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COMPETING WITH LABOUR:
Skills and Competitiveness in Developing Countries

Sanjaya Lall

Queen Elizabeth House

Oxford University

Development Policies Department

INTERNATIONAL LABOUR OFFICE GENEVA

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Preface

The present paper is part of the contribution of the Development Policies Department to understand the emerging issues in development given the recent changes triggered by globalization of the world economy, and the responses in terms of national economic and social management.

This paper deals with the impact of rapid technological change on skill needs for competitiveness in developing countries. Upgrading competitiveness is essential to growth with rising living standards and improved working conditions B increasingly, such upgrading needs the development of new higher value-added activities rather than the exploitation of existing resources and low wage, unskilled labour. Moving into such activities necessitates the creation of new skills and capabilities, regardless of the level of development of the economy.

Emerging technologies call for more skills, higher levels of skill and different kinds of skill. The widespread application of information technologies also has to focus on the complex of education and training needed to handle such technologies. Most successful economies are raising the skill content of their labour force. However, skills should not be equated with formal education B this is a necessary but not sufficient condition for creating competitive capabilities. Formal education has to be enhanced by learning, the specific experience of handling particular technologies, solving problems and adapting them to different conditions. The development of capabilities in this sense is a prolonged, costly and difficult process, often subject to a range of market failures. The factors that determine capability development are incentives facing firms, the factor markets they operate in and the institutions that affect learning. Each of these markets can be deficient, and each can be improved by policies. Government policies to promote learning are then the most important factor in national competitiveness. This is true whether a country pursues a relatively autonomous strategy or one dependent on foreign direct investment.

The evolution of world trade shows that export dynamism is increasingly driven by technological complexity. The developing world has greatly raised its share of complex exports, but success is highly concentrated in a few countries in East Asia and Latin America. Inflows of foreign direct investment have played a major role in several countries, but some, like the Republic of Korea, have managed to develop indigenous capabilities by dint of intensive industrial policy. Even the FDI dependent strategy has worked well in a small number of countries, and the ten leading recipients continue to account for over three-quarters of flows to the developing world.

Skill formation is similarly concentrated. The paper gives new data on educational enrolment by all developing countries and regions, and shows large and growing disparities. East Asia leads, and Sub-Saharan Africa lags, by practically all measures. The disparities are particularly large for high level technical education, increasingly important for competing in advanced industrial activities. It is difficult to take quality differences into account, but if they were the differences may rise rather than diminish. The paper produces some statistical evidence that skills and technological competence are related with each other and with competitiveness.

The final section deals with policy implications. It reviews the theoretical arguments for policy intervention in skill creation, based on market failures in education and training: most of the arguments have been made for industrialised countries but they apply with greater force to developing ones. It goes on to make a case for coordinated skill development and industrial development policies, and draws upon the example of some leading Asian economies to illustrate how this has been done. It describes briefly different systems of training used throughout the world and ends with a plea for country specific strategies.

Samir Radwan
Director
Development Policies Department

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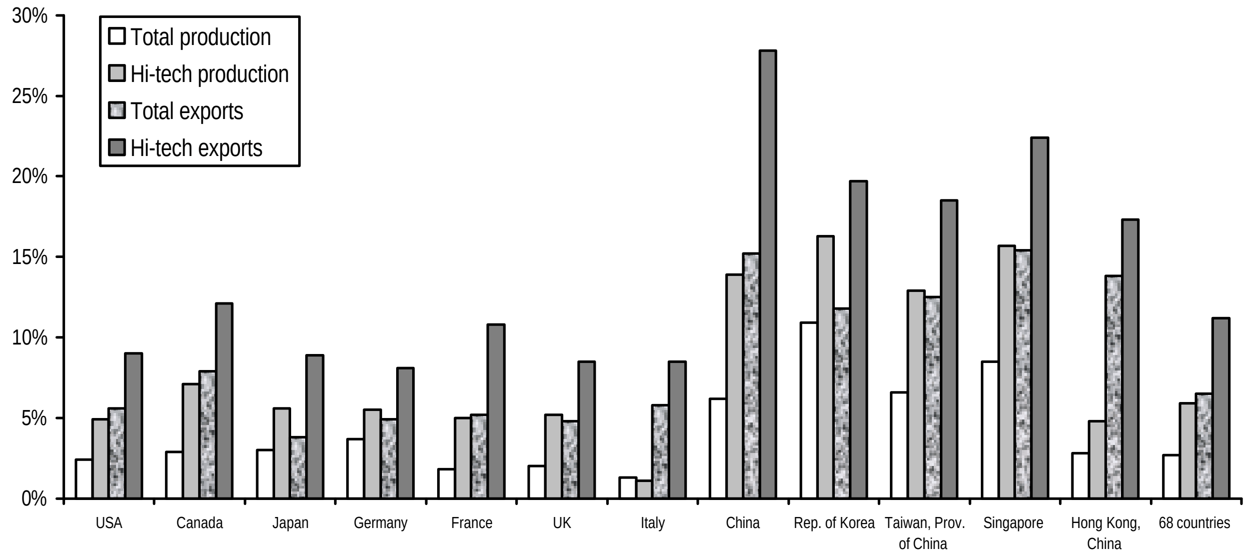
1. Introduction

Rapid technical progress is driving sweeping changes in the global economy. It is so broad and far-reaching that some analysts see the emergence of a new technological 'paradigm' that will transform the whole productive system (Freeman and Perez, 1988). This paradigm offers a cornucopia of productive knowledge, with immense scope for raising incomes, employment and welfare. It is also an irresistible force for globalisation. By reducing transportation and communication costs, it links economies and societies in closer, tighter webs. It facilitates the integration of production under common ownership (of transnational companies), allowing access to capital flows, world markets, skills and technology. Its productive potential induces, or forces, governments to liberalise trade and investment policies. The international community fashions new 'rules of the game' to facilitate trade, capital and information flows and protect property rights.

The emerging system is immensely productive; it is also enormously demanding and challenging (World Bank, 1998). It is causing large shifts in the location of productive and innovative activity, patterns of comparative advantage, systems of industrial organisation and management, relations between productive and other sectors, and the nature of work itself. In general, 'technology intensive' activities, those with rapidly changing technologies and high rates of research and development spending, are growing faster than others (Figure 1). The ability to compete in free markets depends increasingly on the ability to incorporate new technologies into manufacturing and services, even in traditional activities; sustained growth, however, calls for a structural change from simple to more advanced technologies. The 'bottom line' in the emerging paradigm is clearly *competitiveness* – the ability of an economy to grow in an open market with advantages that yield rising wages, sustained employment creation and improved working conditions. This requires greater technological, organisational and managerial capabilities on the part of firms – it is firms that compete, not countries (Krugman, 1994). However, it also requires supportive policy: firms develop competitive capabilities by responding to market signals and drawing upon factor markets and institutions. They learn from their interactions with other firms, competitors, suppliers and customers. These markets, institutions and networks can suffer from deficiencies, many of which can be remedied only by government policy.

Figure 1: Growth rates of total and high technology production and exports, 1980-1995



Competitiveness in the new technological context requires more of developing countries than just providing cheap labour. The competitive advantage given by low wages for unskilled or semi-skilled workers should certainly be exploited, but it is only a starting point. Such an advantage is temporary and evanescent; it cannot support rising wages or better living standards unless skills and technologies are upgraded to allow labour to be used in more productive, higher value-added activities. The development of such competitive capabilities is very unevenly distributed, across economies and within them. Within economies, significant sections of the population are being left out of the dynamics of creating high incomes and good working conditions that fulfil their potential. They stagnate in low-paid, unfulfilling work or are unable to find work at all (to a lesser extent this is also true of advanced industrial countries). Across economies, few developing countries have built up the capacity to compete in modern activities with rapid and sustained income and employment growth. Some others have had short bursts of growth in modern activities but are at risk of losing their competitive positions as technologies change and markets liberalise. Many more are at risk of being marginalised in the dynamics of technological change and globalisation. They lack the technological skills and capabilities to compete in modern activities; their main competitive advantages remain unprocessed natural resources or cheap unskilled labour. Neither holds the promise of sustained growth in incomes and productive employment.

Competitiveness depends on many things. One vital determinant – ultimately perhaps the most important single determinant – is the *level and improvement of workforce skills at all levels*. In a general sense, this is so widely accepted that there is no need to argue the case at length. However, it is useful to clarify how skills and competitiveness are related, and how the nature of skill needs is changing in the emerging globalised world. This paper starts with the changing nature of skill needs and describes the role of skills and capabilities in the literature. It goes on to describe the evolving nature of global competition, highlighting the divergences in performance between developing countries and regions. It then deals with some major determinants of competitiveness: FDI inflows, technology transfer and technological effort. A separate section describes skill creation patterns. We then consider some statistical evidence on skills, technology and competitiveness. The paper closes with the main policy considerations.

2. Skills and Competitiveness

The effective use of technologies (‘effective’ in terms of being competitive in world markets) requires skills, and the move from simple to complex technologies requires more, better and more diverse skills. Emerging new technologies often call for entirely new types of skills, both for direct production and services and for the organisation of production and for managing knowledge networks (section 2.1). The recognition that skills or human capital are important to comparative advantage is of long standing; however, there is a new burst on interest in its role in economic growth and competitiveness. This is partly a belated acknowledgement of its traditional role; it is also a recognition that skills are growing in significance. Increasing capital mobility and technology transfer mean that these factors need not be provided wholly by a country: its real comparative advantage then depends on the ability to furnish the *less mobile* productive factors. These include natural resources, skills and technological capabilities. However, the exact nature of the skills needed for competitiveness is not clear from the economics literature, and it is worth discussing at some length (section 2.2). This becomes particularly important because some avenues of skill acquisition are being constricted by the emerging policy regime.

2.1 New Skill Needs

The new technological paradigm calls for *more* skills, for *higher levels* of skill and for *different kinds* of skill. The reasons for these trends are obvious. The pace and ubiquity of technical progress means that all activities have to improve their technologies, and so the skills needed to operate them, if they are compete. With the liberalization of trade and investment, even non-traded activities are increasingly exposed to international competition, and have to improve their competitive base to survive and grow. The need for increased skills rises with the level of development, but even the least developed countries have to improve their human capital base if they are to grow and prosper. The *World Employment Report 1998-99* notes:

> "In both developed and developing countries, employment of skilled workers has been on the rise… The rate of growth of employment in the period 1981-96 in advanced countries has usually been highest for professionals and technicians… In developing countries, too, this occupational category has witnessed a high growth rate, though one less disproportionate to other categories in comparison to developed countries. In contrast, the rate of growth of employment for the production and related workers category (which contains skilled manual and craft workers but mainly the unskilled and semi-skilled) has been very low, often negative, for developed countries. In the developing countries for which data are available, with some exceptions (e.g. Philippines), this group has witnessed much lower employment growth than the highly educated and trained group of professionals and technicians." (p. 32)

While there has been considerable growth in low-skill, poorly paid services, the trend for international *competitiveness* is clear. Countries must raise skill levels to raise living standards in open, competitive markets. There is no other way to can keep – and improve – competitiveness. It is possible for short periods to enhance competitiveness based on unskilled labour. This is the case with economies like Bangladesh or Mauritius, which have focused their competitive advantages on garment assembly (*WER 1998-99*, p. 36). However, this is only an entry-level strategy. Maintaining a competitive edge with rising wages in low technology activities is certainly possible, but it calls for more advanced skills. For instance, in the clothing industry, it requires sophisticated design, quality control, logistics and delivery as product cycles become shorter and reliable, rapid delivery becomes vital to winning orders.

This is a manifestation of the changing nature of competition itself. Traditional modes of competition, based on low costs and prices, are being replaced by competition driven by quality, flexibility, design, reliability and networking (Best, 1990, calls this the 'new competition'). This change is not just in markets for advanced manufactures but also to mundane consumer goods like clothing, footwear and food products. Firms are specialising increasingly in different segments of the production chain, outsourcing segments and services to other firms to reap economies of scale and specialisation. At the same time, the leading firms in most industries are broadening their field of technological competence to manage effectively the complexities of supply chain management and innovation (Grandstrand, Patel and Pavitt, 1997). Information flows, interaction and networking are the new weapons in the competitive armoury; in very technology intensive activities these often include strategic partnerships with rivals and close collaboration with vertically linked enterprises.

These trends lead to growing 'information intensity' of modern production, quite apart from the massive increase in the direct use of information technology by enterprises. For instance, about fifty per cent of the value of a new car now lies in its 'information content' – design, process management, marketing, sales and so on. As *The Economist* noted, "over three-quarters of the value of a typical manufactured product is already contributed by service activities such as design, sales and advertising."[1] The general rise in the share of high value services greatly strengthens this trend (Quah, 1997). The importance of services such as finance, communications, transportation and servicing to competitiveness is too evident to merit further discussion. This applies almost as much to developing countries as to developed ones, at least to those that aspire to move into modern manufacturing and service activities geared to world markets.

The use of new technologies, in particular information-based technologies, calls for more, better and newer kinds of skills (*WER 1998-99*, p. 39). The technological reasons for this are self-evident, but there are also organisational reasons. New skills are entailed in setting up and working effectively with new forms of work organisation and production systems. In many cases, these skills have to be complemented with other changes: different attitudes to work, new occupational categories, new work relationships and new management systems. Moreover, none of these changes is once-for-all: skills are subject to constant change. Consequently, the education and training system has to upgrade skills constantly in line with emerging needs. Thus, "the demand for professionals and technicians has increased in all countries, as their analytical, cognitive and behavioural skills equip them better to adapt to more sophisticated technology. However, even within these high-skilled jobs the trend is increasingly towards multi-skilling – combining specialised professional expertise with business and management skills... [Even for production workers] the trend is towards up-skilling and multi-skilling. A study of 56,000 production workers over an eight-year period shows that skill requirements in production jobs have changed across the board. It is not only that each job has experienced up-skilling, but the overall distribution of production jobs has shifted away from the less skilled to the more skilled." (*WER 1998-99*, p. 47)

In most fast-growing East Asian economies there has been a sharp increase in the use of skilled workers, especially of highly trained managers, engineers and scientists. For instance, in Singapore the share of professionals in manufacturing employment has risen from 3 per cent in 1983 to 7 per cent in 1996, and that of technical and engineering manpower has grown from 5 to 16 per cent (Low, 1998, p. 24). For the working population as a whole, the share of professional and technical workers has increased from 15.7 per cent in 1990 to 23.1 per cent in 1995. Surprisingly, Singapore still suffers from a pressing shortage of skilled employees, particularly at higher levels, a shortage it remedies by allowing skilled expatriates. In the Republic of Korea, with a more diverse industrial sector and less specialisation in technology-intensive activities than Singapore, there is a similar trend to rising skill intensity (though the level of skill intensity tends to be lower).

Figure 2 shows how the skill composition of employees in Korean manufacturing has grown since 1976 (Cheon, 1999). The figure has four categories of manufacturing. 'E-O light' refers to light and 'E-O heavy' to heavy export-oriented manufacturing: the former is essentially low technology, labour intensive activity and the latter is complex, technology- and capital-intensive. 'Import competing' activities are sophisticated industries in which Korea is still import dependent, while the rest of manufacturing is a mixture of activities aimed primarily at the domestic market but not subject to intense import competition. The skill intensities of these categories reflect their technological character. Import competing industries generally take the lead, followed in the employment of scientists and engineers by heavy export-oriented industries and in high skill jobs by 'others'. Light E-O activities tend to be lower skill by all measures. All categories experience a rise in skill intensity, the only exception being the share of scientists and engineers in 'E-O light' activities. While the average years of education rise for all categories, this understates the change in the composition of skills. For instance, the share of scientists and engineers rises eight-fold, and the share of high skill jobs three-fold, in heavy export-oriented activities over the period.

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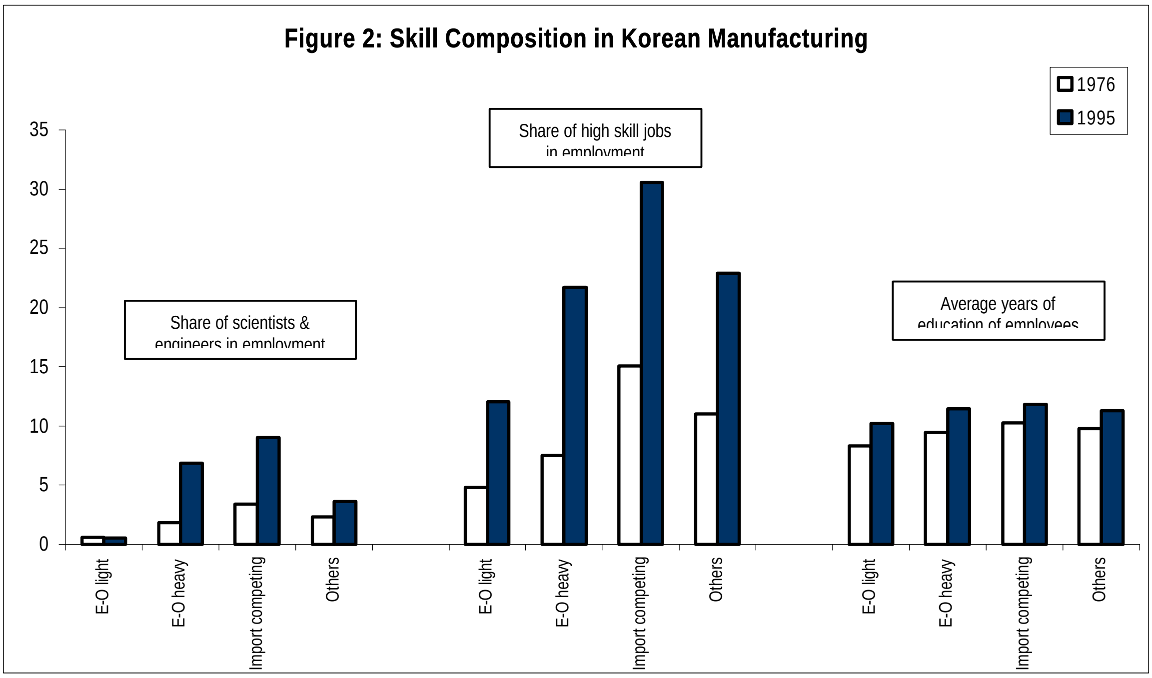
[1] *The Economist*, 'World Economy Survey', September 28, 1996, p. 48.



As noted, new organisational practices also require new skills. *WER 1998-99* identifies four features of these practices (page 42). The first is work teams. This "lies at the core of the new systems", and involves greater group responsibility, broader skills on the part of workers and frequent job rotation. The second is involvement in off-line activities, such as problem solving, quality improvement, health and safety. The third is a flattening of organisational hierarchies, with greater responsibility by shopfloor workers and more intense information exchange. The fourth is links to other human resource policies. Work organisation can only be successful if training and remuneration systems are changed to prepare and reward employees for the new responsibilities.

