Perspectives on Global Development 2010
Shifting Wealth

Chapter 5

The Growing Technological Divide in a Four-speed World

The massive transfer of manufacturing capacity from OECD members to the developing world is one of the most striking changes in the global distribution of industrial activity over recent decades. Against the backdrop of shifting wealth, this chapter focuses attention on some of the major characteristics of the growth process in converging countries, particularly on their ability to absorb technologies and generate new ones. Shifting wealth has been accompanied by a growing technological divide between those developing countries which are capable of innovating, and those which seem not to be. There are several different channels through which technological generation and acquisition can take place – upgrading of human capital, R&D, FDI and trade. To meet the challenge of achieving competitive advantage, policy makers in developing countries must promote effective policy actions that help domestic firms absorb state-of-the-art technology and management know-how. However, this requires a far more active government policy to create an enabling environment than typically exists in most poor and struggling developing countries today.

Introduction

Chapter 1 presented the "four-speed" framework as a way of understanding the growth performance of the developing world over the last two decades. Explaining the different outcomes in economic performance between countries is however no easy task. Despite promising theoretical advances such as endogenous growth theory, the current state of understanding about the precise causes of economic growth and success is still relatively vague (Kenny and Williams, 2001, Pritchett, 2006). It is known that human capital – education and training – is important. It is also known that the institutional setting within which growth takes place is a key factor in explaining growth. However as a practical guide for policy makers growth theory has been found to be wanting. This chapter adopts a more modest aim. It does not attempt to explain the fundamental differences in economic performance between converging, struggling and poor countries in the four-speed world. Rather, it focuses attention on some of the major characteristics of the growth process in converging countries, particularly their ability to absorb technologies and generate new ones. A new cleavage within the developing world may be forming, between those countries which are capable of innovating and those which seem not to be. This – growing – technological divide is a source of concern.

The technological divide within the developing world

As economies develop, the drivers of economic growth change. Porter *et al.* (2001) proposed a three-stage model. Early growth depends on putting unused or underutilised factors of production, such as labour or land, to work. Later the challenge is to use factors more efficiently. Finally growth comes to depend largely on innovation. Different issues arise at each stage, and countries that fail to recognise the changing nature of the challenges they face and the correspondingly different requirements for institutions and policies can find their growth stalling (Wiggins and Higgins, 2008).

As the process of shifting wealth deepens and incomes rise in the developing world, the capacity to absorb and generate new technologies clearly becomes more important. A large theoretical and empirical literature has found that growth in total factor productivity (TFP) (the unexplained part of growth beyond the direct inputs of capital and labour) depends to a great degree on the ability of countries or industries to adopt the technologies and production techniques of their more productive peers (see Aghion and Howitt, 2006).

About half of total cross-country differences in per capita income and growth are due to differences in the efficiency of production, as measured by levels of TFP. TFP, in turn, is mainly driven by technological development and innovation, with a strong influence from research and development (R&D) (Guinet *et al.*, 2009). According to a study by Hulten and Isaksson (2007), differences in TFP levels are the dominant factor in explaining differences in development levels. Hulten and Isaksson (2007) also find that the gap between rich and most poor nations is likely to persist, given their prevailing rates of saving and productivity change.[1]

Calculating the contribution of TFP to output growth within the framework of the four-speed world described in Chapter 1 is instructive. Average TFP contributions over the period 2000-07 reveal a clear and growing technological divide (Table 5.1). Struggling or poor countries have extremely low TFP contributions to growth (0.5% and 0.6% per year respectively) compared with their converging peers (2.8%). It is also striking that these converging countries have an average TFP contribution two and a half times higher than the affluent countries (1.1%). China stands out in terms of its TFP contribution (4.4%). India has experienced a lower value (2.1%), but this is still significantly higher than the average for poor or struggling countries. India's performance is driven by knowledge-intensive service exports and information technology rather than manufacturing (Dahlman, 2009).[2] Thanks to these gains in TFP, and capital deepening in firms, labour productivity in China and India has improved – keeping real labour costs to about 20% of the US equivalent even in the context of rapidly rising wages (Dougherty, 2008).

Table 5.1. **Growth accounting, 2000-07**

	Output growth (average annual growth rate) (%)	Contribution to output growth by		
		TFP (%)	Physical capital (%)	Human capital (%)
Affluent	3.3	1.1	1.6	0.6
Converging	5.7	2.8	1.8	1.1
Struggling	3.1	0.5	1.2	1.4
Poor	3.2	0.6	1.2	1.4
Brazil	3.4	1.4	0.7	1.3
China	9.3	4.4	4.4	0.5
India	7.0	2.1	3.7	1.2
South Africa	4.2	1.8	1.7	0.7

Source: Authors' calculations based on Heston *et al.* (2009).

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A factor explaining TFP contributions to growth which is particularly important for China and India is the massive shift of resources, notably labour, out of agriculture and into manufacturing and services. Economy-wide TFP growth is not simply the weighted sum of sectoral growth rates since it also captures changes in the structural composition of the economy, and hence reflects the gains from moving labour from relatively unproductive to relatively more productive sectors. As discussed in Chapter 2, the simple dual-sector model of Lewis-Ranis-Fei fits in well with the stylised facts in the Chinese case – labour has been moving from low-productivity sectors, such as traditional agricultural and primary production, towards higher productivity activities in modern manufacturing (and modern agriculture), a process which has generated the surplus that spurred rapid capital accumulation and growth.

