12. Industrial upgrading: can progress continue?

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12.1 INTRODUCTION

The fastest supercomputer in the world in 2010 was housed in 100 refrigerator-sized cabinets at the National Center for Supercomputing in Tianjin. It had 14000 processing chips and could make 2500 trillion calculations per second, which was rather quick indeed. This computing behemoth lost its title as the fastest to a machine in Japan a year later and then to one in the United States (US). But in 2013, the People's Republic of China (PRC) regained the top spot with a new computer at the National University of Defense Technology (BBC 2010; Top 500 2013).

The PRC also boasts one of the fastest trains in the world: the CRH380A runs at 431 kilometers an hour (km/h) on special tracks that are part of the new high-speed Beijing–Shanghai route. Even in conventional travel, the country is a leader, producing more automobiles than any other country. It churned out 22 million vehicles in 2013, a level greater than the combined production in Japan and the US (Organisation International des Constructeurs d'Automobiles 2014). The PRC is also a global leader in other high-value sectors. For example, 26 percent of its exports are high-technology, ranking it ninth in the world in 2011 in this area—higher than such technological heavyweights as the US, Japan, and Germany.

Thus, by some measures, the PRC has achieved high technological sophistication and has done so in a remarkably short time since beginning reforms in the 1970s. This bodes well for its efforts to become a high-income country, as the ability to develop, adapt, and apply technology, and to create high-value goods and services, is critical for moving up the income ladder. Indeed, if other developing countries could match this progress they could also avoid the middle-income trap.

If we delve more deeply, however, we find that the PRC's technological advance is a little more prosaic. The supercomputer in Tianjin is powered by chips that were designed and developed by Intel, a US firm. The example of its high-speed trains is even more revealing. The

PRC attempted to develop its own technology in the 1990s, but found it could only reach speeds of 180 km/h instead of the 250 km/h achieved in other countries. It changed course and decided to bring in the technology from Europe and Japan through joint ventures and technology transfer agreements.

On vehicle production, the PRC may be the world's largest producer (and consumer), but local manufacturers are mostly crowded at the low end of the market. The higher end is dominated by foreign producers, which either export to the PRC or have set up operations there. As for the PRC's ranking in high-technology exports, a substantial proportion is in finished products as part of processing trade, which is dominated by foreign enterprises, not domestic firms. In fact, the country's value added is often low. As an extreme example of this, the value added from the assembly of an Apple iPod is less than $5 of its $150 export value, or about 3 percent. The PRC is developing its own technology, but continues to rely on foreign technology in many areas. Whether that approach can sustain its long-run progress remains to be seen.

It is important to recall that the PRC was still a low-income country until the late 1990s and only crossed the threshold from lower-middle to upper-middle status in 2010. Its large economy—now the world's second biggest—belies a modest per capita income. Productivity has grown rapidly, especially since the early 1990s, but much needs to be done to close productivity and technology gaps with the rest of the world. Furthermore, the services sector is underdeveloped, remains closed to private competition, and is blighted by low productivity. Moving up the value chain and producing more sophisticated goods and services with advanced technology is the only way that the PRC can avoid the middle-income trap and become a high-income country by 2030.

The government recognizes that upgrading production is critical for developing the economy. To this end, it has focused recently on promoting so-called 'indigenous innovation,' which includes high-end manufacturing as one of seven sectors for attention under the Twelfth Five-Year Plan, 2011–2015. Achieving these objectives will involve getting the mix right between competitive forces, on the one hand, and the support of government on the other.

12.2 STRUCTURAL TRANSFORMATION: FOUR CRITICAL SHIFTS

To avoid the middle-income trap, a country needs to invest in productive capacity and thereby expand the value of what goods and services it

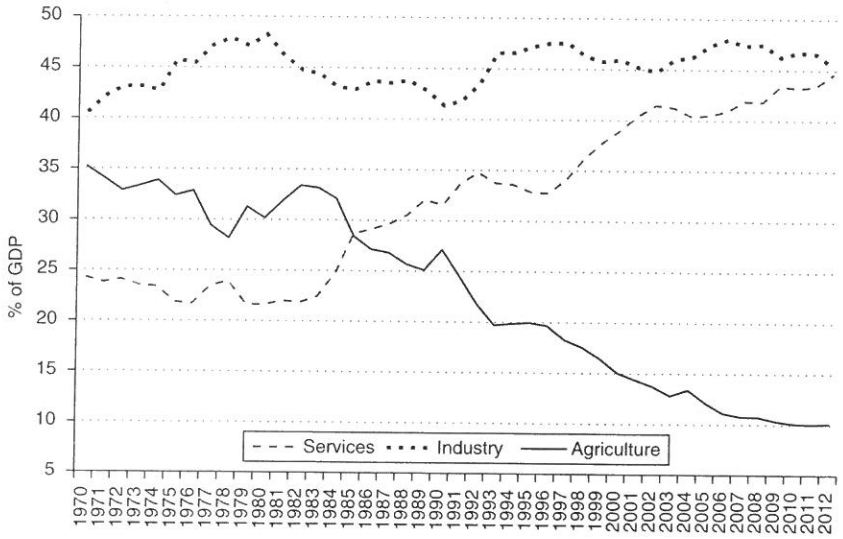
produces—and it needs to sustain rapid increases in output over several decades. This is a fairly straightforward concept as a high-income country is one that, by definition, produces a high level of value on a per capita basis. There are generally three sources of increasing value: an increase in how much is produced, which can come from increased factor inputs; an increase in the efficiency of production so that more can be produced from the same inputs; and an increase in the value of what is produced, so that higher value goods and services are produced.

These sources of growth are, of course, closely interrelated. The difficulty is not in defining them, but in ensuring that they are actually making a contribution. As an economy evolves, the relative importance of the three sources of growth may change over time. As such, there is commonly a shift from the 'extensive margin' (adding more inputs) to the 'intensive margin,' which involves increasing productivity through greater efficiency and moving up the value chain. The increase in the intensive margin is intimately linked to improvements in technology and innovation.

For the PRC, four fundamental but highly interrelated shifts in the structure of its economy have underpinned the process of producing more, increasing efficiency, and generating higher-value goods. These are (1) the shift from agriculture to industry and services, (2) the shift from public to private ownership, (3) the shift from domestic to greater foreign ownership, and (4) the intensification of technology and production of higher value goods. The importance of these shifts will continue to change over the coming decades.

The first shift was the movement of labor and capital from agriculture to industry and services. Increased efficiency in farm production through mechanization and other technological improvements reduced demand for labor. Surplus labor, which was making a minimal contribution to rural output, moved to and supported the development of industry and services. In 1968, the primary sector contributed 42 percent of national output, which fell to 28 percent by the beginning of reforms a decade later (Figure 12.1). It had declined to 20 percent by 1995 and 10 percent by 2012. This will likely fall further over the next two decades, though not substantially. When Japan and the Republic of Korea transitioned from middle- to high-income countries in the 1960s and the mid-1990s, respectively, agriculture accounted for about 7 percent of output in both countries (World Bank, *World Development Indicators*). This transformation represents a key aspect of the extensive shift, where labor resources move to industry and services.

The declining share of agricultural output in gross domestic product (GDP) has been offset by a rising share in industry, particularly manufacturing, and services. In 1962, industry accounted for about 32 percent of



Note: GDP = gross domestic product.

Source: World Bank, *World Development Indicators* (accessed August 2013).

Figure 12.1 Value added by sector, 1970–2012

value added and rose steadily to 48 percent by the beginning of the reform period as the government promoted heavy industries. Industry's share has, however, remained fairly stable since then, although it dropped in the initial reform period after agriculture was liberalized. From 1993 to 2012, industry's share of value added has remained in the 43–47 percent range.