The use of information technology is pervasive in these new work methods: for different plant layouts, process control, total quality management and just-in-time inventory systems. All these necessitate higher skill levels and training effort, with the intensity of skill upgrading rising with the complexity and sophistication of the technologies involved. In addition, the increased importance of networking between firms (and between firms and technology institutions) for competitiveness requires specific 'communicative' skills. A recent study shows how these skills are enabling skilled workers in the UK to move into knowledge-intensive sectors more readily than worker without such skills (Tomlinson, 1999). The knowledge-intensive sectors themselves are the most dynamic in industry with respect to their 'learning potential', so that employees who can enter them benefit from a virtuous cycle of skill creation and upgrading.

In developing countries, the importance to skills to new forms of work organisation are stressed by the *WER 1998-99*,

> "Because the new forms of work organisation require greater responsibility and greater skills from the workforce, low literacy rates in developing countries impede its introduction. However, in many cases, firms in developing countries have managed to become significantly more competitive through changes in work organisation despite relatively low levels of education. This has required much time and resources being devoted to group meetings and training… *Though considerable progress can be made with a poorly educated labour force, particularly in early stages of restructuring, in the*

long run firms which have educated labour are likely to make more progress in their training schemes. This is because the requirements of a multi-skilled workforce and worker participation in continuous improvement call for an understanding of the underlying technical processes." (p. 45, italics in original)

As we shall see later, relatively few developing countries are investing in the education structure that provides the basic skills on which competitiveness rests. However, most countries are opening their economies to global competition, striving to raise their competitive advantages in trade and in attracting foreign direct investments. There is thus emerging a real danger of skill marginalisation at the national level, mirroring trends seen clearly within many countries.

2.2 Skills, Capabilities and Comparative Advantage

Let us briefly review some the analytical basis for relating skills and comparative advantage. A good example of recent work is the work of Wood (1994). Wood extends traditional neoclassical (Heckscher-Ohlin) trade theory to argue that the conventional determinants of trade patterns – capital and labour – are no longer relevant. Capital is highly mobile and travels the world in search of higher returns. Labour is largely immobile. 'Raw' labour is not important to modern industrial activities: here competitiveness depends on skills. Thus, the interaction of these two immobile factors – natural resources and skilled labour – now determines patterns of comparative advantage.

There is a lot of validity in Wood's analysis: capital in all forms is now certainly more mobile than before; and immobile skills are clearly vital to competitiveness. However, its analytical framework restricts the practical utility of this work. It is difficult to see why the comparative advantage of two poor, skill-scarce developing countries, one with natural resources and another without, should differ. The one with resources need not, as is the case in much of Africa, have much higher wages than the one without, if the resources are badly exploited or facing stagnant markets. However, there are two more basic problems, concerning how skills affect competitiveness and how they are acquired. Both reflect problems inherent in much of traditional neoclassical analysis of skills and competitiveness.

First, the analysis ignores the role of technology – and the *skills, knowledge and capabilities* arising arise from technological learning – in determining comparative advantage. It simply assumes that if 'skills' (given by formal education) are present, technologies will be imported, absorbed and used efficiently without cost and risk. No distinction is drawn between formal education-based skills and experience-based capabilities in building competitiveness. Second, it oversimplifies *how such skills and capabilities are acquired*, and so is misleading in terms of policy conclusions.

Technological capabilities do not appear as a determinant of comparative advantage in theories of trade. In fact, *technological activity in any form* has no role in the conventional analysis of comparative advantage in developing countries (Box 1). Developing countries are technological "followers", for whom, it is assumed, technology is easy to find, transfer, use and upgrade. In other words, technology markets are efficient and technology has no tacit elements that entail further cost, effort, uncertainty or time. All governments have to do is to 'get prices right' so that enterprises select the technologies appropriate to their factor prices. Once they have done this, they will automatically use them at best practice levels. There is no difference between acquiring *capacity* (the physical plant, equipment and blueprints) and *capability* (the ability to use these efficiently). Comparative advantage then depends entirely on relative factor endowments, and any attempt to change this – apart from providing the conditions for faster accumulation of factors – is by definition inefficient.

Box 1: Trade Theory and Technology in Developing Countries

Trade theory does not give a significant role to technology – and so to technology-related skills – in determining comparative advantage in developing countries. Some theories ignore this role altogether, while others consider it important only for developed countries. In general, it accepted that developed countries innovate and create technological advantages; developing countries merely import and (passively) use technologies created abroad. The critical premise is that existing technologies move across countries and enterprises without cost, risk, effort or externalities. Their absorption and use is assumed an easy, and economically trivial, process. Thus, differences between developing countries in technology and technological capabilities play no role in either determining their comparative advantage or differentiating their trade patterns. Developing countries remain a homogenous, passive group of technology users, their comparative advantages ruled by factor endowments.

In Heckscher-Ohlin (H-O) theories, technology and skills do not appear at all. Production functions are assumed identical across countries, with technology fully diffused across firms and countries. Firms automatically select techniques suited to their relative factor (capital-labour) prices. Once they have made the right choice (i.e. labour-intensive techniques for developing countries), they use the technologies efficiently without lags, learning or effort. Since labour is taken to be homogenous and technology users automatically reach 'best practice' levels, there is inefficiency only if governments intervene to distort factor prices or prevent free trade.

Neo H-O theories, incorporating skills as a third factor of production, continue to assume efficient markets for technology and its costless and automatic application. The advantage of developing countries lies in low-skill, labour-intensive activities, with no specific effort, lag, learning or risk involved in using these at best practice. A new version (Wood, 1994) assumes capital to be fully mobile and makes comparative advantage to be dependent two immobile factors, skills and natural resources. Technology remains a permissive, and so irrelevant, factor. Skills are treated as a generic resource, created by 'the education system ' and generally measured by school enrolments or years of schooling (Gemmel, 1996). The possibility that the efficient use of technology needs skills and knowledge *specifically* related to those technologies, acquired only by prolonged experience and problem solving with those technologies, is ignored. However, extensive research on enterprise level capability development suggests that such specific skill acquisition is central to industrial competitiveness, and is the main factor differentiating patterns of comparative advantage across developing countries (Lall, 1999).

Even technology-based (product cycle and other neo-technology) theories direct their attention to developed countries and neglect technological learning in developing countries. They take comparative advantage to depend on 'innovation' – discrete improvements to products or processes (or shifts of the production function). The use of existing technologies or their adaptation to local conditions (reaching or moving along the production function) remains automatic and costless. Industrial countries are the innovators; developing countries receive mature technologies from them as they percolate down and use them efficiently. As in H-O models, their comparative advantage in using mature technologies depends on low wages and skills. In these models, countries can improve their competitive positions by facilitating technology inflows, by opening their economies to trade, licensing and (particularly) foreign direct investment.

Strategic or 'new' trade theories, while eschewing assumptions of perfect markets, also concentrate on advanced countries. Abstracting from factor endowments, they use scale and (more recently) agglomeration economies to explain trade patterns (Krugman, 1986 and 1991). Its main focus is intra-industry trade between industrial countries; in developing countries, trade remains mainly between industries and is explained by traditional factor endowments. Interestingly, 'learning' appears in some models as an explanatory variable, but it is taken as a form of scale economies over time: passive, automatic and predictable, dependent only on the volume of production. As such, it raises no policy issues, apart from the possibility of gaining first mover advantages. Some analysts also note the existence of cumulative causation, externalities and path dependence as determinants of competitiveness (Venables, 1996). However, this applies primarily to agglomeration processes, not to technological learning.

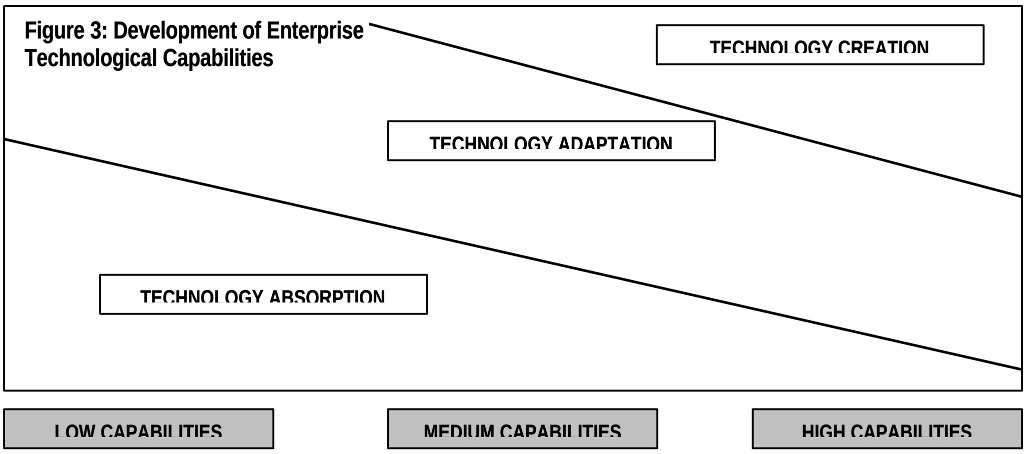
In sum, it is difficult to find any existing trade theory that bases the analysis of comparative advantage in developing countries on technology, and so on the learning and skill development processes that underlie technological learning.

There is a large literature, based on micro-level research in developing countries, that suggests that this approach is oversimplified and misleading: it misrepresents how firms become technically efficient and draws the wrong policy conclusions. The technological capability approach, drawing on the evolutionary tradition of Nelson and Winter (1982), leads to a very different understanding of the process of technological learning. It also leads to different policy conclusions on the relevant markets and institutions. This literature (reviewed by Lall, 1999) shows that there is a significant difference between capacity and capability. Firms in developing countries operate with imperfect knowledge of technological alternatives. Finding technologies is a difficult, often costly, process. More important, once a technology is imported, its efficient use requires them to undergo a process of developing new skills and knowledge to master its tacit elements. The process can be costly, prolonged, risky and unpredictable. It can involve externalities and coordination problems, when skills and technology 'leak' out to other firms, or when the efficiency of one firm depends on learning processes in other firms (say, its suppliers). Thus, the learning process can face 'market failures' which prevent, curtail or distort it. The failures are particularly large in markets for skills and technology, prone to widespread information deficiencies, uncertainty and externalities.

Some technologies are more difficult and costly to master than others because the learning process is longer and more uncertain, and involves more advanced skills, greater technological effort and more externalities and coordination problems. Technology development involves a deepening process: starting from easy technologies and moving into difficult ones, and, within given technologies, starting from simpler functions (final assembly) and moving into more complex functions (improvement, design and development). More difficult technologies offer greater rewards in terms of further learning because they generally have greater potential for further productivity increase. Several also have larger spillover effects, in particular those related to mechanical and electrical engineering. Simple technologies, by contrast, tend to have limited learning potential, smaller scope for technological upgrading and less spillover benefits to other activities. Unless countries move into more complex technologies, their competitive edge is highly vulnerable to easy entry, technical change and market shifts. Thus, the process of competitive industrial development is one of promoting more demanding and deeper forms of learning.

The same process applies to individual firms (Aharoni and Hirsch, 1997). Their capabilities to absorb, use, adapt and build upon technical knowledge must deepen with time if they are to maintain a competitive edge. The deepening process requires a shift from simple operational skills at one end to advanced innovative skills at the other. Since all advantages erode with time, skills and knowledge must be continually renewed. The essence of competitiveness is to move from imitable assets (such as absorptive capabilities) to more proprietary assets (adaptation, improvement and innovation). Figure 3 illustrates the shifting structure of technological capabilities as (successful) firms mature and enhance their competitiveness.

Figure 3: Development of Enterprise Technological Capabilities



In the capability approach, comparative advantage can vary significantly between developing countries according to their systems for experience-based skill and technological learning, even if they have similar ‘endowments’ in the conventional sense. The evolution of competitiveness depends on how effectively a country allows its enterprises to access and master new technologies, and to cope with increasingly difficult learning, over time.

Some traditional determinants of comparative advantage remain relevant – but only when their assumptions conform to the needs of capability building. For instance, relative factor costs *per se* do affect trade patterns, but only when technological conditions resemble the conditions of perfect competition, universally available technologies and no learning costs that form the basis of simple H-O models. These apply to a few simple technologies, where small firms making can undertake competitive production of undifferentiated products, easily mastering the technologies involved. Under these conditions, and wage differences by themselves become an important competitive factor. While this seems to 'explain' a significant part of exports by developing countries, however, it does not mean that the H-O assumptions are generalisable: such technologies and products form a small part of the competitive edge of developing countries. More importantly, the H-O model does not provide a satisfactory account of trade patterns even in these simple technologies. It does not take account of the learning that is needed here to become internationally competitive, and of the consequent differences in success with labour-intensive exports in the developing world. It fails signally to explain how different countries upgrade their export structures at very different rates, when starting with very similar factor endowments. And it fails to explain the role of foreign buyers and investors in furnishing the complex elements of low technology exports – design, marketing, branding and distribution.

Similarly, theories that use human capital as a factor of production are right to the extent that skills are vital to competing in complex technologies. This explains why rich countries (with higher education levels) specialise in the export of relatively complex products. However, these theories do not consider how competitive skills are developed. A base of formal education is a *necessary* but *not sufficient* for efficiently using technologies: technology specific skills and learning are also necessary. Where mastering new technologies involves costly, uncertain and externality-prone learning, establishing an advantage requires that human resources be combined with (and enhanced by) purposive technological effort. The degree of effort rises the more advanced the technology and the more technology-specific the learning required. Countries with similar skill endowments thus vary in their export patterns, depending on learning abilities and trajectories.

Finally, neo-technology theories also confuse necessary with sufficient conditions. Developing countries rely primarily on foreign technologies, and access to foreign technologies or FDI is necessary to provide the initial input into learning. However, this does not ensure that all low wage countries use imported technologies with equal efficiency – their own capability determines their competitiveness.

2.3 Strategies to Develop Skills and Capabilities

What affects 'national learning abilities'? A number of factors interact to determine what and how well enterprises learn: macroeconomic conditions, trade and competition policies, factor markets and institutions (Lall, 1996). In the presence of widespread market failures, the evolution of learning *depends on how these failures are remedied*. Thus, government policies on learning become basic determinants of comparative advantage (Lall, 1998). Government interventions are not, as in much of neoclassical theory, necessarily distorting – on the contrary, policies to remedy market failures are legitimate factors deciding comparative advantage. The case is identical to that on the role of government in industrialisation more broadly (Stiglitz, 1996). There is a valid case for policies to coordinate, guide and subsidise learning, and to develop such factors as skills and technology where externalities and information failures are particularly pervasive.

To simplify, successful strategies in the developing world to promote skills and learning for competitiveness fall under two broad headings.

- *Autonomous strategies* to accelerate and guide learning by domestic firms, by promoting infant industries, coordinating investments in related activities, overcoming externalities, directing credit, and developing specific skills and institutions.

- *FDI dependent strategies* that rely on TNCs to lead export growth and upgrading. This has two subsets of strategies: those based on targeting TNCs and using industrial policy to guide them into more technology-intensive activities, and more passive strategies that rely on market forces to attract and upgrade activities.

Korea and Taiwan are leading examples of the national-led strategy, Singapore and Malaysia of the FDI-led targeted strategy, and Mexico and Thailand of the FDI-led market-led strategy. The categories are somewhat simplified; many countries have mixtures of strategies. With the march of liberalisation and globalisation, moreover, there is greater convergence of strategies. Nationalistic countries are liberalising on FDI, and most developing countries are moving towards the FDI-led strategy in complex, technology-intensive exports.

This is understandable: MNCs have several advantages over local firms in coping with using new technologies ('new', that is, to a particular location) and exporting the output. 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 and finance to implement the learning process. Their advantages in exporting include access to major 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 a local firm, not only because it may not have the technological competence but also because it faces higher transaction and coordination costs in integrating into an international corporate system.

While the FDI-led strategy has advantages, and is easier in that MNCs bring in the missing factors needed for competitiveness, simply opening up to FDI is not a complete answer to competitiveness problems. It does not absolve the government from helping develop local capabilities. MNCs transfer the technologies suited to existing capabilities in host economies. Where skills, supplier capabilities and technical knowledge are low, they import simple labour-intensive technologies and create the capabilities to use these efficiently. They do not invest in creating more advanced capabilities that need more sophisticated skills, or transfer advanced functions that are efficiently centralised elsewhere. Only the government can upgrade the skill creation system or boost supplier capabilities. If they do not, MNC export activity can remain technologically stagnant at low levels. Moreover, there are market failures in the FDI process itself. Effective promotion and targeting of investors can allow a country to attract higher quality FDI, and so a more dynamic export structure, than a passive *laissez faire* policy.[2]

More important, a national-led strategy can create broader, deeper and more flexible capabilities than an FDI-dependent strategy, given the technologies used. The learning process within foreign affiliates may remain curtailed and shallow compared to that in 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 such functions as advanced engineering or design, which MNCs tend to centralise in industrial countries. As they grow and mature, developing countries can undertake these functions efficiently; indeed, it is imperative that they do so to support their comparative advantage.

It is important to note that many policies needed to promote technology-specific skill development are constricted by the emerging 'rules of the game'. Many of the instruments used by countries like Korea and Taiwan are no longer permitted by the new rules of world trade and investment. These include the protection of selected infant industries, directed and subsidised credit to selected activities and enterprises, local content rules, imitation and reverse engineering, restrictions on inward FDI, interventions in technology purchases, export subsidies and so on. These interventions were necessary to promote particularly difficult forms of learning and

[2] For a study of how Costa Rica used targeted promotion to attract Intel's first major semiconductor plant in Latin America see Spar (1998).

technology diffusion, and provided the base for technology-specific skill accumulation. Without them, countries are likely to be confined to a slower pace of specific skill creation.

At the same time, the new rules promote other forms of technology specific skills and learning. The opening of economies to freer competition, while restricting firms from investing in more risky and difficult learning, forces them to upgrade their skills base and direct learning in more 'healthy' directions. By reducing inefficient levels of protection and rent-seeking opportunities, it reorients the whole economy to world markets and technologies. Other policy avenues for upgrading skills remain open – and become all the more important. These include formal education and training, enterprise-financed training and restructuring of the education system to new skill needs. They also include strengthening of the technology infrastructure and linkages between education, research and technology institutions and the productive sector. These policies constitute the core elements of competitiveness strategies undertaken in many advanced industrial countries.[3] Whether or not this would suffice for developing countries, with less efficient markets and institutions, is another matter. We return to policy issues later.

3. The New Context for Competitiveness

3.1 Technological Change and Export Patterns

The best way to illustrate the changing nature of global competition and the role of technology is through recent trends in world manufactured exports (Table 1). We separate manufactures from primary products and divide the former into technological categories: resource based, low technology, medium technology and high technology. As the names indicate, technology-intensity rises along these categories.