The role of human capital and education

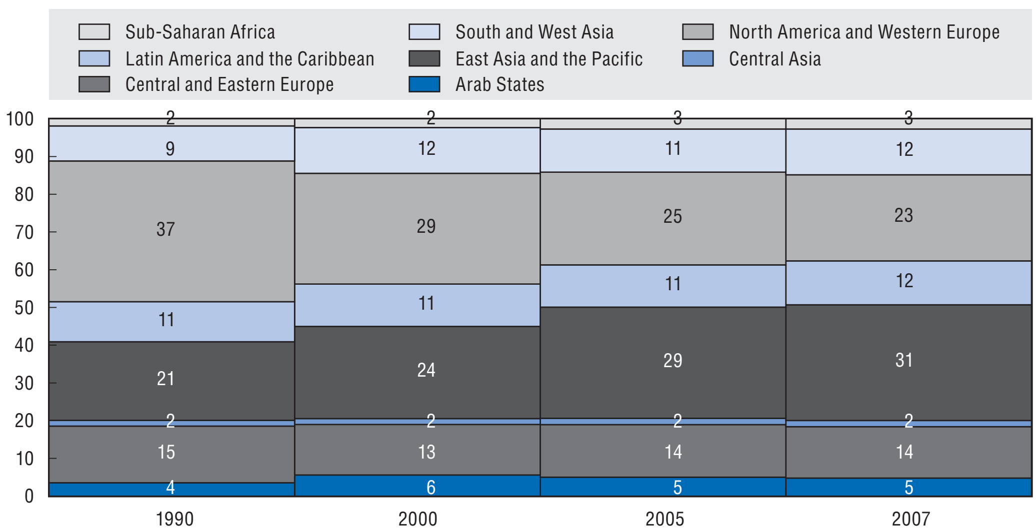
The capacity to innovate is crucial. Human capital is an important part of this, and education may be expected to be a key explanatory factor. Recent evidence suggests that schooling quality in the development of cognitive skills is of particular importance to enhancing human capital and economic growth (Hanushek and Woessmann, 2008). As well as aiding in the development of skills-intensive industries and new technologies, human capital also influences the country's productivity performance by facilitating technological diffusion between firms.[3]

One widely accepted lesson is the developmental importance of primary education. China has been exemplary in this sense. Even prior to its economic opening in 1978, China stood out for its massive investment in basic education. The number of students in primary education tripled and the number in secondary education increased by a factor of ten between 1952-78, raising the average worker's level of education from 1.6 years to 8.5 years, in the period 1950-92 (Maddison, 2007, p. 66). When China opened up to global markets in the 1980s, the relatively high education levels of low-wage Chinese industrial workers proved an irresistible draw for firms looking to shift labour-intensive production offshore (Schwartz, 2010, p. 256).

Nevertheless, in a highly competitive global economy, to focus only on the provision of primary education is surely a short-sighted policy and risks condemning developing countries to being stuck with a low-skilled, low-tech economy. Policy makers in the developing world are clearly aware of this, and over the last two decades the expansion of higher education in some parts of the developing world has been dramatic. Globally, the total number of tertiary students rose from 101 million in 2000 to 153 million in 2007, an increase of more than 50% (UNESCO, 2009). Within these global totals, the share of students from the developing world has been rising particularly rapidly – all developing regions outside North America, Europe and Central Asia have seen their shares grow (Figure 5.1). Since 1990, the largest increases have been in East Asia and the Pacific, which have enlarged their share of global tertiary enrolments from 21% to in excess of 30%. Of course, the share of the population with access to tertiary education in the developing world is still far below that of developed countries. But for the global labour market, absolute numbers are the ones which matter.

Figure 5.1. **Tertiary enrolment by region**

Share of world total by region



Note: Calculations based on number of pupils enrolled in tertiary education worldwide regardless of age.

Source: UNESCO (2009).

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China and India have been pouring resources into education over the last couple of decades – China grants 75 000 higher degrees in engineering or computer science every year, and India 60 000 (*The Economist*, 2010). These increases seem to be feeding a rise in research capability in the developing world. Of the increase from 5.8 million to 7.1 million researchers worldwide between 2002 and 2007, two-thirds was in the developing world – 2.7 million researchers in 2007, against 1.8 million five years earlier. The biggest increase – yet again – was in Asia. This region is now home to 41.4% of the world's researchers, up from 35.7% in 2002, a trend which has principally been at the expense of Europe and the Americas (UNESCO, 2009).

There is a temptation to see gains in human capital and educational achievement in the Asian giants as representing a competitive threat to other countries (particularly through the pressure they put on wages – see Chapter 2). However, it is important to stress the positive spillovers from the rise of research capacity and educational attainment in China and India. These come not only through enhanced economic growth but also through expanded educational opportunities. China and India are becoming increasingly effective centres of learning for the developing world (Altenburg *et al.*, 2008). Universities in India and China have long received students from other parts of the developing world, though the brightest were often sent to universities in North America and Western Europe. China and India now offer some world-class centres of learning, and the available evidence highlights increasing South-South co-operation in this field.[4]

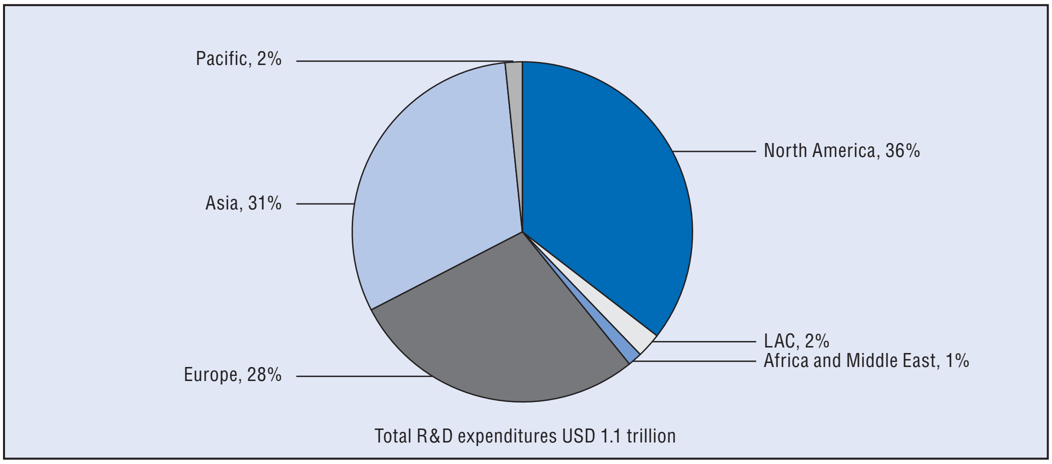
Shifting patterns of R&D expenditure

The shift in technological capacity is also reflected in the sharply rising amount of research and development (R&D) being carried out in the developing world – an activity that has traditionally been concentrated in Europe, Japan and the United States. Multinationals are proving to be a major contributor to this changing pattern. Between them they carry out more than half of all global R&D, and the R&D budget of a large multinational can be greater than the total R&D expenditure of all but the biggest developing countries. In 2007, for instance, Toyota (USD 8.4 billion) and General Motors (USD 8.1 billion) outspent India. The 1 000 companies most active in R&D in the world in 2008 (the "G 1000") spent a total of GBP 396 billion (BIS, 2010).

