New Technologies, Competitiveness, and Poverty Reduction

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I. Introduction

This paper considers poverty reduction from the perspective of manufacturing competitiveness. Its premise is that industrial growth has been and will continue to be one of the prime drivers of income, employment, and skill generation—the main forces behind poverty alleviation. In the Asian region more than elsewhere, the countries that tackled poverty most successfully did so by *growing*, and using rising incomes to support other economic and social policies to alleviate poverty. Growth, in turn, relied mainly on manufacturing to lead investment, exports and structural change. The most successful economies were those that oriented their manufacturing sectors to exports. Their initial expansion was in labor-intensive products, but this accompanied rapid upgrading into more complex capital and skill- and technology-intensive technologies, products, and activities. The growing absorption of labor, in other words, went hand in hand with a move up the value chain, rising skill levels, and greater abilities to use new technology. Industrial competitiveness was the key.

The combination of attaining export competitiveness and upgrading its technical structure was necessary for *sustained* income and employment growth. Realizing export competitiveness was essential to switch from inefficient import substitution, reap scale economies, integrate into the global economy, and build technical competence. This was a demanding task even in simple labor-intensive products, and a large part of the developing world, as in Sub-Saharan Africa, has failed to achieve even this. However, this was not enough: without constant technical upgrading (of products, technologies, and activities) even successful exporters would lose their competitive edge and stagnate in low value-added activities. Only with upgrading could they cope with intensifying competition, rising wages, rapidly changing technologies, new skill needs, and the spread of global production systems. All these factors are stronger today, and the lessons from the early leaders apply with even greater force.

This paper reviews briefly the technological nature of manufacturing competitiveness in recent years and the strategies adopted by leading East Asian countries.

II. Technical Change and Competitiveness

Technical change is evidently so rapid and pervasive that there is little need to dwell on it in general terms. It is, however, useful to stress some factors of particular relevance to developing countries and their growth strategies.

To start with, no activity, regardless of its nature and location, is immune to new technologies. Exposure to world markets means that every producer has to become competitive, i.e., to use techniques, skills, and organizational forms that allow it to match international levels of cost, quality, flexibility, and delivery. The range of technical choice that used to exist—say, for intermediate technologies—is narrowing rapidly. The cushion against prolonged learning and high costs and inefficiencies that firms in developing countries had is far more limited. The needs that efficient technologies impose are also very different. They call for new skills, logistic systems, specialized infrastructure, and organizational forms, with a heavy emphasis on information and communications. Engaging in technological effort now entails much more networking and collaboration with other firms, universities, and research institutes than before.

Learning to use a technology's ”best practice” may sound easy; it is not. It often involves long, complex, risky, and costly processes of building new skills, information, linkages, and supply networks. As a result firms do not travel down predictable learning curves. Many are even unaware of what the curve looks like and what the process involves. As a result, the same technology is often used at very different levels of efficiency in different countries, and within a country in different plants. The secret of industrial success lies in reducing these disparities and moving the local frontier closer to international frontiers.

In the developing world this needs strategies to foster and deepen technological learning. Note that technological learning is not “innovation” in the normal sense, but mastering efficiently foreign technologies and keeping up with technical progress. The countries that industrialized fastest and most competitively were those that learned faster and more efficiently, and diffused their learning most widely within the economy. They were able to create *systems of learning and diffusion* that involved sets of interacting firms, institutions, and government agencies. The learning system had to become more complex and sophisticated as the industrial structure upgraded. With growing industrial maturity, it involved launching into formal research and development (R&D), not so much to innovate at the frontier but to monitor, select, and adapt complex new technologies.

Rapid technological progress has another interesting aspect. Activities with different degrees of “technological intensity”— those with higher than average expenditures on R&D—tend to grow faster than less technology-intensive activities. While every activity makes use of new technologies, differences in innovative potential and the speed of application of new innovations affect growth rates. The data (Table 1) show that ”high technology” activities the world over are expanding in both production and trade much faster than other manufacturing activities; note also that trade is growing much faster than production, showing the globalization of world economies. This holds for the most advanced as well as the newly industrializing economies. The 68 countries together account for over 95 percent of total world industrial production.