This is mirrored in the trend for manufacturing, which has accounted for 32–34 percent of output since the early 1990s. While its share has not changed much over time, industrial output in absolute terms has, in each of the last four decades, grown 5 percent to 18 percent on average (Table 12.1). The number of workers in industry grew from just under 70 million at the beginning of the reform period to 225 million in 2011.

Services, meanwhile, have steadily expanded their share of output, offsetting a decline in agriculture. Services rose from 22 percent of total value added in the early 1980s to 45 percent in 2012.[1] In absolute terms, the sector, like industry, grew yearly at double digits over the past four decades and contributed 42 percent of GDP growth (Table 12.1). Employment in services has also grown, from less than 50 million workers in 1978 to 273 million in 2011, with growth more pronounced than in industry. The expansion in value added and the employment share of services are

Table 12.1 Average GDP growth and contribution of major production sectors (percentage)

Period	GDP growth rate	Agriculture		Industry		Services	
		Growth rate	Contribution to GDP growth	Growth rate	Contribution to GDP growth	Growth rate	Contribution to GDP growth
1971–80	6.3	1.7	31.8	4.8	45.3	22.9	22.9
1981–90	9.3	16.1	29.1	14.9	43.5	21.2	27.3
1991–2000	10.5	7.1	19.3	14.4	45.9	15.5	34.9
2001–11	10.4	14.0	11.8	18.3	46.5	19.2	41.7

Note: GDP = gross domestic product.

Source: ADB staff estimates based on World Bank, *World Development Indicators* (accessed August 2013).

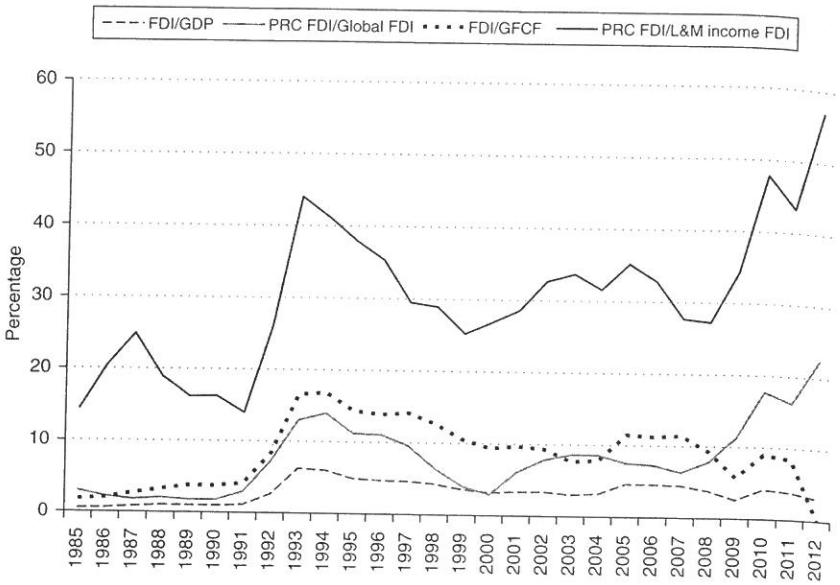
significant given that the economy as a whole was growing rapidly during this time. Services have accounted for an increasing slice of a rapidly expanding pie, although remaining low for the country's income level.

The second shift has been a change in enterprise ownership from the public to the private sector. This has been a key aspect of the economic reform process and has supported large and consistent increases in productive output over the past three decades. The initial years after 1978 saw important reforms in household responsibility in agriculture and the promotion of township and village enterprises that encouraged entrepreneurship while remaining under local government control. Constitutional and regulatory amendments in 1988 gave much greater prominence to private enterprises and provided the legal basis for sole proprietorships, partnerships, and limited liability to companies above the micro level. The development of private enterprises was allowed alongside the continued presence of state firms. By the mid-1990s, it was apparent that the economy would need even larger private sector involvement and so a privatization program was implemented.

These changes have greatly expanded the private sector's contribution to the economy over the years. In 1999, for example, private enterprises produced only 6 percent of the industrial output of domestic enterprises. By 2011, they produced 40 percent. As the private sector tends to be more dynamic than the public sector, this has translated into greater productivity.

The third structural shift has been the increase in foreign direct investment (FDI). This expanded greatly with the opening of special economic zones as part of the reform process in the early 1990s. By the early 2000s, the PRC accounted for more than 30 percent of all FDI channeled to low- and middle-income countries and more than 50 percent by 2012 (Figure 12.2). Foreign direct investment peaked at just below 17 percent of the country's total investment in the early 1990s and has fallen gradually to just below 9 percent by 2011. Despite the declines, these are still substantial figures for a large country and have stayed strong and steady for a number of years.

Foreign firms, including joint ventures, now account for 18 percent of the PRC's total industrial value added. These firms have not only added new investment, thus expanding the extensive margin, but have brought technology to make new products that have improved the intensive margin. Indeed, the government has offered access to its large internal market in exchange for technology transfer, notably through joint ventures. This trade of technology-for-market has worked well, although its longer-term implications for the PRC's indigenous technology development remain uncertain.



Note: GDP = gross domestic product, GFCF = gross fixed capital formation, FDI = foreign direct investment, L&M income = low- and middle-income countries, PRC = People's Republic of China.

Source: World Bank, *World Development Indicators* (accessed August 2013).

Figure 12.2 Foreign direct investment (net inflows), 1985–2012

These three shifts have had a big impact on the fourth: the improvement in productivity and the production makeup of industry (and services). Private domestic firms, foreign firms, and state firms have all tried to maintain or increase market share in a growing market. Thus, competition, the internal dynamics of firms, and government policy have combined to encourage an upgrading of industrial structure. This has effectively raised the economy's technology level and value added, and is expected to continue doing so.

However, there is concern that insufficient local innovation is happening among domestic firms, which is preventing the economy from fully developing its own high-value industrial (and services) capacity. More local innovation would enable the PRC to become less dependent on foreign firms and their technology, and reach a higher level in value chains. But getting there is difficult for middle-income countries and explains why they often become trapped.

12.3 CURRENT STATE OF TECHNOLOGY, PRODUCTIVITY, AND THE SOPHISTICATION OF PRODUCTS

The PRC has made substantial progress in the growth of productivity, supported by technology, and in evolving its production mix. However, this started from a very low base and the economy's sophistication is lower than expected given the country's technological successes (noted in the opening section, for example) and its reputation as the workshop of the world.

12.3.1 Total Factor Productivity Growth

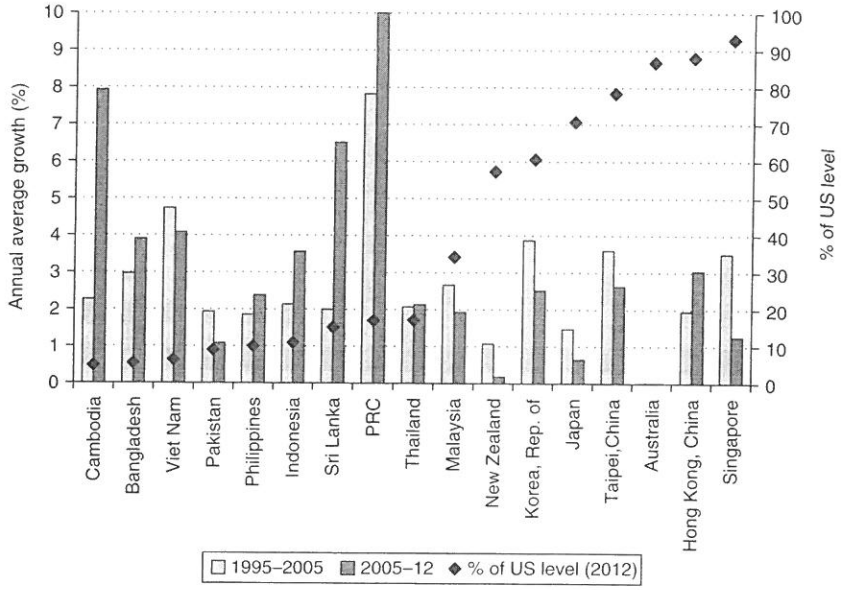
Productivity has grown rapidly over the past three decades. A central measure of productivity is total factor productivity (TFP), the change in the economy's aggregate output not accounted for by increases in the inputs of capital and labor. Most estimates of TFP growth in the PRC in the reform period indicate an annual increase of 3–4 percent, which is fairly consistent across studies and time periods, although it is high by international standards. Table 12.2 shows the results of various studies from the late 1980s on TFP growth. According to Kim et al. (2010), the rate of growth was the third highest among 53 developed and developing countries during 1991–2003.