The table shows that *advanced technologies are the engine of trade growth*. Exports of primary products (not shown) grew at below 2 per cent per annum during 1980-96, compared to over 8 per cent per annum for manufactures. Within manufactures, growth rates for the categories

Table 1: Evolution of World Manufactured Exports by Technological Categories

	Shares (%)				
	1980	**1985**	**1990**	**1995**	**1996**
Resource based	19.5	19.3	15.5	14.0	13.7
Low tech	25.3	23.4	23.7	22.0	21.3
Medium tech	38.6	37.3	38.5	36.9	37.2
High tech	16.5	20.1	22.2	27.1	27.7
	Rates of Growth (% p.a.)				
	1980-85	**1985-90**	**1990-95**	**1995-96**	**1980-96**
Resource based	2.0	10.1	6.4	-0.2	5.7
Low tech	0.7	15.3	6.9	-0.9	6.9
Medium tech	1.6	15.7	7.7	3.0	7.8
High tech	6.3	17.4	13.0	4.5	11.6
Total	2.3	15.0	8.6	2.1	8.1

Source: Lall (1998)

[3] An excellent example is the fourth competitiveness White Paper of the UK Department of Trade and Industry (1998).

rise with technology intensity. The highest rate is for high technology (fine chemicals, electronics, aircraft and precision instruments) followed by medium technology products (machinery, chemicals, simple electronics and transport equipment). Low technology products (textiles, clothing, toys, simple metal and plastic products, footwear), the main comparative advantage of developing countries, grow more slowly. Resource based products grow the slowest. Medium technology products still constitute the largest single category in world trade, but, at present growth rates, a small number of high-tech products are set to exceed them soon. Of the fifty most dynamic exports in the world over 1980-1996, medium and high technology products accounted for a full 75 per cent by value. Within these 'ultra-dynamic' exports, high technology products again grew the fastest, followed by medium technology products. Low technology products were the slowest growing category.

Interestingly, the growth rate of high technology products outpaces those of other products even more in the relatively slow-growth period of 1990-96. This suggests that technology intensive products *as a whole* are less vulnerable to cycles (though some high-tech products like semiconductors are notoriously cyclical). In general, therefore, export dynamism involves upgrading the technological structure of exports. It also involves moving up the technology scale *within* each industry, though the trade data do not demonstrate this directly. Some countries manage high growth rates within low technology products (like China, see below) by enlarging their market shares at the expense of competitors. However, there are reasons to believe that export structures dominated by technology intensive products have better growth prospects than do others.

- Activities with the rapid product or process innovation generally enjoy faster growing demand as compared to technologically stable activities.[4]

- Technology-intensive activities are less vulnerable to entry by competitors compared to low technology activities where scale, skill and technology requirements are low. A low-technology export structure is a good starting point, but it can sustain export growth only by taking shares from other low technology exporters. In relatively slow-growing markets, this is possible but difficult. It needs considerable technical effort, high skill levels and differentiation.

- *Ceteris paribus*, technology-intensive activities lead to faster *growth* in capabilities and higher *quality* capabilities. They offer higher learning potential and greater opportunity for the continued application of science to technology.

- Capabilities in technology-intensive activities are more attuned to technological and market trends, and so are more *flexible* and *responsive* to changing competitive conditions.

- A technology-intensive structure is likely to have larger *spillover* benefits to other activities and to the national technology system.

The export growth rates of developing countries are consistently higher than of developed ones. While this may be expected (since they start with a small base), it is less so that developing countries are now significant exporters of high technology products. By 1995, their high technology exports ($299 billion) comprised the largest single export category, higher in value than low

[4] To quote the US National Science Foundation, "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." NSF (1998), chapter 6.

technology exports ($266 billion). Their world market shares of high-tech products, nearly 30 per cent, was growing rapidly, and would exceed that of low technology products in the near future if past growth rates continue.

The figures suggest that the developing world is well poised – in terms of the competitive base – to gain from emerging technological forces. This would be premature, for two reasons. First, sophisticated manufactured exports emanate from a very small number of countries, and their competitiveness determines the overall patterns. Second, a large proportion of ostensibly high-tech exports consists of simple, labour-intensive final assembly; in other words, the *depth* of local competitiveness differs by country.

Table 2: Growth Rates and Shares of Manufactured Exports by Technological Categories, 1980-96 (%)

	Growth Rates (% p.a.)				Developing Country Shares in World (%)		
	World	Industrialised Countries	Developing Countries	Developing less Industrialised	1980	1996	Change in share
Total	8.1	6.6	14.0	7.4	9.8	23.0	13.3
Resource based	5.7	5.2	7.4	2.2	17.9	23.1	5.2
Low technology	6.9	5.9	12.6	6.7	15.0	34.4	19.4
Medium technology	7.8	7.2	17.4	10.2	3.0	11.5	8.6
High technology	11.6	9.8	21.1	11.3	8.1	29.8	21.7

Source: Lall (1998)

Take concentration at the regional level (Table 3). Asia dominates with nearly 80 per cent of total manufactured exports from developing countries in 1980 and 1996. LA1 (Latin America including Mexico) is a distant second, accounting for under a fifth, but raises its share over the period at the expense of SSA and ME (Middle East and North Africa). SSA1 (Sub-Saharan Africa including South Africa and Mauritius) suffers significant losses of market share in total and in all categories, while SSA2 (excluding these two 'outliers') practically disappears except for RB, where it contributes less than 1 per cent. Exposure to world markets has been insufficient to stimulate industrial exports in much of Africa, despite very low wages and widespread trade liberalization because of the absence of the policies, institutions and skills to manage technological upgrading.

At the country level, only thirteen – the four mature Asian Tigers, four new Tigers (Indonesia, Malaysia, Philippines and Thailand), China, India, and the three large Latin American economies – account for over 93 per cent of manufactured exports from developing countries. The level of concentration rises over time: in the mid-1980s, their share was around 80 per cent. It also rises with technological sophistication. The leading five countries account for 62 per cent of the developing world's total manufactured exports in 1996. Their share is 46 per cent in resource based, 63 per cent in low technology, 69 per cent in medium technology, and 78 per cent in high technology, exports. The same countries dominate most categories: China, Singapore, Korea, Taiwan, and Mexico, with Malaysia, Thailand, Indonesia and Brazil on the fringes.[5]

[5] The high level of dispersion and concentration in exports persists if we correct for the country size effect by taking *per capita* manufactured exports. In 1995, the top five developing exporters are Singapore, Taiwan, Hong Kong, Malaysia and Korea, with average *per capita* exports of $9,474 (excluding Singapore, which is an outlier with *per capita* exports of $32,392, the top 4 have exports of $3,744). The bottom five countries have average *per capita* exports of $8.2. The ratio

Table 3: Regional Shares of Developing Country Manufactured Exports			
	1980	1990	1996
Total Manufactures			
Asia	78.1%	76.7%	78.4%
LA1	7.6%	12.3%	16.7%
LA2	N/A	9.0%	7.5%
SSA 1	7.0%	2.4%	1.4%
SSA 2	2.0%	0.5%	0.1%
ME	7.4%	8.6%	3.5%
Resource Based Manufactures			
Asia	60.4%	57.7%	64.8%
LA1	13.9%	19.4%	27.7%
LA2	N/A	16.0%	22.9%
SSA 1	11.0%	5.2%	2.6%
SSA 2	4.8%	1.4%	0.8%
ME	14.7%	17.7%	4.9%
Low Technology Manufactures			
Asia	89.2%	81.1%	79.7%
LA1	3.6%	9.0%	12.1%
LA2	N/A	7.5%	6.1%
SSA 1	4.9%	2.1%	1.7%
SSA 2	0.3%	0.3%	0.0%
ME	2.3%	7.8%	6.5%
Medium Technology Manufactures			
Asia	73.7%	66.6%	66.6%
LA1	8.5%	21.7%	28.1%
LA2	N/A	12.0%	10.6%
SSA 1	8.4%	2.6%	2.5%
SSA 2	0.8%	0.5%	0.0%
ME	9.4%	9.2%	2.8%
High Technology Manufactures			
Asia	96.6%	94.4%	88.6%
LA1	1.6%	4.1%	10.6%
LA2	N/A	2.6%	1.1%
SSA 1	1.1%	0.4%	0.2%
SSA 2	0.2%	0.1%	0.0%
ME	0.7%	1.1%	0.5%

Definitions: 'Asia' includes all countries in Asia except for Japan, the Central Asian republics and those included in the Middle East. 'LA1' includes Mexico, 'LA2' excludes it from the Latin American region. 'SSA1' covers all countries in Sub-Saharan Africa including South Africa and Mauritius; 'SSA2' excludes these two. 'ME' stands for the Middle East, and includes all Arab countries in Asia and North Africa, plus Iran and Turkey.

There are significant differences in national patterns of specialisation (Table 4). Six of these countries – Philippines, Singapore, Malaysia, Mexico, Korea and Taiwan – have very high (over 60 per cent) shares of advanced (high plus medium technology) products in their manufactured exports. India, China, Indonesia and Argentina are the technological laggards (with shares of below 40 per cent). Even these laggards are far more advanced than other developing countries, around half of which have shares of advanced exports below 20 per cent, and around one-quarter below 10 per cent.[6] These differences suggest that only a few countries are set to enjoy fast growth in the new technical 'paradigm'. Many others are not set to enter manufactured exports in any significant way; some are large exporters of manufactures but concentrate on low technology products with few signs of graduating. Interestingly, the Latin American export structure has regressed technologically after liberalization: with the striking exception of Mexico, the others have developed exports in resource based rather than high technology activities (Benavente *et al.*, 1997).

Because of the significance of high-tech exports, Annex Table 1 shows the world market shares of the leading thirty exporters in the world in 1996, and the changes in their shares since 1985. The leading developed exporters (USA, Japan, Germany and UK) lose market shares over the period, while the newer Asian exporters (China, Philippines and Thailand) register dramatic rises. Of the mature NIEs, Singapore is the leader (though around half of Singapore's exports are re-exports). Taiwan and Korea follow Singapore (though by 1996 Malaysia is a larger exporter of high-tech products than Korea); they all have healthy increases in their market shares. Of the Latin American countries, only Mexico is a significant high-tech exporter; practically all is final assembly from it *maquiladora* plants (local content here is still lower than in most Asian countries).

The depth of domestic technological and skill contribution to exports differs by country. There are indirect ways to gauge this: the *technological sophistication* of the processes located in the exporting country, the level of *domestic content* (physical and technological) and the *main agents* of export activity (TNCs as compared to local enterprises). In terms of process sophistication and domestic content, the clear leaders in high and medium technology exports are Korea and Taiwan. They have

of the top 5 to the bottom 5 is 1160 including Singapore and 394 excluding it. The ratios for the top and bottom 10 are 278 including Singapore and 106 excluding it. If we take total *per capita* manufactured exports by developing countries, the share of the top 5 countries is 67%, higher than their share of total manufactured exports (62%).

[6] These include relatively large exporters of manufactures like Pakistan, Sri Lanka and Bangladesh.

Table 4: Technological Structure of Manufactured Exports, 1996 (% of each country's total manufactured exports)				
	Resource Based	Low Technology	Medium Technology	High Technology
Hong Kong	4.4	52.7	14.0	28.9
Singapore	12.7	7.9	14.0	65.4
Korea	9.4	28.4	26.6	35.7
Taiwan	5.1	33.9	20.2	40.9
Indonesia	34.9	41.9	8.5	14.7
Malaysia	17.8	13.1	8.7	60.4
Thailand	14.5	35.6	13.5	36.3
Philippines	5.9	19.1	7.2	67.8
India	31.1	52.3	13.1	4.4
China	9.8	56.3	13.4	20.6
Argentina	49.1	18.8	28.8	3.3
Brazil	25.6	31.8	34.0	8.6
Mexico	7.1	20.9	35.2	36.9
Developing Asia	11.4	32.3	15.8	40.4
Latin America, Caribbean	22.8	23.1	31.3	22.8
Sub-Saharan Africa	25.0	36.8	32.3	6.0
Sub-Saharan Africa (excl. Mauritius, S. Africa)	88.5	5.2	4.6	1.7
Middle East, North Africa	19.5	59.6	15.3	5.6
World	13.7	21.3	37.2	27.7

Source: Calculated from UN Comtrade data.

high levels of local input into complex exports and provide much of the equipment, designs and skills needed in the production chain. The lowest content in high-tech exports is in countries like Mexico, Indonesia and Thailand. Singapore has low levels of physical domestic content, but is specialised in complex processes and furnishes considerable skills and designs locally.

As far as the agents of export activity go, domestic enterprises account for the bulk of manufactured exports from Korea, Taiwan, Hong Kong and India. TNCs dominate manufactured exports from Singapore, China, Malaysia, Thailand, Philippines, Indonesia and the Latin American countries. Of technology intensive exporters, *only Korea and Taiwan show significant domestic competence* – the others depend heavily on foreign affiliates, mainly to assemble imported components. For countries lower down the technological scale, many economies have FDI in low technology assembly of clothing (driven by the quota allocation system under the Multi-Fibre Agreement). Relatively few have 'graduated' from this into high technology products – the main site for such graduation has been South East Asia, because of the TNC relocation of electronics assembly.

By any measure of technological competence, therefore, Korea and Taiwan lead the developing world. As illustrated below, they developed their competence by heavy investments in skills, technology and institutional development, guided by pervasive industrial policy (Lall, 1996). Their larger enterprises are now leading TNCs, with considerable technological and marketing muscle. Singapore's success within a highly TNC-dependent strategy was also due to pervasive industrial policy on investment, skills and infrastructure (Lim, 1998).

3.2 FDI and Competitive Success

World trade is increasingly related to TNC activity. TNCs now account for very 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 TNCs are increasing their

Table 5: FDI Inflows, 1986-97

	INFLOWS ($ m)							INFLOWS (shares)	
	1986-91 Ave.	1992	1993	1994	1995	1996	1997 (prov.)	1986-91	1997
World	159,331	175,841	217,559	242,999	331,189	337,550	400,486	100.0%	100.0%
Developed countries	129,583	120,294	138,887	141,503	211,465	195,393	233,115	81.3%	58.2%
West Europe	66,470	85,837	83,877	78,417	122,779	99,954	114,857	41.7%	28.7%
North America	54,674	23,662	48,302	53,571	69,596	82,851	98,994	34.3%	24.7%
Other	8,439	10,796	6,708	9,515	19,090	12,588	19,263	5.3%	4.8%
Developing countries	29,090	51,108	72,528	95,582	105,511	129,813	148,944	18.3%	37.2%
North Africa	1,196	1,582	1,579	2,364	1,262	1,313	1,811	0.8%	0.5%
Sub-Saharan Africa	1,673	1,589	2,068	3,329	3,874	3,515	2,899	1.1%	0.7%
Latin America, Caribbean	9,460	17,611	17,247	28,687	31,929	43,755	56,138	5.9%	14.0%
Developing Europe	88	214	264	405	467	1,029	796	0.1%	0.2%
West Asia	1,329	1,827	3,447	1,518	-746	303	1,886	0.8%	0.5%
Central Asia	4	142	424	896	1,561	2,084	2,627	0.0%	0.7%
South and East Asia	15,135	27,683	47,348	58,265	66,571	77,624	82,411	9.5%	20.6%
Central and Eastern Europe	658	4,439	6,143	5,914	14,214	12,344	18,424	0.4%	4.6%
Memo Item									
Least Developed (43)	781	1,463	1,747	844	1,096	1,965	1,813	0.5%	0.5%
African LDCs	590	470	558	548	880	1,214	1,162	0.4%	0.3%
Oil exporting (24)	8,786	15,019	17,214	23,820	21,786	24,106	30,890	5.5%	7.7%

Source: UNCTAD, *World Investment Report 1998*.

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 the trade in intermediate products. Thus, a very large part of TNC trade is now *intra-firm*. In the USA, for instance, exports by TNCs to their majority-owned affiliates in 1996 comprised 48 per cent of parent company exports, up from 41 per cent in 1977. Half of exports by foreign TNCs 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 part of world trade by developing countries requires the participation of TNCs. This holds even more for the most dynamic products in trade: complex, technology intensive and differentiated manufactured products.

Table 6: Leading 10 developing country recipients of FDI	
1986-91	1997
Singapore	China
China	Brazil
Mexico	Mexico
Hong Kong	Singapore
Malaysia	Argentina
Thailand	Chile
Brazil	Indonesia
Argentina	Venezuela
Taiwan Province	Malaysia
Korea, Rep. of	Thailand
Share 64.4%	Share 75.9%
Source: Calculated from UNCTAD (1998).	

However, few developing countries are able to participate in this dynamic system of TNC trade and production. FDI flows to the developing world are rising rapidly (Table 5), from an average of $29 billion in 1986-91 to $149 billion in 1997. The memo item illustrates the marginalisation of the least developed countries, particularly those in Sub-Saharan Africa. At the national level, Table 6 shows the leading 10 developing country destinations of FDI flows in 1986-91 and 1997 and their shares in total flows to the developing world. These 10 countries now account for nearly 80 percent, the top 25 for 95 percent. The identities of the recipients have changed somewhat: Korea and Taiwan dropped out of the list by 1996, to be replaced by Chile and Venezuela. At the other end, the bottom 50 developing countries together account of 0.8 percent in 1997, up marginally from zero percent earlier.

3.3 Technology Flows

All developing countries depend on foreign technology as the primary source of new productive knowledge, and access it in many ways. FDI is one major form, equipment imports and formal technology contracts are another; but there are also various other means, such as informal contacts, copying and reverse engineering, migration, export subcontracting and OEM arrangements and so on. Not all of these are easy to measure.

Apart from FDI flows, it is difficult to quantify technology flows to developing countries. Patchy data are available for *royalty and technical fees* paid overseas. In 1997 the developing world as a whole paid $5.8 billion for technology, 14 per cent of the world total of $41 billion.[7] This had risen from $757.5 million in 1980, or 8.4 per cent of the world total. The largest single purchaser of foreign technology in 1997 was Korea ($2.4 billion), accounting for 42 per cent of the total for developing countries (up from 8 per cent of the total in 1980). It was followed by Thailand ($804 m.), China ($543 m.), Mexico ($501 m.), Argentina ($241 m.), Philippines (158 m.) and India ($151 m.). Data are not available on other countries like Taiwan, Singapore, Brazil or Malaysia. The whole of Sub-Saharan Africa paid $84 m., 1.4 per cent of the total for the developing world. Least developed countries paid $9 m. (those in Sub-Saharan Africa $1 m.).

As with trade, most royalties and licence fees flow *between TNC affiliates*. USA receives 76 per cent of its foreign technological earnings from affiliates of its TNCs, Japan 65 per cent and Germany 95 per cent. To the extent that these data capture the volume of technology flows, therefore, the finding that TNC participation is increasingly important to building competitiveness is reinforced.

[7] Data collected by UNCTAD for the *World Investment Report 1999*.

3.4 Technological Activity

Domestic technological effort in developing countries is, as noted earlier, essential to using technologies efficiently and to deepening it over time. Much of this effort is informal – learning, incremental improvements, adaptations and copying – rather than formal R&D effort. This is naturally difficult to measure or compare across countries. In the initial stages, formal R&D is not needed to use simple imported technologies effectively. Over time, however, it becomes important as countries use complex technologies. R&D then becomes necessary to monitor, absorb and adapt technologies, to lower transfer costs, and to obtain technologies not easily available on licence.

Let us consider relative R&D performance internationally (Table 7). There is, again, enormous differentiation in the developing world. Productive enterprise financed R&D as a share of GNP 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 accounts for 86 percent of R&D scientists and engineers in the developing world, Sub-Saharan Africa for 0.3 percent. Even these averages are misleading. The mature NIEs vary between themselves in technological effort (Table 8). The leader in terms of R&D propensities, by far, is the Republic of Korea. The share of enterprise financed R&D in GNP is the highest, not only in the developing world, but also in the world as a whole. It runs neck and neck with Japan, and outpaces all other industrial countries. Taiwan Province comes next in the developing world, spending around the same proportion as the UK, higher than the Netherlands or Italy. In terms of *per capita* R&D spending, the leader is Singapore (here industrialised countries have much higher figures), with Korea a close follower. Hong Kong does not publish R&D data, but reports suggest that total national R&D is only 0.5% of GNP and enterprise financed R&D is a very small proportion of this. The three mature NIEs are clearly in a different class from the rest of the developing world.

