11.9
Low technology	0.9	16.5	9.3	0.8	7.8	19.3	19.8	19.7
Textile, clothing, footwear	2.5	17.0	8.7	2.1	8.4	7.8	8.9	8.6
Other low tech	-0.2	16.2	9.7	-0.3	7.3	11.5	11.0	11.1
Medium technology	1.5	15.0	8.4	2.0	7.4	41.9	41.4	39.5
Automotive	4.7	14.1	7.5	4.2	8.2	10.9	12.0	11.1
Medium tech process	0.3	14.6	9.7	-0.6	6.9	10.4	9.5	9.6
Medium tech engineering	0.3	15.8	8.3	2.1	7.2	20.5	19.8	18.8
High technology	5.4	17.5	13.3	7.5	11.4	14.4	19.2	22.9
Electronic/electrical	7.4	18.8	15.6	6.7	13.0	8.5	13.1	17.3
Other high tech	2.3	15.0	7.5	10.0	8.4	5.9	6.0	5.5

Source: Comtrade database, classified by authors.
Note: Special transactions like electric power, art works, gold bullion, miscellaneous transactions and so on are not shown here

Export growth clearly reflects a mixture of innovation — which raises demand and the competitive abilities of innovative products — and the relocation of export-oriented production from high to low cost sites. There are four ‘dynamic’ technological sub-categories, with growth rates above the manufacturing average: the textile cluster, automotive products, electronic products and other high-technology products. Each shows a different mixture of determinants of growth.

In the textile cluster, pure relocation factors predominate, with fairly modest overall market growth and technical change: segments with low skill requirements are pushed out to low wage areas. In the medium and high technology products, products like electrical equipment and aircraft enjoy high export growth mainly because of innovation. They are not relocated to low wage areas because the technological needs and linkages are too demanding. Others, like autos, face mature demand patterns and do not have very rapid innovation, though production and design are technologically complex and linkage intensive. Exports here have grown in large part because of relocation, but driven less by a search for cheap ‘raw’ labour than for bases with low cost skilled labour, accumulated technological competence and reasonable supplier networks. High-technology products like semiconductors or consumer electronics have a mixture: rapid innovation, demand growth and relocation of assembly processes (high value-to-weight ratios make the splitting of processes economical). This accounts for their exceptional dynamism.

This depiction simplifies complex dynamic sequences within each technology. The balance between technological and relocation forces varies over time, and the extent of export activity depends on a host of cost, policy and other factors, some of which we touch on later. The main actors also differ by technology, period and country. While MNCs play a dominant role in both innovation and relocation in most industries, their contribution is relatively low in low technology industries where other agents (like buyers) can provide local producers with the information or designs needed. In the garment industry, buyers drove exports by subcontracting local firms; in particular, where local manufactures were capable and aggressive, as in East Asia, MNCs played a relatively small role. Over time, many Asian firms grew into international intermediaries, with extensive production.

networks and affiliates overseas.[4] By contrast, local firms in Latin America and North Africa played a less dynamic role, and MNCs from the major markets were the most important agents of low technology export growth.

In industries with rapid innovation and valuable proprietary technologies, MNCs tend to dominate export activity, but in different ways according to host country characteristics. Countries with low technological capabilities specialise in final assembly, mainly in EPZs and with low local content and practically no domestic design or research input. Those with advanced technological capabilities and supply bases tend to have greater local value added, even design and development activity. The former can shade into the latter over time (as in Singapore), but the process may be slow and halting. Some countries have developed their own technological capabilities in advanced industries, by dint of massive investments and pervasive industrial policy (Korea and Taiwan are the leading examples). They have drawn upon MNC innovation by licensing, imitation, joint ventures and, most important, OEM arrangements, but built up domestic capabilities rather than depending passively on continued import of MNC technologies. In general, given the technology, the nature and locus of developing country competitiveness depend on three main parameters:

- The human capital base
- Technological effort
- FDI inflows.

In turn, each of these is determined by such factors as the initial base of 'endowments', size, stability, location, and government policies (on education, FDI, industry and trade). We see below how these parameters have worked in different ways among the major exporters of East Asia.

Table 3 shows export growth and shares for industrial and developing countries. The latter have uniformly higher growth rates, perhaps expected given their smaller base. What is less expected is that their lead rises with technological complexity. At first sight this is counter-intuitive. The comparative advantage of developing countries should lie in technologically simple activities, and there is no presumption that the underlying determinants have changed significantly in recent years. Are the data a statistical artefact, reflecting the relocation by high-tech MNCs of simple processes? Or, if they reflect genuine local technological capabilities (which entails considerable skill formation and technical effort), is there a massive change under way in the developing world? Or,

4 Quotas and rising costs forced the leading garment firms from the Asian NIEs to establish offshore factories in lower-wage countries. Hong Kong and Taiwan Province sourced extensively from Mainland China and Southeast Asian countries (but also spread to South Asia, Africa and the Caribbean), the Republic of Korea used Indonesia, North Korea and the Caribbean region, and so on. The East Asian NIEs exported directly to US buyers from these assembly sites, taking advantage of import quotas in the US market. This phenomenon has become known as '*triangle manufacturing*'. It has changed Asian NIE firms from suppliers to US retailers and merchandisers to important (and fiercely competitive) middlemen in the international commodity chain. Their networks encompass as many as fifty or sixty exporting countries. This development highlights the success of the strategy followed by the Asian NIEs, built around continuous learning, from EPZ through brand-name subcontracting to original brand-name manufacturing (Gereffi, 1999).

do the data reflect the dynamism and effort of a few countries? The explanation is, as noted, a mixture. Certainly a part of the explanation is that a significant part of the growth of high-tech exports is the spread of low technology assembly. Manufactured export activity in the developing world is highly concentrated; this is true of all technological categories, but concentration is higher in advanced technologies. And there is considerable technological development in some developing countries. Some of this occurs under MNC auspices, and some within local enterprises. In each case, it requires human capital formation and directed effort to move from ‘easy’ to ‘difficult’ activities, processes and functions.

The large and rising share of developing countries in LT products does not need much analysis. The relocation of labour-intensive processes has raised their share to over half in the textile cluster. This share is much higher than in other low technology products because of the intense activity of foreign buyers, and the low skill and technological needs of low-end garment manufacture (really the basic entry-level export-oriented manufacturing activity). The lowest share of developing countries is in ‘other’ HT products, where the sheer complexity of the technology and makes relocation and the local development of competitiveness very difficult.

Table 3

GROWTH AND SHARES OF MANUFACTURED EXPORTS BY TECHNOLOGICAL CATEGORIES

	Growth Rates 1980-97 (% p.a.)				Developing Country Shares of World (%)		
	World	**Industrialized Countries**	**Developing Countries**	**Difference: Developing-Industrialized**	**1985**	**1995**	**Change in share**
All exports	7.0	6.5	8.5	2.0	25.0	26.9	1.9
RB	5.7	5.1	8.1	3.0	22.4	24.0	1.6
Agro based	6.1	5.6	7.8	2.2	22.0	23.8	1.8
Other RB	5.6	4.9	8.3	3.4	22.6	24.0	1.5
LT	7.8	6.2	12.4	6.2	25.8	37.0	11.2
Textile cluster	8.4	6.3	11.9	5.6	38.7	50.8	12.1
Other LT	7.3	6.2	13.5	7.3	15.7	26.5	10.8
MT	7.4	6.6	16.4	9.8	7.4	16.8	9.4
Auto	8.2	7.5	22.3	14.8	2.4	9.6	7.2
Process	6.9	5.8	15.7	9.9	10.5	23.3	12.8
Engineering	7.2	6.4	15.3	8.9	9.0	17.7	8.7
HT	11.4	9.8	21.2	11.4	10.2	27.1	16.9
Electronic	13.0	10.9	21.7	10.8	13.4	33.1	19.7
Other HT	8.4	7.9	17.3	9.4	4.3	8.3	4.0
Total mfrs.	**7.9**	**6.8**	**13.5**	**6.5**	**14.7**	**24.0**	**9.3**

Source: As Table 2.
Notes: We use 1985 figures as the base to calculate shares to avoid missing values for a number of large developing countries, and 1995 as the end year to avoid the effects of the export slowdown afterwards. Industrialised countries include Israel and Central and Eastern Europe. Developing countries include the mature Tigers, Turkey and South Africa.

The next lowest is in automotive products, where there are also difficulties in building a competitive base. However, many large developing countries have long experience in this activity; with regional trade agreements and liberalization of FDI regimes, MNCs have massively restructured and expanded the industry in Latin America. Automobile and component exports have boomed to the USA from Mexico (under NAFTA) and between Brazil and Argentina (under Mercosur). But it is not only MNCs spearheading the growth of automotive exports: new local competitors have emerged in Korea for vehicles and Taiwan for components. In electronics, part of the surge in developing world exports comes from MNC driven relocation, and part comes from the growth of local capabilities in East Asia. This raises the developing world share of this high-tech activity to one-third of the total.

As a result, the developing world's largest manufactured exports are now high technology products. In 1997, total HT exports were $287 billion, compared to $177 billion for RB, $274 billion for LT, and $256 billion for MT. On this basis, developing countries as a whole appear well positioned in the most dynamic products in world trade. If they maintain recent performance they will continue to grow rapidly and advance into the most advanced and productive sectors of manufacturing. This is, unfortunately, very misleading as a generalisation. The general trends conceal large regional and national disparities within the developing world.

III. Regional distribution of developing world exports

Table 4 shows the regional breakdown by technological categories for six regions (Sub-Saharan Africa appears twice, with and without South Africa, an obvious outlier). There is enormous regional concentration: East Asia not only dominates all categories, its dominance has risen over time. By 1995, it accounts for three-quarters of total manufactured exports by developing countries. Its share is lowest in the RB category, but even here its share is rising, reaching 53 per cent by 1995.

Its largest share is in HT products, where it accounts for 90 per cent; however, this is a decline from 94 per cent in 1990, due to the rapid growth of such exports by Latin America. This is, in turn, due primarily to Mexican border *maquiladoras* and the advent of NAFTA; the rest of Latin America has done poorly in HT industries.[5] In many dynamic products, Mexico is emerging as the largest competitive threat to Asia-Pacific in the American market. The rest of LAC offers little direct competition to East Asia.

Sub-Saharan Africa, without South Africa, is practically absent from the manufactured export scene, with the minor exception of RB products. It loses shares to other developing countries in every category. MENA is strong but declining in RB, a modest but growing

5 NAFTA and offshore processing arrangements have boosted Mexican exports to the US, not just of HT products but also of automotive, engineering and clothing items. They have made Mexico the largest and most dynamic exporter in Latin America. In 1997, its exports accounted for 68% of HT, 62% of MT, and 54% of LT exports by the Latin American and Caribbean region.

player in LT, and weak and stagnant in MT and HT. We return to these points in the next section.

Table 4

SHARES OF REGIONS IN DEVELOPING WORLD EXPORTS BY MAJOR CATEGORIES
(percentage)

	1985	1990	1995
Total manufactures			
East Asia	66.5	74.0	75.3
South Asia	5.2	5.0	3.7
LAC	19.4	13.9	15.2
MENA	4.9	4.6	3.6
SSA 1	1.2	0.8	0.5
SSA 2	4.0	2.5	2.2
Resource based			
East Asia	44.6	51.7	53.3
South Asia	5.0	5.6	5.3
LAC	33.8	25.3	27.8
MENA	10.1	12.3	7.5
SSA 1	2.3	1.8	1.4
SSA 2	6.6	5.1	6.1
Low technology			
East Asia	76.9	78.4	77.3
South Asia	8.9	8.7	7.3
LAC	10.0	8.0	9.4
MENA	2.2	3.0	4.6
SSA 1	0.7	0.7	0.6
SSA 2	2.1	1.9	1.5
Medium technology			
East Asia	72.3	73.9	73.3
South Asia	2.3	2.2	1.6
LAC	18.7	18.8	20.2
MENA	3.1	2.7	2.8
SSA 1	0.8	0.6	0.3
SSA 2	3.6	2.3	2.1
High technology			
East Asia	90.1	94.2	90.5
South Asia	1.2	1.1	0.6
LAC	5.8	4.1	8.0
MENA	0.7	0.3	0.6
SSA 1	0.2	0.1	0.0
SSA 2	2.2	0.4	0.3

Source: As Table 2.

Note: LAC stands for Latin America and the Caribbean, MENA for North Africa and the Middle East (including Turkey but excluding Israel, which is counted as part of the industrial world). SSA stands for Sub-Saharan Africa (including Mauritius); SSA 1 excludes South Africa, SSA 2 includes it.

IV. Country level performance: East Asia and comparators

Table 5 shows the values and growth rates of manufactured exports for nine East Asian countries, India, three large LAC economies, Turkey and South Africa, as well as the major regions. The first point to note is very high concentration: the leading 15 countries account for 85-90 percent of total manufactured exports by developing countries. The leading five exporters are all from East Asia with the exception of 1997 when Mexico displaces Malaysia, and account for around 60 percent of the total through the period. East Asia has the highest rates of export growth over 1985-95; LAC has higher rates over 1980-97, but this is misleading since its exports in 1980 are under-reported by missing data for Brazil, Mexico and Chile. In the 1990s, however, LAC does have faster growth than East Asia, with the lead widening after 1995. The sole explanation is Mexican maquilas.

China has been (by far) the largest exporter in the developing world since 1990. Its growth rate over 1985-95 of 36 percent is unmatched in the sample, and probably by any large exporter in the world. The outlier in the 1995-97 recession is Philippines, which emerges as the most dynamic exporter in the region, a result of an MNC-led boom in semiconductor exports. Its growth rate is much higher than Mexico, but from a lower base; however, it is also more impressive in that there are no special tariff or transport cost factors favouring the Philippines. Low wages and good EPZ facilities are part of the reason but the main explanation seems to lie in the abundance of high level technical manpower relative to regional competitors like Malaysia and Thailand.