But there are two important exceptions to the high rates found by most studies. A well-known study, Young (2003), corrects the official data and finds a much lower rate of 1.4 percent. Holz (2006) also critically assesses and corrects the data, and generates an even lower rate of 1 percent over a slightly longer and more recent timeframe, 1978–2005, compared with Young's 1978–98.

There is evidence that the rate of TFP growth fell—and rather dramatically—after 1995. For example, the rate averaged 3.7 percent for all of 1978–2003 in the study by the Organisation for Economic Co-operation and Development (OECD 2005), but was below that average from 1995 onwards and declined to 2.8 percent by 2003. As Table 12.2 shows, Zheng et al. (2009) find a rate of 3.3 percent until 1995 and a much lower rate of 1.9 percent afterwards. Zheng and Hu (2006) find a similar trend.

The trend suggests that the PRC was able to maintain a high rate of economic growth in the latter period because of its high investment rate, with a reduced reliance on increasing productivity. This is worrying for the longer term.

The high rates of productivity growth suggested by the majority of studies are comparable to those achieved by successful Asian economies during their



Notes:
PRC = People's Republic of China, US = United States.
Labor productivity is gross domestic product per person employed, calculated in purchasing power parity terms.

Source: The Conference Board (2012).

Figure 12.4 Labor productivity in Asia

This difference between a high growth rate and a low level of technical efficiency is also apparent in the simpler measure of labor productivity. With the PRC's total output expanding rapidly and the labor force growing slowly, labor productivity would be expected to rise rapidly. This is what happened between 1995 and 2005, with labor productivity growing 6.7 percent annually (Figure 12.4), the highest in the region and higher than countries in all other regions, except Eastern Europe, where six countries were above that level. The growth in labor productivity has continued: its rate was the third highest in the world in 2010, bettered only by Qatar and Singapore.

However, the level of labor productivity in 2012 was only 17 percent of the US rate (Figure 12.4). This is to be expected as labor productivity is defined as GDP per person employed, and is therefore similar to GDP per capita—and this measure is much lower in the PRC than in the US. Within Asia, the PRC also lags considerably compared to the developed

economies, including the Republic of Korea (61 percent of the US level in 2012) and Taipei,China (71 percent). By regional comparison, the PRC's level of labor productivity is similar to Thailand and Sri Lanka. It is below a number of middle-income countries, most Latin American countries, and several African countries, including South Africa (24 percent) and Tunisia (20 percent) (The Conference Board 2012).

The evidence suggests that productivity appears to be growing quickly in the PRC. However, it is still at a low level and, despite the rapid growth of the economy and important increases in the adoption and use of technology, the country has a long way to go to become a high-productivity and thus a high-income economy.

12.3.2 Product Specialization

The PRC has developed an interesting production mix based on its rather unique development pattern. The traditional path for developing countries is to specialize, initially, in the production of low-value, labor-intensive goods to take advantage of their abundant labor supply, and when capital, technology, and skills are in short supply. There is certainly evidence of this in the pre- and early post-reform periods in the PRC. However, the country also underwent a heavy industry drive prior to the reform period, which involved investment in such areas as chemicals and metals.

Notably, from the early 1990s, the PRC received considerable FDI. While much of this focused on the traditional comparative advantage sectors of producing cheap, low-cost, low-technology goods, an increasing portion has involved the production of technologically complex goods. However, foreign investment has focused on the processing trade in which advanced components are often imported for processing and final assembly prior to export.

Given this, the PRC's involvement in value chains differs within and between sectors, prompting a lively debate about the technological sophistication of the country's export products. Even so, its product and production structure includes these three elements: a focus on traditional comparative advantage goods, heavy industrial goods, and goods that are part of the processing trade. This mix sometimes makes it appear that the PRC's production mix is more sophisticated than it really is.

12.3.3 Overall Productive Output

Firms in the PRC are producing higher-value products and this shift can be seen in its overall productive output. While the data give only a limited view of intra-subsectoral upgrading, they do show a process of

Table 12.3 Gross industrial output: top five industrial subsectors, 1995–2011 (CNY billion, 2000 prices)

Subsectors	1995	2000	2005	2010	2011	Annual % change* 1995–2011
Textiles	495	515	1083	1908	2027	19.3
Raw chemical materials and chemical products	411	575	1398	3207	3776	51.2
Ferrous metals, smelting and pressing	394	473	1835	3469	3977	56.8
Transport equipment	355	536	1343	3711	3927	62.9
Food processing	327	372	907	760	872	10.4
Communication equipment, computers and other electronic equipment	272	755	2307	3679	3961	84.8
Electrical machinery and equipment	279	483	1188	2901	3193	65.3
Electric power, heat power: production and supply	262	461	1520	2714	2940	63.9

Notes:
* Total percentage increase/number of years.
Highlighted data are the top five industrial sectors for the given year.

Source: National Bureau of Statistics, *China Statistical Yearbook*; gross domestic product deflator from World Bank, *World Development Indicators* (accessed August 2013).

inter-subsectoral upgrading. Table 12.3 lists the top five subsectors at four discrete points between 1995 and 2011 (the top five are shaded).

Textiles were the largest subsector in 1995 by gross output; this is a low-value subsector that low-income countries initially move into before industrial upgrading. Textiles are followed by three heavier subsectors: chemicals, metals, and transport equipment, which largely reflect the legacy of the country's pre-reform heavy industrial phase and the continuing emphasis on production by state-owned enterprises.

Food processing was the fifth largest subsector in 1995, which, like textiles, is generally a low-value industry lacking in technological sophistication. Since 1995, all five subsectors have grown rapidly, particularly textiles and food processing, with growth averaging 19.3 percent and 10.4 percent, respectively, from 1995 to 2011. Both, however, have dropped out of the top five and been overtaken by the higher-value subsectors of electronic equipment and electrical machinery and equipment.

Because the data in Table 12.3 show gross output, the impact of the

processing trade on output is reflected in some of the figures. Even so, the simple figures show a clear picture of a country moving from low- to middle-income status in its production structure, albeit in a manner still bearing the legacy of its earlier heavy industrial phase.