Table 1. **Rates of Growth of High Technology and Other Manufacturing, 1985-1997 (percent)**

	All Production	All Exports	High-tech Production	High-tech Exports
China, People’s Rep. of	11.70	20.50	14.90	30.20
Korea, Rep. of	10.20	10.60	15.40	18.70
Singapore	8.00	15.00	13.10	21.70
68 countries	7.30	5.90	10.80	2.70
Taipei,China	4.70	12.00	11.60	18.90
United States	2.90	8.80	4.70	10.10
Canada	2.70	7.30	8.10	10.40
Germany	2.20	4.10	3.80	5.80
Italy	2.00	5.60	0.60	6.20
UK	1.70	6.30	3.30	8.00
Japan	1.70	2.40	5.20	4.40
France	1.20	5.80	3.60	10.80
Hong Kong, China	-0.20	13.50	3.50	18.10

Source: National Science Foundation, US Senate (1999).

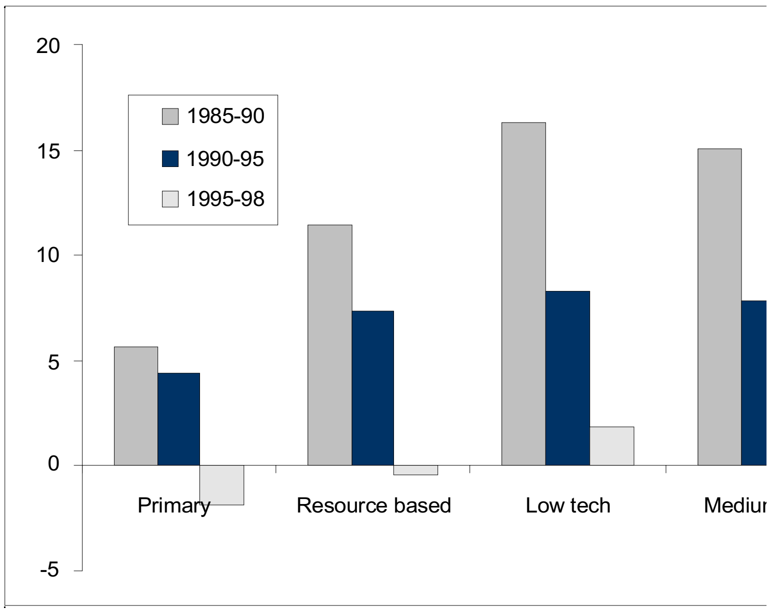
Not only do technology-intensive industrial activities lead in dynamism, they also generally offer greater learning potential and greater spillover benefits for other activities. Such activities have become the most active field for international investment. This has important implications for developing countries. First comes the “market positioning” argument. A country that wants to locate its production and exports in the fastest growing markets has to move into technology-intensive activities and upgrade its technology structure. Second, countries that want to deepen technological development and gain from the spillover effects of learning in lead sectors again have to focus on technology-intensive activities. Third, those that wish to share in the most dynamic segments of world trade—the international production systems of transnational companies—have to build the capabilities for technology-intensive activities. They can enter initially the assembly stage but later have to upgrade within the system, moving up into manufacturing, design, development, and regional service activities.

Consider now some results of my work on technological patterns of exports. This provides a useful perspective on efficient industrial activity more generally, in that the ability to compete in export markets shows how countries are doing in industrial development per se. I have broken down exports into four categories of manufactured products. I take out primary products because my main concern is with industry. There are four categories of manufactured products: resource-based; low technology (like textiles, clothing, footwear, simple engineering products); medium technology (industrial machinery, automobiles, chemicals, and so on); and high technology. The medium technology group is the largest—the heartland of heavy industry—but the high technology group, with only 18 products at the 3-digit level SITC level, is driving world trade and may soon be the single largest category.

Figure 1 shows growth rates for the period 1985-1998. Primary products were growing the slowest, followed by resource-based manufactures. Low and medium-technology products grew at more or less the same rate, but the pattern changed over time as medium technology products pulled ahead. The fastest growing group in every subperiod (including the relatively stagnant one after 1995) was high-technology products. At the start of this period in 1985, the 18 high-technology products comprised about 10 percent of world trade; by 1998 they accounted for nearly a quarter.