Table 7: R&D Propensities and manpower in major country groups (simple averages, 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	Government	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**
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.*

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 8: Technological Effort in Major Developing Countries (Ranked by Enterprise Financed R&D % GNP)					
	Country	Year	Total R&D (% GNP)	Ent. Fin. R&D (% GNP) (a)	R&D per capita 1995 ($) (b)
1	Korea	1995	2.7	2.27	261.9
2	Taiwan	1994	1.8	1.00	198.0
3	Singapore	1994	1.1	0.69	294.0
4	South Africa	1991	1.0	0.50	31.6
5	Malaysia	1992	0.4	0.17	15.6
6	Chile	1994	0.8	0.16	38.6
7	India	1995	1.1	0.14	3.7
8	Turkey	1995	0.4	0.12	11.1
9	China	1993	0.6	0.11	3.7
10	Mexico	1995	0.4	0.09	13.3
11	Brazil	1985	0.4	0.08	14.6
12	Argentina	1996	0.3	0.05	24.1
13	Peru	1984	0.2	0.05	4.6
14	Indonesia	1993	0.2	0.04	2.0
15	Thailand	1991	0.2	0.02	5.5
16	Sri Lanka	1994	0.2	0.02	1.4
17	Philippines	1984	0.1	0.02	1.1
18	Mauritius	1992	0.4	0.01	13.5
19	Venezuela	1992	0.5	0.00	15.1
20	Pakistan	1990	0.3	0.00	0.8
21	Nigeria	1987	0.1	0.00	0.3

Sources: UNESCO, *Statistical Yearbook 1995;* OECD; national sources.
Notes: (a) R&D financed by productive enterprises.
(b) Last available total R&D as % of 1995 income using p.c. income data from *World Development Report 1997.*

TNCs account for substantial portions of technological effort in countries like Singapore, Malaysia, Brazil and Mexico. Interestingly, the latter two, while attracting most US TNC affiliate R&D, are poor performers in overall terms. There is little complementarity here between TNC R&D and local R&D effort. In Korea and Taiwan, local R&D takes precedence, driven by strategies to restrict FDI inflows and reverse the passive reliance on foreign technologies that marks most countries.

How large is *R&D by TNCs in developing countries* compared to their overall research effort? For US TNCs, this constitutes only 1 per cent of the total R&D, under 8 per cent of their overseas R&D spending. It is very concentrated by destination. Over one-fourth of developing country R&D by US TNCs is in Brazil, followed by Mexico (20 per cent), Singapore (19 per cent) and Taiwan (12 per cent). Of the other major Asian countries, Hong Kong accounts for 6 per cent, Malaysia for 3 per cent, Korea and Philippines for 2 per cent each, China for 0.8 per cent, Indonesia and India for 0.6 per cent each and Thailand for 0.3 per cent. The whole of Sub-Saharan Africa (excluding South Africa) accounts for 0.1 per cent.

While TNC affiliate R&D bears some relation to local technological effort, at the country level there are important differences. The largest investor in R&D, Korea, receives relatively little TNC R&D. The reason is obvious: nationalistic government policies that have held back inward FDI for decades and curtailed its role. It is important to note, however, that the growth of Korean R&D is *causally related* to its restrictions on FDI. As with Japan earlier, it was only by curtailing easy reliance on 'ready made' TNC technology that it could force the deepening of domestic R&D capabilities. Brazil and Mexico, the largest recipients of TNC R&D, have relatively little enterprise financed R&D. The substitution between TNC and domestic innovative effort is evident.

4. Skill Formation in Developing Countries

4.1 Differing Skill Needs with Levels of Development

Building human resources involves two distinct processes — *skill development* through formal education and training and *capability formation* through specific technology-based experience. The requirements of both differ by the level of development. Moreover, each level and strategy reflects and produces specific kinds of skills and capabilities (Figure 4).

The move from one level of competitiveness to another requires changing both the skill creation system and the way that the productive system uses it, contributes to it and interacts with it.

Figure 4: Human Capital and Industrial Development Patterns

Level/Pattern of Industrial Development	Human Capital Profile: Skills	Human Capital Profile: Technological Capabilities
Low levels, mainly simple assembly and processing activity for domestic market	Literacy, simple technical and managerial training. Practically no in-firm training except informal on-job learning	Ability to master assembly technologies, copy simple designs, repair machines, but many activities operate well below world best practice levels of technical efficiency.
Intermediate level, with export-oriented activities in light industry, some local linkages in low-tech products	Good secondary & technical schooling and management financial training. Low base of engineering and scientific skills. In-house training mainly by export-oriented enterprises. SMEs have low skill levels.	World-class assembly, layout, process engineering and maintenance in export oriented industries. In others; capability to undertale minor adaptations to processes and products. Little or no design/ development capabilities. Technology institutions weak
Deep industrial structure but mainly inward-oriented; technological lags in many activities	Broad bur often low quality schooling, vocational and industrial trainin. Broad engineering base. In-house training lagging. Training institutes de-linked from industry. Management and marketing skills weak. SMEs have some modern skills.	Process mastery of capital and skill intensive technologies, but with inefficiencies. Considerable backward linkages, significance adaptaion of imported technologies. Little innovation, low linkages with universities and technology institutions
Advanced and deep industrial structure, with many world-class activities, own design & technology base	Excellent quality schooling and industrial training High levels of university trained managers, engineers and scientists.. Training institutes responsive to industrial needs. Large investments in formal and informal in-firm training . SMEs have high skill levels and competence	Ability to monitor, import and adapt state of art advanced technologies. Good design and development capabilities in sophisticated technologies. Deep local linkages with suppliers, buyers, consultants, universities and technology institutions.

In general, the more 'mature' an economy and the higher the income level at which its competitiveness is achieved, the greater and more diverse its human capital needs. For economies at lower levels of development, gearing competitiveness to higher levels of sustainable income requires the skills to deal with progressively more complex, advanced and fast-changing forms of information and technology. The skill profile can be simply described:

- *At the worker level*: Greater availability of better educated and trained workers, with higher quality of education (in particular numeracy and IT skills), more relevant to evolving technological needs. Greater flexibility in skills and work attitudes, leading to more efficient and cooperative team work and multi-skilling on the shop floor, more receptivity to and ability to manage new technologies, more willingness and ability to suggest improvements to products and processes. Continuous upgrading and retraining of employees. Greater range of specialized training institutes for particular technologies, operated by industry, associations, the government and international consortia.

- *At the technical and supervisory levels*: As above, plus more training for team-working, handling computer aided manufacturing methods, operating total quality management and continuous improvement systems, feeding back product and process improvements, liasing with engineering and development departments. The provision of proper incentives for implementing the best technologies and work practices. *At the engineering levels*: Larger supply of highly-trained engineers with practical knowledge of industrial technologies and needs, spanning wider range of sub-disciplines, capable of undertaking more advanced functions in product and process design, quality management, reliability and cost in new activities, interacting with and helping vendors and subcontractors, using research results and drawing upon technology institutes for improvements.

- *At the management and marketing levels*: Highly trained managers able to launch and operate 'flatter' systems with more intense interactions with suppliers and buyers, keep pace with globalization, absorb and act upon increasing information flows and encourage investments in innovation and marketing. Most important, managers must be able to change traditional human resource management and development policies (to the extent that they have any) to take account of new demands on skills and team-working, providing incentives for improvement and productivity, and give opportunities for continuous training and learning.

- *At the innovation levels:* Scientists and engineers of the quality, training and knowledge able to absorb and build upon the most advanced technologies, design and test new products and processes, interact with research laboratories and keep track of relevant developments in basic science. Science and technology support institutions have to be better equipped and staffed, and provided the motivation to conduct research relevant to industrial needs and to establish close linkages with the industrial sector.

As the industrial sector grows more complex and sophisticated, the challenge of providing better and more appropriate human capital becomes more important. In the process, relevant institutions develop and firms become more conscious of the need for and training. However, given the complexity of the information involved, the long-term nature of skill investment and the inherent uncertainties and externalities, there can be widespread market failures in human capital formation. As a result, markets can fail to provide properly an economy's skill needs and to keep with its changing profile. There is a clear need for policy support, accepted by governments of all political and economic persuasions. Surprisingly, it is the richest countries, with the most developed skill bases, that worry most about human capital problems.

4.2 Investments in Skill Creation: Educational Enrolments

Skills arise from a variety of sources: formal education, vocational training, in-firm training, specialized employee training outside the firm, and learning on the job. The relative importance of these sources varies by economic structure, the nature of knowledge being utilised and the level of

Table 9: Enrolment Ratios (percentage of age groups)

Mean for group (unweighted)	**Enrolment Ratios (1980)**			**Enrolment Ratios (1995)**		
	1 level	2 level	3 level	1 level	2 level	3 level
Developing countries	**88**	**34**	**7**	**91**	**44**	**11**
Sub-Saharan Africa	74	17	1.3	78	23	2.9
MENA	88	42	9.7	92	59	14.3
Latin America	102	45	14.1	103	53	18.1
Asia	95	44	7.4	99	54	14.4
4 Tigers	106	72	13.0	100	82	36.4
4 new Tigers	103	43	12.3	102	60	17.3
S Asia	75	28	4.0	93	42	4.8
China	112	46	1.3	120	69	5.7
Others	96	37	3.7	98	35	5.9
Transition economies	**100**	**77**	**14.6**	**95**	**76**	**22.2**
Developed Economies	**102**	**84**	**27.2**	**104**	**113**	**50.6**
Europe	101	82	24.5	104	113	44.6
N America	101	91	49.1	102	102	92.0
Japan	101	93	30.5	102	99	40.3
Austr/N Zealand	111	84	27.0	106	132	65.0

Source: Calculated from UNESCO, *Statistical Yearbooks*, various.

Table 10: Grade 8 TIMSS Assessment, 1994-95 (overall mean)			
Science		**Mathematics**	
All countries	**516**	**All countries**	**513**
Singapore	607	Singapore	643
Czech Republic	574	South Korea	607
Japan	571	Japan	605
Bulgaria	565	Hong Kong	588
South Korea	565	Belgium (Flemish)	565
Netherlands	560	Czech Republic	564
Slovenia	560	Slovak Republic	547
Austria	558	Switzerland	545
Hungary	554	Netherlands	541
England, Wales	552	Slovenia	541
Belgium (Flemish)	550	Bulgaria	540
Australia	545	Austria	539
Slovak Republic	544	France	538
Ireland	538	Hungary	537
Russian Federation	538	Russian Federation	535
Sweden	535	Australia	530
United States	534	Iran	528
Canada	531	Canada	527
Norway	527	Ireland	527
New Zealand	525	Belgium (French)	526
Thailand	525	Israel	522
Israel	524	Thailand	522
Hong Kong	522	Sweden	519
Switzerland	522	Germany	509
Scotland	517	New Zealand	508
Spain	517	England, Wales	506
France	498	Norway	503
Greece	497	Denmark	502
Iceland	494	United States	500
Romania	486	Scotland	498
Latvia	485	Latvia	493
Portugal	480	Iceland	487
Denmark	478	Spain	487
Lithuania	476	Greece	484
Belgium (French)	471	Romania	482
Iran	470	Lithuania	477
Cyprus	463	Cyprus	474
Germany	431	Portugal	454
Kuwait	430	Kuwait	392
Colombia	411	Colombia	385
South Africa	326	South Africa	354

Source: National Science Foundation, 1998.

development. Basic schooling and literacy may be sufficient to absorb simple industrial technologies (though even these require a complement of some high level technical and managerial manpower). Advanced schooling and tertiary education become important as more complex knowledge is tackled. Sophisticated modern technologies require high levels of numeracy and a broad base of skills on the shopfloor. They also need a high proportion of technical personnel. Among these, the role of engineers merits particular attention.[8]

It is difficult to compare skill formation across countries. For reasons mentioned above, informal skill creation on the job is difficult to measure at the enterprise level – and impossible to quantify at the national level. Data on enterprise training are patchy and incomplete (though its significance is reviewed below). The available data only allow us to compare enrolments across countries for similar levels of formal education. This also has problems. The definitions of education levels are not uniform. The quality of education at similar levels differs greatly, as does the relevance of the curriculum. Enrolment rates do not show differences in completion rates. Nevertheless, enrolment data are available on a comparable basis, and the rates reveal something about the *base* for skill acquisition.

Table 9 shows broad enrolment patterns for the main groups of countries, including developed and transition economies (detailed country level data are shown in Annex Table 1). The regional enrolment rates are simple averages, not weighted by the relevant populations. They show increases in enrolment rates in all regions. They also show large disparities, mirroring those shown earlier in technological effort. Sub-Saharan Africa lags at all, particularly the tertiary, levels of education. The four mature Tiger economies of Asia lead the developing world at higher levels, just slightly lagging the developed economies. The four new Tigers, Latin America and Middle East/North Africa are roughly similar in their

[8] For a perceptive analysis of the role of engineers and engineering education in the industrial development of the UK, USA and Japan see Von Tunzelman (1996).

secondary and tertiary level enrolments, just behind the levels reached in the transition economies. South Asia and China have low levels of tertiary enrolment, but China is considerably stronger at the secondary level. To the extent that these simple indicators of skill formation are valid, they show large gaps in the education base for competitiveness.

As noted, these figures conceal differences in completion rates, quality and relevance to skill needs. While we cannot correct for these, it is instructive to consider one indicator of the quality of mathematics and science school training. This is given by the TIMSS (Third International Mathematics and Science Study) scores for 8th Grade students (Table 10). Of the 41 countries in which half a million 13 year olds were tested, the position of Asian Tigers was as follows: Singapore reached first place in both mathematics and science; Korea came second in mathematics and fourth in science; Hong Kong came fourth in mathematics and 24th in science. Japan was the best of the developed countries, coming third in both. Of other developing countries, Thailand was half way down in both, while Iran did poorly in science but better than Thailand in mathematics. Kuwait, Colombia and South Africa took the last three places in both subjects. These figures confirm that there are indeed large quality differences in two subjects of critical importance to technological skill development. While most developing countries are not in the test, it would not be surprising if the quality ranking was similar to the enrolment rates, with East Asia coming on top and Sub-Saharan Africa at the bottom.

The breakdown of tertiary enrolments in *technical subjects* is more relevant than general enrolment for assessing capabilities to absorb technological knowledge, and of this, enrolments in engineering is probably the most significant. Table 11 shows the total numbers enrolled in tertiary education and in the three main technical subjects (science, mathematics/computing and engineering) by region in 1995. This time the regional averages are weighted by population. The figures show much wider dispersion in skill creation than the general enrolment rates (country level data are shown in Annex Table 2). The Asian NIEs enrol over 33 times the proportion of their population in technical subjects that in Sub-Saharan Africa (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

Table 11: Tertiary level enrolments and enrolments in technical subjects (1995)

	3 level enrolment		*Technical enrolments, numbers & % of population*							
	Total	*% pop.*	*Natural Science*		*Math's, 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 Tigers	3,031,400	4.00%	195,200	0.26%	34,200	0.05%	786,100	1.04%	1,015,500	1.34%
4 new Tigers	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%

Source: Calculated from UNESCO (1997) and national sources

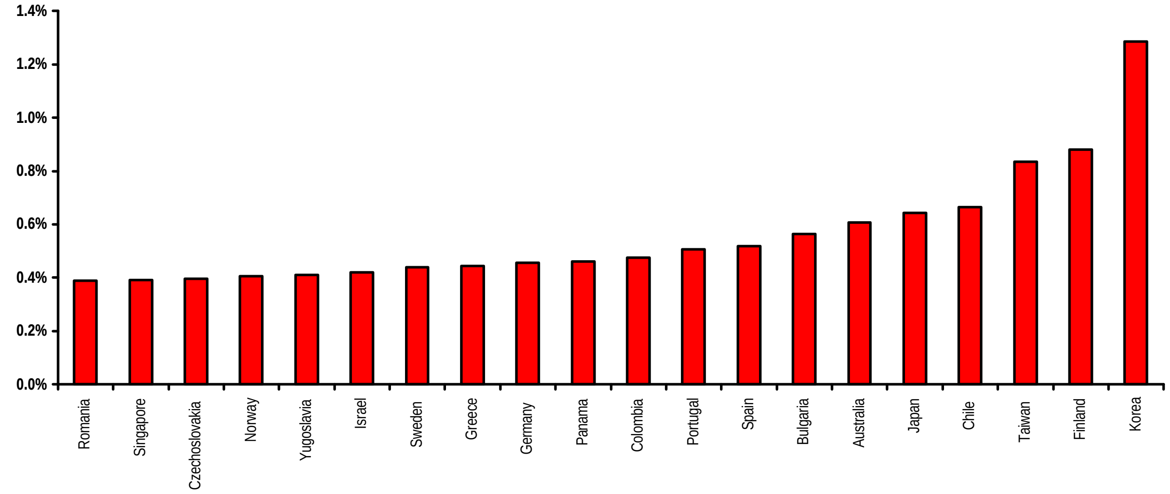
(18 per cent), India (16 per cent) and Korea (11 per cent) – account for 44 percent of the developing world's technical enrolments, the top ten for 76 percent and the top 20 for 93 percent.

Different regions lay different emphasis on *science as compared to engineering*. This is of interest since there is a general presumption that science is oriented to basic research while engineering is more directly related to production technology. Sub-Saharan Africa enrols one and half times as many science students as engineers (though the numbers are so small that this may not indicate a general propensity). MENA has the opposite emphasis. Latin America places heavy emphasis on engineering, with nearly five times the number of engineering as compared to science enrolments. Asia as a whole appears less engineering oriented than Latin America. However, this is misleading, reflecting the propensity of South Asia (dominated by India) to favour science, with enrolments in science some four times higher than in engineering. The mature Asian Tigers, by contrast, enrol four times more students in engineering than in science, China six times and the new Tigers seven times. The transition economies are similar to China, while the developed economies have twice as many students in engineering as in science.

Engineering enrolments in the developing world are as highly concentrated as total technical enrolments, but the leaders differ. China continues to lead, accounting by itself for *23 per cent* of the developing world's total enrolments. It is followed by Korea (14 per cent) and Mexico (7 per cent); these three account for 44 percent of the total. India drops to sixth place, after these three, Indonesia and Philippines. The top ten account for 78 percent and the top 20 for 94 percent.

The absolute enrolment figures do not indicate, however, the *intensity* of skill creation (in relation, that is, to the size of the economy). The best way to gauge this is by enrolments as a share of the total population. Figure 5 shows the top 20 (including developed and transition) countries by

Figure 5: Leading 25 countries in engg. enrolments as % populations, 1995



this measure. The leader, by a significant margin, is Korea, followed by Finland and Taiwan Province. The fourth is Chile, followed by Japan. Large economies like China and India do not appear in this list; nor do USA, UK, Netherlands or Italy. Clearly, the technological lead of the two larger Tigers shown earlier is based upon massive investments in human capital.