12.3.4 Export Structure

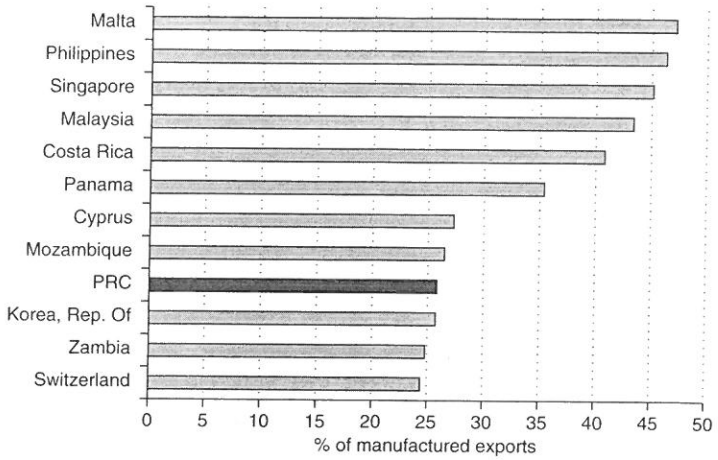
The change in the economy's output structure can also be seen in the evolving nature of its exports. Much has changed since the beginning of the reforms, but a good part of that change has happened over the past decade. In 1995, two categories of garments—knitted and non-knitted-crocheted—were the top exports, followed by other apparel products, cotton cloth, and leather shoes (Table 12.4). Together with toys, another low-technology

Table 12.4 Top five exports, 1995–2011 ($ billion, 2000 prices)

Sectors	1995	2000	2005	2010	2011	Annual % change*	
						1995–2005	2005–11
Garments, excluding knitwear and crocheted	15	18	29	44	51	9	12
Garments, knitted or crocheted	7	12	25	54	63	26	25
Toys	4	6	6	9	10	5	10
Cotton cloth	4	3	6	10	12	5	18
Leather shoes	3	4	7	9	10	13	6
Mechanical and electrical products	...	105	378	841	958	c.c.	26
Plastic articles	1	5	10	17	21	90	18
High and new-technology products	...	...	193	444	484	c.c.	25
Automatic data processing machines	...	...	68	148	156	c.c.	21
Parts for auto data processing Equipment	...	...	25	28	26	c.c.	1
Rolled steel	2	2	12	33	45	50	46
Telephone sets	...	...	...	44	57	c.c.	c.c.

Notes:
... = data not provided; c.c. = cannot be calculated; * total percentage increase/number of years.
Highlighted data are the top five exports for the given year.

Source: National Bureau of Statistics, *China Statistical Yearbook*; United States GDP deflator from World Bank, *World Development Indicators* (accessed August 2013).



Note: PRC = People's Republic of China.

Source: World Bank, *World Development Indicators* (accessed August 2013).

Figure 12.5 Share of high-technology exports in manufactured exports, top 12 countries, 2011

subsector, these goods were 1995's top five export products. By 2011, only knitted-crocheted garments remained in the top five (and then occupying the fourth rather than second spot). More sophisticated products have surpassed these simple products significantly, including mechanical, electrical, data processing, and other high-technology equipment and products, including computers and telephone sets.

The high-technology structure of exports is further revealed by a comparison with other countries. Globally, the PRC ranks 9 in the share of high-technology exports in total manufactured exports (Figure 12.5). Some countries ranked higher are small island economies on the European or US periphery. This listing reveals a great deal because it excludes many of the world's high-technology countries and includes those that do much of the outsourcing and assembly for high-technology companies and countries. Two Asian countries possibly caught in the middle-income trap, Malaysia and the Philippines, are in the top five, whereas the US ranks twenty-eighth. Technological heavyweights Japan and Germany are not even in the top ten.

These figures and more complex analysis on product space have prompted some experts to render inflated depictions of the technological sophistication of the PRC's export sector and its industry.[2] Given the high

Table 12.5 Share of domestic value added and exports by firm ownership, 2002 and 2007

	Domestic value added in exports (% of total value of exports)	Processing exports (% of total exports)	Exports (% of country's total exports)
2002			
Wholly foreign-owned	33.4	87.5	28.9
Joint venture firms	43.6	70.5	22.9
State-owned firms	69.3	32.2	38.1
Collectively owned firms	72.8	27.4	5.8
Private firms	83.9	9.0	4.3
All firms	53.9	55.7	100.0
2007			
Wholly foreign-owned	44.1	83.0	38.1
Joint venture firms	56.9	59.5	17.7
State-owned firms	72.1	25.8	18.9
Collectively owned firms	73.3	24.0	4.0
Private firms	80.8	9.6	21.3
All firms	60.6	50.0	100.0

Source: Koopman et al. (2008).

level of processing trade involving foreign companies in the PRC's export profile, more detailed analysis of the country's value added is needed. A start has been made, notably by Koopman et al. (2008), who have examined the value added in manufactured goods and in exports and processing trade in particular. The following analysis draws on their work.

In total, wholly owned foreign firms produce almost 40 percent of exports from the PRC, while joint-ventures between foreign and domestic firms produce a further 18 percent (Table 12.5). Taken together this means that almost 60 percent of all exports involve foreign firms; a staggering amount. Wholly owned foreign firms are concentrated in processing and assembly, with 83 percent of their exports classified as processing exports (these are exports involving lower local value added than domestic firms and the heavy use of high value imported components). The domestic value added in foreign firm's exports was 44 percent in 2007. The value added in exports by other firms is far higher at over 70 percent for state and collective firms and 80 percent for private domestic firms.

Firms with foreign ownership export a lot—and a lot of high-technology goods—but contribute less value added than do joint ventures or domestic firms. The extreme case is illustrated by the breakdown of the cost components for iPods, which are designed in the US but assembled in huge

BOX 12.1 ADDING VALUE TO THE IPOD?

While the PRC exports large quantities of high-technology electronics, the value created within the country is often very low. Take the iPod, for example. The 32GB, fifth-generation iPod sells for about $299 in the US. The US company Apple makes the product, but it is assembled at contract factories in the PRC. So how much value is added in the PRC? This is hard to determine but a detailed analysis by researchers suggests that the assembly probably accounts for less than $5. When the assembled iPod is exported from the PRC its value is recorded at about $150. The additional value (up to $299) comes from subsequent sales margins in the US and elsewhere. Thus, the value added during assembly is just over 3 percent of its recorded export value.

So is the Chinese contribution only about $5? Not likely. The main component of the iPod is the hard drive. It is by far the most expensive part, accounting for just over half of the cost of all 400-plus parts that go into the gadget. The Japanese firm Toshiba makes the hard drive, but much of its production has been off-shored from Japan to take advantage of lower production costs. Toshiba makes most of its hard drives in the Philippines and the PRC.

A supply chain analysis was unable to determine which of those two countries makes the hard drives that go into the iPod. If they are made in the PRC, then a much greater part of the $150 export value is earned domestically. Or is it? We would also need to know where the components that go into a hard-drive are made and, indeed, whether they are imported into the PRC.

How much gross profit does Apple make on an iPod? The company earns about $80, which is its return for inventing and designing the device.

Source: Linden et al. (2007).

factories in the PRC. The value added during assembly represents just 3 percent of the item's final export value (Box 12.1).

However, the domestic value added in the exports of foreign firms is rising, along with these firms' share of the country's total exports. From 2002 to 2007, wholly owned foreign firms' share of total exports increased from 29 percent to 38 percent, while that of joint ventures fell by five percentage points (Table 12.5). The proportion exported by private local firms increased significantly from 4 percent to 21 percent and was entirely accounted for by the fall in the proportion attributed to stated-owned enterprises (from 38 percent to 19 percent). During that same period, the domestic value added in the exports of foreign firms rose from 33 percent to 44 percent, and for joint venture firms there was a similar rise from 44 percent to 57 percent. For all other ownership types, the share of value added remained largely unchanged.

These results mirror other assessments of the economy, especially those recognizing that industrial production has rapidly evolved over the past

three decades and that the PRC faces a vastly different environment than Japan and the Republic of Korea when they designed their high-growth strategies.

Production, for one thing, is now more geographically diverse. Globalization and the development of global production systems has meant that production does not need to locate at a single site, but can be dispersed, with components brought together for final assembly.