Table 5

MANUFACTURED EXPORTS IN THE MAIN DEVELOPING COUNTRIES

(millons of dollars)

	Values (millions of dollars)					Growth rates (annual percentage)					
	1980	**1985**	**1990**	**1995**	**1997**	**1980-85**	**1985-90**	**1990-95**	**1995-97**	**1980-97**	**1985-95**
Leading countries											
Hong Kong	13 239.9	15 979.5	27 834.3	28 333.0	25 876.9	3.8	11.7	0.4	-4.4	4.0	5.9
Singapore	15 031.9	19 014.0	48 876.8	109 900.5	116 179.7	4.8	20.8	17.6	2.8	12.8	19.2
Korea	16 314.5	29 025.0	62 409.1	119 138.4	126 053.3	12.2	16.5	13.8	2.9	12.8	15.2
Taiwan	18 782.4	28 948.8	63 487.2	104 464.0	108 849.1	9.0	17.0	10.5	2.1	10.9	13.7
Malaysia	6 121.3	8 626.5	21 772.0	64 822.9	68 995.2	7.1	20.3	24.4	3.2	15.3	22.3
Indonesia	4 251.4	3 856.4	11 900.8	29 018.5	29 240.6	-1.9	25.3	19.5	0.4	12.0	22.4
Philippines	3 995.6	3 428.7	5 662.7	13 704.2	21 823.3	-3.0	10.6	19.3	26.2	10.5	14.9
Thailand	2 258.4	3 657.6	17 255.0	46 129.4	47 190.4	10.1	36.4	21.7	1.1	19.6	28.8
China	N/A	6 049.2	48 043.4	132 784.0	164 209.3	N/A	51.4	22.5	11.2	N/A	36.2
India	4 901.9	6 208.9	13 986.6	25 021.0	27 178.4	4.8	17.6	12.3	4.2	10.6	15.0
Argentina	3 387.2	3 702.9	6 609.7	11 355.4	13 865.2	1.8	12.3	11.4	10.5	8.6	11.9
Brazil	14 855.8	17 616.8	23 404.6	35 327.3	38 079.4	4.4	5.8	8.6	3.8	6.1	7.2
Mexico	5 867.5	8 336.2	13 216.3	64 822.3	92 645.6	9.2	9.7	37.4	19.6	18.8	22.8
Turkey	1 671.5	5 790.4	9 803.4	18 475.4	22 311.8	36.4	11.1	13.5	9.9	17.6	12.3
South Africa	6 490.4	4 963.7	6 842.0	16 095.7	15 907.7	-5.2	6.6	18.7	-0.6	5.4	12.5
Total above	**117 169.6**	**165 204.5**	**381 103.8**	**819 391.9**	**918 405.8**	**7.1**	**18.2**	**16.5**	**5.9**	**12.9**	**17.4**
Share in total for developing countries	102.1	91.5	90.9	85.8	92.3						
Chile	1 439.6	1 234.5	2 649.0	7 085.9	7 293.6	-3.8	16.5	21.7	1.5	10.7	19.1
Regions											
East Asia	80 780.3	120 084.2	309 971.9	719 342.0	710 451.7	8.3	20.9	18.3	-0.6	13.6	19.6
South Asia	5 930.0	9 444.3	21 020.0	35 399.8	35 078.7	9.8	17.4	11.0	-0.5	11.0	14.1
LAC	10 269.2	35 042.5	58 428.5	145 134.0	181 516.1	27.8	10.8	20.0	11.8	18.4	15.3
MENA	7 634.7	8 823.7	19 307.5	34 299.4	48 387.0	2.9	17.0	12.2	18.8	11.5	14.5
SSA 1	3 625.6	2 222.8	3 540.2	4 841.4	3 616.7	-9.3	9.8	6.5	-13.6	0.0	8.1
SSA 2	10 116.0	7 186.5	10 382.2	20 937.1	19 524.4	-6.6	7.6	15.1	-3.4	3.9	11.3
Developing countries	114 730.3	180 581.2	419 110.2	955 112.3	994 957.9	9.5	18.3	17.9	2.1	13.5	18.1
Industrialized countries	967 387.4	984 928.8	1 875 637.9	2 877 696.9	3 054 139.6	0.4	13.7	8.9	3.0	7.0	11.3
World	1 082 117.7	1 165 510.0	2 294 748.1	3 832 809.2	4 049 097.5	1.5	14.5	10.8	2.8	8.1	12.6

Source: Calculated from UN Comtrade database. Regional totals were given separately from country data.
Notes: 'Developing countries' include all above regions but not the Central Asian countries or the transition economies of Asia, on which data is not available for the period. I include Israel with the group of industrial countries.

Data for 1980 are not available for Brazil, Chile, Mexico, Turkey and Egypt. The figures shown are for 1981, explaining why the 1980 total for the top 15 countries exceeds the total for developing world for that year (derived from regional totals). Rates of growth for these countries (for 1980-85 and 1980-97) are adjusted for the shorter time period; however, the regional growth rates for these periods reflect the low base since I could not account for the missing (major) countries for that year. That is why LAC shows very high growth rates for 1980-85 and 1980-97.

Acronyms: LAC stands for Latin America and the Caribbean, MENA for North Africa and the Middle East (including Turkey but excluding Israel, which is counted as part of the industrial world). SSA stands for Sub-Saharan Africa; SSA 1 excludes South Africa, SSA 2 includes it. Industrial countries include Central and East Europe but not the Soviet Union or the transition economies of Central Asia, on which there are no usable data.

Table 6 shows the technological breakdown of exports by the above countries and regions in 1985 and 1995. Annex Table 1 gives a more detailed breakdown by technological sub-categories.

Table 6
PERCENTAGE DISTRIBUTION OF MANUFACTURED EXPORTS, 1985 & 1995
(percentaje)

	1985				1995			
	RB	**LT**	**MT**	**HT**	**RB**	**LT**	**MT**	**HT**
Hong Kong	3.2	63.0	19.1	14.8	6.0	52.0	15.1	27.0
Singapore	43.5	8.6	23.4	24.5	13.9	7.0	19.3	59.8
Korea	8.6	41.4	37.2	12.8	10.9	20.3	39.0	29.8
Taiwan	9.9	52.9	26.0	25.9	5.4	30.0	27.5	37.2
Malaysia	53.7	8.0	11.4	26.9	18.0	11.2	19.9	51.0
Philippines	39.6	17.1	6.4	36.9	9.5	13.1	8.6	68.9
Thailand	37.9	35.4	22.0	4.7	19.3	25.3	20.5	34.8
Indonesia	75.2	15.5	6.4	3.0	44.1	30.3	16.0	9.5
China	38.8	43.7	12.2	5.2	10.9	51.8	19.8	17.4
India	40.6	45.3	10.1	4.1	30.2	48.7	14.6	6.6
Argentina	60.2	16.3	19.0	4.4	41.8	17.4	36.5	4.4
Brazil	44.0	21.3	29.8	4.9	38.0	16.7	38.6	6.6
Mexico	21.1	13.2	55.4	9.0	7.3	19.8	45.2	27.7
Chile	90.6	2.2	6.8	0.3	79.1	7.9	11.9	1.1
Turkey	21.8	53.1	23.5	1.6	16.9	56.9	21.4	4.8
Egypt	62.0	35.2	1.7	1.1	50.3	39.3	8.1	2.3
South Africa	53.4	16.4	21.2	9.0	49.7	16.4	30.0	3.9
East Asia	23.0	38.3	23.0	15.7	11.9	29.3	25.3	33.4
South Asia	32.3	55.8	9.2	2.8	25.1	58.7	12.1	4.2
LAC	59.3	16.9	20.3	3.6	32.2	18.4	36.1	13.3
MENA	70.3	14.6	13.4	1.7	36.7	37.9	20.9	4.5
SSA 1	64.7	19.3	14.5	1.6	40.8	44.2	13.0	1.9
SSA 2	56.9	17.3	19.1	6.7	48.2	22.2	24.4	5.2
Developing countries	34.1	32.9	21.0	12.1	17.6	29.9	27.2	25.3
Industrial countries	19.9	16.4	45.0	18.7	17.9	15.9	43.8	22.4
World	22.1	18.9	41.3	17.7	17.8	19.4	39.7	23.2

Take first the structure of industrial country exports. The evolution is far more gradual than for developing countries, indicating structural maturity. The main change is a shift from RB and MT to HT (mainly electrical/electronic) products, though MT products continue to dominate. While LT products retain their share, within it the fashion cluster loses share slightly and other low technology products gain. Within MT, engineering products (a wide range of industrial machinery) are the main item; they are also the largest single subcategory of manufactured exports by industrial countries and raise their share over time. This is the 'heartland' of industrial production, the outcome of lengthy learning, skill development and linkage development. Competence in these is perhaps the best indicator of overall technological development in industry.

Developing countries have practically the same share of RB products as industrial countries, but a considerably higher one in HT (an 'aberration' due to MNC electronics assembly, mainly in East Asia). Other HT exports are much lower, as is the share of MT products (particularly automotive and engineering). The most rapid shift in structure is the doubling of the share of HT products over the decade, followed by a significant gain also in MT. The largest loss is borne by RB products, but LT products also lose three percentage points. The share of the textile cluster in LT products is the second highest, after electronics, over three times its share in industrial countries.

At the regional level, East Asia has the highest specialisation in HT, two and half times that of LAC, its nearest competitor in the developing world. Practically the whole of this comes from electronics. Other HT products constitute less than 2 percent of its total (the highest here is South Asia, due to Indian pharmaceutical exports). LAC has a higher specialisation in MT than East Asia, due to automotive exports.[6] It also has a strong showing for MT process industries (chemicals and metals), where MENA and SSA2 are also strong.

In low technology products, the highest reliance is in South Asia. All the major economies there rely heavily on clothing and textile exports (India and Pakistan in both, Sri Lanka and Bangladesh only on the former), total earnings coming to $18 billion in 1995. Surprisingly, there is practically no change in the structure over time.[7] MENA and SSA 1 also have relatively high shares of such products. In the former, Turkey is the dominant exporter of clothing, but Morocco and Tunisia are also highly dependent on this product (total exports in 1995 of the region here came to $10 billion). All three have succeeded largely due to trade preferences created by MFA and special access to the European market; their wages are much higher than in Asia and quality is not distinctly better. In SSA1, the high share of textile exports is due entirely to knitwear from Mauritius; no other Sub-Saharan African country has significant exports. So small is the total value of manufactured exports by SSA1 that Mauritius' $1.3 billion of exports makes it the largest subcategory for the region. LAC was never a major clothing exporter, traditionally being a high wage region. However, a number of Central American and Caribbean economies have entered the arena and rely on garments for most of their non-traditional export earnings (taking the total earnings to $13 billion).

East Asia is the largest exporter in the textile and garment category ($122 billion), with China dominating the world market. Enterprises from the Asian NIEs are the most proficient in the manufacture, sale and sourcing of garments for world markets. However, the export share is low because of rapid diversification away from this activity – most governments regard it as a sunset industry, suitable only for low wage entrants, and are encouraging its relocation elsewhere. The major outstanding question is, of course, what will happen to exports by the developing world when (and if) the MFA ends and other trade preferences are removed. China is likely to raise its share at the cost of many newcomers in South Asia (India should also be able to expand significantly) and elsewhere. Since the industry remains the major manufactured export for a number of countries – and has not generated much deepening or diversification – this could spell a serious setback to their export-oriented industrialisation process.

At the country level, the most high technology export structure now is that of the Philippines, with nearly 70 percent of manufactured exports coming from HT products (a near doubling in just ten years). Singapore and Malaysia follow; these three countries are the only ones to have over half the share in this category. Of the mature NIEs, Hong Kong has the lowest technology export structure; the lack of upgrading in the face of rising wages and land costs has been a major factor in the virtual stagnation, and recent decline, of its exports. Singapore, with an even higher wage level, has by contrast maintained double-digit export growth in the first half of the 90's by deliberate strategies to raise the technological level of industrial activity. Korea and Taiwan, particularly the former, have significant and diversified MT as well as HT exports. Of all the countries in the

[6] Latin American exports of auto products (including components) came to $25.4 billion in 1997. Of this, $17.4 billion came from Mexico, $4.4 billion from Brazil and $2.6 billion from Argentina. This was larger than for East Asia, at $22 billion; of this, Korea accounted for $12.3 billion and Taiwan for $4.5 billion.

[7] This is most surprising for India, which has a diverse industrial sector facing (hesitant and incomplete) liberalization. Few of the domestic market oriented heavy or engineering industries have increased export competitiveness sufficiently to show up in the figures. For an analysis see Lall (1999.c).

sample, their industrial structure is the nearest to mature industrial countries in terms of the depth and range of manufacturing activity. China has a predominantly low technology export structure, a manifestation of the boom in labour-intensive exports from its Special Economic Zones. However, it has been upgrading its structure by reducing the share of RB exports, which has fallen to almost one-fourth of its 1985 level. Thus by 1995, China has a much larger share of HT products – and very much larger export values – than India, Argentina or Brazil, all large economies with a strong import-substituting tradition that have undergone recent liberalization (to different extents).

V. Competitive capabilities and export performance

1. Introduction

There are different factors driving export success in East Asia, with different actors, patterns of specialisation and levels of domestic competence. However, the export data as they stand are misleading in showing the technological base of the exporting country. High-tech (even low technology) exports may be based on the assembly of imported components, with little or no domestic physical, skill or technological inputs. The same exports from another country may embody high local content in all these. To move from technological export structure to the prospect for export growth and policy implications we need to understand the technology base.

Based on what we know of local content, participation of domestic firms as exporters or suppliers, local design and development, use of local equipment and technical services, we can rank national technological capabilities in East Asia. The ranking (excluding China, which is so different and diverse that it is difficult to rank) goes something like:

- Korea
- Taiwan
- Singapore
- Hong Kong
- Malaysia

- Thailand
- Philippines
- Indonesia

The ranking is impressionistic, and may differ by individual activities (Philippines is more advanced than Thailand in electronics but not in many other industries). Nevertheless, in overall terms it is plausible and useful; the groupings that emerge from the cluster analysis (below) add further dimensions. There is no doubt that Korea has built up the largest, more diverse and deepest technological capabilities, not just in the region but in the whole developing world. It is followed closely by Taiwan, with a more flexible and technology oriented structure but less heavy industry. Singapore remains heavily dependent on MNCs for innovation, but within this framework it has induced MNCs to enter advanced activities, deepen the technological base and undertake the most technology-intensive functions locally. Malaysia is trying to do the same, but has some way to go. Thailand has advanced local companies in low and medium technology activities, but lags in deepening high-tech activities. Philippines has more advanced skills but its production structure is still relatively shallow. Indonesia has a recent and weak technology base.