Figure 5.2 shows how this translates into geographical concentration. Three regions predominate: North America accounts for 36% of worldwide R&D expenditure, Asia 31% and Europe 28%. The small balance, approximately 5%, is spread across the whole of the Latin America/Caribbean, Pacific and Africa/Middle East regions. The concentration is even starker at the country level. By itself the United States accounts for about 33% of global R&D and Japan, the second-largest, about 13%. China at 9% comes next, followed by Germany (6%) and France (4%). The top two countries thus account for almost half of the global total, and the top five about two-thirds. Adding the next five countries – Korea, the United Kingdom, the Russian Federation, Canada and Italy – increases the total to just below 80%, meaning that four-fifths of the world's R&D is concentrated in just 10 countries (National Science Board, 2010).

Most of this R&D budget is still spent in affluent countries. But attracted by rapidly expanding markets and the availability of low-cost researchers and research facilities, the world's leading multinationals have rapidly increased their R&D bases in low- and middle-income countries. R&D expenditures by Chinese affiliates of US companies, for example, increased more than 20-fold in a decade: from less than USD 50 million in 1997 to over USD 1.1 billion in 2007 (Ibarra-Caton and Mataloni, 2010). A few specific examples demonstrate the nature of this: General Electric's health-care arm has invested more than USD 50 million in building a new R&D centre in India's Bangalore; Cisco is reportedly

Figure 5.2. **Research and development expenditure**
Share of world total by region, 2007



Source: National Science Board (2010).

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spending more than USD 1 billion on a second global headquarters – Cisco East – also to be based in Bangalore; Microsoft's R&D centre in Beijing is its largest outside its American headquarters (*The Economist*, 2010). Surveys of the most attractive R&D locations summarised by Pilat *et al.* (2009) suggest that these trends will only intensify in the future.

For the recipient countries, expenditures by foreign-owned companies can represent a large share of national R&D. In 2003 the share of foreign affiliates in total R&D was 24% in China, 48% in Brazil, 47% in the Czech Republic and 63% in Hungary (Nolan, 2009). Bruche (2009) observes that although much of this outsourced R&D is relatively routine in nature, there are emerging poles of higher-level innovation in a number of middle-income economies including Brazil. This strengthens the sense that the world is moving away from a model in which technologies are developed by multinationals based in high-income countries and then exported to low-income countries, towards "polycentric innovation", as multinationals spread their R&D centres around the world.

Securing a share of global R&D

Given general acceptance that ability to absorb technologies and take advantage of the presence of foreign firms and trade depends crucially on domestic capacity, some developing countries have made efforts in recent years to increase their own public R&D expenditure. Tunisia is one example. Its government has set a target of 1% of gross domestic product (GDP), as part of an initiative to upgrade its productive capacity in response to competitive threats in its traditional European Union market from emerging market exporters. In Latin America, a number of countries have established technology development funds (TDFs) to positively affect R&D intensity. Econometric evidence shows that participation in TDFs leads to increased R&D expenditures and induces beneficiary firms to take a more proactive attitude towards innovative activities (Hall and Maffioli, 2008). Low-income countries too are increasingly conscious of the need to boost R&D if they are not to be left behind. As part of its drive for private sector investment to transform its smallholder agricultural economy into a regional hub for financial services, Information and Communication Technologies (ICT) and tourism, the government of Rwanda, for instance, has recently announced its intention to establish an Endowment Fund to promote development through scientific innovation (*African Business*, 2010).

China and India are however again the big story, with a sharp expansion in the resources dedicated to science and technology. China now ranks amongst the top countries in both total R&D spending and number of researchers, with gross R&D expenditure reaching 1.5% of GDP – against the OECD average of 2.2% (see OECD, 2010b). The equivalent figure in 1995 was 0.6% and, given that Chinese GDP has more than doubled over the same period, the implied growth in absolute expenditure is huge. Measured in PPP terms, China's R&D expenditure is now second only to that of the United States (Yusuf, 2009). India lags behind somewhat, though its expenditure on R&D has been increasing at around 20% per year (Dougherty, 2008).[5]

The size and dynamism of the Indian and Chinese economies are important in terms of their capacity to absorb and generate innovation. First, they can innovate on a much bigger scale, enabling both countries to invest heavily in R&D and skills development. They can make major purchases of embodied technology in different forms – licences, machinery and even entire high-tech firms – and can attract leading scientists, managers and consultants. Second, both countries are also highly attractive for foreign direct investment (FDI). China in particular leverages investors' interest in its large and growing market by obliging them in return to share technology.[6] The ability to do this, and so address its technological backwardness, has been a fundamental motive for the country's strategic opening to FDI and trade – with its high savings rate China was hardly in need of foreign capital. China has, in effect, been trading market access for technology (Altenburg *et al.*, 2008, p. 330).

For developing countries the world over, then, the challenge represented by the emergence of China and India in terms of their innovative capacity is a serious one. But the issue is especially urgent for countries geographically near the Asian giants and with strong trading links. With China and India's increasing share of global R&D, their rapid absorption of technology from abroad and the establishment of national innovation systems, other Asian countries are aware that they need to move quickly. If not, their options for maintaining growth by diversifying into higher-tech products could be constrained by China's having cornered the competitive advantage in this more lucrative segment (Yusuf, 2009). When measured by R&D expenditure, technological effort in other Asian countries is certainly lagging behind that of the Asian giants – Malaysia spends less than 1% of GDP on R&D and in Thailand the figure is closer to 0.25%.