What were the ”drivers” of export growth by technology? High-technology growth was driven by innovation (introduction of new products and substitution of old products), high income elasticity of demand, and relocation (shifting labor-intensive operations to low wage areas) within integrated global production systems. Medium-technology exports grew because of technical progress and rising demand, but much less relocation in search of low wages: heavy industries need strong local suppliers and capabilities and so do not lend themselves easily to such shifts. Low-technology products, facing stable demand and slow technical progress, were driven largely by relocation from high- to low-wage areas. Over the longer term, we may expect that technology will be the dominant force in

Figure 1. **Rates of export growth by technological categor**

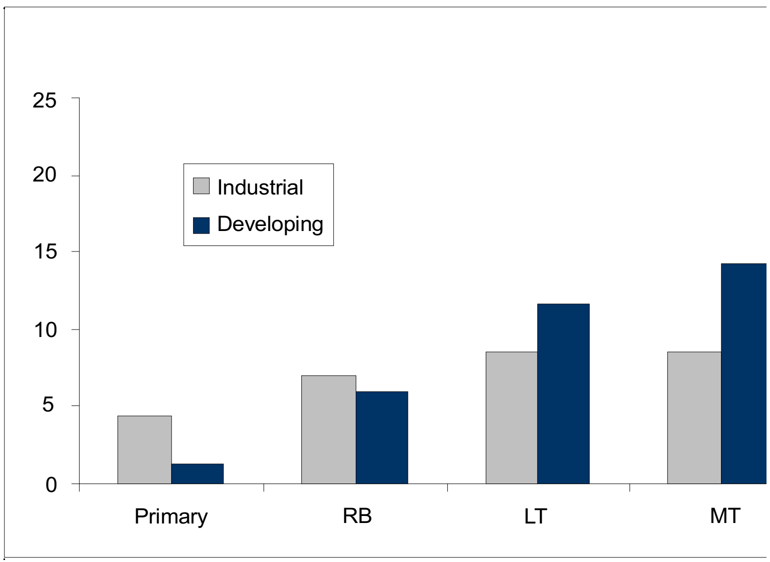


relative export growth. High-technology products will continue to lead (the composition of products may, of course, change) and medium-technology products will grow faster than low-technology products as the restructuring of location in the latter matures. Given the dynamic forces at work, in other words, there will be a continued structural shift up the technology scale, with positioning in the technology-intensive segments being the best for sustained growth.

III. Role of Developing Countries

Developing countries' exports overall are growing faster than for developed countries; this is expected since they started from a lower base. However, the technological patterns of their growth are interesting and unexpected. Developing countries grew slower than developed countries in primary products and resource-based manufactures (Figure 2), presumably because of the faster application of new technology or because of trade barriers and subsidies in the industrial world.

Figure 2. **Growth rates of manufactured exports by industrial an countries, 1985-98**

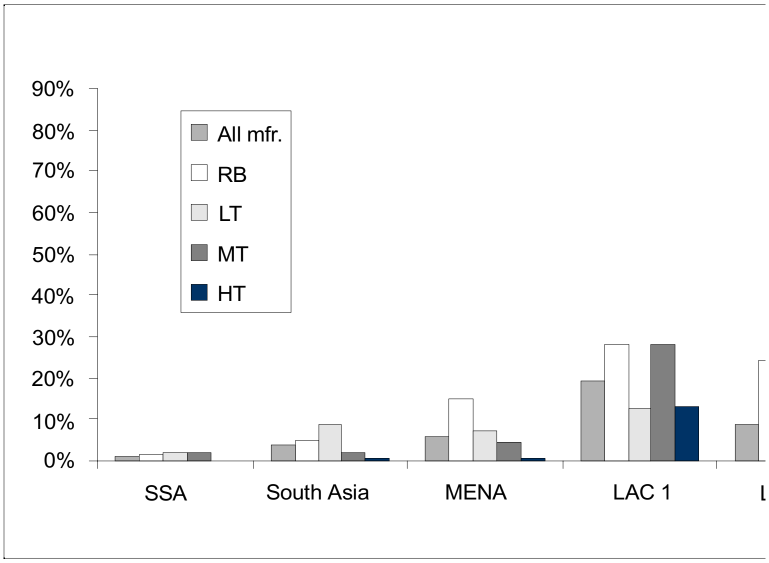


As far as nonresource-based manufacturers are concerned, however, the patterns are counterintuitive. Theory would lead us to expect that developing countries would grow fastest relative to developed countries in low technology, less in medium technology, and the least in high technology. The data show the reverse. The lead of developing countries rises with technology intensity. Moreover, high-technology exports are now the largest single component of developing country manufactured exports. The value of electronic exports by developing countries in 1998 was nearly $100 billion larger than its exports of textile, clothing, and footwear products (their traditional stronghold).