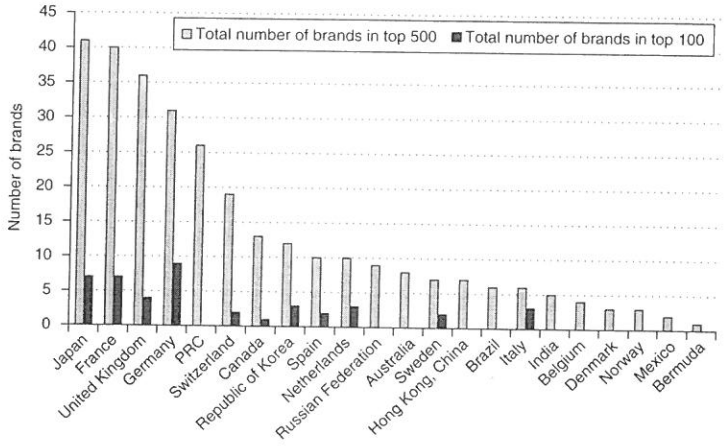
The PRC has integrated itself into such systems by allowing foreign investment, but it remains at the lower end of the value chain. It has sought to overcome this by imposing local content requirements on foreign firms (through supply contracts with domestic firms) and joint venture arrangements. The rationale for local content requirements is to ensure that more of the value added contained in components is generated in the PRC through supply contracts with Chinese firms.

In summary, the PRC's product and export structure has moved from lower to higher-technology products, but there are still many areas for upgrading the value of production. Not surprisingly, policymakers are concerned about developing indigenous innovation and benefiting more from large-scale foreign investment.

12.3.5 Global Brands

Another measure of a country's technological advance is the extent to which it is developing its own, globally recognized branded products. The US, with its large multinational companies, is still the global leader of brands, and not all of them, such as McDonald's, are engaged in high-technology production. Many European companies are known for quality (for example, German engineering). Japan and the Republic of Korea, meanwhile, have broken into key product markets over the past three decades in automobiles and electronics and now produce products with globally recognized names that are synonymous with quality (Sony, Honda, LG, Hyundai, Panasonic, for example). The PRC, despite the large size of its economy, has few globally recognizable brands, because its exports tend to be dominated by foreign-invested enterprises and its successful domestic brands are not known overseas.

Determining brand value is complicated, yet several measures are available, which all point to the limited although not insignificant presence of Chinese brands. In the 2014 Brand Finance *Global 500*,[3] which ranks the value of the world's top brands, the PRC has two brands in the top 50, nine in the top 100, and a total of 26 in the top 500 (Figure 12.6).[4] Three of the top brands are financial institutions, though they are hardly household names globally.[5] The top two non-financial brands are China



Notes:
PRC = People's Republic of China.
The United States, with 185 brands in Brand Finance *Global 500* and 55 brands in Interbrand *Top 100*, is excluded to improve the graphic presentation.

Sources: Brand Finance, *Global 500 2014*; Interbrand, *The New Top 100* (accessed March 2014).

Figure 12.6 Global brands, 2013

Mobile (thirty-first) and China Telecom (seventy-fifth). The 26 Chinese brands include sectors as varied as financial institutions, automobiles, petroleum, telecoms, insurance, and construction. For its 26 brands, the PRC is ranked 5 in the world, among countries with the most brands in the top 500. It is behind Germany, France, and the United Kingdom, but ahead of Switzerland and Canada, all of which have much smaller economies than the PRC's. The US is the leader, with almost one-third (185) of the top 500.

Interbrand, another branding consultancy, also ranks the top brands in the world, with the US accounting for 55 percent of the top 100 in 2013.[6] Asia accounts for 22 percent of the remaining 45 brands, with seven from Japan and three from the Republic of Korea. No brands from the PRC make the list.

However, some PRC brands are emerging globally, such as Lenovo, due in part to its purchase of IBM's personal computer unit in 2005, and automobile manufacturer Chery, which has been both exporting and producing vehicles abroad. Haier is now the world's largest household appliances manufacturer. That said, none of these companies are listed in the two brand rankings. Chery's chief executive Yin Tongyao has said

it will likely take 'dozens of years' to compete at the upper ranks of the global car market, and that Chery currently has weak brand identity (Financial Times 2010).

The PRC benefits from a large internal market for automobiles that allows for significant technological learning in how to be a successful global player. Twenty-one of the top-50 producing automobile companies in the world, by units produced, are from the PRC. These companies produced 6.8 million vehicles in 2009, though this is less than Toyota's production of 7.2 million units in the same year (OICA 2014). Chinese producers target the low end of the market.

Nobuyuki Idei, a former chairman of Japan's Sony Corporation, echoes the views of Chery's chief executive. In a 2010 interview, Idei reckoned that it would take another ten years before automakers in the PRC would be able to become global companies with branded products as recognizable as Sony and Samsung (South China Morning Post 2010).

12.4 CHALLENGES AHEAD

The challenge for industry and services in the PRC is to generate high productivity and to move from a middle-income to a high-income phase of development and technological innovation. Policymakers have certainly recognized this. To remedy the situation, they have encouraged 'indigenous innovation' and included high-end manufacturing as one of the seven sectors highlighted for policy support in the Twelfth Five-Year Plan, 2011–2015. Achieving this, however, is not a straightforward process but one that is intertwined with other important strategic and policy goals.

The PRC faces three fundamental challenges to industrial (and services) upgrading. These involve what can be broadly defined as industrial policy, although this has fallen out of favor in Western thinking despite its contribution to industrial deepening in Asia's tiger economies. The three areas are (1) innovation infrastructure, which includes the promotion of research and development along with human capital upgrading, notably in science, engineering, innovation, and entrepreneurship; (2) support to sectors and firms to encourage upgrading, which is the traditional area of industrial policy that was used in East Asia and involves credit, tax and other fiscal incentives, along with information sharing and general promotion; and (3) the direction in the mix of ownership structure. The third area is particular to the PRC and involves questions of whether innovation and upgrading will hit a glass ceiling if significant parts of the economy remain under state ownership, on the one hand, and foreign ownership, on the other.

12.4.1 Innovation Infrastructure

Innovation infrastructure can be divided into the broad areas of education, research and development, and intellectual property rights. Each is supported and funded (or partly so in the case of research and development) by government. They are key ingredients to assisting the economy, its productive sectors in particular, in using, adapting, and innovating technology.

Education, including scientists and engineers

Chinese society has historically placed great emphasis on education and learning due, in part, to its Confucian heritage. Learning has not been confined to the liberal arts, but includes science-related fields, which are of course critical for industrial upgrading. Historically, that emphasis on learning spawned many inventions that occurred first in the PRC, such as gunpowder and printing, before they occurred in, or were carried over to, Europe. For various reasons, the country lost that technological and inventive edge and lagged considerably behind developed regions by the time of the PRC's founding in 1949. The development of the education system and, with it, technological capacity has had its ups and downs since then, but has been strong from the immediate pre-reform period onwards.

Educational attainment is quite high in the PRC and similar to other middle-income countries. As Table 12.6 shows, 90 percent of the population aged 15 and over has completed primary education. While on par with other middle-income countries, this is lower than developed countries, which are now very close to universal attainment. Secondary school attainment, at 61 percent is near the level of Chile and Malaysia and higher than in some developed countries.