2. Strategic considerations

What were the broad strategies pursued by these countries to expand manufactured exports? Part of export growth was based on the better exploitation of existing advantages (natural resources and unskilled or semi-skilled labour), while part relied on the creation of new advantages (skills, technological capabilities, clusters and so on). Thus, some strategies (or part of larger strategies) involved liberalising on export activity and attracting FDI to realise existing advantages; others went beyond, to ‘dynamising’ existing advantages by intervening in factor and product markets. The basic choice was between the agents involved: local enterprises or MNCs. All countries used both, but with different balance and emphasis, depending partly on the nature of technologies involved (local firms in simpler technologies) and partly on strategic objectives.

To simplify and reiterate, the main strategic issues are as follows. The development of export competitiveness inevitably requires investments in capabilities of various kinds: procurement, production, engineering, design, marketing and so on. The realisation of existing advantages in natural resources or unskilled labour tends to involve less effort, risk and externalities than the development of new advantages in complex activities (though the regional data suggest that even this effort has been out of reach of many countries). Sustained and rapid manufactured export growth needs moving from easy to complex products and processes within activities, and across activities from easy to complex technologies. The choice between local and foreign firms to lead the capability building process depends on the existing base of skills and experience and the demands of exporting. It also depends upon the ability of governments and institutions to help enterprises to develop the necessary capabilities and tap externalities (e.g. coordinate investments in vertically linked activities or undertake collective learning). MNCs and local firms face different factor markets and have to overcome different market failures in learning.

MNCs have several advantages over local firms in using new technologies (‘new’ to a particular location) for export activity. They have mastered and used the technologies elsewhere; they may have created the technology in the first place. They have large internal reserves of skill, technical support, experience and finance to design and implement the learning process. They have access to major export markets, established marketing channels and well-known brand names. They can transfer particular components or processes from a production chain to a developing country and integrate it into an international system. This is much more difficult for local firms, not just because they may not have the experience or technological competence – they inevitably face higher transaction and coordination costs in integrating into MNC corporate systems.

While the MNC-led strategy has many benefits, and can be a highly effective and rapid means of exploiting existing advantages, a passive FDI strategy may not be the best way to dynamise competitiveness. MNCs may not invest in a particular country because of imperfect information or poor image. Thus, effective promotion and targeting of investors can allow a country to attract more and higher quality FDI. Where MNCs do invest, they initially transfer equipment and technologies suited to existing skills and capabilities. To move on to more advanced activities and functions, they have to upgrade local skills, technological capabilities and supply chains. This is economical only where the education and training base is growing, local suppliers are raising their capabilities, technology institutions are able to provide more advanced services, and so on. Such supply side upgrading needs government support. Moreover, a policy to induce MNCs to enter more advanced activities by offering such inducements as specialised infrastructure and skills can accelerate the upgrading process. With a completely passive policy, MNC exports can remain at low, technologically stagnant, levels. Thus, an MNC dependent export strategy needs a proactive element for dynamic competitiveness.

More important, an FDI-dependent strategy is not a substitute for building domestic capabilities. There are many activities in which MNCs have no competitive advantage over domestic firms, particularly those served by SMEs. The development of national enterprises may also lead to broader, deeper and more flexible capabilities, since the learning process within foreign affiliates may be curtailed as compared to local firms. The very fact that an affiliate can draw upon its parent company for technical information, skills, technological advances and so on means that it needs to invest less in its own capabilities. This applies particularly to functions like advanced engineering, design or R&D, which MNCs tend to centralise in industrial countries. As they mature industrially, it is imperative for developing countries to undertake these functions locally to support their future comparative advantage. This is why some countries choose to promote technology development in local firms.

Different countries make different strategic choices in these respects. Taking our sample of leading developing country exporters, we may distinguish between four:

'Autonomous', based on the development of capabilities in domestic firms, starting in simple activities and deepening rapidly over time. This strategy used extensive industrial policy, reaching into trade, finance, education, training, technology and industrial structure. It involved selective restrictions on FDI, and actively encouraged technology imports in other forms. All these interventions were carried out in a strongly export-oriented trade regime, with favours granted in return for good export performance. The prime examples are Korea and Taiwan.

'Strategic |FDI dependent', driven by FDI and exports to MNC global networks. There was strong effort to upgrade MNC activity according to strategic priorities, directing investments into higher value-added activities and inducing existing affiliates to upgrade their technologies and functions. This strategy involved extensive interventions in factor markets (skill creation, institution building, infrastructure development and supplier support), encouraging R&D and technology institutions, and in attracting, targeting and guiding investments. The best example is Singapore.

'Passive FDI dependent', also driven by FDI but relying largely on market forces to upgrade the structure (with rising wages and growing capabilities). The main tools were a welcoming FDI regime, strong incentives for exports, with good export infrastructure, and cheap, trainable labour. Skill upgrading and domestic technological activity were relatively neglected (though some countries had a relatively good base), and the domestic industrial sector tended to develop in isolation from the export sector. Malaysia, Thailand and Philippines are good examples, along with the Special Economic Zones of China (and the maquilas of Mexico).

'ISI restructuring', with exports growing from long-established import-substituting industries where competitive (or nearly competitive) capabilities had developed. The main policy tool was trade liberalization or strong export incentives (some, as in Latin America, within regional trade agreements). This led to considerable upgrading, restructuring and expansion of these industries along with their supplier networks. In some countries the main agents were domestic enterprises, in others they were MNCs. The main difference from the 'autonomous' strategy was the lack of clear and coordinated industrial policy to develop export competitiveness, with haphazard (often weak) support for skills, technology, institutions and infrastructure. China and India are examples within Asia, the large Latin American economies elsewhere; elements of this strategy are also present in many other economies.

These strategies are not mutually exclusive. Countries tend to combine them, and to vary the combinations over time. Nevertheless, this simple typology is useful as an analytical tool, and we use it with appropriate caveats.

The main tools for building local capabilities were in the following areas:

- Trade policy
- Credit allocation and subsidies
- Infrastructure development
- Industrial structure
- Skill formation
- Technology promotion
- FDI attraction, targeting or restriction

Of these, the first four will not be discussed here. The nature of industrial policy in East Asia is too well known to merit further attention in this paper (see Lall, 1996, Stiglitz, 1996, World Bank, 1993). Infrastructure development is too specialised a topic to be tackled here, and is difficult to compare across countries. Let us look at the three main supply-side determinants of competitiveness where we can make cross-country comparisons.

3. Skill formation

The role of skill formation in export competitiveness is so basic, and widely accepted, that it does not need analysis here. What is worth noting is that with the growing pace of technical change, the spread of information technologies and intensifying global competition, the need for skill development has become more pressing. More importantly, the patterns of skills needed for competing in modern manufacturing have changed, and along with this the tools and institutional structures suited to skill formation. Traditional methods of education and training often prove inadequate, even in developed countries. In the traditional setting, industrial development required simply improving the quantity and quality of primary schooling and basic technical education, and encouraging all forms of in-firm training. In the emerging competitive setting, there has to be greater emphasis of high-level, specialized training, with close interaction between education and industry to assess and communicate evolving needs. We cannot assess the suitability of skill formation systems in this sense, certainly not on a national basis. What we can do is to compare educational enrolments, going beyond the three general levels (primary, secondary and tertiary). Given our interest in technology, we focus on enrolments at the tertiary level in technical subjects: science, mathematics and computing, and engineering.

Table 7

TERTIARY LEVEL ENROLMENTS AND ENROLMENTS IN TECHNICAL SUBJECTS (1995)

	3 level enrolment		Technical enrolments, numbers & % of population							
	Total	% pop.	Natural Science		Maths & computing		Engineering		All Technical subjects	
	No. students		numbers	%	numbers	%	numbers	%	numbers	%
Developing countries	35,345,800	0.82	2,046,566	0.05	780,930	0.02	4,194,433	0.10	7,021,929	0.16
Sub-Saharan Africa	1,542,700	0.28	111,500	0.02	39,330	0.01	69,830	0.01	220,660	0.04
MENA	4,571,900	1.26	209,065	0.06	114,200	0.03	489,302	0.14	812,567	0.22
Latin America	7,677,800	1.64	212,901	0.05	188,800	0.04	1,002,701	0.21	1,404,402	0.30
Asia	21,553,400	0.72	1,513,100	0.05	438,600	0.01	2,632,600	0.09	4,584,300	0.15
4 mature NIEs	3,031,400	4.00	195,200	0.26	34,200	0.05	786,100	1.04	1,015,500	1.34
4 new NIEs	5,547,900	1.61	83,600	0.02	280,700	0.08	591,000	0.17	955,300	0.28
S Asia	6,545,800	0.54	996,200	0.08	7,800	0.00	272,600	0.02	1,276,600	0.10
China	5,826,600	0.60	167,700	0.02	99,400	0.01	971,000	0.10	1,238,100	0.13
Others	601,700	0.46	70,400	0.05	16,500	0.01	11,900	0.01	98,800	0.08
Transition economies	2,025,800	1.95	55,500	0.05	30,600	0.03	354,700	0.34	440,800	0.42
Developed economies	33,774,800	4.06	1,509,334	0.18	1,053,913	0.13	3,191,172	0.38	5,754,419	0.69
Europe	12,297,400	3.17	876,734	0.23	448,113	0.12	1,363,772	0.35	2,688,619	0.69
N America	16,430,800	5.54	543,600	0.18	577,900	0.19	904,600	0.31	2,026,100	0.68
Japan	3,917,700	0.49					805,800	0.10	805,800	0.10
Australia, NZ	1,128,900	5.27	89,000	0.42	27,900	0.13	117,000	0.55	233,900	1.09

Enrolment data are not the ideal way to measure skill creation. They ignore on-the-job learning, other forms of training, and quality differences in the education provided. Nevertheless, they are the only data available on a comparable basis, and they do show something about the national base for technical skill acquisition. Table 7 shows the total numbers enrolled in tertiary education and in the three technical subjects by region in 1995 (weighted by population). The Asian NIEs enrol over 33 times the proportion of their population in technical subjects that in SSA2 (including South Africa). The ratio is twice that of industrial countries, nearly 5 times Latin America and the new NIEs, and over 10 times South Asia and China. The leading 3 countries in terms of total technical enrolments – China (18%), India (16%) and Korea (11%) – account for 44 percent of the developing world's technical enrolments, the top ten for 76 percent and the top 20 for 93 percent. Annex Table 1 shows the ratios for each of the countries.

In terms of the intensity of technical skill creation (enrolments as a percentage of the population), the world leader is Korea (1.65%), followed by Finland (1.33%) and Australia (1.17%). Taiwan, the next developing country, is fifth (1.07%). Singapore comes in much later, in 38 position, below Philippines and Hong Kong. However, this is misleading in that the polytechnics provide a great deal of technical education in Singapore (and students going abroad), not captured in the UNESCO data. The new Asian NIEs, apart from Philippines, are well behind: Indonesia (54 place), Thailand (70) and Malaysia (75). China and India are even further (82 and 78 respectively). The large Latin American economies are somewhere in the middle: Argentina (39), Mexico (44), and Brazil (71).

These figures have to be treated with care. The connection between technical enrolments and technological competence is not direct. The quality of the training and the ability of industry to exploit the available skills in terms of R&D or other technical effort matter a great deal. The accumulated stock of trained manpower, and more importantly its base of experience, is extremely important. While most highly industrialised countries are near the top of the ranking, they are not the leaders: USA is 17 on the list, Germany 8 and Japan 20 (Table 8).

Table 8

TECHNICAL TERTIARY ENROLMENTS BY COUNTRY

(% population) 1995

1	Korea	1.65	38	Bolivia	0.34
2	Finland	1.33	39	Costa Rica	0.34
3	Australia	1.17	40	Turkey	0.33
4	Taiwan	1.06	41	Ecuador	0.29
5	Spain	0.97	42	Uruguay	0.29
6	Ireland	0.90	43	Venezuela	0.29
7	Austria	0.78	44	El Salvador	0.26
8	Germany	0.77	45	Morocco	0.25
9	UK	0.75	46	Tunisia	0.24
10	Chile	0.73	47	Indonesia	0.23
11	Portugal	0.73	48	Nicaragua	0.22
12	Sweden	0.73	49	Honduras	0.20
13	Greece	0.72	50	Thailand	0.19
14	Canada	0.69	51	Brazil	0.18
15	Israel	0.68	52	S. Africa	0.17
16	N. Zealand	0.68	53	Hungary	0.16
17	USA	0.68	54	Malaysia	0.13
18	Norway	0.67	55	Egypt	0.12
19	Italy	0.64	56	India	0.12
20	Japan	0.64	57	Jamaica	0.11
21	France	0.61	58	Paraguay	0.11
22	Denmark	0.60	59	China	0.10
23	Panama	0.59	60	Zimbabwe	0.09
24	Netherlands	0.56	61	B'desh	0.08
25	Philippines	0.55	62	Nepal	0.08
26	Colombia	0.51	63	Sri Lanka	0.08
27	Switzerland	0.51	64	Cameroon	0.06
28	H. Kong	0.49	65	Madagascar	0.06
29	Romania	0.49	66	Pakistan	0.05
30	Argentina	0.47	67	Senegal	0.05
31	Singapore	0.47	68	Mauritius	0.04
32	Peru	0.46	69	Congo	0.03
33	Mexico	0.44	70	Kenya	0.02
34	Belgium	0.43	71	CAR	0.01
35	Jordan	0.42	72	Ethiopia	0.01
36	Algeria	0.41	73	Malawi	0.01
37	Poland	0.39			

Source: Calculated by author from UNESCO (1997).

Nevertheless, for newly industrialising economies the intensity of technical enrolments is an important determinant of how much, and how good, a skill base they provide for technical upgrading: it is a necessary but not sufficient condition. The data correspond broadly to the rankings on the technological base for manufacturing competitiveness. As we see now, they also correspond to the intensity of formal R&D effort.