An input, not an end in itself

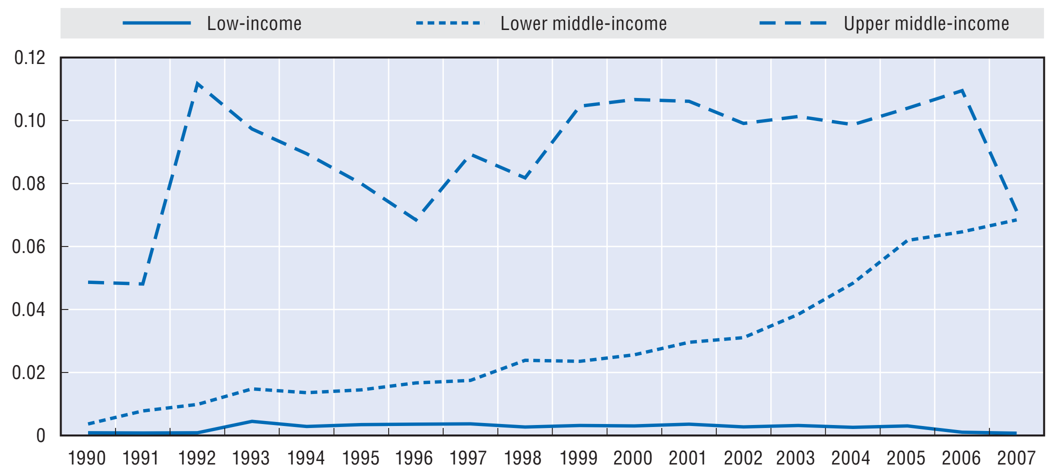
Of course, R&D expenditure is an input measure, not an output. On output measures the evidence for the advance of India and China is more ambiguous. Some indicators of technological output show Chinese and Indian progress in a very favourable light. China's share of patent applications worldwide has risen quite sharply, for example, from about 1.5% in the late 1980s to nearly 10% in 2004 (Burns, 2009). Nevertheless, China and India together represent only about 1% of all patents granted to foreigners by the US Patents and Trademark Office compared to more than 6% in the case of the much smaller Korea (Altenburg *et al.*, 2008).

This divergence between inputs and outputs is reflected in other indicators. Thus, while the number of articles published by China's scientific community has grown at a furious pace, India's has remained comparatively static. This is surprising, since India's legal system appears to offer better protection to intellectual property rights and so should promote more research activity (Dougherty, 2008). There are legitimate questions over the depth of innovation in the Chinese case. It is also often argued that the usual indicators of innovation such as patent grants overstate the innovation capacity of China given that much innovation in China is associated with incremental improvements in production technology rather than major breakthroughs (Puga and Trefler, 2010; see also OECD, 2010b). Although rising rapidly, only 11% of patents by Chinese firms in 2006 were considered inventive, compared with 74% of patents by foreign firms patenting in China. China's spending on R&D remains heavily focused on experimental development: only 5.2% of total R&D in 2006 was aimed at basic research, compared to 10-20% on average in OECD countries.[7]

Considering this broader picture (strong technological commitment, but outputs that remain modest), it does not come as a surprise that composite indicators such as the alternate innovation capability index in the Global Competitive Index of the World Economic Forum rank neither China nor India as major innovation powers (though in a number of aspects, they have moved up the ranking rapidly in recent years). Growth in output indicators for other lower-middle-income countries has also been relatively modest. More starkly, for low-income countries there has been absolutely no increase in their rate of patent activity over the last 20 years, suggesting an already serious technological divide is only worsening (Figure 5.3).

Figure 5.3. **Patent intensity**

Patent applications per 100 000 people



Source: World Bank (2009).

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New workshops of the world? The role of manufacturing

One of the most striking characteristics of shifting wealth has been the massive transfer of manufacturing capacity from OECD members to the developing world and, in particular, towards East Asia. The magnitude and the speed of this change is unprecedented, and the industrialisation it has brought to China and India has lifted millions out of poverty (Altenburg *et al.*, 2008; UNIDO, 2009).

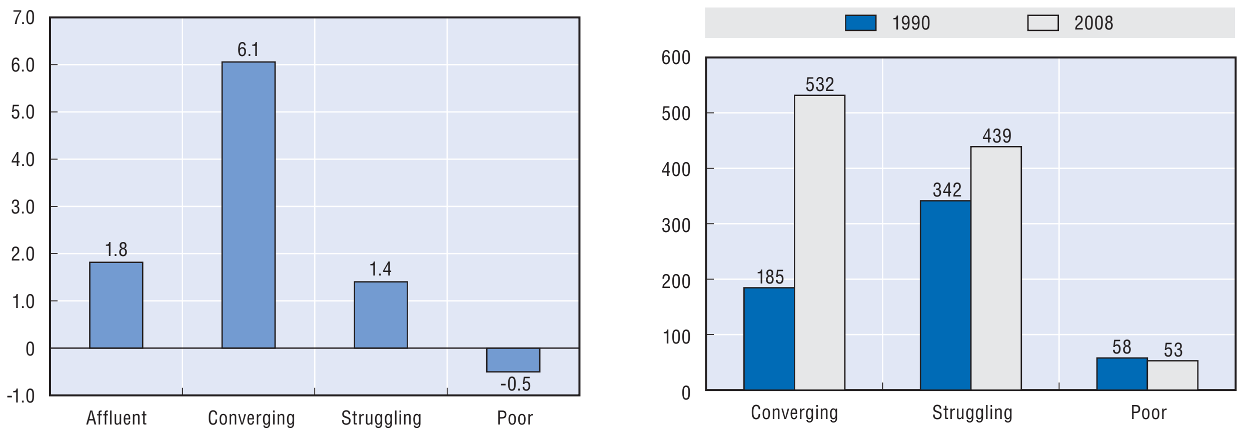
Behind this movement lie deep structural changes in the global economy – the growing significance of industrial clusters, the rapid increase in the proportion of manufacturing output that is traded internationally, the explosive growth of task-based manufacturing – and their consequences for the location of manufacturing and for commodity markets (UNIDO, 2009). These structural changes will transform future patterns of economic development and opportunities for development.