Attainment in tertiary education is weaker, however, although the data presented in the table do not fully account for recent increases in the PRC. The average attainment for 2000 and 2005 for those aged 15 and over was only 5 percent but rose to 9 percent in 2010. Chile and the Philippines had rates above 20 percent in the first half of the 2000s. In 1949, there were approximately 100 000 students studying at university, certainly a much higher level than in other developing countries at that time. Nearly half of these students were enrolled in science, engineering, and medicine. Tertiary education has expanded rapidly over the past decade, rising from 4.1 million students in 1999 to 23.1 million in 2011 (Figure 12.7). There are now more than 1 million university professors and teachers (Perkins 2011, 49). At the postgraduate level alone, about 200 000 students are enrolled in engineering, science, and medicine. At the same time, however, funding per student has fallen 23 percent since 1999.[7]

Table 12.6 Educational attainment, selected countries

	At least primary	At least secondary	Tertiary
	% of population aged 15 and over		
High income in/before 1965			
United States	98	70	17
Germany	98	24	3
France	99	12	3
Sweden	99	37	6
Australia	99	66	17
Middle income			
Brazil	86	44	6
Chile	96	67	22
Malaysia	89	69	11
Philippines	95	64	26
Thailand	87	32	7
PRC	90	61	5

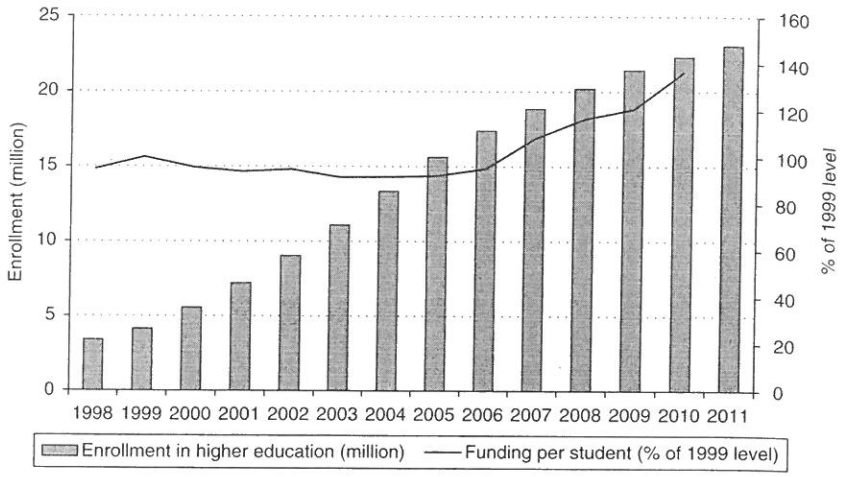
Note: For high-income countries, the figures are an average of 1960 and 1965; for middle-income countries, the figures are an average of 2000 and 2005.

Source: Author's estimates based on educational attainment data from Barro and Lee (2010).

The share of scientists and engineers in the population in the PRC remains considerably below developed countries, including successful late developers in Asia. There are 24 scientists or engineers for every 10000 people, compared with 83 in the Republic of Korea and 106 in Japan (Figure 12.8). This is a considerable difference. Most other developed countries also have much higher levels than the PRC.

The low level of scientists and engineers might be expected given that the PRC is still a lower middle-income country. Indeed, 35 percent of its workforce was still in farming and other primary activities in 2011 and a large proportion work in low-skilled jobs in manufacturing assembly. But while the proportions are low, the absolute numbers are high. Indeed, the PRC has more scientists and engineers in absolute terms, some 1.8 million of them, than any of the high-income countries shown in Figure 12.8, with the exception of the US.

It should be noted that attainment is a lagged indicator and does not account for higher attainment among younger people.[8] For the PRC, the current high output of graduates will add to the general level of attainment in the coming years. Even so, attainment figures give some indication of



Note: Data for 2000 and 2008 for funding per student are averages of immediately preceding and following years.

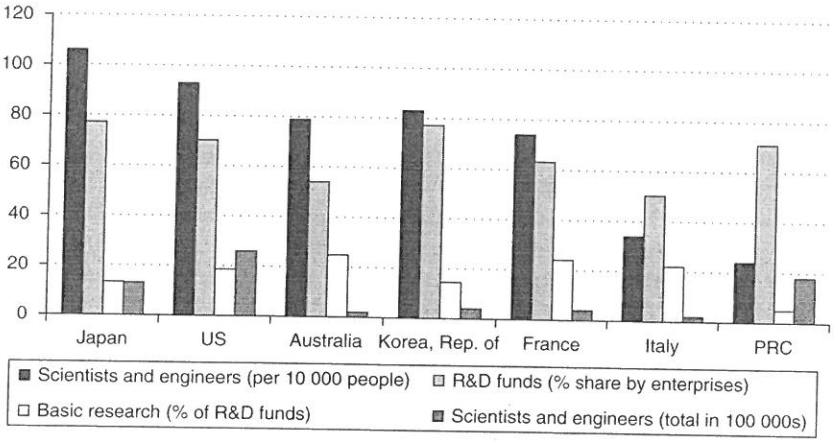
Source: Author's estimates based on the National Bureau of Statistics, *China Statistical Yearbook*.

Figure 12.7 Enrollment in higher education and funding per student, 1998–2011

the human capital present in the workforce. The PRC has suffered from low educational attainment in rural areas, which has an important impact on the economy because rural residents migrate to the cities to work but lack education and skills for better jobs. Furthermore, attainment rates do not reflect the quality of education, and the PRC may actually be scoring well here. Unfortunately, data using the standard measure to compare quality are not available for the whole of the PRC.[9] Overall, the country needs to increase its human capital and the percentage of science graduates in the workforce.

Level of research and development spending

Research and development by businesses and public research institutions is important for improving the technological capacity of a country's industry. Overall, the level is still in the lower range for the PRC, although it has increased significantly in recent years. As shown in Figure 12.9, research and development expenditure as a percentage of GDP almost tripled to 1.7 percent from 1996 to 2010. This is still below the level of most developed countries, including the Republic of Korea and Japan. The target



Notes:
PRC = People's Republic of China, R&D = research and development, US = United States.
Data for various years from 2002 to 2006; 2007 data for the PRC.

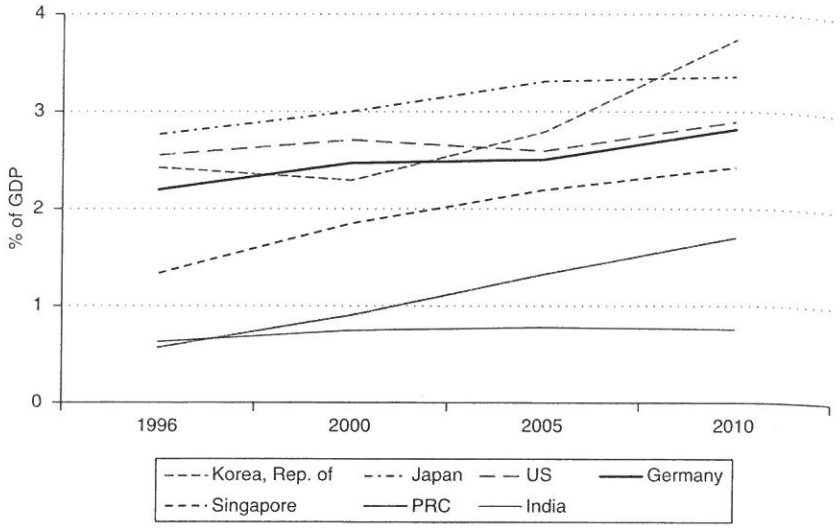
Source: National Bureau of Statistics (2007).

Figure 12.8 Share of scientists, engineers, and research and development, selected countries

in the Eleventh Five-Year Plan, 2006–2010, was 2 percent but 1.8 percent was achieved, suggesting that the 2.2 percent target of the current plan is ambitious (BBVA Research 2011).

The proportion spent by enterprises, as opposed to research institutions and universities, was 71 percent and is similar to many developed countries, albeit slightly below Japan and the Republic of Korea. This suggests the productive sector is doing a significant proportion of research and therefore aiding the development of more technologically advanced products and production processes. It is in the area of basic research—which provides the scientific foundation for applications in industry—that the PRC is lagging. The country dedicates 5 percent to basic research, whereas developed countries dedicate 15 percent to 25 percent.

The PRC is ranked 2 in the world in the number of scientific research papers published in 2004–08, up from 6 in the previous four-year period.[10] The quantity ranking is not matched by quality, however, as the PRC is ranked seventh in total global science citations, on par with Canada and Italy, countries with much smaller populations (Royal Society 2011: 25). The lower level of basic research probably accounts for the PRC's limited



Notes:
GDP=gross domestic product, PRC=People's Republic of China, US = United States.
For countries without 2010 data, 2009 or 2006 data is used.