4. Technological activity

Technological activity in developing countries consists less of R&D for innovation than of diffuse engineering and technical work for learning, adaptation and improvement. Given its nature, such activity is difficult to measure, though we know that its intensity and effectiveness determine industrial competitiveness and growth. What we can measure is formal R&D, a rough indicator of technological effort. Nevertheless, it is useful to look at R&D for its own sake in East Asian NIEs newly industrialising countries, since it is becoming an important input into competitiveness in these countries. With the use of more complex technologies, R&D becomes necessary to absorb them and adapt them to local conditions. It is the best way to monitor global technological developments and select those relevant to competitive needs. It lowers the cost of technology transfer and captures more spillovers created by the operation of TNCs. A growing R&D base permits better and faster technology diffusion within the economy and facilitates greater use of local resources. It makes it feasible and attractive for TNCs to locate their own design and development work there. Most importantly, it permits the industrial sector greater flexibility and diversification, and allows it greater autonomy.

Table 9

R&D PROPENSITIES AND MANPOWER IN MAJOR COUNTRY GROUPS

(latest year available)

Countries and regions (a)	**Scientists/engineers in R&D**		**Total R&D**	**Sector of performance (%)**		**Source of Financing (% distribution)**		**Source of financing (% of GNP)**	
	Per mill. population	**Numbers**	**(% of GNP)**	**Productive sector**	**Higher education**	**Productive enterprises**	**Govern-ment**	**Productive enterprises**	**Productive sector**
Industrialised market economies (b)	1,102	2,704,205	1.94	53.7	22.9	53.5	38.0	1.037	1.043
Developing economies (c)	514	1,034,333	0.39	13.7	22.2	10.5	55.0	0.041	0.054
Sub-Saharan Africa (exc. S Africa)	83	3,193	0.28	0.0	38.7	0.6	60.9	0.002	0.000
North Africa	423	29,675	0.40	N/A	N/A	N/A	N/A	N/A	N/A
Latin America & Caribbean	339	107,508	0.45	18.2	23.4	9.0	78.0	0.041	0.082
Asia (excluding Japan)	783	893,957	0.72	32.1	25.8	33.9	57.9	0.244	0.231
Mature NIEs (d)	2,121	189,212	1.50	50.1	36.6	51.2	45.8	0.768	0.751
New NIEs (e)	121	18,492	0.20	27.7	15.0	38.7	46.5	0.077	0.055
S Asia (f)	125	145,919	0.85	13.3	10.5	7.7	91.8	0.065	0.113
Middle East	296	50,528	0.47	9.7	45.9	11.0	51.0	0.051	0.045
China	350	422,700	0.50	31.9	13.7	N/A	N/A	N/A	0.160
European transition economies (g)	1,857	946,162	0.77	35.7	21.4	37.3	47.8	0.288	0.275
World (79-84 countries)	1,304	4,684,700	0.92	36.6	24.7	34.5	53.2	0.318	0.337

Source: Calculated by author from UNESCO Statistical Yearbook 1997. Regional propensities for R&D spending are simple averages.

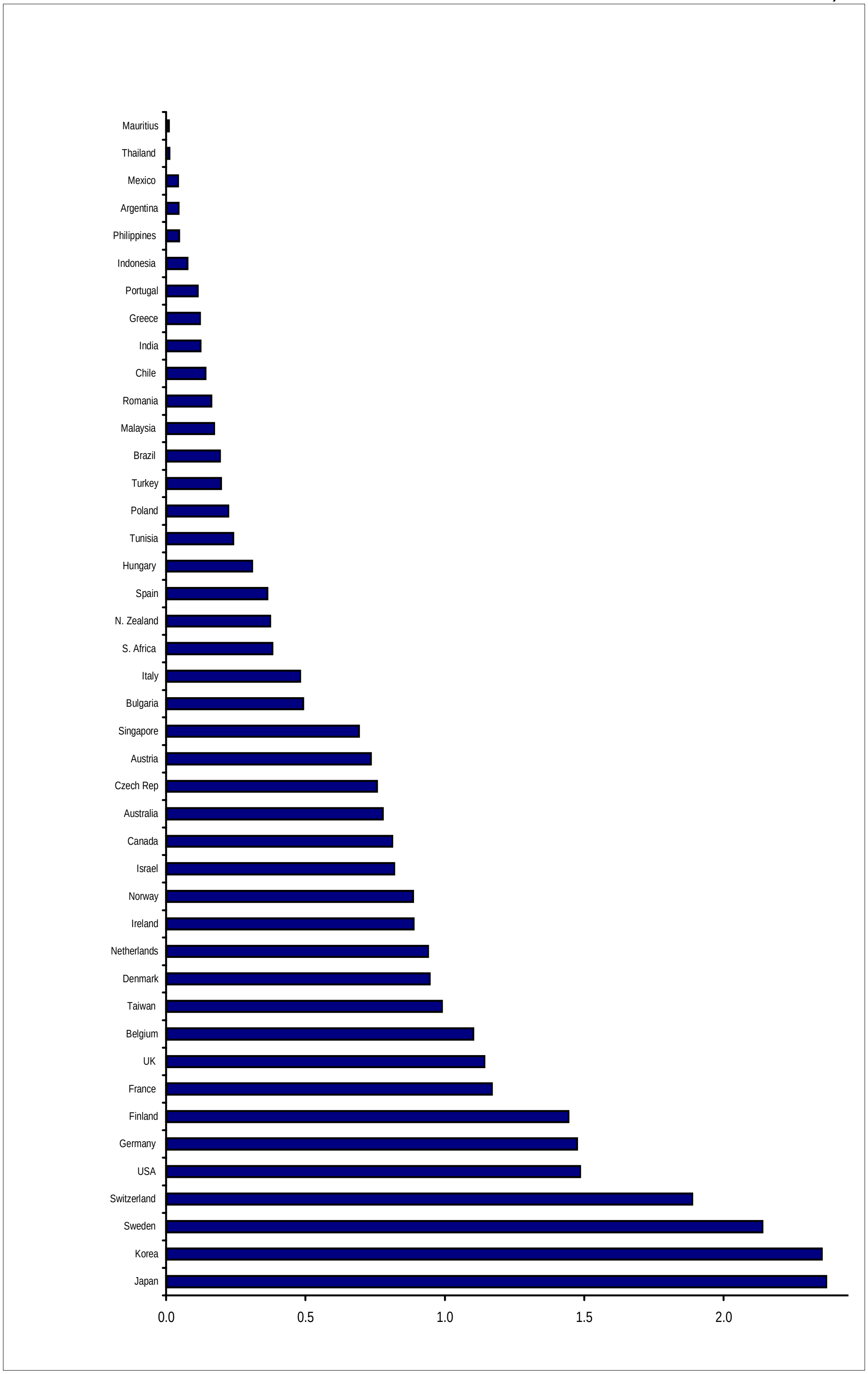
Notes: (a) Only including countries with data, and with over 1 million inhabitants in 1995

(b) USA, Canada, West Europe, Japan, Australia and N Zealand. (**c**) Including Middle East oil states, Turkey, Israel, South Africa, and formerly socialist economies in Asia. (**d**) Hong Kong, Korea, Singapore, Taiwan Province. **(e)** Indonesia, Malaysia, Thailand, Philippines. **(f)** India, Pakistan, Bangladesh, Nepal **(g**) Including Russian Federation.

Table 9 shows R&D scientists and engineers and expenditures in the developing world. The patterns again reflect the technological depth of exports analysed earlier. Productive enterprise financed R&D as a share of GNP—perhaps the best indicator of technologically useful R&D—in the mature NIEs is nearly 400 times higher than in Sub-Saharan Africa, and around 10 times higher than in the new NIEs and Latin America. Asia as a whole accounts for 86 percent of R&D scientists and engineers in the developing world, Sub-Saharan Africa for 0.3 percent, and Latin America for 10 percent. The proportion of enterprise financed R&D in total R&D spending is highest in the mature NIEs, followed by the new NIEs, and lowest in Sub-Saharan Africa. Latin America and South Asia are similar, with below 10 percent of national R&D financed by productive enterprises.

Figure 1

RD FINANCED BY PRODUCTIVE ENTEPRISES AS % OF GNP, 1995



The regional averages conceal large variations at the national level. Figure 1 shows productive enterprise financed R&D as a percentage of GNP for the 50 leading (including industrial) countries. Korea again turns out to be one of the leaders; its figure is the highest, not only in the developing world, but also, apart from Japan, in the world as a whole. Taiwan comes next in the developing world, with a lower ratio than the UK but more than the Netherlands or Italy. Singapore comes next, though much lower in the world scale. While its high dependence on FDI has not held back the growth of private sector R&D (much of it in foreign affiliates), this has needed a strong government push, and the innovation base remains narrow. Hong Kong does not publish R&D data, but reports suggest that total R&D is only 0.5% of GNP and enterprise financed R&D is a very small proportion of this. The other three NIEs are in a class apart, and the ranking corresponds to the impressionistic one on technological content.

Of the new NIEs, Malaysia leads while Thailand comes in last, lower than Indonesia. This reveals an important weakness in Thai competitiveness, the shallowness of its high technology export activity (Lall, 1998.c). Malaysia has succeeded in raising R&D in MNCs (especially in electronics), adopting some of the same tactics as Singapore; again, it has a long way to go before it can match the latter in technological competence.

MNCs account for substantial portions of technological effort in Singapore, Malaysia, Brazil and Mexico. Interestingly, the latter two countries attract the most US MNC R&D in the developing world (UNCTAD, 1999), but are poor performers in overall terms. In Korea and Taiwan, R&D by local firms takes precedence, driven by strategies to restrict FDI inflows and reverse the passive reliance on foreign technologies that marks most developing countries.

5. Inward FDI

World trade, and so competitiveness, is increasingly related to TNC activity. TNCs now account for large shares—over two-thirds—of world trade (UNCTAD, WIR 1996). Their shares are higher in technologically advanced and differentiated products, and are rising in response to liberalised trade and investment policies. This may seem surprising in view of the fact that MNCs are increasing their international production, which can substitute for exports. However, international production does not replace the export of products at the top of the technology scale (from headquarters or from other advanced affiliates) or at the bottom (from affiliates in low wage countries).

It also raises trade in intermediate products. A very large part of TNC trade is now intra-firm. In the USA, for instance, exports by MNCs to their majority-owned affiliates in 1996 comprised 48% of parent company exports, up from 41% in 1977. Half of exports by foreign MNCs in the USA (accounting for 20 per cent of total US exports) were also intra-firm. The propensity to engage in intra- as compared to inter-firm trade is again higher in the more technologically complex and novel products. Similar trends are likely to exist in other major capital exporting countries.

This suggests that entry into a large (and most dynamic) part of world industrial trade by developing countries requires the participation of MNCs. This holds even more for the most dynamic products in trade: complex, technology intensive and differentiated manufactured products. However, few developing countries are able to participate in this system. FDI flows to the developing world are rising rapidly, from an average of $29 billion in 1986-91 to $149 billion in 1997, but they are highly concentrated. The top 10 developing countries account for nearly 80 percent, the top 25 for 95 percent.

Table 10

INWARD FDI FLOWS AS PERCENTAGE OF GROSS DOMESTIC INVESTMENT

	1985-90	1991	1992	1993	1994	1995
WORLD	5.4	3.1	3.3	4.4	4.5	5.2
Regions						
All Developed	5.5	3.2	3.2	3.7	3.5	4.4
W. Europe	8.9	5.3	5.3	5.8	5.1	6.7
N. America	5.5	3.4	2.5	3.8	5.5	4.6
All developing	8.0	4.4	5.1	6.6	8.0	8.2
N. Africa	2.7	2.2	3.8	4.1	5.7	3.0
Other Africa	9.2	7.3	6.4	8.2	12.5	13.2
L. America	11.3	7.8	8.1	7.2	10.3	11.0
W. Asia	1.2	1.7	1.5	2.2	1.0	-0.6
S. & E. Asia	9.7	3.8	4.7	7.5	8.3	9.0
C. & E. Europe	1.0	0.4	0.8	7.9	5.0	5.2
Developing Countries						
H Kong	12.2	2.3	7.7	7.1	8.2	8.4
Singapore	59.3	33.6	12.4	23.0	23.0	24.6
Korea	1.9	1.0	0.6	0.5	0.6	1.1
Taiwan	5.1	3.1	1.8	1.8	2.5	2.7
China	14.5	3.3	7.8	7.1	8.2	8.4
Indonesia	7.6	3.6	3.9	3.8	3.7	6.5
Malaysia	43.7	23.8	26.0	22.5	16.1	17.9
Thailand	10.2	4.9	4.8	3.4	2.3	2.9
Philippines	13.6	6.0	2.1	9.6	10.5	9.0
India	1.2	0.3	0.4	1.0	2.4	3.6
Pakistan	5.1	3.3	3.5	3.5	4.6	6.7
B'desh	0.3	0.1	0.1	0.4	0.3	..
S. Lanka	6.9	2.4	5.4	7.5	5.3	2.0
Argentina	13.0	15.1	25.5	31.0	4.8	11.7
Brazil	3.1	1.4	3.0	1.3	3.0	4.7
Chile	21.5	7.3	7.2	6.9	14.0	10.8
Mexico	16.9	8.5	6.4	6.0	14.3	17.1
Egypt	3.1	2.8	5.3	6.4	14.8	7.2
Morocco	8.5	5.1	6.6	8.0	8.8	4.1
Tunisia	14.7	4.0	12.5	13.7	10.2	6.1
Turkey	3.5	2.3	2.3	1.4	1.6	2.2
Côte d'Ivoire	-0.6	2.1	-29.1	10.7	3.3	1.5
Ghana	17.8	2.3	2.5	9.4	22.6	22.2
Kenya	1.3	1.2	0.5	0.2	0.3	1.7
Mauritius	4.5	2.4	1.7	1.6	1.9	1.9
Nigeria	34.9	19.8	26.3	36.5	50.5	50.0
Uganda	8.4	0.2	0.6	10.1	12.6	21.1
Tanzania	3.3	0.3	1.1	2.0	-0.4	..