Table 12: Change in Tertiary Technical Enrolments 1980-95 as % population

	3 level enrolments Total	Natural science	Maths & computing	Engineering	Total technical subjects
Developing countries	0.46%	0.03%	0.01%	0.04%	0.08%
Sub-Saharan Africa	0.21%	0.01%	0.01%	0.01%	0.03%
MENA	0.70%	0.02%	0.03%	0.07%	0.11%
Latin America	0.34%	0.01%	0.02%	0.03%	0.05%
Asia	0.48%	0.04%	0.01%	0.04%	0.09%
4 Tigers	2.39%	0.14%	0.04%	0.49%	0.68%
4 new Tigers	0.65%	-0.02%	0.08%	0.05%	0.12%
S Asia	0.49%	0.07%	0.00%	0.02%	0.09%
China	0.48%	0.01%	0.01%	0.06%	0.08%
Others	0.13%	0.05%	0.01%	-0.01%	0.05%
Transition economies	0.34%	0.01%	0.01%	-0.11%	-0.08%
Developed economies	1.43%	0.11%	0.10%	0.22%	0.43%

Source: Calculated from UNESCO *Statistical Yearbooks,* various.

Table 12 gives the changes during 1980-95 in the shares of the population enrolled at the tertiary level in total and in technical subjects. The developed world raises its total tertiary enrolments by three times more than the developing world. Within the developing world, as noted, there are large differences. The four mature Tigers raise their tertiary enrolments much faster than the others (including the developed countries), followed by MENA and the new Tigers. Latin America and Africa show moderate increases, while 'other' Asia brings up the rear. The transition economies show the same increase as Latin America, but with a significant switch away from technical subjects.

In science enrolments, the mature Tiger economies again take the lead, followed by the developed countries and South Asia. The new Tigers show a decrease. In engineering, the mature Tigers lead, followed by the developed countries. Transition economies show a decline, along with 'other' Asia. Sub-Saharan Africa register marginal increases in all categories. The two striking facts about this table are the exceptional growth of high level skill creation by the mature Tigers, and the rapid rise in enrolments in the developed countries that already had very high levels of education at the start of the period. This again shows the pressure to create new skill in the new paradigm.

Another way to evaluate the relative skill performance of countries is to compare an index of skills over time. The classic work on skills by Harbison and Myers (1964) derived an index for national skill levels using data for 1957-58 for 65 countries. This index was based on secondary school enrolments plus tertiary enrolments multiplied by five (both enrolments as percentages of the age group). We have worked out the same index – called HMI – for 1995.

Table 13 shows the 65 countries covered by the original HMI ranked according to their skill levels in 1995. It also gives the original ranks assigned by Harbison and Myers. Rich industrial countries hold the top 9 places. Of these leaders, Canada, Finland and Norway have improved their ranks significantly. The first developing country on the list is Korea, which also improves its rank significantly. Taiwan comes next, with a slight improvement (Singapore and Hong Kong were not in the original HMI). Of the large countries, China and Brazil retain their previous ranks exactly, while Argentina, Mexico, India and Pakistan deteriorate. Of the new Tigers, Malaysia and Thailand remain at their original ranks, while Indonesia improves (Philippines was not included).

Another comprehensive measure of skills is the one produced by Barro and Lee (1993, 1996). This uses years of schooling at various levels in 1985. The B-L data are used as the main measure of skills in many recent statistical analyses of human capital, growth and comparative advantage (for a review of the concepts and applications see Gemmel, 1996).

Table 13: HMI ranks, 1995 and 1957-58

1995		1957-58	1995		1957-58	1995		1957-58
1	Canada	9	23	Argentina	14	45	Malaysia	45
2	Australia	3	24	Poland	20	46	Indonesia	53
3	USA	1	25	Peru	37	47	Brazil	47
4	Finland	11	26	Uruguay	18	48	China	48
5	N. Zealand	2	27	Lebanon	44	49	Jamaica	39
6	Belgium	5	28	Chile	27	50	Paraguay	45
7	Norway	17	29	Costa Rica	29	51	Zimbabwe	60
8	Netherlands	4	30	Czech	19	52	India	34
9	UK	6	31	Hungary	25	53	Congo	59
10	Korea	23	32	S Africa	31	54	Myanmar	52
11	France	8	33	Yugoslavia	21	55	Nigeria	57
12	Spain	32	34	Egypt	30	56	Cote d'Ivoire	61
13	Sweden	15	35	Thailand	35	57	Ghana	46
14	Denmark	16	36	Colombia	46	58	Pakistan	42
15	Germany	12	37	Ecuador	43	59	Senegal	56
16	Russia	10	38	Bolivia	51	60	Kenya	58
17	Japan	7	39	Turkey	38	61	Afghanistan	64
18	Italy	22	40	Cuba	33	62	Sudan	54
19	Greece	26	41	Iran	49	63	Uganda	55
20	Israel	13	42	S Arabia	63	64	Ethiopia	65
21	Taiwan	24	43	Mexico	36	65	Tanzania	62
22	Portugal	28	44	Tunisia	50			

There are clear differences between these skill measures: tertiary technical enrolments as a percentage of the population, HMI based on adding secondary and tertiary enrolments (times five) as a percentage of the age group, and the B-L measure of years of schooling. The first two have different numerators and denominators; the third simply takes the average period of education. However, they are highly correlated in statistical terms, and with incomes (Table 14).

Table 14: Correlation Coefficients of Income and Three Skill Measures

	Per capita income	Tertiary technical enrolment	Revised HMI	B-L total years of schooling
Per capita income	1.00			
Tertiary technical enrolment	0.86	1.00		
Revised HMI	0.78	0.93	1.00	
B-L total years of schooling	0.82	0.89	0.81	1.00
Number of observations: for income and HMI, 120; for tertiary technical enrolment, 119; for Barro and Lee, 84.				

The high degree of correlation is reassuring but intriguing. It is reassuring that each measure appears to capture different aspects of skill creation. It is also reassuring in that high levels of income have a strong positive relation with skills, since we would expect such a correlation. However, it is puzzling in that the measures do not differ more. The tertiary technical enrolments measure should show greater variance between countries at similar levels of income and general education, to reflect different technical traditions and strategies. Either these differences are not so pronounced as to show up in the data, or the use of a large base (population) used to deflate technical enrolments reduces the scope of the variance. In a later section we report on some statistical findings on export performance and skills, using mainly the HMI.

Annex Table 4 gives the details of several indices calculated for 120 countries. It also provides the available data from Barro and Lee on years of schooling in three forms: secondary, higher (tertiary) and total, as well as R&D spending by productive enterprises (as a share of GNP) and per capita incomes in 1995.

4.3 Skill Creation by Enterprise Training

Enterprise training (that is, provided to employees *after* formal schooling and vocational training) is one of the most important sources of skill formation. The current technological revolution raises its importance, by accelerating the pace of change in skill needs and by making many skills very task specific. There is a broad consensus that developed countries, and within them the leading enterprises, invest more in training than smaller enterprises and those in developing countries. Training takes place in all settings, of course; otherwise workers would be incapable of performing the simplest tasks. However, the duration, content and nature of training differ considerably.

Training in enterprises can be a very effective and economical way to develop the skills of the workforce. [9] Employers tend to be well-informed about skill needs (though they may not be equally aware of training methods and its rewards). Some have the expertise and resources to train in traditional and emerging skills. Their costs tend to be low as compared to pre-employment post-school training, though they lose part of the benefits of training is their employees leave. Studies suggest that enterprise-based training yield higher private returns than other post-school training modes, both in developing and industrialised countries. In these other modes, there are significant risks of providing inappropriate or unnecessary skills. Thus, the *prima facie* case for the cost-effectiveness of enterprise-based training is strong.

In addition to cost-effectiveness, enterprise training is an essential complement to new investment in technology, plant and equipment as well as new organisational methods. Many studies in mature industrial countries suggest that the shortage of appropriate worker skills is a major constraint on the adoption of new technologies, while well-trained workers accelerate this adoption.[10] A series of country studies in developing countries (Tan and Batra, 1995) demonstrate that training can raise productivity in the firm, and improve its technological capabilities (Table 15).

Table 15: Training in Developing Countries and Productivity Gains

Country	Productivity Gains
Indonesia (1992)	71.1
Colombia (1992)	26.6
Malaysia (1994)	28.2
Mexico (1992)	44.4

Source: Tan and Batra (1992)

In Malaysia, there is evidence that these productivity effects are higher when firm training is accompanied by complementary investments in new technology (Box 2). Workers also benefit from firm investments in training and technology. Evidence from Colombia, Mexico and Taiwan indicate that the firm level productivity gains from training, R&D and exporting are shared with employees in the form of higher wages. These activities generate new skills and knowledge that are embodied in employees, and that make them more valuable to the employer than comparable workers elsewhere. To the extent that this knowledge is partly firm specific, employers and workers have an incentive to share the costs and benefits of such investments. Of the three countries, employer investments in R&D and training are associated with the highest wage premia (more than 60 per cent) except in Colombia where exporting is more important (51 per cent).

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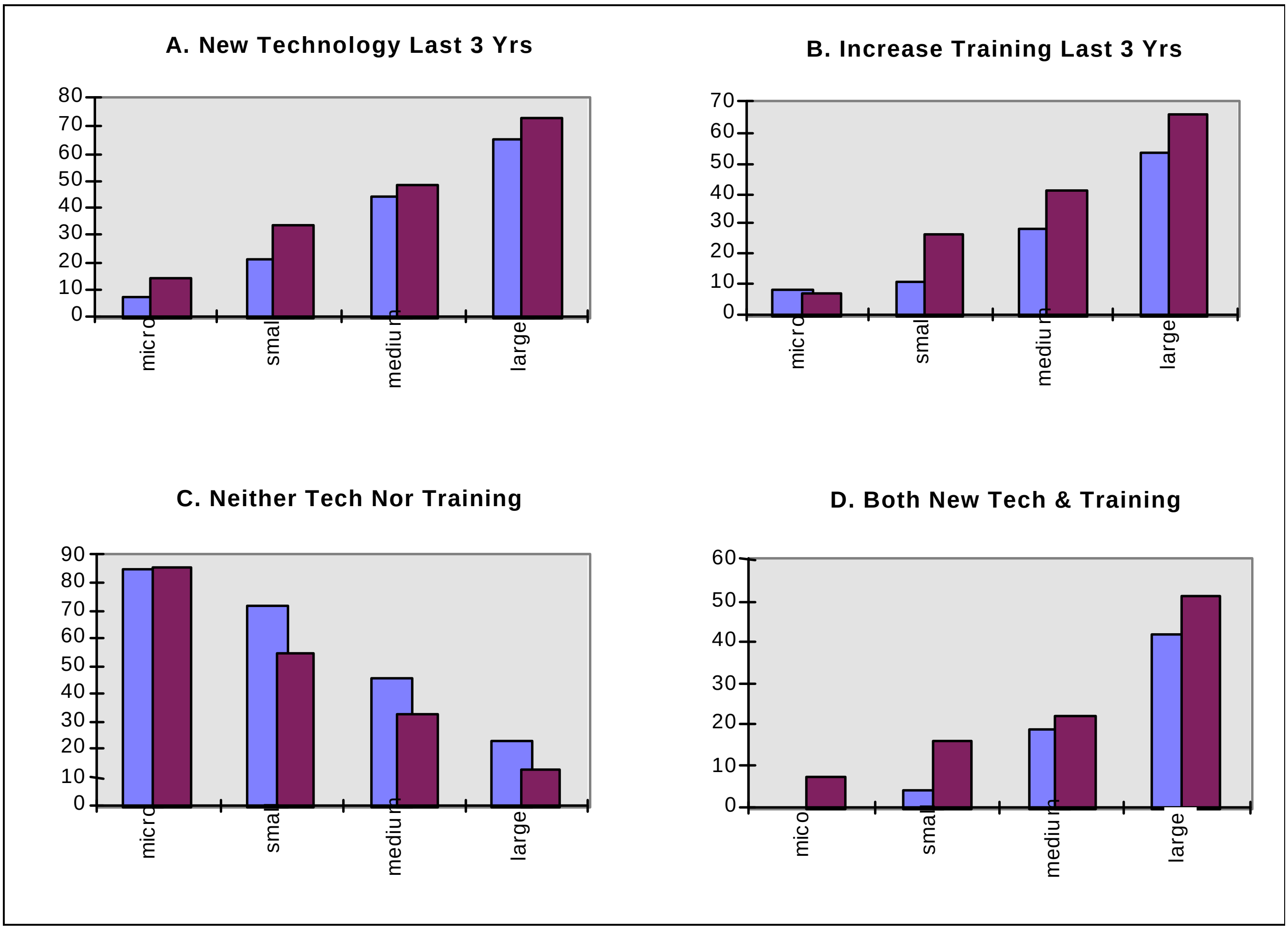
[9] This draws extensively on the work done by Tan and Batra (1995).
[10] On the USA see Bartel and Lichtenberg (1987), and on the UK various papers in Booth and Snower (1996).

Box 2: Efficiency, Technology and Training in Malaysia

In a recent study of Malaysian enterprises, current efficiency levels of firms were linked to past investments in technology and training. The figure below shows the percentage of efficient and inefficient firms that:

- introduced new technology (including computerisation, automation and new production machinery) in the past 3 years;
- increased provision of training over the last three years;
- neither invested in new technology nor increased training;
- both introduced new technology and increased training.

Technology and Training in Past 3 Years



Panels A and B reveal a strong relationship between size and the introduction of new technology or increased training provision over the past three years. Within each size category, efficient firms were more likely to have done so than inefficient firms. Panels C and D, which combine responses from both questions, are mirror images of each other. Firms that neither invested in new technology nor increased training are primarily micro and small firms, while those that did both are found mainly among larger firms. In each size category, efficient firms were less likely to have done neither, and more likely to have done both, as compared to inefficient firms. These trends reinforce the links between new technology introduction, rising skill requirements, increased training, and higher productivity.

Source: Tan and Batra (1995).

Not all employers provide training, however, despite these demonstrated gains in productivity. As noted, some are unaware of the benefits or methods of training, while others fear the loss of trained workers to other firms. Training is a form of investment in employees' human capital – and it involves costs: in materials, time and foregone production. Thus, the incidence of training is highly variable (Table 16).

Table 16: Incidence of Enterprise Training in Some Developing Countries					
Country	Sample Size	% firms providing informal training	% firms providing any formal training	% firms providing internal formal training	% firms providing formal training externally
Colombia (1992)	500	75.9	49.6	3.7	48.7
Indonesia (1992)	300	18.5	18.9	9.7	14.2
Malaysia (1994)	2,200	83.1	34.7	25.2	20.4
Mexico (1994)	5,072	11.3	10.8	5.8	7.9
Taiwan (1986)	56,047	N/A	9.3	-	-
Source: Tan and Batra (1995)					

Recent surveys provide insights into the incidence of training in manufacturing firms in Mexico, Colombia, Indonesia, Malaysia and Taiwan. These estimates illustrate broad patterns of training in the manufacturing sectors of the different countries. The table suggests that a sizeable proportion of enterprises in all five developing economies provide no worker training at all, either informal on-the-job or structured formal training. This problem is especially pronounced in small and medium enterprises, where more than half the firms give no formal structured training, and over a third do not provide any informal training. This suggests that several constraints on training – such as poor information about the benefits of training, high training costs, the inability to exploit scale economies in training, weak managerial capabilities, absence of competitive pressures, or market imperfections – may be at work.

The most important determinants of worker training are as follows:

- The educational attainment of the workforce (educated workers are better learners and benefit more from training).
- Firm size (large firms can spread the fixed costs of training across a large number of workers). In particular, transnational and export-oriented firms are more prone to train than others. In Taiwan, high technology firms train more than low technology ones in the same industries.
- The training and management capabilities of employers (which tend to be weaker in small firms).
- The presence of external public or private training institutions able to deliver relevant training at low cost.

Payoffs to training depend on the technology used by firms, their export behaviour, and growth of markets (Tan and Batra, 1995). For example, in Japan, rapid economic growth in the 1960s and 1970s was accompanied by dramatic increases in employer training, especially among smaller firms. Between 1967 and 1984, the incidence of training in large firms with over 1000 employees rose from 95 percent to 100 percent; for firms with 30-99 employees, training incidence nearly doubles – from 43 to 79 percent – over this period. At the other end is Sub-Saharan Africa, characterised by poor growth and macroeconomic policies, protected markets, high levels of government regulation and low levels of educational attainment. Firms there provide minimal on-the-job training; most are unaware of their skill deficiencies; some that are do not know how to go about training.[11] At the same time, poorly educated workers are costly to train, and make the introduction of new technology unviable.

Poorly educated entrepreneurs and managers can also hold back training efforts. In the UK, for instance, one reason for relative lags in training result from the low level of qualifications of industrial managers compared to Germany (Finegold and Soskice, 1988). Combined with the other deterrents to training noted above, this has led the UK to what Finegold and Soskice termed a 'low skill trap', where poor educational qualifications, weak training and low levels of technology used interact with

[11] For a study of Ghana see Lall *et al.*, 1994, and for three East African countries see Lall (ed.)(1999).

each other.[12] A similar phenomenon – with much greater intensity – is likely to obtain in poor countries with backward education systems and without public funds and institutions for training.

4.4 Some Statistical Evidence

There is a large recent literature on 'endogenous' growth models using skills as a determinant of growth performance in econometric analysis. The findings are variable, but there is widespread agreement that human capital is vital ingredient of sustained growth, and an important explanation of long-term divergences in growth performance.[13] The role of human capital in growth is too large a subject to review here, and relates indirectly to our concern with competitiveness. However, a paper by Gemmell (1996) is worth noting because he differentiates between stocks and growth of human capital and between different levels of human capital formation. To quote,

> "The evidence … from samples of both developed and developing countries during the period 1960-85 provides considerable support for a role for *both* initial stocks and subsequent growth of human capital in fostering faster income growth. Since 'initial' stocks in 1960 are the result of *prior* human capital accumulation, these results may be interpreted as indicating that human capital affects income growth both in the relatively short term (within a small number of years) and over the longer term (perhaps measured in decades). Distinguishing between 'primary', 'secondary' and 'tertiary' human capital, our results also suggest, plausibly, that human capital effects on growth are most evident at the primary and secondary levels in low- and higher income LDCs respectively (where they are the most prominent form of human capital investment), but at the tertiary level in developed countries. This should *not* be interpreted as implying that other 'levels' of human capital in the respective country groups are unimportant. Not only is the reliability of education data generally poorer at 'higher' (i.e. tertiary) levels, especially in LDCs, but investments in education at higher levels usually requires prior investment in lower levels of education."[14]

We already noted the work of Wood, which finds that in a world of capital mobility the interaction of two immobile factors – skills and natural resources – determines comparative advantage.[15] This analysis defines comparative advantage in terms of the share of manufactures in total exports. We have focused on technological upgrading within manufactures, which we consider as the real driver of competitiveness in the modern world.