In the 1990s, many developing countries were encouraged to abandon industrialisation strategies on the grounds that other sectors could also be dynamic sources of growth, and that there was "nothing special about manufacturing". Looking back at the phenomenal success of Asian countries in manufacturing, one is led to ask if this was the right advice. It is now acknowledged that most trade growth is obtained by moving into new products, not by intensifying the export of similar products (Hummels and Klenow, 2005). And the scope for such innovation through processing of raw materials and commodities is likely to be relatively limited compared to the enormous variety of products within manufacturing. Productivity gains too are generally easier to generate in manufacturing, through learning-by-doing and scale economies (Thirlwall, 2002).[8]

Looked at through the framework of the four-speed world, the data suggest that there is indeed a link between countries which have achieved strong economic growth in the 1990s and 2000s and their ability to sustain strong growth in manufacturing value-added: since 1990 growth in manufacturing value added (MVA) per capita in the converging group of countries has been in excess of 6% per annum, while for the struggling and poor groups the figure is approximately half that (Figure 5.4).

Figure 5.4. **Manufacturing value added per capita, 1990-2008**

% annual change | Current USD



Source: Authors' calculations based on World Bank (2009).

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This is not to deny that other sectors can play an important role in generating technological spillovers. Some services have shown that they can act as economic drivers for developing countries: the information and communication technologies sector in India is a very strong example (Dahlman, 2009; Dasgupta and Singh, 2005). Since the mid-1980s the Indian software industry has grown in a spectacular way, achieving average annual growth rates of more than 30% over the past decade. The Indian software and services sector reportedly employed nearly 1.3 million people in 2006, with revenues of

USD 30.3 billion (Altenburg *et al.*, 2008).[9] As suggested in Chapter 4, growth in the service sector can also underpin poverty reduction strategies. Broader econometric evidence also supports the view that services can act as a catalyst for growth. In a study of 18 Latin American countries over 1951-2006, Acevedo *et al.* (2009) found strong evidence that segments of the service sector acted as drivers of economic growth, notably finance, commerce and transport.

Nor should the scope in resource rich countries for development through moving into higher-value-added commodity exports be dismissed. Although it has, for various reasons, proved difficult in the past,[10] this is still an extremely important strategy for many developing countries. Moreover, there are a number of examples of countries having used their natural resource base efficiently to achieve high levels of income per capita and development. These include not only developed countries such as Norway and Australia, but also developing countries such as Chile and Botswana which have succeeded in catalysing their development through the prudent management of their natural resources (Wright and Czelusta, 2004; Havro and Santiso, 2008). In this sense, there need be no "resource curse".

Nonetheless, the association between manufacturing capacity, growth and innovation appears to be especially strong (see, for example, UNIDO, 2009; Wells and Thirlwall, 2003). Even in a post-industrial advanced economy like the United States (where 70% of GDP is accounted for by services) manufacturing is still responsible for 60% of R&D spending (National Science Board, 2006). Scientists and engineers make up 9% of the manufacturing labour force, twice the share in the rest of the economy (Scott, 2008).

Led by global markets, yet still geographically concentrated

Two characteristics are notable in the dramatic shift of manufacturing capacity towards the developing world. The first is the increasingly important role FDI has played in transferring manufacturing capabilities across borders over the last two decades. Approximately two-thirds of China's inward FDI has gone into manufacturing, and the country's foreign-funded enterprises now account for 60% of pharmaceuticals output, 75% of medical, precision and optical output, 88% of electronic and telecommunications and 96% of computer and office equipment. In China's passenger-vehicle industry, joint ventures with global firms take 72% of the domestic market (Nolan, 2009).

The second factor is the extent to which growth in MVA has been geographically concentrated. Whether due to the development of indigenous firms or spurred on by FDI or trade, the accumulation of manufacturing capacity has been largely limited to Asia. As Table 5.2 shows, MVA per capita has increased nearly six-fold in China since 1990, but stagnated in Latin America and sub-Saharan Africa. China is estimated to represent about 15% of world value-added in manufacturing, similar to Japan and more than 50% greater than its share in world PPP GDP. Given the pace of expansion of the Chinese economy, it may well overtake the United States in the next five to seven years to become the world's leading producer of manufactured goods (OECD, 2010b).

Export processing zones as a tool for technological upgrading

Simply looking at the total exports from an economy in assessing its structure or growth can be misleading because of the increasing importance in trade flows of integrated value-chains and the vertical dis-integration of production – something discussed in more depth in the next section. Provided the right policy framework is in place (Ancharaz, 2009),

Table 5.2. **Manufacturing value added per capita 1990-2007**

USD

	1990	1995	1998	2000	2005	2007
World	812	837	886	944	1 014	1 060
CIS	462	216	195	237	327	361
Sub-Saharan Africa	30	26	28	28	30	30
China	100	199	256	303	491	597
Latin America	622	696	733	687	759	789
North Africa	150	155	171	194	208	215
Developing countries	171	215	239	253	326	366
Industrialised (excl. CIS)	3 491	3 658	3 925	4 238	4 421	4 554
Asia	117	170	195	222	314	367

Source: UNIDO (2009).