Source: UNCTAD, World Investment Report 1997.

Table 10 shows FDI inflows as a percentage of gross domestic capital formation in the leading developing countries. It illustrates the differences in the contribution to relative industrial development made by MNCs. At one end, the two larger mature NIEs, Korea and Taiwan, have had relatively low reliance on FDI, and in the past used restrictions on foreign entry as a deliberate tool of policy. At the other, Singapore has drawn upon FDI heavily, with Malaysia following. Thailand has about the same level as Taiwan, except that in Thailand most high-tech export activity is concentrated in MNCs.

All countries are converging now in their FDI policies. This reflects, not just external pressures to liberalise economic policies, but also the growing realisation that MNCs will play an increasing role in future competitiveness. Globalised production is growing apace, and MNCs from NIEs like Korea and Taiwan are very active in this. Many new technologies are not available without majority owned foreign affiliates. The cost and risk involved in autonomous technological strategies are much higher today. And, with appropriate policies backed by skill creation, it is possible to attract R&D by MNCs. All this means that traditional nationalistic strategies of the sort pursued by Korea and Taiwan are less and less relevant today.

However, the structures of exports we see in East Asia are the results of past strategies, and they show very clearly the difference made by these strategies. The next section provides econometric evidence on these strategies, strongly supporting many of the qualitative inferences drawn above.

VI. Cluster analysis of export structure and strategies[8]

This section presents the results of cluster analysis of export performance in three technological categories (ignoring resource based) for 73 countries, developed and developing. Cluster analysis is a statistical technique to group entities according to their similarities with respect to given features.[9] In this case, countries are clustered according to a measure of export structure and the most important strategic variables expected to this structure. The countries in a given cluster are thus (statistically) similar to each other with respect to all the variables entered; in other words, they follow similar strategies to achieve a given outcome in terms of export structure.

The dependent variable is the technological composition of exports, measured by revealed comparative advantage for each category (a country's share of, say, high-tech exports in the world divided by its total share of world exports gives its HT RCA). Three of the explanatory variables are the factors just discussed: technical

8 Manuel Albaladejo carried out this analysis.

9 Cluster analysis is used to identify relatively homogeneous groups of cases based on selected characteristics. In this paper, it helps us identify groups of countries with similar export patterns (dependent variable) and strategies (independent variables). We are impartial in the treatment of the variables by not weighting their values. We use *K-means cluster analysis*. This is used to cluster large numbers. The number of groups has to be specified in advance. Say we want five clusters. Using the **Squared Euclidean distance**, the sum of the squared differences over all of the variables, we identify "five initial cluster centres" as a reference point for the other cases. Since good cluster centres separate the cases well, the strategy is to choose those five cases (countries) with large distances between them, using their squared Euclidean values as the initial cluster centres. Other cases then group to the cluster with the smallest distance between the case and the cluster centre. The algorithm used for determining clustering membership is based on nearest centroid sorting. Once the cases are classified, we obtain the final cluster centres, which simply are the average values of the variables for cases in the clusters. The final cluster centres, which for comparative purposes are shown in a proximity matrix, can also be broken down in sub-centres according to the number of variables (this is what we show in the tables).

skills (numbers enrolled in tertiary technical subjects as a percentage of the population), enterprise financed R&D as a percentage of GNP, and FDI as a percentage of gross domestic investment for the relevant investment for the relevant period. In addition, we have used manufacturing wages and gross domestic investment as a percentage of GDP.

The analysis is carried out for 1985 and 1995. We specified five clusters for each exercise. Note that all the variables are in standardised form (a mean of 0 and a standard

deviation of 1). Thus, the results shown are not actual values but deviations from the standardised mean. Note also that the group averages can go with individual countries differing in particular characteristics: the cluster analysis groups them on the combination of the six variables.

Table 11 shows the cluster results for HT RCA in 1995, and describes the main features of each cluster. Cluster 1 (Malaysia, Singapore and Thailand) has the highest RCA in high-tech exports, followed by cluster 4 (Korea and Taiwan only). There are two other clusters with an above average RCAs, but below the levels of the first two clusters. Most OECD countries are in cluster 2, while cluster 3 combines Mexico, some East Asian (Philippines and Hong Kong), European (Portugal, Spain, Hungary and Netherlands) countries and New Zealand. Cluster 5 comprises all the other countries in the developing world (plus Greece); these have a negative RCA in HT products.

Table 11

HT CLUSTER, 1995

	1	2	3	4	5
HT RCA	2.72	.61	.66	1.69	-.635
Technical Enrolment	-.46	.94	.44	2.76	-.55
Manufacturing Wages	-.21	1.53	.19	.20	-.63
FDI (% GDI)	1.97	-.07	1.18	-.91	-.28
GDI (% GDP)	2.27	-.42	.09	1.94	-.09
R&D (% GNP)	-.16	1.35	-.31	2.12	-.56
Characteristics	Very high RCA in HT products, weak technical skills with below average wages. Very high reliance on FDI, high domestic investment rates and below average R&D	Positive but not high HT RCA, above average technical enrolment, very high wages, about average FDI, relatively low domestic investment and high R&D	Positive but not high HT RCA, above average wages, strong FDI inflow, about average investment rates and below average R&D	Strong HT RCA, very strong technical skills, above average wages, below average FDI, strong domestic investment and very high mean R&D	Below average in all variables
Cluster membership	Malaysia Singapore Thailand	Australia Austria Belgium Canada Denmark Finland France Germany Ireland Israel Italy Japan Norway Sweden Switzerland UK USA	Hong Kong Hungary Mexico Netherlands New Zealand Philippines Portugal Spain	Korea Taiwan	Bangladesh China Greece India Indonesia Nepal Pakistan Sri Lanka ALL LATIN AMERICA excluding Mexico AFRICA MENA

The East Asian NIEs generally stand out in terms of strategic characteristics. Malaysia, Singapore and Thailand are highly specialised in HT products. They have below average technical enrolments and wages (Singapore is averaged with the others) and low R&D effort. However, they are very highly dependent on FDI, and have high domestic investment rates. At the other end, Korea and Taiwan are less HT specialised and base their competitiveness on very high levels of skill creation and R&D effort (both are the highest of all cluster averages). They combine high domestic investment with low FDI. Cluster 3 combines moderate HT RCA with above average skills, wages and domestic investment. It has high dependence on FDI and below average R&D. The main cluster with the OECD countries has positive RCA in HT, above average technical enrolments and high wages and R&D. It is just below average in inward FDI and domestic investment.

The results for MT (Table 12) show the main strengths of the OECD, with very high RCA, marginal FDI, and high R&D. Korea and Taiwan cluster together again, with positive but not high RCA in MT products. All other clusters show negative RCAs. Hong Kong, Malaysia and Singapore cluster with Hungary and New Zealand with very high FDI and below average R&D. The large Latin American economies come in cluster 5, with all variables coming somewhat below average.

Table 12

MT CLUSTER 1995

	1	2	3	4	5
RCA in Medium-Tech Exports	-.76	-.13	.13	1.16	-.12
Technical Enrolment	-.48	-.10	2.76	.95	-.49
Wages in Manufacturing	-.67	.03	.20	1.51	-.57
FDI (% GDI 90-94)	-.22	2.60	-.91	.03	-.28
GDI (% GDP 90-94)	.68	.86	1,94	-.40	-.80
R&D (% GNP)	-.56	-.13	2.12	1.21	-.57
Cluster membership	Algeria Chile China Congo Costa Rica Egypt Honduras India Indonesia Jamaica Jordan Kenya Mauritius Nepal Pakistan Panama Paraguay Philippines Portugal Romania Sri Lank Thailand Tunisia Turkey Zimbabwe	Hong Kong Hungary Malaysia New Zealand Singapore	Korea Taiwan	Australia Austria Belgium Canada Denmark Finland France Germany Ireland Israel Italy Japan Netherlands Norway Spain Sweden Switzerland UK USA	Argentina Bangladesh Bolivia Brazil Cameroon CAR Colombia Ecuador El Salvador Ethiopia Greece Madagascar Malawi Mexico Morocco Nicaragua Peru Poland Senegal South Africa Uruguay Venezuela

Table 13 shows the results for LT products. The cluster with the strongest RCA includes China, Thailand and Indonesia in East Asia, India, Pakistan, Sri Lanka and Bangladesh in South Asia, and Turkey and Tunisia in MENA, along with El Salvador in LAC and Mauritius and Zimbabwe in SSA. This cluster has the lowest average wages and technical enrolments, with low FDI and R&D, but above average domestic investment. The lowest RCA in this exercise, not surprisingly, is the OECD group, but the other East Asian NIEs also cluster with negative RCAs. FDI does not seem to be particularly important for the group with the highest RCAs in low technology exports.

Table 13

LT CLUSTER, 1995

	1	2	3	4	5
RCA in Low-Tech Exports	-.07	-.23	-.57	-.40	1.41
Technical Enrolment	2.76	.02	.95	-.37	-.78
Wages in Manufacturing	.20	-.08	1.51	-.56	-.75
FDI (% GDI 90-94)	-.91	2.09	.03	-.21	-.43
GDI (% GDP 90-94)	1.94	.81	-.40	-.34	.45
R&D (% GNP)	2.12	-.25	1.21	-.57	-.55
Cluster membership	Korea Taiwan	Costa Rica Hong Kong Hungary Malaysia New Zealand Portugal Singapore	Australia Austria Belgium Canada Denmark Finland France Germany Ireland Israel Italy Japan Netherlands Norway Spain Sweden Switzerland UK USA	Algeria Argentina Bolivia Brazil Cameroon CAR Chile Colombia Congo Ecuador Ethiopia Greece Honduras Jordan Kenya Madagascar Mexico Morocco Nicaragua Panama Paraguay Peru Philippines Poland Senegal South Africa Uruguay Venezuela	Bangladesh China Egypt El Salvador India Indonesia Jamaica Malawi Mauritius Nepal Pakistan Romania Sri Lank Thailand Tunisia Turkey Zimbabwe

In sum, the cluster analysis illustrates nicely many of the points made qualitatively about strategies in East Asia and resulting patterns of competitive advantage. In particular, it makes strikingly clear the differences between Korea and Taiwan on the one hand and the other NIEs.

What the analysis does not show, however, is the difference between FDI dependent countries with respect to their strategies. It lumps together countries that targeted FDI strongly (Singapore) with those that did less (Malaysia) or not at all (Philippines and Thailand). This is because the RCA figures do not capture differences in the depth of TNC export-oriented activity in these countries. Let us turn to the issues raised here.

VII. FDI targeting strategies

1. Introduction

In contrast to earlier periods of openness in the world economy, the current era is characterised not just by fast growth in international trade but, under pressures of technical change, also by a proliferation of other forms of cross-border linkage. These include FDI (with a large component of international mergers and acquisitions), technology sales and licensing, strategic alliances between firms, franchising and a variety of subcontracting links. It is these linkages, rather than the expansion of trade *per se*, that are giving rise to truly globalised production systems, which are controlled, organised and co-ordinated by transnational corporations. Global production systems involve closer, more complex international links than traditional arm's-length trade. The allocation of activity is being 'optimised' across the globe in a form never before witnessed in economic history.

A striking feature of this new context is how TNCs are increasingly shifting their portfolios of mobile assets across the globe to find the best match with the immobile assets of different locations. In the process, they are also shifting some functions that create their ownership assets like R&D, training and strategic management ('deep integration') within an internationally integrated production and marketing system. The ability to provide the necessary immobile assets thus becomes a critical part of FDI – and competitiveness – strategy for developing countries. While a large domestic market remains a powerful magnet for investors, TNCs serving global markets increasingly look for other attributes, which are changing in response to policy liberalisation and technical change. The opening of markets creates new opportunities and challenges for TNCs and gives them a broader choice of modes with which to access those markets. It also makes them more selective in their choices of potential investment sites.

Apart from primary resources, the most attractive immobile assets for export-oriented TNCs are now world-class infrastructure, skilled and productive labour, and an agglomeration of efficient suppliers, competitors, support institutions and services. Cheap unskilled labour remains a source of competitive advantage, but its importance is diminishing. Natural resources are similar. They give a competitive basis for growth as long as they are plentiful in supply and face growing demand. However, most primary exports face slow growing markets and are vulnerable to substitution, while resource based manufactures are among the slowest growing in world trade.

The sites that will receive most FDI in the emerging economic and policy setting are those that provide allow TNCs to set up competitive facilities able to withstand global competition. This means that the host country has to provide competitive immobile assets – skills, infrastructure, services, supply networks and institutions – to complement the mobile assets of TNCs (Narula and Dunning, 1999). While transport costs and taste differences mean that large markets will continue to attract more investment than small ones, few countries can afford to take a continued inflow of FDI – especially high quality, export-oriented FDI – for granted. This means that the ultimate draw for FDI is the economic base: FDI incentives and targeting cannot by themselves compensate for the lack of such a base.

The East Asian experience, particularly of the new Tigers like Malaysia and Philippines, shows that attracting FDI into high technology activities can happen without any particular government strategy. In their case, it was largely a matter of good luck and welcoming FDI policies. High-tech TNCs had already established a base in Singapore (on which more below). The rise of the semiconductor industry and the need for cheap labour for assembling and testing the devices had led US companies to look for cheap labour overseas. Over time, Japanese and other firms joined in this quest (helped by the rise of the Yen in the mid 1980s), and the tendency spread to a number of other export-oriented electronics activities. Countries with low wages, stable macro regimes, good EPZ facilities, English speaking workers and attractive FDI incentives were able to attract investments relocating from the developed countries as well as from Singapore. Apart from these general attractions, therefore, FDI targeting did not play much of a role.