This pattern suggests that developing countries have made great technological progress and are set to benefit from global competitive trends. Unfortunately this is only partially true. Export dynamism and success in technology-intensive exports are very highly concentrated, both by region and by country. Moreover, the local depth and "rooting" of high-technology activity vary greatly among the successful exporters, raising doubts about the sustainability of competitive performance by those with shallow roots.

Consider first the concentration at the regional level (Figure 3).

Figure 3. **Regional shares of developing country manufactures**

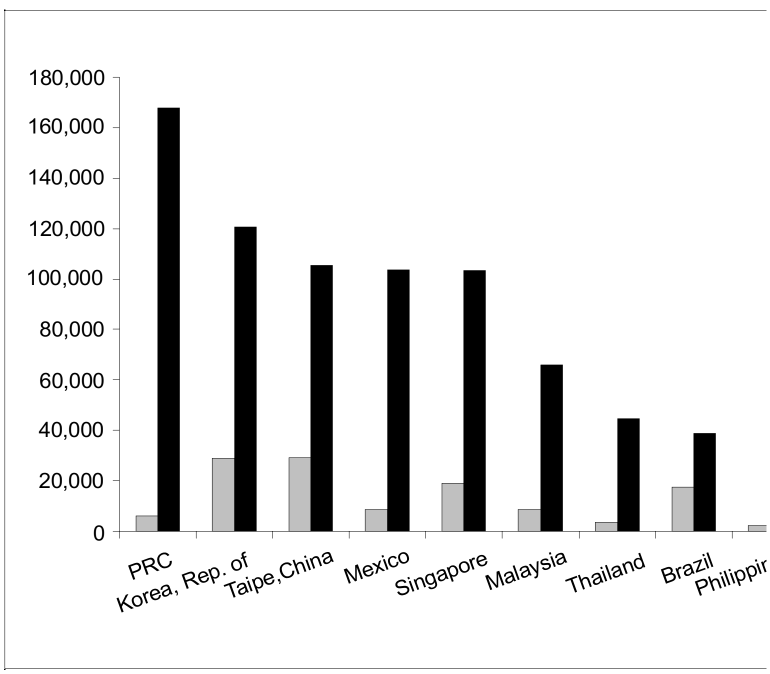


East Asia now accounts for about 75 percent of total manufactured exports, and about 90 percent of high-technology exports. At the other end, Sub-Saharan Africa (even including South Africa) is very weak in manufactured exports and practically off the map in high-technology exports: a clear sign of its marginalization in the dynamics of world trade and all that this offers. South Asia does well in low-technology products, basically clothing, but greatly underperforms other categories. South Asia's export structure has remained relatively static over time and is concentrated in slow-growing products (the figures exclude software exports by India). The smaller countries in the region (Bangladesh and Sri Lanka) face particular threats from the impending abolition of the Multi-Fibre Agreement that gave them a sheltered market niche.

Latin America and the Caribbean (LAC) is shown twice. LAC 1 includes Mexico and LAC 2 excludes it. The reason for this distinction is the massive trade "distortion" caused by the North American Free Trade Association, which gives Mexico privileged access to the United States and Canadian markets over its neighbors (and over competitive exporters in South East Asia). Without this distortion, LAC II is doing poorly in dynamic products in world trade—surprising in view of the size and industrial traditions of Argentina, Brazil, and Chile. In Mexico, by contrast, assembly activity in *maquilladoras* and elsewhere aimed at the United States market are driving medium-technology exports like automobiles and high-technology exports like electronics.