Source: World Bank, *World Development Indicators* (accessed August 2013).

Figure 12.9 Research and development expenditure, 1996–2010

Nobel Prize recognition in the sciences.[11] There is a concern that the education system is too rigid, does not promote creativity, and therefore does not encourage the type of research necessary to make significant scientific breakthroughs.

A further concern is that many of the PRC's brightest scientists leave the country, causing a scientific brain drain. To counter this, the government launched the Thousand Talents scheme in 2008 to lure Chinese academics and industrialists based abroad back to the PRC over the following ten years. Over a thousand academics have accepted the offer, lured by attractive salaries and appointments. But by early 2011, many leading figures in their fields had not been enticed into returning (Jia 2009, Zhong 2011). Of the 2139 Chinese nationals who earned a science or engineering doctorate in the US in 2002, 92 percent were still living there five years later (Wang 2010).[12]

Intellectual property rights

The protection of intellectual property is an important element of innovation infrastructure because it encourages investment in innovation

by allowing investors to reap the commercial benefits and protecting it from use by rival companies. Without protection, there is less incentive to invest.

For developing countries, weak protection of intellectual property rights generates two problems, but it also creates one potential opportunity. First, it discourages foreign companies from bringing their latest technologies and so has a negative impact on innovation.[13] Second, a weak regime discourages innovation by local companies because their innovations and breakthroughs are not protected. This is a particularly important concern as more countries develop indigenous innovation.

However, weak intellectual property rights also allow companies to benefit, without compensation, from the intellectual property of other countries, which is probably the main reason it is weak in the PRC. This is the latecomer's benefit and may be a source of innovation and productivity improvement.

The PRC's intellectual property regime is relatively weak, as borne out by international comparisons. The country is ranked 45 out of 70 countries, below all developed and many middle-income countries, including South Africa (21), Chile (23), Malaysia and the Republic of Korea (both 25), Thailand (32), India (33), and Mexico and Brazil (both 42) (Horst 2007).

Patent registration is another indicator of technological progress and the development of new products, although it is only a rough measure as many registered patents do not result in commercially viable products. Even so, the PRC had the world's third highest new patent registrations in 2012, with just over 217000, after Japan and the US (Table 12.7).

On a per capita basis, however, new registrations are low, at only 161 per 1 million people, and considerably below developed countries. Here, the PRC ranks only 17 in the world. A similar pattern holds for total patents in force, with the PRC ranked 3, with 875385. The country registers only 648 patents per 1 million people, well below developed countries, including the top performers, which include the Republic of Korea, at over 14000, and Japan, at just under 13000 (Table 12.7). The PRC is ranked 33 in the world for patents in force, weighted by population.

Patents can be divided into resident and non-resident registrations. The latter denotes patents registered within a country by outsiders. In this regard, 34 percent of the patents for the PRC were registered by non-residents, a level which is high relative to Japan and the Republic of Korea but not so relative to other comparator countries (Table 12.8). The distinction between resident and non-resident registrations is important as the latter are less likely to result in commercially viable products being produced within that country.

Table 12.7 Patent grants, 2012

Top six countries	Patent grants	% resident	Per 1 million people	Rank per 1 million people
Japan	274791	82	2154	2
United States	253155	48	806	5
PRC	217105	66	161	17
Republic of Korea	113467	74	2269	1
Russian Federation	32880	68	229	13
Canada	21819	11	626	8

Note: PRC = People's Republic of China.

Source: World Intellectual Property Organization; population data from World Bank, *World Development Indicators* (accessed March 2014).

Table 12.8 Patents in force, 2012

Top seven countries	Total	Per 1 million people	Rank per 1 million people
United States	2239231	7133	11
Japan	1694435	13283	6
PRC	875385	648	33
Republic of Korea	738312	14765	5
Germany	549521	6710	12
France	490941	7473	9
United Kingdom	459447	7267	10

Note: PRC = People's Republic of China.

Source: World Intellectual Property Organization; population data from World Bank, *World Development Indicators* (accessed March 2014).

12.4.2 Promoting Innovation in Sectors and Firms

The PRC has poured considerable funding into science and technology development, beginning early in the reform period and continuing to this day. It initiated the largest program, the Key Technologies Research and Development Program, in 1982, followed four years later by the National Hi-Tech Research and Development Program. Further efforts include the 973 program, which focuses on multidisciplinary research on socio-economic issues; the Torch program, the main high-technology industries support program; and the Spark program, which focuses on science and

technology demonstration projects in rural areas to revitalize the rural economy. These programs have different modalities, but they generally support research in public institutions and industry for the commercialization of innovations. The Torch program also helped to establish 56 high-technology development zones and business incubators.

Along with these funding programs, the government at the national and subnational levels has a number of policy tools at its disposal related to tax, land, and labor that have been used to encourage and support industry, including innovation and technological upgrading.

The effectiveness of these programs is still to be ascertained. Hu and Jefferson (2008) review the analysis by Hu (2007) on technology parks and by Du and Xu (1997) on the Spark program; they conclude the programs have been 'successful.' Barbieri et al. (2011) provide preliminary evidence that policy support for industrial clusters in the Specialized Towns of Guangdong province have had a positive effect on innovation and economic growth. Establishing a causal link between programs and outcomes is always difficult.

12.4.3 Ownership Structure

While the PRC has the same objectives that its successful East Asian neighbors had in moving up the value chain, it has a much different ownership structure. The main East Asian economies that grew rapidly over the past five decades built economies on the basis of private, domestic firms. These firms first produced simple, lower-value goods and then increasingly moved into high-value ones, including automobiles, electronic devices, machine tools, steel, and chemicals.

The economies of Japan, Republic of Korea, and Taipei,China nurtured such enterprises, often through a combination of large conglomerates (*keiritsu* in Japan, *chaebols* in the Republic of Korea), and with support for small and medium enterprises (Taipei,China). Only in the city-states of Singapore and Hong Kong, China, did substantial FDI develop the manufacturing and services sectors. In Singapore, the government aggressively pushed foreign firms to upgrade the sophistication of their production and encouraged the movement of low-value production offshore to neighboring countries.[14]

In contrast, the PRC retains a substantial number of large state-owned enterprises, despite the privatizations of the late 1990s and early 2000s. Furthermore, foreign-invested firms comprise a sizeable portion of the country's manufacturing base, and even more so of its export base. These firms tend, as noted, to contribute much lower value added than domestic firms. To increase the value added in its production structure, the PRC

needs to consider whether further privatization and further development of domestic firms is needed.

State enterprises

The large involvement of the state in production hampers productivity growth and technological upgrading. The PRC did undertake significant reforms of the state sector in the mid-1990s, notably to improve management systems and, thereby, performance. Privatization, by contrast, was conducted on a fairly limited scale.

The government elaborated a policy of 'grasp the large, release the small,' which meant maintaining control of large state-owned enterprises and privatizing smaller ones in less strategic areas. As a result, the number of state enterprises declined. Industrial state enterprises, in particular, fell by nearly half, from 50 000 in 1999 to just over 25 000 by 2004. The large state enterprises were clearly retained, as the combined output of the remaining firms was only slightly lower (8 percent in real terms) than that of the larger group of firms five years earlier (National Bureau of Statistics, *China Statistical Yearbook*).

Research suggests that greater privatization would generate substantial dividends for the economy. The full privatization of state-owned firms significantly improved firm performance and profitability, according to Huang and Wang (2011). This occurs especially when new owners come from outside the company. In addition, privatization leads to expanded sales and higher labor productivity, attributable to a decrease in managerial expenses, according to Bai et al. (2009). Ownership reform has also led to increases in innovation and more labor intensive modes of production, thus raising the returns to capital (Jefferson and Su 2006). Factor allocative efficiency within sectors is also affected by ownership structure. Chen et al. (2010) find that a 1 percent increase in a state-owned enterprise's contribution to industrial gross output in a given sector is associated with a reduction in factor allocative efficiency by 4–5 percent.