However, the surge of high-tech export-oriented FDI did not spread to other parts of the developing world – countries in South Asia, North Africa and Latin America that played host to TNC assembly for export continued to concentrate on garments and other simple products. The main exception was Intel’s investment in Costa Rica, analysed at length elsewhere in this study. Within South East Asia itself, while TNCs invested in automation and skill creation in their high-tech assembly operations, sustained deepening of local content and technologies took place mainly as a result of government interventions. These interventions involved incentives for upgrading, and supply side support in terms of skill and infrastructure creation and support for local suppliers. Malaysia adopted Singapore-style strategies to induce firms to raise local content; however, this was mainly by attracting other TNCs rather than by upgrading a (relatively weak) local skill and industrial supplier base. There was some increase in TNC R&D activity, but not to the levels reached by Singapore. Other countries in the region did not adopt similar proactive strategies. As a result, high-tech TNC operations still remain fairly shallow in Thailand, Philippines and Indonesia. This shallowness constitutes an important constraint to their future industrial growth and competitiveness, and their governments are seriously concerned to improve their FDI targeting and upgrade local skills and supply capabilities.

There is thus a strong case for policy interventions both to attract higher quality FDI and to induce investors to upgrade and deepen their activities over time. The economic rationale for interventions is three-fold: high transaction costs; deficient information on the potential of the host economy; and insufficient coordination between the needs of TNCs, the assets of the host economy and the potential to improve those assets.

First, high transaction costs. While most FDI regimes are converging on a common (and reasonably welcoming) set of rules and incentives, there remain large differences in how these rules are implemented. The FDI approval process can take several times longer, and entail costs many times greater, in one country than another with similar policies. After approval, the cost of setting up facilities, operating them, importing and exporting goods, paying taxes, hiring and firing workers and generally dealing with the authorities, can differ enormously (Table 14).

Such costs can, ceteris paribus, affect significantly the competitive position of a host economy. An important part of competitiveness strategy thus consists of reducing unnecessary, distorting and wasteful business costs. This affects both local and foreign enterprises. However, foreign investors have a much wider set of options before them, and are able to compare transaction costs in different countries. Thus, the attraction of TNCs requires not just transaction costs be lowered but also, increasingly, that they be benchmarked against that of competing host countries. One important measure that many countries are taking to ensure that international investors face minimal costs is to set up one-stop promotion agencies able to guide and assist them in getting necessary approvals. However, unless the agencies have the authority needed to negotiate the regulatory system, and unless the rules themselves are simplified, this may not help. On the contrary, there is a risk that a "one stop shop" becomes "one more stop".

Table 14

BUSINESS TRANSSACTION COSTS

Area of operation	Transaction	Enterprise exposure	Effects on
Business Entry	Registration Licensing Property rights Rules Clarity Predictability Enforcement Conflict Resolution	Monetary costs to firms Time costs (including compliance and delays) Facilitation costs Expert evaluations of rules and their functioning Number of rules, formalities	Rate of new business entry Distribution of firms by size, age, activity Size of shadow economy Rate of domestic investment FDI inflows, quantity and quality Investment in R&D
Business Exit	Bankruptcy Liquidation Severance/Layoffs Rules Clarity Predictability Enforcement Conflict Resolution	Rate of change of rules Changes in costs and number of rules Availability of rules and documents to firms Rates of compliance and/or evasion Use of alternatives to formal institutions	Rate of exit (and entry) Prevalence of credit Average and distribution of profitability of corporations
Business Operation	Taxation Trade-related regulation Labour hiring/firing Contracting Logistics Rules Clarity Predictability Enforcement Conflict Resolution	Cost of compliance Higher costs of operation Costs of conflicts & conflict resolution Search costs and delays Insufficient managerial control 'Nuisance' value Problems in making contracts Problems in delivery	Business productivity Export growth Size of shadow economy Growth of industries with specific assets or long-term contracting Rate of innovation and R&D Rate of business expansion Rate of investment in new equipment Subcontracting

Source: World Bank, Business Environment Division, Private Sector Development Department

Second, despite their size and international exposure, TNCs face market failures in information. They collect considerable information on potential sites, on their own as well as from consultants and other foreign investors. However, their information base is far from perfect, and the decision making process can be subjective and biased.

"Prospective investors, even the largest firms, do not always conduct systematic world-wide searches for opportunities. The search for opportunities is a bureaucratic process whose initiation and direction may be swayed by many factors, including imperfect information and skewed risk perceptions. Most companies consider only a small range of potential investment locations. Many other countries are not even on their map" (IFC/FIAS, 1997, p. 49).

Taking economic fundamentals as given, it may be worthwhile for a country to invest in altering the perception of potential investors by providing better information and improving its 'image' (Wells and Wint, 1990). However, such promotion efforts are highly skill-intensive and potentially expensive. They need to be carefully mounted, and they should be targeted to maximise their impact. Targeting can be general (countries with which there are trade or historic connections, or which lack past connections but are ripe for establishing them), industry specific (investors in industries in which the host economy has an actual or potential competitive edge), even investor specific. Note that targeting or information provision is not the same as giving subsidies or fiscal incentives: incentives play a relatively minor role in a good promotion programme, and good long-term investors are not the ones most susceptible to short-term inducements. The experience Ireland, Singapore and more recently Costa Rica (Spar, 1998), suggests that promotion can be extremely effective in raising the inflow of investment and of raising its quality.

Third, effective promotion should go beyond simply 'marketing a country' into coordinating the supply of immobile assets with the specific needs of targeted investors. This addresses potential failures in markets and institutions for skills, technical services or infrastructure in relation to the specific needs of new activities targeted via FDI. A developing country may not be able to meet such needs, particularly in activities with advanced skill and technology requirements. The attraction of FDI in such industries can be greatly helped if the host government discovers the TNC's needs and meets them. As Costa Rica illustrates, the fact that it was prepared to invest in training to meet Intel's skill needs was a major point in attracting the investment (Spar, 1998). Singapore goes further, and involves TNC managers in designing its on-going training and infrastructure programmes, ensuring that it remains attractive for their future high technology investments. The information and skill needs of such coordination and targeting exceed those of promotion per se, requiring the agency involved to have detailed knowledge of the technologies involved (their skill, logistical, infrastructural, supply and institutional needs) as well as of the strategies of the relevant TNCs.

2. Singapore's experience

It is interesting to contrast the approaches used by two FDI-dependent free-trade Tigers — Hong Kong and Singapore. Hong Kong left resource allocation by foreign and domestic investors almost entirely to market forces and made no attempt (at least until very recently) to intervened aggressively in attracting and upgrading FDI and in improving the various factor markets and institutions. Their different outcomes illustrate the case for strategic intervention in FDI.

Hong Kong: In line with its laissez faire approach, the Hong Kong government did not influence the extent or form of technology imports. Its industrial and manufactured export growth was sparked off by an influx, after the communist take-over, of seasoned textile and other entrepreneurs and technicians from Mainland China. This led to the growth of dynamic small and medium-sized exporters specialized in labour-intensive activities such as textiles, garments, toys and simple consumer electronics, mainly aimed at world markets. Given the initial base of skills and learning, they obtained the information and technologies they needed in mainly externalised forms, primarily capital goods. The economy's colonial administration, its long experience of entrepôt trade, and the strong presence of expatriate-run trading, finance, property and other enterprises (the "Hongs"), strengthened the initial base of skills with an advanced physical, administrative, trading and financial infrastructure for export activity.

Despite open door policies to FDI, indigenous firms dominated Hong Kong's manufacturing. TNCs went mainly into service activities, while those that entered manufacturing specialized in more advanced technologies within the same broad labour-intensive set of activities as local firms. The government made no effort, at least until recently, to target high technology FDI or to induce industrial deepening and technological upgrading. Technological information needs were relatively simple, and were fulfilled by scouting international suppliers of equipment (greatly helped by the liberal trading environment and the Hongs), growing contacts with export markets, and some government technology support institutions. The presence of foreign buyers was a vital source of technological information and assistance. Over time there was significant upgrading of equipment and products within the low-technology activities that the colony started with, but there was relatively little entry into complex, research intensive technologies that other Tigers targeted.

In this context, the government did help technology imports indirectly. Its export promotion measures enabled local firms to contact foreign buyers through the Hong Kong Trade Development Council, a well funded and staffed body which provided information on overseas markets, and assisted foreign buyers establish contacts with local suppliers. In addition, technology imports and diffusion were undertaken by the Hong Kong Productivity Council (below), and a textile design and training institute helped to upgrade production and design skills for the main export activity. However, the colony's rising wage and land costs led to massive deindustrialization. Employment in manufacturing declined by 50 percent and the share of manufacturing in GDP fell from 25 to 7 percent over 1980-95. The technological structure of manufactured exports was the weakest of the Tigers, and export growth flagged over time (and has been negative for some years). The Hong Kong example suggests that, where the appropriate skills, institutions, and infrastructure are present, free market policies can stimulate investment and competitiveness in activities with relatively 'easy' learning. There is a gradual process of upgrading thereafter, but its scope is relatively constricted. Hong Kong now lags behind other Asian NIEs in high technology areas of electronics.

Box 1
SINGAPORE'S USE OF FDI TO UPGRADE TECHNOLOGY

"The Singapore philosophy vis à vis foreign investment in the industrial sector is that multinationals are to be exploited ('tapped' is the favourite word) for the competitive assets that they can bring to the country which will contribute to its particular stage of industrial development. The government's goal is always to maximise learning, technological acquisition, rapid movement up the industrial ladder, and the skills and incomes of its working population. To this end it is willing to contribute capital, tax concessions, infrastructure, education and skills training, and a stable and friendly business environment. While the country is well integrated into international production networks in certain sectors, its fortunes are not tied to those of particular multinational companies, which (like local companies) the government refuses to help if they are unable to compete in the rapidly changing local environment and the world market. Thus over time many multinational factories in Singapore have closed their doors – particularly in low-value, labour-intensive product lines and processes like simple electronic components and consumer goods – and shut down completely or relocated to neighbouring countries, with the Singapore government's blessing." (Lim, 1995, p. 224)

The decisions of MNCs about what new technologies to bring into Singapore are strongly influenced by the incentive system and direction offered by the host government. The Singapore government is the only one in the region which, like many governments in Western countries, gives grants to firms for complying with specified requirements. These are often to do with entering particular (advanced) technologies. The government supports these incentives, acting in consultation with MNCs (or anticipating through proactive planning) by providing the necessary skilled manpower.

In many instances, it is the speed and flexibility of government response that gives Singapore the competitive edge compared with other competing host countries. In particular, the boom in investment in offshore production by MNCs in the electronics industry in the 1970s and the early 1980s created a major opportunity, to which the government (acting through the EDB) responded by ensuring that all supporting

industries, transport and communication infrastructure, as well as the relevant skill development programmes, were in place to attract these industries to Singapore.

This concentration of resources helps Singapore to achieve significant agglomeration economies and hence first-mover advantages, and has allowed it set up many advanced electronics related industries. An example is the disk-drive industry, where all the major US disk-drive makers have located their assembly plants in Singapore. These industries demanded not only electronics components and PCB assembly support, but also various precision engineering-related supporting industries such as tool and die, plastic injection moulding, electroplating and others. These supporting industries have been actively promoted by the government as part of a “clustering” approach to ensure the competitiveness of the downstream industries.

As labour and land costs have risen (often with encouragement by the government), the Singapore government has encouraged MNCs to reconfigure their operations on a regional basis, relocating the lower end operations in other countries and making Singapore their regional headquarters to undertake the higher end manufacturing and other functions. This has often led MNCs to set up regional marketing, distribution, service and R&D centres to service the ASEAN and Asia-Pacific region. To promote such reconfiguration, various incentives have been offered under the regional headquarters scheme, the international procurement office scheme, the international logistics centre scheme, and the approved trader scheme. There are now some 4,000 foreign firms located in Singapore, about half of them being regional headquarters. Some 80 of these regional headquarters have an average expenditure in Singapore of around US$18 million per year

Source: Lall (1996), EDB Website.

Singapore: Singapore has a much smaller and higher wage economy than Hong Kong’s, but has been able to deepen its industrial structure much more by deliberate industrial strategies, within which FDI targeting played a critical role (Box 1). As a result, it has enjoyed sustained industrial and manufactured export growth (the crisis was a setback from which it is now recovering strongly).

Singapore started, like Hong Kong, with a strategic location and established entrepôt facilities but with a smaller base of trading and financial activity. Despite a tradition of shipbuilding and associated skills, Singapore had a weak entrepreneurial base and did not benefit from an influx of experienced businessmen and technologists from Mainland China. Nor did it have access to a large, poorer but culturally similar hinterland to which it could sell its services. After a spell of import substitution, it switched to free trade and pursued growth through aggressively seeking and targeting foreign direct investment, while raising domestic resources by various measures. Moreover, it deepened its industrial and export structure by using incentives to persuade MNCs to move from labour to capital, skill and technology-intensive activities. Its knowledge policy was directed at consciously acquiring, and subsequently upgrading, the most modern technologies in highly internalised forms. This allowed it to specialize in particular stages of production within global systems of MNC production, drawing on the flow of innovation generated by the firms and investing relatively little in its own innovative effort.

The management of industrial policy and FDI targeting was centralised in the Economic Development Board (EDB), part of the Ministry of Trade and Industry (MTI) that gave overall strategic direction. EDB was endowed with the authority to coordinate all activities relating to industrial competitiveness and FDI, and given the resources to hire qualified and well-paid professional staff (essential to manage discretionary policy efficiently and honestly). Over time the agency has become the global benchmark for FDI promotion and approval procedures. Its ability to coordinate the needs of foreign investors with measures to raise local skills and capabilities has also been critical – and a feature that many other FDI agencies lack. The government conducts periodic strategic and competitiveness studies to chart the industrial evolution and upgrading of the economy: the latest was published in 1998 (Ministry of Trade and Industry). Unlike many other countries, TNC leaders are actively involved in the strategy formulation process and are given a strong stake in the development of the economy.[10]

In recent years, since its 1991 Strategic Economic Plan, the government has focused its strategy around industrial clusters. The term cluster was not used to denote geographical agglomerations (though in view of the tiny size of the economy all industry is in fact very tightly concentrated) but inter-linked activities in a value chain (in the Porter sense). In the manufacturing sector the cluster programme (called Manufacturing 2000), the government analyses the strengths and weaknesses of leading industrial clusters, and undertakes FDI promotion and local capability/institution building to promote their future competitiveness. One explicit objective of the programme is to avoid the kind of industrial 'hollowing out' experienced by Hong Kong (and many other industrial countries). As Professor Chia puts it,

"The key element of Manufacturing 2000 is the development of industry clusters, that is, the complex of vertically and horizontally linked supporting industries and resources that collectively make the end products or services competitive. The strategy is to upgrade capabilities across the entire value chain in each industry cluster, including product and process development, production, engineering and strategic marketing. The cluster approach has been adopted for major sectors including electronics" (Chia, 1998. P. 5)

This strategy has allowed it, for instance, to become the leading centre for hard disk drive production in the world (Mathews, 1999, and Wong, 1997, 1996), with considerable local linkages with advanced suppliers and R&D institutions.[11] In 1994, the government set up an S$1 billion Cluster Development Fund (expanded to S$2 billion later) to support specific clusters like a new wafer fabrication park. It also launched a Co-Investment Programme to provide official equity financing for joint ventures and for strategic ventures, not just in Singapore but also overseas (as long as this serves its competitive interests). The EDB can take equity stakes to support cluster development by addressing critical gaps and improving local enterprises. For instance, the EDB co-invested in a local firm SemiTech jointly with Texas Instruments, HP and Canon to make 16M DRAMs. The government also offers start-up grants to attract TNCs to particular areas thought critical to particular industry clusters.