We also noted significant problems in measuring the impact on skills on competitiveness. To reiterate, measures of both skills and competitiveness suffer deficiencies. Take skills. As far as formal education is concerned, it is difficult to correct for differences in quality, coverage and relevance. The skills that really matter for competitiveness – skills applied to productive work – arise from enterprise training and experience-based learning of specific technologies. These are impossible to measure across countries. While formal education is related to both, the relation is not exact. Formal education may provide the base for higher levels of enterprise training and capability building, but it is not sufficient. Some training can proceed without higher formal education (and can compensate for the lack). Technological capability building needs much more than formal qualification: it needs support for difficult, costly and uncertain learning.

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[12] Their findings are reviewed and updated in the Spring 1999 issue of the *Oxford Review of Economic Policy*. For a theoretical analysis of technology and skills see Redding (1996).

[13] See World Bank's (1993) statistical analysis of skills and growth in East Asia (and other regions for comparison).

[14] Gemmell (1996), p. 24-25, Italics in original. The acronym 'LDCs' here refers to developing countries generally, not the 'least developed' countries in the UN sense.

[15] Wood, 1994, Wood and Berge, 1997.

Similarly, competitiveness is difficult to measure, even within categories of manufactured products. Existing trade data comprise fairly broad categories. For instance, high technology electronics contain several items that are fairly standardised and stable, while low technology products can have items experiencing dynamic technological change. Even within real high-tech electronics, the data cannot differentiate between different stages of production, some of which are simple, labour-intensive assembly operations. As noted above, we have to look at the technological sophistication of the production process, local physical and skill inputs and so on within each country before we can say clearly if it has a genuine competitive advantage in any category of technology. This is not possible with current export statistics.

Thus, we should treat statistical analyses of national competitiveness and skills with circumspection. This said, it is still useful to see if the normal skill measures relate to those of competitiveness. Some preliminary investigation confirms that the expected relations hold, though more work remains to be done to refine the data and the econometric methods employed.

Table 17: Correlation matrix of skills, technology and outward FDI

HMI	1.000		
R&D	0.528	1.000	
Out FDI, 92-97	0.381	0.371	1.000

Outward FDI: One indicator of competitiveness, relevant mainly to industrialised and newly industrialising countries, is the outward direct investment. Taking the 35 countries that export significant amounts of FDI per annum (over $80 million) in during 1992-97, Table 17 shows the correlation matrix of FDI, skills (HMI index for 1995) and enterprise financed R&D as a percentage of GNP.

The skill index and R&D are quite highly correlated, confirming that in these relatively advanced countries technological effort goes together with advanced education levels. Outward FDI is positively and significantly related with both these variables. While the correlation is not very high, since a large number of other factors also affect FDI behaviour, this supports the expectation that this form of competitiveness depends upon skill levels.

Technology content of exports: The share of medium plus high technology in total manufactured exports by a country can serve as a measure of its competitiveness in complex exports. Medium technology products are from industries with complex production processes (chemicals, metallurgy) or difficult skills and learning processes (machinery, transport equipment). High technology exports are based on both complex processes and advanced skills as well as large investments in research and development.

However, there is one interesting difference: medium technology products are more ‘rooted’ in skill-endowed economies because they are more costly to relocate. They tend to have high weight-to-value ratios. In contrast, many high-technology products, like electronics, have easily separable labour-intensive processes that can be relocated economically because of low weight-to-value ratios (Lall, 1998). This explains why the developing world has a much higher share of high rather than medium technology exports; the countries that export the latter tend to have genuine domestic capabilities in complex activities (the mature NIEs and large import substituting economies). Taken together, however, the share of ‘complex’ exports can be a good indicator of technological sophistication, and we analysed the effect of skill measures on it.

Table 18 shows the results of regression analysis on this share in 1995 for 72 countries. Skills and R&D were used in separate regressions because of their very high correlation. Inward FDI per capita in 1991-96 was also used as an explanatory variable. The results were generally significant and in line with expectations.

We also ran a regression on the *change in the share* of medium and high technology exports over 1985-95, with inward FDI and technical tertiary enrolments as explanatory variables. While

Table 18: Regression results for shares of HT+MT products in total manufactured exports, 1995						
	All countries (72)		**Developing Countries** (47)		**DMEs** (25)	
Skills T-statistic	***0.10*** ***6.24***		***0.00*** ***2.78***		*0.00* *1.58*	
R&D T-statistic		***25.96*** ***8.49***		***0.23*** ***3.16***		***0.20*** ***5.52***
FDI per cent GDI (85-90) T-statistic	*0.29* *1.58*	***0.46*** ***2.84***	**0.00** **1.69**	**0.00** **2.20**	0.00 -0.66	0.00 0.27
Adj. R square	**0.37**	**0.52**	**0.19**	**0.22**	**0.04**	**0.55**
F value	21.64	38.91	6.34	7.58	1.52	15.84
Significance levels: Total sample: 1 per cent 2.390, 2.5 per cent 2.00, 5 per cent 1.671, 10 per cent 1.289 Developing countries: 1 per cent 2.423, 2.5 per cent 2.021, 5 per cent 1.684, 10 per cent 1.303 DMEs: 1 per cent 2.50, 2.5 per cent 2.069, 5 per cent 1.714, 10 per cent 1.319. Bold shows significance at 5 per cent; bold and italics show significance at 1 per cent; italics show significance at 10 per cent.						

the regression explained much less of the variance in the dependent (R square reached 0.06), and FDI failed to reach significance, the skills variable (HMI) was positive and significant at 5 percent.

We took *per capita value of high plus medium technology exports* in 72 countries in 1995 as the dependent variable, a regression with skills and inward FDI as the explanatory variables yielded significant results. The R square reached 0.306 and the skills (HMI) and FDI (as a share of gross domestic investment) variables were both positive and significant at the 1 percent confidence level. The value of *per capita low technology exports* in 1995 is also explained by these two variables, again with positive signs and levels of significance and an R square of 0.274. This suggests that export *success in all technological categories requires skills and benefits from inward FDI*, and that these variable are also associated with more technology intensive export structures.[16]

As noted above, *national R&D* effort (financed by productive enterprises) was found highly correlated with skill indices for the main capital exporting countries. We ran a simple regression for a larger sample of 72 developing and developed countries ‘explaining’ R&D propensities with HMI as the independent variable. This yielded a significant R square of 0.443, and the coefficient was positive and significant at the 0.5 percent level. Finally, we ran a simple regression with *inward FDI* (per capita during 1991-96) as the dependent variable and HMI as the explanatory variable. The R square came to 0.139 and the coefficient was positive and significant at 1 percent.

All these statistical results support the general presumption that skills play an important and positive role in competitiveness, directly and via other important factors such as R&D and FDI inflows. Given the approximate nature of the variables and the preliminary nature of the econometric tests reported, these findings are nevertheless reassuring. General and high level skills are essential to competitiveness in all export activity, as they are to technological upgrading.

5. Policy Implications

5.1 Introduction

The role of skills in competitiveness is well understood. So is the role of policy in strengthening human capital. As the *WER 1998-99* puts it on the need for skills and the role of policy,

[16] We ran all these regressions with the variables expressed in logarithms and corrected for heteroscedasticity. The signs and significance levels were the same.

"In recent years, coinciding with rapid globalisation and the spread of new information and communication technology, human capital development is increasingly viewed as a major engine of economic growth; differences in living standards between countries are primarily attributed to differences in educational levels and the quality of the workforce. More concretely, countries with higher levels of skills have certain basic advantages. They can adjust more effectively to the challenges and opportunities of globalisation because their enterprises are more flexible and better able to absorb new technologies and to work with new equipment. Their structure of output and of exports is weighted towards higher-quality goods, they can compete more on the basis of quality than of price, and they have less to fear from competition from lower-wage countries. A higher share of skilled workers in the labour force provides better career prospects for workers and raises job quality" (p. 203-203).

"There has always been a strong case for government financing of education because individuals cannot reap the private benefits which their education brings to others. Similar considerations apply to training. Without public intervention there will very probably be underinvestment in skills by job-seekers, workers and employers relative to their own potential and to the benefits which a trained individual brings to colleagues, the employing organisation and society in general. Such underinvestment or 'market failure' can arise in part because of uncertainty and in part because of conflict over the distribution of costs and benefits of training" (p. 67).

There is a large literature on why education and training 'markets' fail to provide socially desirable levels of investment (for a recent analysis see Stevens, 1999). The failures arise for all parties in the education and training system: the trainees themselves, the institutions providing the training and the employers. These failures interact with each other. In the absence of effective policy action, they may lead to a 'low skill equilibrium' where enterprises adjust to poor education standards and their own unwillingness to train by adopting simple, stagnant technologies. With poor prospects for high skilled work, the demand for advanced education and training remains low, and institutions satisfy this with low quality, often obsolete, educational products.

To quote *WER 1998-99* again, "*Economies which fail to ensure an adequate supply of skilled labour may find that the whole economy becomes adjusted to a low level of skills, or to a low-skills equilibrium*. This may have negative effects on the long-term comparative advantage and growth of the economy" (p. 68, italics in original).

5.2 Market Failures in Creating Skills

Market failures in skill formation can arise at *two levels*. The first is at the *general level* of resource allocation and deepening of the industrial and technological structure. Discussions of market failures in skill formation do not usually consider this level, but there are good reasons to do so. As argued above, many skills vital to industrial upgrading and competitiveness arise not from formal education and training but from the *practical experience* of mastering, adapting and improving specific technologies. The extent to which such experience occurs depends on the rate of investment in the productive sector, the agents involved, the competitive regime and the use of new technologies.

Promoting experience-based skills calls for a conducive investment and competitive environment: sound macroeconomic management, high rates of investment, outward looking trade regimes and open domestic markets. However, a completely liberal policy regime is not the best setting in developing countries for skill development when there are heavy, prolonged and unpredictable learning costs in entering 'difficult' technologies (difficult, that is, relative to existing capabilities). These costs can deter entry into complex activities or more demanding technical functions in a completely free trade setting. The costs are generally greater when completely new skills are necessary, technologies need considerable effort and information to absorb, there are extensive spillovers, and domestic (rather than foreign) firms are involved. In these conditions, capability development requires policy intervention: there is a case for “infant industry” protection of skill and technology development. Such promotion can take many forms and encompass many markets (Lall, 1996). Once governments set about changing the technological structure of industry, they create the need for new skills that only they can foresee. They have to ensure, in other words, that the education and training system is co-ordinated with the industrial system as both evolve: this coordination becomes an integral part of industrial and education policy (Green *et al.*, 1999).

Domestic enterprises tend to face greater market failures (and higher learning costs) than foreign affiliates, particularly in technologically dynamic activities. Large TNCs from developed countries are more aware of the benefits of training and have larger human and financial resources to provide it. However, reliance on FDI does not relieve the country from investing in skills. Attracting TNCs in advanced activities requires a strong base of education and skills, otherwise the investors would not come, or would bring low levels of technology and not upgrade over time. The case of Singapore, the most successful example of technological upgrading under TNC aegis, illustrates the need for a very proactive skill development strategy (below). In any case, FDI cannot (and should not) drive the entire industrial sector: a number of activities will continue to be in local hands, and TNCs need local suppliers to support their activities. Skills and capabilities in competing and linked firms must be upgraded to benefit from the spillover and competitive effects of TNC presence.

The management of industrial policy is not, however, an easy matter. Most industrial policy interventions in developing countries have led to technological stagnation and inefficiency rather than dynamic growth. At the same time, the experience of the few countries that have succeeded suggests that efficient interventions can accelerate dramatically the process of skill and capability upgrading. Given the risks of government failures, all interventions need to be very carefully designed, integrated across different factor markets and monitored. There is a large literature on this subject that is not directly germane to this analysis, but it is essential to bear this larger context in mind. We return to some implications below.

The *second level* of market failures is the *education and training system* in the narrow sense, issues much better covered in the literature. Let us summarise the nature of the failures for each of the three components of the system. For *the trainee*, difficulties arise from the following:

➠ Externalities: The failure to recoup all the benefits of educational investments. Some benefits of skill creation inevitably accrue to others, since skills are not used in isolation.

➠ Information gaps and uncertainty: Individuals may not know of the future value of investments in education and training or of particular skills, and they may not know what skills are needed in the future.

➠ Risk aversion: Even if individuals can forecast the probability of getting returns on skill investments, they may prefer more certain short term returns to available jobs.

➠ Lack of certification of skills acquired during enterprise training: This makes the investment in such training less attractive, since its value to other firms is reduced.

➠ Capital market deficiencies: Individuals may not be able to finance their learning costs and foregone earnings, because capital markets lack the information and monitoring capacity.

Similarly, the *education and training system* (public and private) may suffer from:

- Lack of information on educational needs in industry and demands from students
- Capital market deficiencies in raising the funding for better standards
- Uncertainties about future skill trends, greater in a period of rapid technical and organisational change and overwhelming in a situation where skill needs are determined by government industrial policy.
- High costs of educational services provided.
- In the public sector training institutions, danger of bureaucratic and rigid management, poor remuneration and inadequate incentives for trainers, lack of interaction with the market, and low standards. This can lead to obsolete and irrelevant curricula, poor teaching and equipment, and an over-emphasis on abstract rather than practical training.
- In the private sector system, risks of variable and unsatisfactory standards in the absence of effective monitoring.

The failures on the part of *enterprises* to provide training to their employees can arise from:

- Low absorptive capacity on the part of poorly educated workers.
- Low educational qualifications on the part of employers and managers.
- Lack of appreciation of or information on the benefits of training, and lack of knowledge of 'best practice' technology and skills in relevant activities.
- Lack of training materials or teachers in-house.
- Inability to form efficient training programmes in line with changing skill and technology needs.
- Lack of specialised institutions to provide appropriate training at reasonable cost, or lack of necessary interactions between these institutions and enterprises.
- Lack of finance to cover costs of training.
- Lack of full appropriability, as trainees leave for better-paid jobs after training. This creates a bias toward providing training in specific skills that do not have value to other firms, but this is rarely possible.
- Lack of technological dynamism, with enterprises content to stay with existing technologies, equipment and skill levels. This is exacerbated by policy regimes that stifle competition or hold back exposure to world markets.

There are thus many economic explanations for market failures in the provision of skill related investments in any country. They apply with greater force the less developed the country, with the paradoxical result that countries with the lowest skill levels – and so the greatest skill needs – face the greatest difficulty in providing new skills.

5.3 Policy Needs and Responses

This sketch of market failures in skill development in the previous section allows us to consider the main needs of policy.

At the broad level of industrial policy and technological deepening, the main need is for careful targeting and implementation. The new rules of trade and investment restrict many of the instruments used by the mature Tigers to promote infant industries. However, it is still possible to guide the allocation of resources into more high value activities. This can be done even within a free trade setting (though many developing countries have a period of grace in which they can manage the process of liberalization). In this context, it will be useful to describe briefly the Singapore experience. Singapore is widely regarded as having the most highly skilled workforce in the developing world and one of the most effective training systems. It is highly dependent on FDI to drive technological upgrading and investment, and uses its skill system as a major ‘selling point’ to attract high-tech TNCs in a free trade regime. Skill provision is closely integrated with industrial policy; TNCs play an important role in determining the nature and content of training. The whole effort is coordinated by the EDB (Economic Development Board), the body in charge of targeting FDI and formulating industrial policy. Box 3 describes the main features of the training system.

Box 3: 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 per cent 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 per cent 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 per cent 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).

This case illustrates in some ways the 'best practice' in targeted skill creation for technology upgrading in an FDI-driven context.

As far as the education and training system is concerned, there is a universal need in developing countries to upgrade the quantity, quality and relevance of instruction. The first step in devising a skill strategy is to *benchmark* the education and training system against major competitors. For instance, the UK Government launched a Skills Audit to compare the skill levels of young people in the UK against those in France, Germany, the USA and Singapore.[17] This is not a straightforward exercise, for reasons noted earlier. However, after adjusting for quality, duration and so on, it is possible to come to meaningful assessments of how effective national systems are; the evaluation is easier if the focus is on narrow categories of skills.

[17] UK Cabinet Office, 1996. *The Skills Audit Report* was also published in 1996. The Government launched a major reform of the education system, with the implementation of a National Curriculum and a massive increase in the numbers of students attending tertiary level education.

The next step is to address the various market failures noted above in the demand and supply of education. A huge variety of policy responses exist, ranging from public provision of training to largely private led systems. It is beyond the scope of this paper to consider these at any length.

However, we should comment briefly on the vocational education and training system, particularly relevant to the creation of technical skills. The *WER 1998-99* devotes a chapter to the analysis of training systems, and differentiates between three broad categories (Table 19):

1. *The cooperative system*: Here training is left neither to employer or employee decisions nor to government planning, but emerges after interaction between the three parties. This generally involves strong workforce representation on works councils. Germany is the best known example of this system.[18] Employers offer apprenticeship in all sectors, taking in over half the relevant age group. Chambers of Industry and Commerce are heavily involved in registering apprentices and setting qualification standards. Training is provided by public vocational schools, with half the cost borne by employers; the apprentices also make a contribution by taking low wages. The qualifications are nationally recognised, and poaching is discouraged by strong unions. This is the basis of the 'high skill equilibrium' in Germany. A number of Latin American countries also have a similar system based on vocational training institutions.

Table 19: Main Types of Training Systems

System	Examples	Main Features
Cooperative	Austria, Germany, Switzerland, many Latin American countries	Pressures to train from cooperation between employers' organisations, government and trade unions
Enterprise based		
1. Low labour turnover	Japan	Low labour mobility, lifetime employment, absence of stock-market pressures
2. Voluntarist	UK, USA	Few institutional pressures to train
State driven		
1. Demand led	Hong Kong, Korea, Singapore, Taiwan	State plays leading role in coordinating demand for and supply of skills, in open competitive environment
2. Supply led	Economies in transition; many developing countries in Asia and Africa	Government takes prime responsibility for training in institutions. Little pressure for employers to train.

Source: ILO *WER 1998-99*, Table 3.2

2. *Enterprise based systems*: These rely primarily on training provided by enterprises, with Japan on the one hand (providing massive amounts of training to long-staying employees) and the USA and UK on the other (with voluntary training). This system is often blamed in the UK for its 'low skill equilibrium' while in the USA the deficiencies of enterprise training are apparently offset by a large supply of high level engineering skills.

3. *The state-driven system*: This also has two variants. The mature NIEs had a strong role of government in meeting fast-changing skill needs. In Korea, in particular, the government created skills in advance of setting up new industries (Green *et al.*, 1999). The other variant is state led education in former socialist economies as well as in many developing countries.

[18] For a recent analysis of this system and its response to pressures of globalisation and unemployment see Culpepper (1999).

The conclusion reached by the *WER* is that "There is no *ideal* training system" (p. 82). Yet all systems are under tremendous pressure as competitive forces mount and technical change proceeds unabated. It is imperative for governments to respond to these pressures if they are to participate fully and gainfully in globalisation (and staying out is no longer a viable option). How they should respond in particular social, economic and institutional settings is a complex matter to which there is no general solution.

The *WER 1998-99* points to four elements of a general response:

1. *Social partnership*: The need for close collaboration between employers, workers and the state to determine skill needs and the most effective ways of meeting them.

2. *Co-financing*: Governments can no longer be expected to meet the burden of training and education costs, and means have to be found of inducing individuals and enterprises to finance them. This also involves making the delivery of training more efficient and relevant, improving capital markets and monitoring skill needs on a regular basis.