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Box 5.1. **Upgrading trade**

How easy is it for a country to shift its trade up the value chain? Presented below is an index of technological sophistication (ITS) for the exports of selected countries. The ITS rises as more of a country's exports fall into higher-tech categories (Woo, 2010).* Table 5.3 summarises ITS scores for selected countries in 1995 and 2007. It confirms that Asian economies tend to specialise in higher-tech exports, and this contrasts with their Latin American and sub-Saharan African peers. China's increasing exports of higher-tech products are reflected in an increase in its ITS score from 3.13 in 1995 to 3.75 in 2007, suggestive of rapid technological catching-up. By contrast, exports from India and Indonesia are significantly less technologically sophisticated than in the rest of their region and their ITS scores have little changed between 1995 and 2007. Indeed, the scores have changed little in most countries suggesting that technological upgrading is an outcome of long, cumulative processes of learning and assimilation of more advanced technology. Hence moving from a low-tech structure to a high-tech one may be a challenging goal for many developing countries.

Few rules are iron-clad, however, and there are important exceptions to this pattern. The ITS score of the Philippines jumped from 1.93 in 1995 to 4.11 in 2007 because of a sharp increase in electronics (HT1, from 16% to 61%). Equally impressively Costa Rica's ITS also jumped from 1.66 in 1995 to 3.11 in 2007. Its biggest export share gains were made in electronics (HT1, from 0.8% to 28%) and medium-tech engineering (MT3, from 2.9% to 13.7%). Brazil, Mexico, Mauritius and South Africa all have a bigger presence in high-tech categories than the rest of their regions. In some cases, including Costa Rica, Mexico and the Philippines, the link with the presence of foreign multinationals is clear. But even in Brazil, 14 of the largest 25 "Brazilian" firms are in fact foreign-owned affiliates (Nolan, 2009), and these are responsible for a large share of high-tech exports.

* The ITS index is constructed by assigning lower values to the lower-tech categories and higher values to higher-tech: 1 to primary products (PP), 2 to resource-based manufactures (RB1, RB2), and 3 to low-technology manufactures (LT1, LT2) and 4 to medium-technology (MT1, MT2, MT3) and 5 to high-technology (HT1, HT2). The percentage of exports in each category is then multiplied by the assigned value, and these are summed and divided by 100. The resulting index ranges from 1 to 5, with higher values indicating greater technological sophistication.

Box 5.1. **Upgrading trade** *(cont.)*

Table 5.3. **Index of technological sophistication for selected economies**

	Index of technological sophistication in 1995	Index of technological sophistication in 2007
OECD	2.92	2.96
Asia (except Japan)	3.09	2.95
China	3.13	3.75
Hong Kong, China	3.53	3.95
India	2.5	2.61
Indonesia	2.19	2.22
Japan	3.98	3.69
Korea	3.78	3.88
Malaysia	3.58	3.47
Philippines	1.93	4.11
Singapore	3.98	3.68
Chinese Taipei	3.80	3.94
Thailand	3.16	3.34
Latin America	1.98	2.16
Argentina	2.05	2.06
Brazil	2.53	2.49
Chile	1.55	1.58
Colombia	1.81	2.07
Costa Rica	1.66	3.11
Mexico	3.37	3.25
Peru	1.45	1.53
Sub-Saharan Africa	1.62	1.82
Mauritius	2.74	2.75
South Africa	1.82	2.44

Source: Woo (2010).

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export processing zones (EPZs) can play an important role in the diversification of export structures and the development of domestic economies.

Around the world it is estimated that 66 million people are employed in EPZs or EPZ-like operations, 40 million of whom are in China (Milberg and Amengual, 2008). The vast majority of FDI in China is located in its special zones that provide preferential treatment for investors. Beginning in 1979, China established its first four Special Economic Zones (SEZs) that were established to capture foreign investment from Chinese living overseas along China's southeast coast, including Hong Kong, China; Chinese Taipei and Macao. In 1984, 14 new Open Cities were designated along the coast: they all set up Economic and Technology Development Zones (ETDZs). As a result of the lobbying of provinces and cities throughout China, there were over 100 investment zones by 2003, including High Technology Development Zones recognised by the central government, with at least one in each of China's 31 provinces (Jefferson, 2007, p. 211). They have played a major role in China's export success. EPZs contributed less than 6% of China's exports in 1995 but about 25% by 2005 (Wang and Wei, 2008).

India has also dramatically expanded its SEZs, created to promote exports and attract investment in the manufacturing sector – there were 19 in 2004 and 558 in 2007 (see OECD, 2009a). Outside Asia, there have been longstanding EPZ-type arrangements, particularly in

Central America, and increasingly in Africa. For instance, EPZ exports represented 52% of national exports in Costa Rica in 2006 (as compared to 21% in 1997) and 56% of national exports in Madagascar in 2005 (ILO, 2008).

This expansion of EPZs has not been uncontroversial. It has occurred in the face of growing international political and economic resistance. Political resistance comes from labour activists and NGOs, international organisations and regional trading arrangements. The economic forces working against EPZs include the declining terms of trade for manufactures and the enormous gains by China in world export shares of many products produced in EPZs (Milberg and Amengual, 2008).

The establishment of EPZs typically incurs two types of cost factors. Firstly, the direct costs for establishing the EPZ in terms of infrastructure and subsidised services. Secondly, the indirect costs in the form of foregone government revenue and national income as a result of exemption from taxes, import and export duties. In some senses, then, it is not a first-best policy option, and can act in a distortionary way on the domestic economy. For policy makers the key question is whether the positive effects, in terms of employment generation and spillover effects on the rest of the economy, particularly in terms of technological upgrading, outbalance the costs.

A number of studies are not particularly encouraging on this score, showing that spillover effects and externalities typically tend to be limited as a result of low integration between businesses in the EPZs and the local economy.[11] As the *Industrial Development Report* (UNIDO, 2004, p. 84) puts it, "like FDI, EPZs by themselves do not guarantee success in the absence of capacity in the domestic firms to establish backward and forward linkages, diversify their output and upgrade their capabilities. Exposing only part of industry to the rigours of globalisation may protect and even entrench uncompetitive enterprises elsewhere. EPZs cannot substitute for economy-wide productivity gains and improvement of business environment conditions."