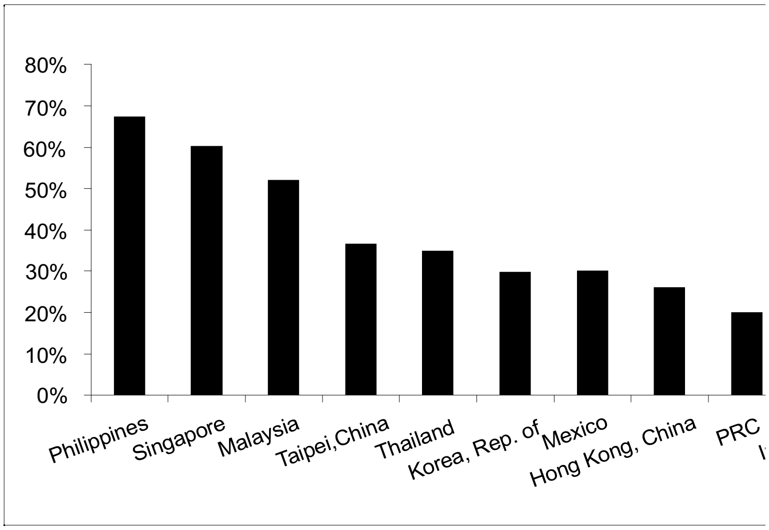
Now take concentration at the country level. Figure 4 shows the 12 largest developing world exporters of manufactures in 1985 and 1998. These countries account now for about 90 percent of developing country exports and their dominance has been rising over time. Levels of concentration rise by technology levels, being highest for technology-intensive products. Thus, liberalization and globalization are leading to higher rather than lower barriers to entry for new competitors in advanced activities.

Figure 4. **Values of manufactured exports by leading developi**
1985 and 1998 ($ million)



Consider now the technology composition of exports by the leading exporters, to see how they differ among themselves (Figure 5). The results are again surprising: the most high-technology composition is for the Philippines, with almost 80 percent of manufactured exports coming from semiconductors. Then come Singapore and Malaysia, followed by other Asian newly industrialized economies (NIEs). The laggards in the group are India and Brazil.

Figure 5. **High technology products in manufactured expo**



IV. Drivers of Competitive Success among NIEs

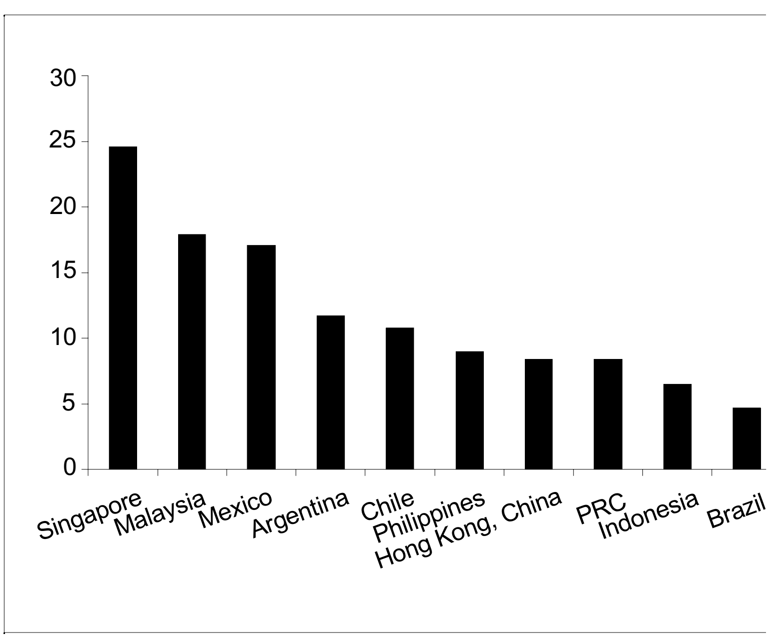
The drivers of technological success in export activity differ by country. In all the countries with the exception of the Republic of Korea (henceforth Korea) and Taipei,China, high-technology exports are driven by transnational corporations (TNCs) relocating the final labor-intensive stages of production to low-wage countries. As noted, the rapid growth of high-technology exports reflects not just their innovative content and rising final demand, but the separation and relocation of labor-intensive processes to low-wage areas. Such assembly operations have various beneficial learning and spillover effects (labor-intensive activities in high-technology activities seem better for host countries than in low-technology activities), but they do not—at least initially—need strong local technological capabilities. The risk is that when the initial edge provided by low wages runs out, countries may not be able to move up the value chain ladder because they have not built their skill, information, technology, and supplier base to the demanding levels needed.

Only Korea and Taipei,China in East Asia have managed to build up strong domestic capabilities in these high-technology activities, by dint of assiduous and comprehensive industrial policy (the People's Republic of China [PRC] is doing well in emulating them but at a much lower level). Thus, we observe two different patterns of high-technology competitiveness with different implications for sustainability: one based on TNC assembly activity and the other on building local capabilities. A third pattern is industrial policy combined with heavy reliance on TNCs: the Singapore case, to which we return below.