3. C*ertification*: This is necessary to improve labour transferability and so efficient labour markets.

4. *Cost effectiveness:* This involves decentralisation of decision making and the increasing participation of private training providers. This still requires considerable support and monitoring of standards by the government.

5.4 In conclusion…

Competitiveness has become something of a 'buzz word' today, and its over-use may detract from its immediacy and urgency. This paper has noted that there is enormous and possibly growing divergence between different developing countries in their abilities to compete in a rapidly changing and demanding world. The new technological paradigm will impose increasing demands on the existing base of skills and knowledge, and countries will have to develop their base to deal with it in a way that leads to sustained growth and technological upgrading. This will require a mixture of policies. There is no single optimum path: the technological leaders had different strategies, reflecting their differing objectives and political economies. Certain basic elements were common to them, such as the creation of human capital, fostering an efficient technology support system, ensuring access to new technologies, and close contacts with world markets. Others differed, in particular their interventions in imports, FDI and domestic competition and credit policies. Different strategies resulted in very different industrial structures and technological bases.

The lessons that other countries can draw depend on their economic and political situations. Some interventionist strategies may not be feasible or desirable for countries that lack the particular political economy within which they worked in the past. Others may not be feasible because the policy environment has changed, or the pace of technical change and globalization of production make them risky or inefficient. Yet even when all this is taken into account a very important role remains for policy interventions. Many past interventions, that cut countries off from world markets and technology flows, hampered their human capital development and stifled technological learning and deepening, have to be quickly removed. They have to be replaced by more carefully crafted policies geared to efficient human resource and technology development. Free markets themselves cannot lead countries to develop the systemic abilities they need to cope efficiently with new technologies. The exact nature of policies needed for each country cannot be prescribed in general *a priori* terms, but would depend on its specific economic context and social/political environment.

This paper has sought to illustrate the general trends and lay out the general considerations that should drive the choice.

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STATISTICAL ANNEX

Annex Table 1: World Market Shares of Leading 30 Exporters of High Technology Products					
Rank	Country	1996	1985	Change in market share 1985-96	% change in market share
1	USA	16.86%	22.64%	-5.8%	-25.5%
2	Japan	14.30%	21.69%	-7.4%	-34.0%
3	Germany	8.45%	11.46%	-3.0%	-26.2%
4	Singapore	7.45%	2.55%	4.9%	192.8%
5	UK	6.48%	7.34%	-0.9%	-11.7%
6	France	5.38%	5.67%	-0.3%	-5.2%
7	Taiwan	4.42%	2.50%	1.9%	76.8%
8	Malaysia	4.04%	1.10%	2.9%	267.7%
9	Korea	3.95%	1.99%	2.0%	98.0%
10	Netherlands	3.40%	2.95%	0.4%	15.2%
11	Mexico	2.84%	1.28%	1.6%	121.9%
12	China	2.67%	0.02%	2.6%	14037.1%
13	Italy	2.35%	3.20%	-0.8%	-26.5%
14	Canada	2.11%	2.58%	-0.5%	-18.3%
15	Sweden	1.71%	1.77%	-0.1%	-3.3%
16	Ireland	1.60%	1.22%	0.4%	30.5%
17	Thailand	1.56%	0.21%	1.3%	634.2%
18	Belgium	1.27%	1.48%	-0.2%	-14.3%
19	Switzerland	1.19%	1.65%	-0.5%	-27.9%
20	Philippines	1.12%	0.12%	1.0%	862.0%
21	Spain	0.95%	0.63%	0.3%	49.8%
22	Finland	0.82%	0.40%	0.4%	107.9%
23	Austria	0.76%	0.81%	-0.1%	-7.0%
24	Hong Kong	0.72%	1.27%	-0.5%	-43.1%
25	Denmark	0.54%	0.67%	-0.1%	-18.6%
26	Israel	0.50%	0.46%	0.0%	7.6%
27	Indonesia	0.42%	0.04%	0.4%	890.3%
28	Portugal	0.30%	0.20%	0.1%	48.1%
29	Australia	0.27%	0.12%	0.2%	130.9%
30	Brazil	0.24%	0.44%	-0.2%	-44.9%

Annex Table 2: Enrolment Ratios, 1980, 1987 and 1995									
	Enrolment Ratios (1980)			**Enrolment Ratios (1987)**			***1995 Enrolment Ratios***		
	1 level	***2 level***	***3 level***	***1 level***	***2 level***	***3 level***	***1 level***	***2 level***	***3 level***
Sub-Saharan Africa									
Benin	64	16	1.6	63	16	2.5	72	16	2.6
Botswana	92	21	1.4	115	33	2.8	115	56	4.1
Burkina Faso	15	2	0.2	32	6	0.6	38	8	1.1
Burundi	29	3	0.6	67	4	0.8	70	7	0.9
Cameroon	104	19	1.6	111	27	2.7	88	27	3.3
CAR	71	14	0.9	66	12	1.2	58	10	1.4
Chad	36	5	0.3	51	6	0.5	55	9	0.8
Congo	141	74	5.0	138	60	7.7	114	53	5.3
Côte d'Ivoire	74	18	2.8	72	19	2.5	69	23	4.4
Ethiopia	35	9	0.4	37	15	0.9	31	11	0.7
Ghana	80	41	1.6	71	40	1.5	76	37	1.4
Kenya	115	20	0.9	96	23	1.5	85	24	1.6
Lesotho	103	18	1.7	112	25	3.0	99	28	2.4
Madagascar	143	12	3.0	97	21	3.8	72	14	3.4
Malawi	60	3	0.7	66	4	0.6	135	6	0.8
Mali	27	9	0.3	23	6	0.8	32	9	0.8
Mauritania	37	11	1.0	52	16	3.4	78	15	4.1
Mauritius	108	48	1.0	106	51	1.3	107	62	6.3
Mozambique	99	5	0.1	68	5	0.2	58	7	0.4
Niger	27	5	0.3	29	6	0.6	29	7	0.3
Nigeria	97	19	2.2	64	24	2.9	89	30	4.1
Rwanda	63	3	0.3	67	6	0.4	82	11	0.6
Senegal	46	11	2.8	60	15	2.9	69	16	3.4
Sierra Leone	52	14	0.7	60	19	0.7	50	17	1.3
South Africa				100	55	12.0	117	84	17.3
Sudan	50	16	1.8	49	20	2.1	54	13	3.0
Tanzania	93	3	0.2	66	4	0.3	67	5	0.5
Togo	122	34	2.2	101	24	2.6	133	27	3.2
Uganda	50	5	0.5	74	13	0.9	73	12	1.5
Zaire	94	34	1.2	76	23	1.5	72	26	2.3
Zambia	90	16	1.6	97	17	2.3	89	21	2.5
Zimbabwe	85	8	1.3	133	46	4.2	116	47	6.9
Middle East and North Africa									
Afghanistan	34	10	1.5	25	8	1.3	45	22	1.8
Algeria	95	33	6.2	96	55	9.4	107	62	10.9
Egypt	78	54	17.6	90	69	19.8	100	74	18.1
Iran	101	44	5.0	114	48	5.6	99	69	14.8
Iraq	115	57	9.3	98	49	12.5	90	44	11.5
Jordan	104	76	26.6	97	65	23.0	94	63	24.5
Kuwait	102	80	10.9	94	82	16.6	73	64	25.4
Lebanon	111	59	33.8	125	66	27.0	109	81	27.0
Libya	120	67	7.8			10.1	110	97	16.4
Morocco	83	26	6.0	71	37	9.8	83	39	11.3
Oman	60	14	0.0	97	38	3.3	80	66	4.7
Saudi Arabia	63	30	7.3	71	44	13.4	78	58	15.3
Syria	102	47	17.6	110	59	17.8	101	44	17.9
Tunisia	103	27	5.1	116	40	5.7	116	61	12.9
Turkey	96	35	6.1	117	46	10.4	105	56	18.2
United Arab Emirates	88	52	2.2	99	60	8.7	95	78	8.8
Yemen	44	5	1.2	88	25	2.7	79	23	4.3

Latin America and Caribbean									
Argentina	106	56	21.6	110	74	40.8	113	77	38.1
Bolivia	84	36	12.6	91	37	16.6	95	37	22.2
Brazil	99	34	11.9	103	38	10.6	112	45	11.3
Chile	109	53	13.2	103	70	17.8	99	69	28.2
Colombia	128	44	10.6	114	56	13.9	114	67	17.2
Costa Rica	105	48	23.3	98	41	24.8	107	50	31.9
Cuba	108	80	19.5	104	88	22.6	105	80	12.7
Dominican Republic	118	42	10.0	101	74	18.6	103	41	18.0
Ecuador	113	51	36.5	117	56	29.3	109	50	20.0
El Salvador	75	24	4.3	79	29	17.7	88	32	17.7
Guatemala	71	18	8.4	77	21	8.6	84	25	8.1
Haiti	74	13	1.0	83	19	1.2	56	22	1.1
Honduras	93	30	8.3	106	32	8.8	111	32	10.0
Jamaica	101	59	6.2	103	64	4.2	109	66	6.0
Mexico	115	46	14.4	118	53	15.7	115	58	14.3
Nicaragua	99	43	14.1	99	43	8.4	110	47	9.4
Panama	106	61	22.1	107	60	28.2	106	66	27.2
Paraguay	104	26	8.5	103	29	8.8	109	38	10.3
Peru	114	59	19.4	122	65	23.8	123	70	31.1
Trinidad & Tobago	97	68	5.0	100	82	4.7	96	72	7.7
Uruguay	106	60	17.3	110	68	47.2	111	82	27.3
Venezuela	109	41	21.4	106	54	26.5	94	35	28.5
Asia									
Bangladesh	62	18	3.0	59	18	4.3	69	21	4.4
China	112	46	1.3	132	43	1.7	120	69	5.7
Hong Kong	106	64	10.5	106	74	13.2	96	75	21.9
India	83	32	9.0	98	39	6.4	100	49	6.4
Indonesia	107	29	4.0	118	48	7.0	114	48	11.1
Korea	110	76	15.8	101	88	36.0	101	101	52.0
Laos	113	21	0.5	110	27	1.6	107	25	1.5
Malaysia	93	48	4.3	102	59	6.6	91	58	10.6
Mongolia	106	88	9.0	102	92	21.7	88	59	15.2
Myanmar	91	22	4.7	103	24	4.8	100	32	5.4
Nepal	88	22	3.0	83	29	5.0	110	38	5.2
Pakistan	39	14	2.0	40	19	5.0	74	26	3.0
Philippines	113	65	27.7	109	68	28.9	116	79	27.4
PNG	59	12	1.9	70	12	2.0	80	14	3.2
Singapore	108	58	7.9	112	68	16.0	104	62	33.7
Sri Lanka	103	55	2.8	107	71	4.0	113	75	5.1
Taiwan	101	89	17.9	99	93.8	26.2	100	88	38.0
Thailand	99	29	13.1	95	28	15.9	87	55	20.1
Vietnam	109	42	2.3	102	42	2.4	114	47	4.1
Transition economies									
Albania	113	67	5.4	100	75	6.0	101	35	9.6
Bulgaria	98	84	16.1	104	76	22.6	97	78	39.4
Czechoslovakia	92	89	17.1	96	82	16.2	103	96	20.8
Hungary	96	69	12.9	97	70	15.2	97	81	19.1
Poland	100	77	17.6	101	80	17.8	98	96	27.4
Romania	102	71	11.0	97	79	9.8	100	78	18.3
Yugoslavia	100	83	21.8	95	80	18.6	72	65	21.1
Developed Market Economies									
Australia	111	84	25.4	106	98	28.8	108	147	71.7
Austria	99	73	23.2	100	100	28.0	101	104	44.8
Belgium	104	91	26.3	100	99	32.7	103	144	49.1
Canada	103	93	42.1	105	104	58.2	102	106	102.9
Denmark	96	105	28.6	99	107	30.5	99	118	45.0

Finland	96	98	32.1	101	106	37.6	100	116	66.9
France	111	85	25.5	113	92	30.9	106	111	49.6
Germany	99	94	26.2	103	96	30.7	102	103	42.7
Greece	103	81	17.4	100	95	26.9	98	95	38.1
Ireland	100	90	20.3	101	98	25.0	104	114	37.0
Israel	95	73	29.3	95	83	34.2	98	89	38.9
Italy	100	72	27.7	95	75	25.9	98	88	40.6
Japan	101	93	30.5	102	95	29.7	102	99	40.3
Netherlands	100	92	30.0	116	104	32.4	107	139	48.9
New Zealand	111	83	28.6	107	85	36.4	104	117	58.2
Norway	100	94	25.6	96	93	33.1	99	116	54.5
Portugal	123	37	11.2	125	59	14.0	128	102	34.0
Spain	109	87	24.2	111	105	31.5	105	118	46.1
Sweden	97	88	30.8	100	91	31.2	105	132	42.5
Switzerland	86	55	18.2	102	91	23.7	107	91	31.8
United Kingdom	103	83	20.1	107	83	22.8	115	134	48.3
USA	99	89	56.0	100	98	59.6	102	97	81.1
Source: UNESCO, World Bank, national sources.									

Annex Table 3: Tertiary enrolments in total and technical subjects, 1995										
	3 level enrolment		*Technical Enrolments at 3 level*							
	No. students	*% of*	*Natural Science*		*Math's, computing*		*Engineering*		*Total Technical subjects*	
	thousands	*population*	*numbers*	*%*	*numbers*	*%*	*numbers*	*%*	*numbers*	*%*
Sub-Saharan Africa										
Benin	11,200	0.207%	1,500	0.028%	30	0.001%	500	0.009%	2,030	0.038%
Botswana	5,100	0.352%	1,000	0.069%	100	0.007%			1,100	0.076%
Burkina Faso	9,500	0.091%	1,600	0.015%	90	0.001%			1,690	0.016%
Burundi	4,300	0.071%	700	0.012%	50	0.001%	60	0.001%	810	0.013%
Cameroon	33,200	0.252%	7,600	0.058%	0	0.000%	800	0.006%	8,400	0.064%
CAR	3,700	0.113%	200	0.006%	0	0.000%	200	0.006%	400	0.012%
Chad	3,500	0.055%	200	0.003%	200	0.003%	70	0.001%	470	0.007%
Congo	13,800	0.532%	1,100	0.042%	50	0.002%			1,150	0.044%
Cote d'Ivoire	51,200	0.374%	7,900	0.058%	2,800	0.020%	1,900	0.014%	12,600	0.092%
Ethiopia	32,700	0.058%	1,800	0.003%	1,100	0.002%	3,600	0.006%	6,500	0.012%
Ghana	9,600	0.055%	1,200	0.007%	200	0.001%	700	0.004%	2,100	0.012%
Kenya	31,300	0.115%	3,600	0.013%			1,000	0.004%	4,600	0.017%
Lesotho	4,400	0.217%	400	0.020%	50	0.002%	100	0.005%	550	0.027%
Madagascar	42,700	0.287%	6,600	0.044%	1,400	0.009%	1,200	0.008%	9,200	0.062%
Malawi	7,300	0.075%	300	0.003%	0	0.000%	500	0.005%	800	0.008%
Mali	6,700	0.062%	100	0.001%	60	0.001%	600	0.006%	760	0.007%
Mauritania	8,500	0.374%	600	0.026%	100	0.004%	0	0.000%	700	0.031%
Mauritius	5,500	0.492%	100	0.009%	100	0.009%	300	0.027%	500	0.045%
Mozambique	7,000	0.041%	1,000	0.006%	200	0.001%	1,100	0.006%	2,300	0.013%
Niger	4,500	0.049%								
Nigeria	335,800	0.301%	41,500	0.037%			22,100	0.020%	63,600	0.057%
Rwanda	3,400	0.066%								
Senegal	24,100	0.290%	3,800	0.046%	200	0.002%	400	0.005%	4,400	0.053%
Sierra Leone	4,700	0.112%								
South Africa	617,900	1.490%	21,700	0.052%	30,500	0.074%	20,000	0.048%	72,200	0.174%
Sudan	60,100	0.225%	2,200	0.008%	900	0.003%	3,600	0.013%	6,700	0.025%
Tanzania	12,800	0.043%	800	0.003%	100	0.000%	2,700	0.009%	3,600	0.012%
Togo	11,200	0.274%	1,000	0.024%			200	0.005%	1,200	0.029%
Uganda	27,600	0.140%	800	0.004%	300	0.002%	1,500	0.008%	2,600	0.013%
Zaire	93,300	0.205%								
Zambia	10,500	0.130%								
Zimbabwe	45,600	0.408%	2,200	0.020%	800	0.007%	6,700	0.060%	9,700	0.087%