Generally, sectors in which the state is a dominant owner tend to exhibit low and even negative productivity. This may be attributed in part to the nature of the sectors, though this is not a given. Chen et al. (2010) find that out of 37 industrial subsectors, state enterprises dominated the five with the lowest TFP growth from 1981 to 2008—gas, water, petroleum and electricity production, and petroleum extraction. In four of these, TFP growth was negative over the period. Chen et al. suggest that to 'ensure the long-term viability of high industrial growth, the restructuring of large state-owned enterprises will be the crux of the next wave of reform' (2010: 16).

Foreign direct investment

In contrast to Japan and the Republic of Korea, the PRC has relied substantially on FDI to develop its industrial structure and expand exports, and this has been a key aspect of the country's industrial policy and export strategy. Indeed, in 1979, in the very early days of the reform process, the Law on Sino-Foreign Equity Joint Ventures was adopted to promote inward investment with state-owned enterprise partners. A substantial increase in FDI occurred after former premier Deng Xiaoping's Southern Tour in 1992.[15] Provinces experimented with the opening of special economic zones to attract foreign investment and offered a combination of good infrastructure, fiscal incentives, and access to a vast market. Cheap labor added to the incentives. As the experiment bore fruit, the zones were expanded and increasingly sanctioned at the national level. As a result, Western and Japanese manufacturing firms poured into the PRC to remain competitive globally and to tap the domestic market. The country rapidly became the workshop of the world—but predominantly an assembly workshop.[16]

The benefits of such investment to an economy are by no means straightforward. Countries seek FDI to help increase output, exports, and employment and to develop the technological level of their industrial structure through spillover to domestic firms. However, the evidence of such spillover is weak. In a review of nine studies on this theme, Hale and Long (2007) find that the evidence of productivity spillover to domestic firms in the PRC is mixed. Moreover, positive results are mostly due to aggregation bias and failure to control endogeneity. The authors' own estimates, involving some 2500 specifications, find no systematic evidence of productivity spillover.

Thus, the PRC needs to shift its industrial structure from assembly and low-technology manufacturing—a significant proportion of which is provided by foreign firms—to higher value-added activities. This shift can be conducted in three ways: (1) enticing foreign firms to upgrade (some municipalities are already seeking higher-value FDI), (2) ensuring that the high-value inputs for production by foreign firms are sourced from domestic firms; and (3) tilting the production structure in favor of private domestic firms. In all these scenarios, the nature of the PRC's engagement with FDI would evolve from the current pattern.

12.5 CONCLUSION

The PRC has made considerable progress in upgrading its structure of production, not only in transforming from agriculture to industry,

but also by increasing technological sophistication. The country is the workshop of the world, with its massive factories and industrial parks generating an increasing supply of goods for domestic and international markets. Can that progress continue—the question posed in the title of this chapter? Certainly, but the rate and extent of progress are key issues.

The PRC maintains a production system based on three types of enterprise—private domestic firms, state-owned enterprises, and foreign firms—and all have a role to play in the transformation of productive activity. Further upgrading will come from expanding the contribution of the most innovative players and innovation will likely come from fostering greater competition.

State-owned enterprises remain a very important part of the economy in the assets they control and the output they generate, although the latter has declined over time. Large state enterprises continue to dominate certain sectors, notably resources, utilities, finance, and construction. These firms are protected and receive preferential access to capital. The extent to which further industrial upgrading will occur through state enterprises depends on the competition they face. State enterprises have been able to maintain their role in the economy, with political leaders unwilling to reduce the influence of these firms because of the power base they provide.

However, the attitude of the senior leadership may be changing. The communique of the Third Plenary Session of the Central Committee of the Communist Party in November 2013 suggested that there may be a further shift to private firms to ensure that 'the market has a decisive function in resource allocation.' Other statements in the communique, nonetheless, suggest that state enterprises will continue to play a significant role.

Either way, innovation and further industrial upgrading will come from private firms. The government is right to stress the need for indigenous innovation, although the means to its achievement are not without potential problems. The main concern is that it may involve providing advantages to domestic firms over foreign ones, picking winners, and intervening in markets. Instead, other market-supporting reforms could help private firms, such as providing equal access to financial resources, offering fair regulatory treatment, and creating a level playing field.

The role of foreign firms remains controversial. They have added to the manufacturing heft of the country and brought new technology and management systems. However, foreign firms have used the PRC primarily as an assembly platform. Enticing them to locate higher-value operations there will help the process of upgrading, but this will require stronger intel-

lectual property rights. Rising wages are already resulting in the shedding of low-technology foreign firms to other parts of Asia, which can create room for higher-level operations.

A better trained workforce, increased investment in research and development, and support for innovation will all help to increase the upgrading of production. Supercomputers aside, the PRC can move further away from merely assembling Apple's iPads to designing and producing more advanced versions of Huawei's MediaPad.

NOTES

1. Preliminary data indicate that, in 2013, services accounted for a larger share of GDP value added (46 percent) than industry for the first time (China Daily 2014).
2. For example, see Rodrik (2006) and Schott (2008) and the critique by Xu (2010) of the analysis based on finished exports.
3. Brand Finance, headquartered in London, bills itself as the world's leading brand evaluation consultancy.
4. Brand Finance discounts expected future royalties to arrive at a net present value of the trademark and associated intellectual property. See www.branddirectory.com/methodology (accessed 1 June 2012)
5. Industrial and Commercial Bank of China (ranked 30), China Construction Bank (51), and Agriculture Bank of China (58).
6. Interbrand bills itself as the largest branding consultancy in the world.
7. Funding per student fell from a peak of CNY18874 in 1999 to CNY14477 in 2009 (National Bureau of Statistics, *China Statistical Yearbook*).
8. Attainment for a broad cohort, such as those aged 15 and above, is a lagged measure because the younger population may be more educated than older people, who attained a certain educational level based on the opportunities and facilities available when they were younger. In short, a 60 year old today was of high school age in the mid-1960s.
9. The main measure used is a comparison of test scores for teenagers conducted by the OECD's Program for International Student Assessment. The PRC is included in the 2009 study, but the test results are only for Shanghai, which makes comparisons with other countries inappropriate. Shanghai, as a city, scored better than any country in the world in mathematics, reading, and science.
10. This is due, in part, to the requirement that doctoral science students publish at least one paper before graduation.
11. Five ethnic Chinese won the prize. In all cases, the winner received his graduate training and conducted his award-winning research outside of the PRC. In comparison, Japan has produced 15 science winners, although the Republic of Korea has produced none.
12. For other countries, the figures were: Republic of Korea 41 percent of 814 stayed abroad, Japan 33 percent of 144, India 81 percent of 615, Brazil 31 percent of 119.
13. Freeman (2010: 10–11) suggests that 'US companies have largely abstained from large scale transfers of technology to China' because the theft of intellectual property is 'so rampant that few, if any companies are likely to expose their technologies to the Chinese marketplace.'
14. Referred to as either the IMS-GT (Indonesia, Malaysia, Singapore Growth Triangle) or SIJORI Growth Triangle (Singapore, Johor Baru in Malaysia, and Riau Islands in Indonesia, notably Batam).

15. During a famous tour of Guangzhou, Shenzhen, Zhuhai and Shanghai, Deng reasserted his economic policies and paved the way for a renewed economic reform program.
16. Steinfeld (2004: 1971) argues that PRC companies 'remain stuck in commodity manufacturing, undifferentiated activities for which innovation is absent.'

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