Let us look now at some evidence on these different drivers of competitiveness. The first is foreign direct investment (FDI). Figure 6 shows FDI as a percentage of gross domestic investment in 1997 (but the picture is more or less the same over the longer term). Reliance on FDI differs sharply among the NIEs, with very high reliance in Malaysia and Singapore in East Asia and in most of Latin America. There is low reliance in the Korea and Taipei,China, which deliberately restricted inward FDI to build up their innovative capabilities. This suggests a tradeoff between deepening technological capabilities and relying on ready-made technology from TNCs.

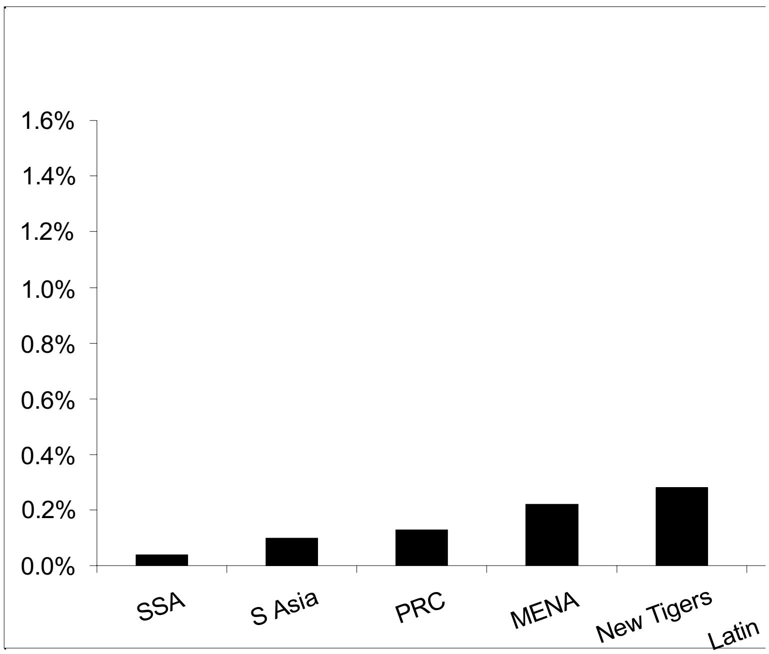
Now let us take human capital. There are again sharp disparities affecting the base of skills that countries have to compete on in technology-based global markets. The figures are only a rough guide to skill formation, since they only deal with formal school and university enrolments, ignoring quality and other differences in the education provided. But these are the only comparable data available, and do show the main form of skill formation. I focus on high level technical skills, as measured by

Figure 6. **Foreign direct investment as % of gross domestic i**



tertiary enrolments in core technical subjects (pure science, mathematics, and computing and engineering) as a percentage of the population. Statistical analysis shows that this measure is the best variable for human capital in explaining export dynamism (Figure 7).

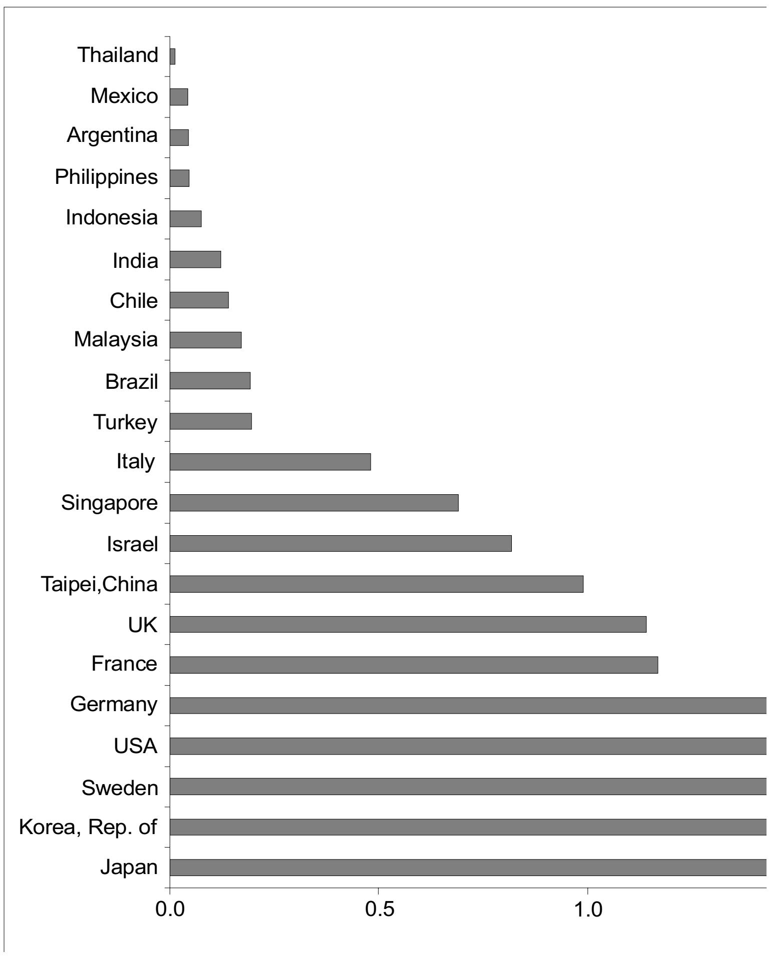
Figure 7. **Tertiary enrolments in technical subjects as %**