Singapore invested heavily in education and training (Box 2) to attract 'high quality' foreign investment. Its policies for attracting FDI were based on liberal entry and ownership conditions, easy access to expatriate skills, very efficient and honest administration, and generous incentives

[10] As Wong (1996) puts it, "Indeed, the spirit of finding out what the industry is facing at 'at the ground' pervades government agencies involved in economic matters in Singapore. Firm political leadership, clear strategic direction at the top, and multi-agency checks and balances have helped ensure that this close attention to the needs of industries does not lead to 'capture' of particular government agencies by specific interest groups". (p. 82-83)

[11] According to Mathews (1999), the HDD industry led to the growth sophisticated local suppliers such as Advanced Systems Automation (making advanced wafer packaging equipment) and Manufacturing Integration Technology (semiconductor testing equipment). The government set up the Institute of Microelectronics in 1991 to conduct R&D and train highly specialised personnel. It encouraged groups of companies to undertake joint technology development (e.g. to improve packaging technologies such as ball grid array). The EDB sometimes takes equity stakes to promote particular technologies, for instance in wafer fabrication facilities.

for the activities that it was seeking to promote. In 1961, it set up the Economic Development Board (EDB) to co-ordinate policy, offer incentives to guide foreign investors into targeted activities, acquire and create industrial estates to attract multinational corporation, and generally to mastermind industrial policy. The public sector played an important role in launching and promoting some activities chosen by the government, acting as a catalyst to private investment or entering areas that were too risky for it to enter. While the main thrust of Singapore's technology import policies was to target FDI, the government also sought over time to increase linkages with local enterprises by promoting subcontracting and improving extension services.

Box 2

SKILL DEVELOPMENT FOR TECHNOLOGY-BASED INDUSTRIALISATION IN SINGAPORE

The Singapore government has invested heavily in creating high-level skills to drive the targeted upgrading of the industrial structure. The university system was expanded and directed towards the needs of its industrial policy, its specialisation changed from social studies to technology and science. In the process, the government exercised tight control of curriculum content and quality, and ensured its relevance for the activities being promoted. Apart from formal education, the government also directed considerable effort to developing the industrial training system, now considered one of the best in the world for high technology production.

Singapore is a regional leader in employee training programmes held outside the firm. It set up the Skill Development Fund in 1979, along with a Skill Development Fund Levy, which collected a levy of 1 percent of payroll from employers to subsidise the training of low-paid workers. This marked the 'identification of a technology-intensive and knowledge-intensive industrial structure and high value-added orientation as national objectives [with] policy thinking focused on the importance of ensuring suitable human resources' (Inagami, 1998, p. 25). The SDF levy is disbursed to firms that send their low-paid employees to approved training courses.

Singapore has two national universities, four polytechnics and numerous public or non-profit specialised training institutes, creditable for an economy with less than 3 million people. Of its university graduates in 1996, 41 percent were in technical subjects. The polytechnics meet the needs for mid-level technical and managerial skills, again with a heavy emphasis on engineering. They cooperate closely with business in designing courses and providing practical training. Numerous Institutes of Technical Education provide blue-collar workers with secondary education with courses to upgrade skills; in 1996 they graduated nearly 6 thousand people in full time courses, another 17 thousand in part-time courses and 29 thousand in continuing education courses. An Adult Cooperative Training Scheme, introduced in 1993, provides training for semi- and unskilled workers aged 20 to 40.

The Vocational and Industrial Training Board (VITB) was established in 1979. It was an integrated training structure which has trained and certified over 112,000 individuals, about 9% of the existing workforce, since its inception in 1979. The VITB administers several programmes. The Full-Time Institutional Training Programme provides broad-based pre-employment skills training for school leavers. The Continuing Skills Training Programme comprises part-time skills courses and customised courses. Customised courses are also offered to workers based on requests from companies and are specifically tailored to their needs. Continuing Education provides part-time classes to help working adults. VITB's Training and Industry Programme offers apprenticeships to school leavers and ex-national servicemen to undergo technical skills training while earning a wage. On-the-job training is carried out at the workplace where apprentices, working under the supervision of experienced and qualified personnel, acquire skills needed for the job. Off-the-job training includes theoretical lessons conducted at VITB training institutes or industry/company training centres. Unusually, the government has collaborated with foreign enterprises (Japanese, French, Indian, German and Dutch) to set up these centres, funding a large part of employee salaries while they are being trained in state of the art manufacturing technologies. Later the Singapore government also worked jointly with foreign governments (Japan, Germany and France) to provide technical training.

Under the Industry-Based Training Programme, employers conduct skills training courses matched to their specific needs with VITB assistance. VITB provides testing and certification of its trainees and apprentices as well as trade tests for public candidates. The Board, in collaboration with industry, certifies service skills in retailing, health care and travel services. Using various grant schemes, the Skills Development Fund provided one training place per four employees in 1992; by 1995, this had risen to one training place per three employees. The salary ceiling for the SDF levy was raised in 1995 (from S$750 to 1,500) to widen its coverage and raise the amounts collected to fund training. National investment in training in Singapore reached *3.6 percent of annual payroll* in 1995, and the SDF plans to raise it to 4 percent by 1999. This can be compared to an average of 1.8 percent in the UK in 1998.

The initial impact of the programme was found mostly in large firms. However, efforts to make small firms aware of the training courses and provide support for industry associations has increased SDF's impact on smaller organisations. SDF is responsible for various financial assistance schemes to help SMEs finance their training needs and to upgrade their operations. It has also introduced a Development Consultancy Scheme to provide grants to SMEs for short-term consultancy for management, technical know-how, business development and manpower training.

The Training Voucher Scheme supports employers to pay training fees. This Scheme enabled the SDF to reach more than 3,000 new companies in 1990, many of which had 50 or fewer employees. The Training Leave Scheme encourages companies to send their employees for training during office hours. It provides 100% funding of funding of the training costs for approved programmes, up to a maximum of $20 per participant hour. In 1990, over 5,000 workers benefited from this Scheme. The success of the Skills Development Fund is due in part to an strategy of incremental implementation. Initially, efforts focused on creating awareness among employers, with *ad hoc* reimbursement of courses. The policy was then refined to target in-plant training, and reimbursement increased to 90% of costs as an additional incentive. Further modifications were made to encourage the development of corporate training programmes by paying grants in advance of expenses, thus reducing interest costs to firms.

The Economic Development Board assesses emerging skill needs continuously in consultation with leading enterprises in the economy, and mounts specialised courses. For instance, in 1998, it offered courses on wafer fabrication, process operation and control, precision engineering, high-end digital media production, and computer networking. The EDB also started an International Manpower Programme in 1991 to help companies based in Singapore to attract skilled personnel from around the world. In 1997, around 2500 professionals and 10,400 skilled workers and technicians were recruited with EDB assistance.

There has been a significant shift in the workforce to more highly skilled jobs. The proportion of professional and technical workers has risen from 15.7 percent in 1990 to 23.1 percent in 1995. Despite these efforts, "there is a chronic shortage of skills of all sorts in Singapore … The MTI [Ministry of Trade and Industry] has projected that given current growth rates, Singapore will be short of some 7,000 graduates annually by the year 2000." (Low, 1998, p. 26)

Sources*:* Lall (1996), EDB Website, Inagami (1998), Low (1998), Selvaratnam (1994).

The decisions of TNCs about what new technologies to bring were strongly influenced by the incentive system, the provision of infrastructure, and the direction offered by the government. The government itself responded (or anticipated through proactive planning and consultation) by providing the necessary skilled manpower, often in consultation with TNCs. In many instances, it was the speed, efficiency and flexibility of government response that gave Singapore the competitive edge compared with other competing host countries. In particular, the boom in investment in offshore production by TNCs in the electronics industry in the 1970s and the early 1980s created a major opportunity. The government seized it by ensuring that enabling support industry, transport and communication infrastructure, as well as skill development programmes was available to attract these industries to Singapore. This concentration of resources helped Singapore to achieve significant agglomeration economies and hence establish strong first-mover advantages.

As labour and land costs rose, the Singapore government used the opportunity to encourage TNCs to reconfigure their operations on a regional basis. Special programmes were launched to make Singapore attractive as a base for regional marketing, distribution, service, and R&D centres to support manufacturing and sales in the region. To promote such reconfiguration, new incentives such as the Operational Headquarters scheme, the International Procurement Office scheme, the International Logistics Centre scheme, and the Approved Trader scheme were introduced. Of these, perhaps the most important is the Operational Headquarters (or International Business HQ, IBH2000) scheme, whereby TNCs are induced to set up the most advanced logistical, management, financial and sometimes technological functions in Singapore to service the entire region.

According the EDB's Annual Report 1998, the scheme has been very successful: for instance, in 1998 Chrysler set up its Asia Pacific headquarters there to house its Regional Training Centre, while SUN Microsystems set up an Asia-Pacific Data Centre. Similarly, Singapore has attracted logistic activities, supported by its superb port and handling facilities. Ascent Logistics has just set up a regional integrated logistics centre to provide specialised services, while Schenker has set up a Logistics Centre to service VW's Asian spare parts hub.

Singapore is justly renowned for the excellence of its infrastructure, in technology as well as in other fields. As noted, it is this superlative provision of basic industrial and technology services that is one of the reasons for the success of its FDI targeting strategy. Let us briefly consider its support for SMEs. In 1962 the EDB launched a program to help SMEs modernise their equipment with funds provided by the UNDP. In the mid-1970s several other schemes for financial assistance were added; of these, the most significant was the Small Industries Finance Scheme to encourage technological upgrading. The 1985 recession induced the government to launch stronger measures, and the Venture Capital Fund was set up to help SMEs acquire capital through low interest loans and equity. A Small Enterprises Bureau was established in 1986 to act as a one-stop consultancy agency; this helped SMEs with management and training, finance and grants, and coordinating assistance from other agencies. In 1987, a US$ 519 m. scheme was launched to cover eight programs to help SMEs, including product development assistance, technical assistance to import foreign consultancy, venture capital to help technology start-ups, robot leasing, training, and technology tie-ups with foreign companies.

In addition, the Singapore Institute of Standards and Industrial Research (SISIR) disseminated technology to SMEs, and helped their exports by providing information on foreign technical requirements and how to meet them. The National Productivity Board provided management advice and consultancy to SMEs. The Technology Development Center helped local firms to identify their technology requirements and purchase technologies; it also designed technology-upgrading strategies. Since its foundation in 1989, the TDC provided over 130 firms with various forms of technical assistance. It also administered the Small Industry Technical Assistance Scheme (SITAS) and Product Development Assistance Scheme to help firms develop their design and development capabilities. It gave grants of over $1 million for 29 SITAS in the past 5 years, mainly to local enterprises. Its earnings have risen to a level where its cost-recoverable activities are self-financing.

The EDB encouraged subcontracting to local firms through its Local Industries Upgrading Program (LIUP), under which MNCs were encouraged to source components locally by 'adopting' particular SMEs as subcontractors. In return for a commitment by the MNCs to provide on the job training and technical assistance to subcontractors, the government provided a package of assistance to the latter, including cost sharing grants and loans for the purchase of equipment or consultancy and the provision of training. By end-1990, 27 MNCs and 116 SMEs had joined this program. Over 1976-88, the total value of financial assistance by the Singapore government to SMEs amounted to S$ 1.5 billion, of which 88% was in the Small Industries Financing Scheme. Grants of various kinds amounted to S$23.4 m. and the Skills Development Fund for S$48.6 m.

While remaining dependent on TNCs for access to new technologies, the Singapore government has growing ambitions to build a local R&D base. While it always sought to upgrade the technology content of local industrial activity, a sharp recession in 1985 convinced it of the need to create a stronger technology base. Initially it focused on using rather than creating technology, but in 1989 it specifically focused on stimulating R&D (Wong, 1999). In 1991 it launched a five-year National Technology Plan and set up the National Science and Technology Board (NSTB), with a S$2 billion fund. It set an R&D target of 2% of GDP by 1995 (in the early 1990s the figure was around 1 per cent), and selected a number of sectors for technology development. The Second National Science and Technology Plan, covering 1996-2000, was more ambitious (note the addition of 'science' to the title, denoting more emphasis on basic knowledge creation). It doubled S&T expenditures, to S$4 billion over 5 years, of which 30% is directed to strategic industries picked by the government. It sought with some success to encourage R&D by local companies as well as by TNCs. By 1998, total R&D in Singapore reached 1.65 percent of GDP, with over 500 private R&D units, 6 university laboratories, 15 public research institutions and 14 government research laboratories. The private sector accounted for 63 percent of total expenditure; of this, 85 percent came from manufacturing, led by electronics (48%), chemicals (15%) and precision engineering (11%), all with strong export competitiveness. TNCs accounted for over 60% of total industrial R&D in 1997 (Wong, 1999).