Middle East and North Africa										
Afghanistan	24,300	0.124%	1,200	0.006%			500	0.003%	1,700	0.009%
Algeria	298,800	1.063%	34,500	0.123%	19,400	0.069%	61,400	0.218%	115,300	0.410%
Egypt	628,200	1.012%	24,700	0.040%	3,000	0.005%	46,600	0.075%	74,300	0.120%
Iran	1,048,100	1.533%	56,000	0.082%	47,300	0.069%	200,900	0.294%	304,200	0.445%
Iraq	209,800	1.044%								
Jordan	99,000	1.843%	4,400	0.082%	8,100	0.151%	9,900	0.184%	22,400	0.417%
Kuwait	28,700	1.697%	1,400	0.083%	600	0.035%	4,600	0.272%	6,600	0.390%
Lebanon	81,600	2.712%	5,200	0.173%	2,200	0.073%	4,500	0.150%	11,900	0.395%
Libya	72,900	1.348%								
Morocco	294,500	1.110%	65	0.245%			2	0.007%	67	0.253%
Oman	7,300	0.331%	300	0.014%	100	0.005%	500	0.023%	900	0.041%
Saudi Arabia	233,700	1.280%	12,600	0.069%	4,000	0.022%	5,900	0.032%	22,500	0.123%
Syria	194,400	1.369%	15,200	0.107%	1,300	0.009%	11,300	0.080%	27,800	0.196%
Tunisia	112,600	1.253%	12,500	0.139%	2,500	0.028%	6,500	0.072%	21,500	0.239%
Turkey	1,174,300	1.930%	39,300	0.065%	25,300	0.042%	134,400	0.221%	199,000	0.327%
UAE	10,600	0.480%	500	0.023%	300	0.014%	400	0.018%	1,200	0.054%
Yemen	53,100	0.353%	1,200	0.008%	100	0.001%	1,900	0.013%	3,200	0.021%
Latin America and Caribbean										
Argentina	1,069,600	3.076%	69,700	0.200%			92,600	0.266%	162,300	0.467%
Bolivia	109,500	1.477%	2,900	0.039%	5,400	0.073%	17,100	0.231%	25,400	0.343%
Brazil	1,716,300	1.079%	46,300	0.029%	92,700	0.058%	149,700	0.094%	288,700	0.182%
Chile	367,100	2.583%	8,800	0.062%			94,300	0.664%	103,100	0.726%
Colombia	644,200	1.799%	12,600	0.035%			170,500	0.476%	183,100	0.511%
Costa Rica	88,300	2.579%	1,100	0.032%	3,400	0.099%	7,300	0.213%	11,800	0.345%
Cuba	122,300	1.115%	2,400	0.022%	800	0.007%	17,400	0.159%	20,600	0.188%
Dom. Republic	123,700	1.581%								
Ecuador	206,500	1.802%	7,200	0.063%	300	0.003%	25,200	0.220%	32,700	0.285%
El Salvador	115,000	2.031%	200	0.004%	2,100	0.037%	12,700	0.224%	15,000	0.265%
Guatemala	80,200	0.755%								
Haiti	6,300	0.088%								
Honduras	54,100	0.957%	200	0.004%	2,700	0.048%	8,400	0.149%	11,300	0.200%
Jamaica	15,900	0.644%	1,400	0.057%	400	0.016%	1,000	0.041%	2,800	0.113%
Mexico	1,420,500	1.559%	39,700	0.044%	64,200	0.070%	296,200	0.325%	400,100	0.439%
Nicaragua	35,700	0.866%	900	0.022%	2,300	0.056%	5,800	0.141%	9,000	0.218%
Panama	76,800	2.919%	1,900	0.072%	1,600	0.061%	12,100	0.460%	15,600	0.593%
Paraguay	42,700	0.884%	1,100	0.023%	2,600	0.054%	1,800	0.037%	5,500	0.114%
Peru	755,900	3.212%	15,500	0.066%	10,300	0.044%	82,400	0.350%	108,200	0.460%
Trinidad & Tobago	8,200	0.637%	1	0.062%			1	0.078%	2	0.140%
Uruguay	68,200	2.141%	1,000	0.031%			8,200	0.257%	9,200	0.289%
Venezuela	550,800	2.521%								
Asia										
Bangladesh	461,100	0.390%	75,500	0.064%	7,500	0.006%	5,800	0.005%	88,800	0.075%
China	5,826,600	0.478%	167,700	0.014%	99,400	0.008%	971,000	0.080%	1,238,100	0.101%
Hong Kong	97,400	1.591%	13,400	0.219%		0.000%	16,600	0.271%	30,000	0.490%
India	5,582,300	0.601%	869,100	0.094%			216,800	0.023%	1,085,900	0.117%
Indonesia	2,303,500	1.167%	25,100	0.013%	128,000	0.065%	293,900	0.149%	447,000	0.226%
Korea	2,225,100	4.955%	163,700	0.365%		0.000%	577,400	1.286%	741,100	1.650%
Laos	6,200	0.127%	100	0.002%	200	0.004%	600	0.012%	900	0.018%
Malaysia	191,300	0.950%	8,800	0.044%	4,600	0.023%	12,700	0.063%	26,100	0.130%
Mongolia	38,600	1.567%	1,500	0.061%	600	0.024%	5,100	0.207%	7,200	0.292%
Myanmar	245,300	0.544%	68,600	0.152%	15,600	0.035%	5,600	0.012%	89,800	0.199%
Nepal	102,000	0.475%	14,100	0.066%			2,000	0.009%	16,100	0.075%
Pakistan	336,700	0.247%	29,400	0.022%			41,200	0.030%	70,600	0.052%
Philippines	1,832,600	2.701%	27,200	0.040%	121,000	0.178%	225,700	0.333%	373,900	0.551%
PNG	13,700	0.319%	200	0.005%	100	0.002%	600	0.014%	900	0.021%
Singapore	83,900	2.522%	1,300	0.039%	1,400	0.042%	13,000	0.391%	15,700	0.472%
Sri Lanka	63,700	0.355%	8,100	0.045%	300	0.002%	6,800	0.038%	15,200	0.085%

Taiwan	625,000	2.910%	16,800	0.078%	32,800	0.153%	179,100	0.834%	228,700	1.065%
Thailand	1,220,500	2.096%	22,500	0.039%	27,100	0.047%	58,700	0.101%	108,300	0.186%
Vietnam	297,900	0.404%								
Transition economies										
Albania	30,200	0.893%	1,000	0.030%	100	0.003%	2,700	0.080%	3,800	0.112%
Bulgaria	250,300	2.942%	5,100	0.060%	3,500	0.041%	48,100	0.565%	56,700	0.666%
Czechoslovakia	178,900	1.743%	4,500	0.044%	2,500	0.024%	40,600	0.396%	47,600	0.464%
Hungary	154,700	1.530%	2,000	0.020%	1,600	0.016%	12,900	0.128%	16,500	0.163%
Poland	747,600	1.939%	19,100	0.050%	12,800	0.033%	119,900	0.311%	151,800	0.394%
Romania	337,000	1.483%	12,800	0.056%	10,100	0.044%	88,500	0.389%	111,400	0.490%
Yugoslavia	327,100	3.191%	11,000	0.107%			42,000	0.410%	53,000	0.517%
Developed Market Economies										
Australia	965,000	5.401%	74,900	0.419%	26,600	0.149%	108,200	0.606%	209,700.0	1.174%
Austria	234,000	2.909%	16,100	0.200%	17,900	0.222%	29,000	0.360%	63,000.0	0.783%
Belgium	322,400	3.184%	8,500	0.084%	10,400	0.103%	24,700	0.244%	43,600.0	0.431%
Canada	2,011,500	6.841%	47,200	0.161%	52,800	0.180%	103,500	0.352%	203,500.0	0.692%
Denmark	169,800	3.251%	6,500	0.124%	6,700	0.128%	18,200	0.348%	31,400.0	0.601%
Finland	205,000	4.014%	10,400	0.204%	12,600	0.247%	45,000	0.881%	68,000.0	1.332%
France	2,083,200	3.585%	304,100	0.523%			50,800	0.087%	354,900.0	0.611%
Germany	2,139,800	2.622%	142,400	0.175%	116,700	0.143%	371,600	0.455%	630,700.0	0.773%
Greece	296,400	2.835%	15,100	0.144%	13,500	0.129%	46,400	0.444%	75,000.0	0.717%
Ireland	121,700	3.432%	17	0.465%	4	0.102%	12	0.338%	32.1	0.905%
Israel	198,800	3.598%	8,000	0.145%	6,100	0.110%	23,200	0.420%	37,300.0	0.675%
Italy	1,791,700	3.132%	107,500	0.188%	51,200	0.090%	205,300	0.359%	364,000.0	0.636%
Japan	3,917,700	3.132%		0.000%		0.000%	805,800	0.644%	805,800.0	0.644%
Netherlands	532,400	3.439%	18	0.114%	9	0.057%	60	0.388%	86.7	0.560%
New Zealand	163,900	4.603%	14,100	0.396%	1,300	0.037%	8,800	0.247%	24,200.0	0.680%
Norway	173,000	3.994%	10,200	0.235%	1,300	0.030%	17,600	0.406%	29,100.0	0.672%
Portugal	295,000	3.006%	8,200	0.084%	13,800	0.141%	49,800	0.507%	71,800.0	0.732%
Spain	1,527,000	3.853%	96,400	0.243%	82,200	0.207%	205,100	0.518%	383,700.0	0.968%
Sweden	245,900	2.798%	11,200	0.127%	14,400	0.164%	38,600	0.439%	64,200.0	0.730%
Switzerland	148,000	2.065%	11,400	0.159%	3,000	0.042%	22,200	0.310%	36,600.0	0.511%
United Kingdom	1,813,300	3.122%	120,700	0.208%	98,300	0.169%	216,200	0.372%	435,200.0	0.749%
USA	14,419,300	5.398%	496,400	0.186%	525,100	0.197%	801,100	0.300%	1,822,600.0	0.682%
Source: UNESCO (1997), national sources.										

Annex Table 4: Skill Indices for All Countries, 1995 (ranked by Harbison-Myers Index)

	Countries	Harbison Myers Index	Technical enrolment index	Technical enrolment % population	Engineering enrolment index	Barro-Lee Data			Enterprise financed R&D%GNP	Per Capita GNP (1995) $
						Secondary	Higher	Total		
						Years of schooling (1985)				
1	Canada	62.05	103.02	0.692%	86.01	3.87	0.97	10.37	0.81	19,380
2	Australia	50.55	112.70	1.174%	84.29	3.05	0.67	10.24	0.78	18,720
3	USA	50.25	88.10	0.682%	68.98	4.90	1.03	11.79	1.49	26,980
4	Finland	45.05	106.72	1.332%	84.20	1.18	0.44	9.49	1.44	20,580
5	New Zealand	40.80	80.01	0.680%	58.38	3.51	0.84	12.04	0.37	14,340
6	Belgium	38.95	53.36	0.431%	44.03	2.48	0.40	9.15	1.10	24,710
7	Norway	38.85	73.52	0.672%	60.25	4.10	0.39	10.38	0.89	31,250
8	Netherlands	38.35	62.39	0.560%	53.80	2.66	0.43	8.57	0.94	24,000
9	UK	37.55	68.69	0.749%	49.83	2.25	0.40	8.65	1.14	18,700
10	Korea, Republic of	36.10	132.06	1.650%	113.83	2.76	0.41	7.85	2.35	9,700
11	France	35.90	66.39	0.611%	40.22	2.08	0.32	6.52	1.17	24,990
12	Spain	34.85	86.95	0.968%	64.41	1.63	0.22	5.58	0.36	13,580
13	Sweden	34.45	64.50	0.730%	49.94	3.68	0.53	9.45	2.14	23,750
14	Denmark	34.30	62.57	0.601%	49.93	1.76	0.56	10.33	0.95	29,890
15	Austria	32.80	68.24	0.783%	47.11	2.95	0.18	6.64	0.74	26,890
16	Germany	31.65	64.87	0.773%	49.00	0.87	0.24	8.54	1.47	27,510

17	Belarus	30.70	53.59	0.466%	53.35				0.65	2,070
18	Russian Federation	30.15	87.94	1.158%	77.59					2,240
19	Japan	30.05	63.54	0.644%	63.54	2.65	0.52	8.46	2.37	39,640
20	Ireland	29.90	79.58	0.905%	51.24	2.44	0.30	8.01	0.89	14,710
21	Ukraine	29.40	65.91	0.723%	65.91				0.60	1,630
22	Italy	29.10	63.14	0.636%	49.26	2.03	0.21	6.28	0.48	19,020
23	Greece	28.55	64.22	0.717%	50.55	1.67	0.34	6.73	0.12	8,210
24	Israel	28.35	69.74	0.675%	56.98	2.65	0.52	9.41	0.82	15,920
25	Taiwan Province	27.80	82.33	1.065%	70.79	2.20	0.33	7.00	0.99	11,500
26	Estonia	27.65	57.93	0.625%	51.88				0.08	2,860
27	Bulgaria	27.50	62.73	0.666%	57.68				0.49	1,330
28	Portugal	27.20	66.63	0.732%	55.43	1.16	0.13	3.83	0.11	9,740
29	Argentina	26.75	54.10	0.467%	44.08	1.27	0.26	6.68		8,030
30	Slovenia	25.05	49.35	0.509%	45.97				0.77	8,200
31	Switzerland	25.00	46.19	0.511%	36.14	3.38	0.37	9.09	1.89	40,630
32	Poland	23.30	39.07	0.394%	34.94	1.33	0.28	8.41	0.22	2,790
33	Singapore	23.05	48.81	0.472%	44.76	1.26	0.15	4.55	0.69	26,730
34	Peru	22.55	55.11	0.460%	49.63	1.48	0.40	5.79		2,310
35	Lithuania	22.50	40.18	0.399%	36.56					1,900
36	Croatia	22.35	44.93	0.515%	42.82				0.23	3,250
37	Uruguay	21.85	35.84	0.289%	34.27	1.85	0.30	6.45		5,170
38	Lebanon	21.60	46.89	0.395%	34.60					2,660
39	Philippines	21.60	54.57	0.551%	43.65	1.30	0.59	6.48	0.05	1,050
40	Latvia	21.35	34.35	0.339%	27.64				0.10	2,270
41	Chile	21.00	62.11	0.726%	59.01	1.71	0.28	6.45		4,160
42	Costa Rica	20.95	43.02	0.345%	36.45	1.07	0.39	5.33	0.00	2,610
43	Moldova	20.50	37.35	0.352%	37.01				0.01	920
44	Panama	20.20	58.84	0.593%	52.19	1.79	0.37	6.30	0.00	2,750
45	Czech Republic	20.00	40.62	0.464%	37.21				0.76	3,870
46	Slovakia	19.20	51.35	0.684%	47.70				0.60	2,950
47	Kuwait	19.10	36.49	0.390%	30.57	2.96	0.42	5.28		17,390
48	Jordan	18.55	39.27	0.417%	27.64	1.34	0.35	4.31		1,510
49	Hong Kong	18.45	40.41	0.490%	29.46	2.88	0.24	7.51	0.01	22,990
50	Hungary	17.65	23.47	0.163%	21.69	2.93	0.30	10.75	0.31	4,120
51	South Africa	17.05	23.61	0.174%	17.32	0.88	0.08	4.95	0.38	3,160
52	Yugoslavia	17.05	57.76	0.517%	52.39	1.12	0.33	7.16		2,500
53	Romania	16.95	39.33	0.490%	34.30				0.16	1,480
54	Egypt	16.45	16.10	0.120%	13.87		0.30			790
55	Thailand	15.55	30.25	0.186%	25.99	0.64	0.20	5.08	0.01	2,740
56	Colombia	15.30	43.55	0.511%	41.79	1.32	0.19	4.53		1,910
57	Ecuador	15.00	32.29	0.285%	29.01	1.41	0.46	5.58		1,390
58	Bolivia	14.80	31.90	0.343%	26.30	1.27	0.25	4.28		800
59	Turkey	14.70	35.66	0.327%	30.35	0.74	0.13	3.29	0.20	2,780
60	Yugo. Macedonia	14.45	35.06	0.427%	29.96					1,500
61	Cuba	14.35	20.55	0.188%	19.09				0.00	1,500
62	Iran	14.30	37.58	0.445%	30.03	1.01	0.09	3.28	0.00	2,000
63	Mongolia	13.50	30.29	0.292%	26.03				0.00	310
64	Saudi Arabia	13.45	18.96	0.123%	14.42					7,040
65	Syria	13.35	23.47	0.196%	17.67	1.11	0.26	3.99		1,120
66	Mexico	12.95	37.53	0.439%	31.83	0.82	0.22	4.42	0.04	3,320
67	Tunisia	12.55	24.49	0.239%	16.15	0.73	0.11	2.48	0.24	1,820
68	United Arab Emir.	12.20	7.51	0.054%	5.70	1.18	0.09			17,400
69	El Salvador	12.05	33.56	0.265%	31.53	0.51	0.09	3.57	0.00	1,610
70	Algeria	11.65	31.14	0.410%	21.55	0.44	0.08	2.39		1,600
71	Malaysia	11.10	15.98	0.130%	12.65	1.39	0.07	5.36	0.17	3,890
72	Trinidad & Tobago	11.05	13.36	0.140%	10.26	1.75	0.11	6.50		3,770
73	Indonesia	10.35	22.98	0.226%	19.11	0.58	0.04	3.75	0.08	980
74	Namibia	10.25	8.98	0.033%	7.36					2,000

75	Brazil	10.15	19.87	0.182%	15.50	0.88	0.21	3.49		3,640
76	Sri Lanka	10.05	7.79	0.085%	5.45	1.84	0.04	5.37	0.00	700
77	China	9.75	9.85	0.101%	8.75					620
78	Jamaica	9.60	12.12	0.113%	8.47	1.20	0.10	4.16		1,510
79	Morocco	9.55	23.73	0.253%	11.46					1,110
80	Nicaragua	9.40	19.57	0.218%	15.69	0.54	0.20	3.78	0.00	380
81	Mauritius	9.35	7.16	0.045%	6.27	0.92	0.09	4.59	0.01	3,380
82	Oman	8.95	5.35	0.041%	4.44					4,820
83	Paraguay	8.95	14.54	0.114%	10.71	0.91	0.16	4.70		1,690
84	Albania	8.30	14.54	0.112%	12.92					670
85	Honduras	8.20	19.56	0.200%	17.00	0.67	0.11	3.56		600
86	Zimbabwe	8.15	8.41	0.087%	7.07	0.23	0.03	2.63		540
87	India	8.10	11.85	0.117%	7.18	0.81	0.12	3.05	0.12	340
88	Congo	7.95	7.54	0.044%	5.32	1.03	0.11	3.14		680
89	Botswana	7.65	7.31	0.076%	3.52	0.26	0.02	3.70		3,020
90	Nepal	6.40	8.51	0.075%	5.22	0.11	0.04	0.86		200
91	Myanmar	5.90	15.39	0.199%	6.06	0.59	0.06	2.02		350
92	Nigeria	5.05	5.85	0.057%	3.99				0.00	260
93	Cote d'Ivoire	4.50	8.34	0.092%	4.43					660
94	Yemen	4.45	4.60	0.021%	4.17	0.07	0.01	0.81		260
95	Ghana	4.40	1.16	0.012%	0.76	0.93	0.03	3.22		250
96	Cameroon	4.35	5.70	0.064%	2.82	0.33	0.02	2.23		650
97	Togo	4.30	4.21	0.029%	2.99					310
98	Bangladesh	4.30	7.66	0.075%	4.15	0.57	0.06	1.97		240
99	Pakistan	4.10	5.06	0.052%	3.98	0.77	0.08	1.92	0.00	460
100	Lesotho	4.00	3.53	0.027%	2.42	0.24	0.02	3.51		770
101	Mauritania	3.55	5.28	0.031%	3.74					460
102	Senegal	3.30	5.55	0.053%	3.14	0.31	0.05	2.39		600
103	Laos	3.25	2.19	0.018%	1.88					350
104	Kenya	3.20	2.00	0.017%	1.34	0.27	0.02	3.09		280
105	Madagascar	3.10	5.96	0.062%	3.27				0.00	230
106	Afghanistan	3.10	1.67	0.009%	1.36	0.26	0.10	1.06		120
107	PNG	3.00	4.23	0.021%	3.88	0.20	0.03	1.65		1,160
108	Benin	2.90	3.95	0.038%	2.53	0.16	0.02	0.70		370
109	Sudan	2.80	3.50	0.025%	2.92	0.28	0.03	0.91		120
110	Eritrea	2.45	1.92	0.019%	0.98					100
111	Uganda	1.95	2.06	0.013%	1.78	0.08	0.01	1.92		240
112	CAR	1.70	1.74	0.012%	1.44	0.16	0.01	1.26		340
113	Ethiopia	1.45	1.16	0.012%	0.90					100
114	Burkina Faso	1.35	1.71	0.016%	0.91					230
115	Mali	1.30	0.97	0.007%	0.90	0.06	0.01	0.82		250
116	Chad	1.30	0.92	0.007%	0.61					180
117	Burundi	1.15	1.38	0.013%	0.76					160
118	Malawi	1.00	1.17	0.008%	1.01	0.10	0.01	2.58		170
119	Mozambique	0.90	1.07	0.013%	0.72	0.05	0.00	1.08		80
120	Tanzania	0.75	1.03	0.012%	0.88	0.15	0.05	2.29		120

Source: Calculated from UNESCO and World Bank data and Barro and Lee (1996).

Notes: Harbison Myers index is sum of secondary enrolment and tertiary enrolment times 5, both as % of age group.

Technical enrolment index is tertiary total enrolment (times 1000) plus tertiary enrolment in technical subjects (times 5000), both as % of population.

Engineering skills index is same as pervious index, with tertiary enrolments in engineering instead of enrolments in all technical subjects.