The most striking fact about the chart is the enormous lead established by the four mature Asian Tigers, outpacing the industrialized countries. They lead the "New Tigers" and the main industrial powers in Latin America by an even higher margin. Sub-Saharan Africa lags the most in skill creation, reinforcing the picture of marginalization given by the export data above.

Let us now look at research and development spending, taking not total R&D (which can be misleading for analyzing industrial technological activity) but that financed by productive enterprises (Figure 8). The leaders in the world in this activity as a percentage of GDP are Japan and Korea. Yet only some 20 years ago, Korea was a typical developing country with 0.2 percent of GNP going into research and development, of which 80 percent came from the public sector. Today, total R&D is over 3 percent of GDP, with over 80 percent coming from the private sector. Singapore and Taipei,China come next in the developing world, with other countries lagging well behind.

Figure 8. **R&D by productive enterprises**



These data again show the highly differentiated response to globalization and technical change among developing countries. The three of the mature Asian Tigers (Hong Kong, China, the PRC excluded) lead the rest, with other industrializing countries in Latin American and Asia lagging. While the New Tigers like Malaysia, Philippines, or Thailand do well in technology-intensive exports, their capability base remains weak and shallow. The striking discrepancy between the technology intensity of their exports and their domestic skills and technological capabilities made up by TNC assembly activities has to be rectified if they are to maintain their past performance. Otherwise, technical change and the entry of rivals with stronger skill bases will lead future dynamic activities to locate elsewhere. The PRC is in an intermediate position, with a combination of capabilities and strategies from each of the three leading Tigers. Its size and established capabilities suggest that it will continue to catch up with the leaders and possibly do better.

V. Conclusion

This overview of technological trends in manufactured exports and their drivers provides a useful lens through which to view growth. It is not suggested that growth is the only factor in poverty alleviation, but it clearly is an important one. Without boosting growth it is difficult to reduce poverty on a sustained basis. And in a liberalized world with inexorable technical progress, it is difficult for most countries to have growth without building industrial competitiveness.

The picture has an optimistic and a pessimistic side. The optimistic side is that it is possible for developing countries to grow and compete effectively in the emerging setting, entering competitive markets for manufactures and moving up the technology scale quickly. The pessimistic side is that the trend is toward increasing divergence rather than convergence. The globalization process is drawing apart the “insiders” and the ”outsiders” to technological dynamism. A few countries on the “inside” are participating in integrated international production systems. Of these, the truly dynamic ones are those that have developed strong local technological capabilities; the other insiders need to follow their example by investing in human and technological capital. Other developing countries are “on the outside” to different extents, from some about to join the insiders on one end to those risking long-term marginalization on the other.

Globalization moves productive resources and knowledge around the world at an accelerating pace. It does not, however, reduce the need for *local* capabilities and institutions; quite the contrary, the strength of the local learning system becomes more and more important to attract and “root” the mobile resources available externally. Simply because capital and technologies are more available (and more footloose), countries have to offer stronger skills, capabilities, supply networks, institutions, and infrastructure if they are to attract high-quality resources. Simply opening up economies to global market forces without upgrading skills and capabilities may serve to exploit existing capabilities, but over the longer term may be a recipe for stagnation at the bottom of the technological and income ladder.