Box 3

R&D PROMOTION IN SINGAPORE

Singapore's gross expenditure on R&D (GERD) had increased six-fold between 1987 and 1998, reaching S$2.33 billion in 1998, or 1.65% of GDP (Table 5). The number of research scientists and engineers per 10,000 labour force reached 66 in 1998. Both the public and private sector had contributed to this impressive growth in R&D intensities. Although R&D expenditure by tertiary educational institutions and public R&D institutes had expanded significantly in absolute terms, their relative importance had actually diminished over the period from mid-1980s to the late-1990s as R&D expenditure by the private enterprise sector grew even faster.

In terms of economic sectors, manufacturing as expected constitutes the major industries performing R&D in the mid-1990s, but it is important to note that the services sector also played a rather significant role as well, accounting for between 12 to 21% of total R&D spending from 1993 to 1997. Industrial R&D efforts were highly skewed, however, with close to 70% of the manufacturing R&D being concentrated in the electronics and IT-related sector alone. This is consistent with the fact that electronics and IT have been the most important and most dynamic sectors in Singapore's economy since the 1980s.

Among private sector firms performing R&D, because foreign MNCs still account for the bulk of the technology-intensive industries, it is not surprising that they also account for a larger proportion of R&D activities in Singapore than local firms. In 1997, foreign-controlled firms accounted for over 61% of private R&D spending, down from over two-thirds in earlier years. Reflecting the concentration of MNCs in the electronics and chemicals sector, the largest concentration of MNC R&D activities is to be found in these two sectors, which accounted for over 70% of total MNC R&D. The dominance of MNCs in the R&D activities of these two sectors were also the most pronounced: MNCs accounted for over 83% and 67% respectively of the total private R&D in these sectors.

Source: Wong (1999)

There are several schemes to promote R&D by the private sector. The Research Incentive Scheme for Companies (RISC) gives grants to set up 'Centres of Excellence' in strategic technologies, and is open to all companies. The R&D Assistance Scheme (RDAS) gives grants for specific product and process research that promotes enterprise competitiveness, and is also open to all companies. The Cooperative Research Program gives grants to local enterprises (at least 30% local equity) to develop their technological capabilities by working together with universities and research institutions. The National Science and Technology Board initiates research consortia to allow companies and research institutes to pool their resources for R&D, and five consortia are already in existence (on marine technology, aerospace, enterprise security architecture, digital media and advanced packaging[12)]. The Innovation Development Scheme (IDS) provides a 50 percent grant to all promising innovation projects; the latest round provided S$130 million to 90 companies, local and foreign, in April, 1997. According to the government, these schemes have succeeded in raising the share of private R&D to 65% of the total.

The Singapore government also plays a catalytic role in promoting selected technologies. The development of biotechnology research capabilities is a good example of the approach to

[12] The Institute of Microelectronics set up the Electronics Packaging Research Consortium in 1996 in collaboration with 11 companies. The government supported the consortium to work on five projects per year as agreed by its members, bringing together Japanese, US, European and local firms. The efforts have led to more reliable IC packages, new packaging designs, training and publications. The consortium has filed four patents.

developing a domestic innovative base (Box 4). It illustrates how the government uses public R&D funds and institutions to build up basic research capability and so attract interest and R&D participation by MNCs, as part of a strategy of technological targeting.

Box 4

SINGAPORE'S INSTITUTE FOR MOLECULAR AND CELL BIOLOGY (IMCB)

A good example of the successful use of various government policies, institutions and financial instruments is Singapore's move into the scientific mainstream with the development of the Institute of Molecular and Cell Biology (IMCB). The IMCB is an ambitious project in the government's overall strategy to use high technology to strengthen its economy. The government places this within the National Biotechnology Programme, started in 1988 to strengthen the national R&D base and fund biotechnology development. An important incentive under this programme is pioneer industry status, which gives tax exemption for 5-10 years, with the largest benefits directed at technology-intensive and export-oriented projects. In addition, funding is provided by the government if there is active research collaboration with the public sector, with no specified limit to the available funding for R&D. Supporting this effort is a strong push in basic research at the National University of Singapore (NUS), which houses the IMCB. The University conducts one-third of Singapore's R&D, and NUS scientists have made their mark in several areas including materials technology, microelectronics and information technology.

Singapore's decision to spend S$13.8 million to build IMCB and to provide annual funding of S$17.5 million was part of a broader approach to develop biotechnology. The government believes that this field fits the country's need (e.g., it requires few natural resources, has high value-added, and can make strategic use of Singapore's global business networks). To nurture this industry, the EDB established Singapore Bio-Innovation (SBI) Pte Ltd., which by 1991 had invested S$41 million in 12 local biotech start-up firms with 1,428 employees making health care, food, and agricultural products. SBI also invests in overseas companies that might be strategic allies.

The investment in IMCB appears to be paying off scientifically. An IMCB group is at the forefront of research on tyrosine phosphates, a hot topic in cancer research. Another group is sequencing the genomes of several fish species, which could serve as a reference vertebrate genome for the human genome project. IMCB laboratories innovative assay systems convinced Glaxo, the pharmaceutical MNC, to establish a S$31 million trust fund for a drug screening centre within IMCB. Glaxo also invested S$30 million for a neurobiology lab to conduct research on degenerative brain disease.

Encouraged by these successes, the government expanded IMCB's research base by establishing the Bioscience Centre, which provides facilities for research at NUS and the Food Biotechnology Centre. The Bioprocessing Technology Unit, opened in 1990, seeks to improve purification, synthesis and fermentation methods for commercial production. The lab recently achieved large yields of TNF-[beta}, which other companies, including Genzyme in the US and Boehringer Mannheim in Germany, are keen to put into clinical cancer trials. The National University Medical Institute, being built near IMCB and the National University Hospital, is modelled on the US National Institutes of Health. Over the years, Glaxo has strengthened its research relationship with IMCB. An R&D venture was started in 1992, and a new Centre for Natural Product Research was launched in 1994. This Centre has discovered some 60-90 novel compounds with promise of further development. Boehringer Mannheim has undertaken another collaboration on colorectal cancer. US companies like Pfizer and Amylin have awarded research contracts. The staff has published over 500 research papers in leading journals and filed several patents.

One obstacle to Singapore's quest for scientific success is its shortage of well-qualified scientists and engineers. To overcome this, the IMCB recruited for scientists from the West offering them research freedom, ample funding and salaries of up to $50,000 for principal investigators. Those who accept IMCB's offer may qualify for renewable 3-year contracts. Singapore's own students represent the largest source of scientific talent at IMCB. Singapore's two polytechnics are training technicians to fill the growing demand from biotech labs and industries. In addition to tuition, graduate students at IMCB receive a handsome ($10,000 a year) stipend.

Source: Lall (1996) and Singapore National Science and Technology Board Website

The Singapore government often takes the lead in identifying and strategic technologies that will build up its future competitive advantage. One such high-profile effort is to develop national information technology capability: the "IT2000—A Vision of an Intelligent Island" plan launched in 1991. Managed by the National Computer Board, a fibre optic network will be laid down connecting all homes, offices and factories in the island with a high speed, high capacity information infrastructure. The pilot network was put in place during 1997, and technical trials were starting with 300 households, to be scaled up to 5,000 households by year-end. By April, 1997, 14 leading IT MNCs had agreed to provide various services and applications.

As with the other Tigers, the technology upgrading reflected in Singapore's export performance and structure is more the result of industrial policy more broadly than of technology policies in the narrow sense. The ability of a tiny economy with 3 million people to induce a shift into the most advanced electronic products has depended, not on laissez faire policies exploiting its static resource endowments. It has been driven by a clear and consistent vision, implemented by targeting and attracting critical foreign investors in the context of a 'cluster' strategy. As Wong (1997) puts it when explaining its success in fostering the world's most advanced hard disk drive industry,.

"The government explicitly recognises the need to promote industrial development as an integrated cluster linking downstream end-product industries, upstream supporting industries and enabling capabilities. In line with this strategy, there was strong emphasis on inter—government agencies cooperation and coordination in formulating industrial policies and implementing industrial promotion programmes. There was also strong emphasis on involving all the various players involved in particular industry clusters in policy formulation dialogue and implementation consultation. Industry players are also strongly represented in the board of government agencies involved in industry and technology promotion, industrial training and tertiary education institutions.

It may have been partly due to luck that Seagate initially chose Singapore for its first offshore production site, but the subsequent concentration of HDD assembly activities in Singapore was the result of dynamic interaction between increasing demand for flexible production capacity on the one hand, and the growing agglomeration of a local supply infrastructure reinforced by government policies on the other. Deliberate government policies to promote FDI by HDD assemblers, coupled with conscious programmes to promote the development of local supply infrastructure, have combined to reinforce the agglomeration advantage that Singapore has created in HDD assembly—despite rising costs and increased competition for FDI by neighbouring countries." (Wong, 13-14).

To conclude, let us quote Mathews (1999) on Singaporean strategy on the HDD industry:

"Undoubtedly what has underpinned Singapore's success is not a reliance on 'market forces' but the continuous intervention of state agencies like the EDB, and recently the NSTB, in shaping and fostering the industry's development. Long before the World Bank recognised the complementarity of market led development and state intervention, Singapore's agencies had been strenuously intervening to attract investment and "encourage" upgrading (through the carrot of incentives and the stick of threatened banishment from Singapore). The process has continued right into the 1990s " (p. 73).

This quick review provides a clear picture of the need for policy support in the FDI process and of one of the world's most successful strategies.

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Annex

Table 1

DISTRIBUTION OF MANUFACTURED EXPORTS OVER TECHNOLOGICAL SUB-CATEGORIES, 1985 & 1995

(percentage)

	Resource based				Low technology				Medium technology						High technology			
	Agro		Other RB		Textiles cluster		Other LT		Automotive		Process		Engineering		Electrical/ electronic		Other HT	
	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995
China	9.1	3.5	29.7	7.5	36.7	33.9	7.1	17.9	0.5	1.0	9.7	6.8	2.0	12.0	0.6	14.8	4.6	2.6
Hong Kong	1.6	3.0	1.6	2.9	44.1	42.5	18.9	9.5	0.0	0.0	1.2	3.4	17.8	11.7	13.5	23.4	1.2	3.6
Singapore	6.2	2.7	37.3	11.2	4.0	2.3	4.6	4.8	0.8	1.1	5.6	4.7	17.0	13.5	20.6	57.3	3.9	2.4
Korea	1.4	1.4	7.2	9.6	27.2	11.6	14.2	8.7	2.3	9.7	10.4	13.4	24.5	15.8	11.3	27.9	1.4	1.9
Taiwan	2.5	0.9	7.4	4.4	29.5	12.9	23.4	17.1	3.0	4.1	5.5	8.8	12.4	14.6	15.3	35.9	0.9	1.3
Malaysia	44.0	11.1	9.7	6.9	5.4	5.1	2.6	6.1	0.2	0.6	3.0	4.8	8.1	14.4	25.1	48.3	1.8	2.7
Indonesia	18.4	12.2	56.8	31.9	13.1	20.6	2.4	9.8	0.0	1.1	5.8	8.4	0.6	6.6	2.1	8.5	0.9	1.0
Philippines	27.2	6.2	12.4	3.3	10.3	8.3	6.8	4.7	0.6	1.8	4.8	1.6	1.0	5.1	36.6	68.6	0.3	0.3
Thailand	24.9	10.0	13.0	9.3	26.8	15.2	8.6	10.2	0.4	2.3	7.9	5.4	13.7	12.8	4.0	32.6	0.7	2.2
India	2.8	1.8	37.8	28.4	40.9	38.6	4.4	10.1	1.9	2.8	2.8	7.0	5.4	4.7	1.6	2.7	2.5	3.9
Argentina	36.9	29.2	23.3	12.6	10.8	11.3	5.5	6.0	2.4	18.9	9.1	9.9	7.5	7.8	3.7	1.9	0.7	2.5
Brazil	16.6	17.1	27.4	20.9	11.6	9.4	9.7	7.3	7.3	11.6	11.8	12.9	10.7	14.2	3.3	3.7	1.6	2.9
Mexico	3.6	2.8	17.5	4.5	5.2	8.9	8.0	10.8	9.2	18.8	5.0	5.5	29.0	20.9	20.8	25.5	1.7	2.2
Turkey	7.4	9.9	14.4	7.0	36.9	43.9	16.2	13.0	1.8	2.9	13.0	10.1	8.7	8.3	1.1	3.5	0.5	1.3
South Africa	10.8	9.9	42.6	39.9	5.3	4.3	11.2	12.8	1.1	4.8	17.6	12.6	2.4	9.5	0.8	3.0	8.2	3.0
East Asia	8.2	4.1	14.8	7.8	24.7	16.8	13.6	12.5	1.5	3.0	6.2	8.4	15.3	13.9	13.9	31.5	1.8	1.9
South Asia	4.5	3.1	27.8	22.0	51.8	51.1	4.0	7.6	1.3	2.5	3.4	6.6	4.5	3.0	1.1	1.9	1.7	2.3
LAC	15.5	13.2	43.8	19.0	9.1	9.3	7.8	9.1	4.1	11.4	9.4	9.7	6.8	14.9	2.5	11.5	1.1	1.8
MENA	7.6	6.5	62.7	30.2	12.3	28.9	2.2	9.0	4.7	2.8	5.8	12.8	2.9	5.3	0.8	3.3	0.9	1.1
SSA 1	35.5	25.8	29.2	15.0	13.6	34.3	5.7	10.0	0.5	0.5	11.5	9.8	2.5	2.7	0.5	0.5	1.1	1.4
SSA 2	18.5	12.9	38.4	35.3	7.8	9.9	9.5	12.3	0.9	4.0	15.7	12.1	2.5	8.3	0.7	2.5	6.0	2.7
Developing countries	9.8	5.9	24.3	11.7	21.7	17.8	11.2	12.1	2.1	4.4	7.0	9.2	11.9	13.6	10.3	23.5	1.8	1.9
Industrial countries	5.9	6.1	14.3	11.9	5.9	5.6	10.4	10.8	14.4	13.2	10.2	9.8	20.5	20.5	11.4	15.3	6.8	6.7
World	6.5	6.1	15.8	11.9	8.2	8.6	10.5	11.1	12.6	11.1	9.8	9.6	19.3	18.8	11.3	17.3	6.1	5.5

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