A case in point is Mexico – a country which has used EPZs extensively (its *maquila* industry) as part of its strategy for diversification. At first sight the policy appears to have achieved much in terms of diversifying Mexico's export structure and raising its level of technological sophistication through the promotion of its maquila industry: the share of trade in GDP has doubled over the last 20 years, with the share of manufacturing rising from 20% to about 85%. The country has an increasing export specialisation in sectors or products integrated in global value chains (see OECD, 2009b). But most of this is based on imported inputs which are re-exported with low levels of value-added and little use of local inputs. Mexico's trade performance can be attributed more to comparatively low labour costs than to high and rising productivity or innovative capacity. In fact MVA as a share of GDP in Mexico has fallen since the 1990s, and its overall growth performance has been poor. What lies behind this disappointing performance is open to dispute, but it has been blamed on a slow "*maquilización*" of the Mexican economy, whereby domestic industry has copied the maquila model and has been "hollowed out" by a rising share of imported intermediates, with a subsequent collapse of the export multiplier (Mold and Rozo, 2006; Palma, 2005).

In the Chinese case, too, the story is more complex than it initially appears. As noted earlier, the use of EPZs has been pervasive. But domestic content is often low. Of China's exports 55% are made by foreign firms, and generally the more high-tech the industry, the higher the foreign firms' share – more than 80% of electronic and telecommunications exports are made by foreigners, as are 70% of plastics, and 60% of electrical goods.[12] But the value added of firms engaged in technology-related products can be minimal. Research by Koopman *et al.* (2008) suggests that the domestic value added of technology-related products in China is extremely low – ranging between 4% for computers and related equipment to 15% for telecommunications equipment. In contrast, given that domestic private companies are less likely to be involved in processing trade, the total value-added component of their exports is high, at 84% against just 3% for foreign-owned firms (see OECD, 2010b).

This puts poorer developing countries in a particularly difficult position. The fact that even a country like China, in so many senses an economic success, continues to struggle with capturing maximum benefits from foreign investment illustrates the scale of the challenge. As Thun (2008, p. 370) puts it, "Rather than strong-arming multinational firms into transferring technology and utilising local suppliers, it is far more effective (and more difficult) to create a policy environment that will support the development of the capabilities that multinational firms are seeking in their supply base".[13]

Governing the value chain

Securing for the local economy an appropriate share of gains in the value chain is clearly not an easy task. Thanks to the literature, we now have a more sophisticated view of the way in which the gains from globalisation are distributed (Gereffi and Korzeniewicz, 1994; Kaplinsky, 2000; Humphrey and Schmitz, 2001). Altenburg *et al.* (2008) argue that the global value-chain approach helps to explain the massive and rapid disbursal of production capabilities away from the OECD countries.

Over the last two or three decades, the decrease in the costs of international communications and reductions in international trade barriers have fuelled what Baldwin (2006) called the "second unbundling": the end of the need to perform most manufacturing stages physically close to each other.[14] Each stage of production can be geographically re-assigned according to countries' comparative advantage, leading to new patterns of specialisation among countries (OECD, 2009c). Moreover, unbundling in this sense is no longer restricted to the manufacturing sector; services are also increasingly susceptible to this kind of outsourcing. Knowledge-intensive firms such as IT specialists and consultants have greatly increased the number of people they employ in developing countries – a quarter of Accenture's staff are now reportedly located in India, for example (*The Economist*, 2010).

The rapid integration of developing country producers into value chains is still mainly driven and co-ordinated by firms based in the United States, the European Union or Japan, but developing country multinationals are becoming increasingly important protagonists. For instance, the Brazilian aircraft manufacturer Embraer, now buys many of its component parts from affluent countries and does the value-added assembly work in Brazil (*The Economist*, 2010).

The rapid acquisition of production capabilities results from the dual role of the lead firms: they demand high quality standards and they often also provide constructive monitoring so that these demands are met. As pointed out by Schmitz (2006), this does not mean that all producers joining such value chains can expect to learn fast from their customers. Lead firms only provide this support where they perceive a low risk of supplier failure, something which is not always the case in many low-income countries. Poor developing countries thus risk being completely excluded from global value chains.

From a strategic perspective, it is also important for policy makers to take into account the fact that power in the value chain increasingly stems from intangible factors (linked with technology, marketing, management practices, etc.) rather than competition through low cost (Kaplinsky, 2000; Humphrey and Schmitz, 2001). Thus a firm that depends on low wages to convert physical inputs into a physical product will consistently face downward pressure on its prices because of competition from ambitious firms throughout the developing world. But a firm which can deploy intangible factors such as design, brands, business contacts or marketing is better able to protect its position because its skills are not easily copied.

As noted in Chapter 3, shifting patterns of South-South demand are also changing the nature of global value-chains. Demand in the developing world tends to be for cheap and undifferentiated goods. This runs against the trend in demand in the affluent economies which since 1970 have increasingly favoured differentiated high-quality products (Kaplinsky *et al.*, 2010). Potentially, this shift of demand patterns gives a second chance for those poor or struggling countries that so far have failed to enter global supply chains and so have missed out on South-North value chains. In addition, in some kinds of goods developing country firms may indeed possess a competitive advantage, through “frugal innovation” – the adaptation of products and marketing practices to better suit the needs of customers in low-income countries (*The Economist*, 2010; van Agtmael, 2008; Prahalad, 2005). Shifting wealth is certainly impacting on the nature of global value chains in ways which are both dynamic and unpredictable.

Conclusion

A number of conclusions can be drawn from this discussion of the role of innovation, exports and FDI in the reconfiguration of the global economy. First, Asian success in the global economy has, to an important extent, been built on manufacturing. However, the nature of competition is changing, and it is increasingly better to compete through the use of intangibles rather than through being lowest cost producer. Second, as reported in Chapter 3, developing countries themselves are increasingly becoming protagonists in global value chains – with important implications for other developing countries in terms of their ability to integrate into these value chains. Thirdly, innovation and technological acquisition do not fall like “manna from heaven” and need to be fostered, and those states which have been most active in trying to promote such upgrading have generally had most success. And last, but by no means least, for the “Bottom Billion” countries in particular, policy advice on how to integrate into the global economy needs to be based on a rigorous assessment of their institutional capacities and human capital – openness to capital inflows and trade, in themselves, are not enough to secure the desired outcomes in terms of innovation and technological upgrading.[15]

This chapter has focused on the manufacturing and industrial sectors, principally because of the striking rise in productive capacities in Asia in these sectors. But this does not mean that other sectors cannot also play their role as technological drivers. Brazil now stands out as a superpower in global food supply and agricultural markets, thanks to a combination of natural comparative advantage, low production costs and rapid technological advances (Barros, 2008), fostered partly by government-subsidised research.[16] There is a sense in which technological advance in agriculture is especially urgent, given the growing demand for agricultural produce and increase in food insecurity. Research-led technological change in agriculture can be a highly efficient way of pursuing poverty reduction (Thirtle *et al.*, 2003).

To meet the challenge of achieving competitive advantage, policy makers in developing countries must promote effective policy actions that help domestic firms absorb state-of-the-art technology and management know-how to achieve stronger technological competitiveness. The promotion of innovation requires a far more active government policy to create an enabling environment than typically exists in most poor and struggling developing countries (Cimoli *et al.*, 2009). For African and Latin American policy makers, this theme is particularly relevant. Although the process has not been without problems (Chandra *et al.*, 2009), East Asian countries have, broadly speaking, been extremely successful in technological upgrading. But for developing countries in other regions, defining a new innovation-led growth strategy represents a major challenge. China and India can potentially provide access to technology for other developing countries at lower cost. Chapter 3 has shown that they can already provide capital goods and knowledge-intensive business services in ways that undercut the traditional affluent-country sources. There is also much scope for deeper South-South technological alliances, an issue that will be discussed further in Chapter 6.

Notes

1. Hulten and Isaksson (2007) carry out a long-run econometric study of 112 countries over 1970-2000. Another long-run study (covering 1970-2006) (Woo, 2010) finds that TFP levels in the developing world are still low relative to the United States, averaging 51%, 58% and 35% for Asia (excluding Japan), Latin America and sub-Saharan Africa respectively. Other studies broadly confirm this pattern of large absolute differences in TFP levels between developing and developed countries.
2. These results are broadly consistent with other calculations of recent TFP growth (see OECD, 2010a; also Bosworth and Collins, 2007).
3. See OECD (2010a) for more detail.
4. At the United Nations meeting on the Millennium Development Goals in 2005, President Hu Jintao of China promised to offer training to more than 30 000 people from developing countries between 2006 and 2009, and subsequent pledges at the November 2006 Forum on China-Africa co-operation made it clear that half of these would be from Africa. The new training programmes include courses in economics and trade, telecommunications, security, health, water pollution technology and sewage treatment, agriculture and financial management (Brautigam, 2009).
5. It should be stressed that it is not just the size but also the composition of R&D spending which is important. While public-sector R&D can be particularly beneficial for creating new technologies with high social returns, private-sector R&D investment is crucial. It can be facilitated by framework conditions which provide sufficient incentives for businesses to invest (OECD, 2010b).
6. One way in which this has been done has been through forcing foreign investors seeking access to the Chinese market to create joint ventures with Chinese state-owned enterprises (SOEs), a policy particularly targeted on the strategic car, semiconductor and civil aviation sectors (Schwartz, 2010, p. 257).
7. For further detail on research and innovation in China, see OECD (2008).
8. An important caveat here is related to measurement issues. It has been argued that whereas it is possible to control for quality change in manufacturing industries (some countries, including the United States, do this), it is virtually impossible in services. Diewert and Fox (1999) ascribed the US productivity slowdown between the 1970s and 1990s to measurement problems related to the introduction of new products.

9. The dynamism of the software sector has been driven both by national firms and multinationals. Among the major national firms are companies such as Tata Consultancy Services, Infosys, Wipro Technologies and Satyam. Among the foreign multinationals, IBM employs more than 60 000 people in India (Altenburg *et al.*, 2008).

10. One problem has been tariff escalation, whereby importing countries have imposed higher tariffs on processed products than the raw materials, thereby providing a disincentive to the commodity-producing country to move up the value chain. According to the WTO (2010), the situation is improving. Tariff escalation remains after the Uruguay Round, but it is less severe, with a number of developed countries eliminating escalation on selected products. Now, the Doha agenda includes special attention to be paid to tariff peaks and escalation so that they can be substantially reduced.

11. See the reviews of the relevant literature in Madani (1999), Engman *et al.* (2006), Milberg and Amengual (2008).

12. See OECD (2005).

13. Conscious of these problems, in March 2006 China's central government announced its "homegrown" innovation strategy for the period of 2006 to 2020. The principal objective of this strategy is to foster indigenous R&D and innovation activity in Chinese industry and reduce dependence on foreign technology (Huang *et al.*, 2008).

14. Baldwin's "first unbundling" was the end of the need to manufacture goods close to the point of consumption as a result of improvements in the speed and cost of physical transport – a trend which has been going on since the late 19th century.

15. A growing body of evidence suggests that reaping the benefits from interaction with the global economy, through trade flows and FDI, is contingent on a certain minimum threshold level of human capital and institutional capacity. See, *inter alia*, Hausmann and Fernández-Arias (2000), Baliamoune (2002), Blonigen and Wang (2005), and Calderón *et al.* (2005).

16. For instance, through the work of Embrapa, a government research agency, a total of 116 new varieties of soya beans were launched between 1968 and 1997, and in the past few years new ones have been added at a rate of almost 100 a year (*The Economist*, 2009).

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From:

Perspectives on Global Development 2010

Shifting Wealth

Access the complete publication at:

https://doi.org/10.1787/9789264084728-en

Please cite this chapter as:

OECD (2010), "The Growing Technological Divide in a Four-speed World", in *Perspectives on Global Development 2010: Shifting Wealth*, OECD Publishing, Paris.

DOI: https://doi.org/10.1787/9789264084728-11-en