

China and India Reshape Global Industrial Geography

Shahid Yusuf, Kaoru Nabeshima, and Dwight H. Perkins

China's meteoric climb as an exporter of manufactures since the mid-1990s, and India's ability to claim a sizable fraction of the global market for tradable information technology (IT)-enabled services over the past six years have contributed to the changing pattern and the volume of global trade (table 2.1).¹ By 2004, China's share of the world's manufacturing exports was 8.3 percent; that of India was 0.9 percent. The two countries' shares of global imports were 6.3 percent and 0.8 percent, respectively. In commercial services, which include IT services, China's share of exports and imports was 2.9 percent and 3.4 percent, respectively; that of India was 1.9 percent and 2.0 percent, respectively (tables 2.1 and 2.2).

China's manufacturing sector accounts for more than 41 percent of gross domestic product (GDP), and in 2005 manufactured goods constituted 93 percent of exports or almost a quarter of the gross value of industrial output. Machinery and transport equipment accounted for 45.2 percent of total exports. These statistics reflect the large gains in manufacturing capability facilitated by heavy investment in plants and equipment embodying the latest technologies and the codification of knowledge on production processes.

The authors are greatly indebted to Jimena Luna and Wei Ha for their assistance with research and production; and to Richard Cooper, Masahisa Fujita, Nobuaki Hamaguchi, Greg Noble, and T. N. Srinivasan for insightful background papers.

1. India's IT-enabled services are principally business processing services and activities associated with the writing, testing, and debugging of software.

Table 2.1 China's and India's Shares of World Exports

World exports	1980		1990		2004	
	China	India	China	India	China	India
I. Manufacturing	0.8	0.5	1.9	0.5	8.3	0.9
1. Iron and steel	0.3	0.1	1.2	0.2	5.2	1.6
2. Chemicals	0.8	0.3	1.3	0.4	2.7	0.7
2.1 Pharmaceuticals	—	—	1.6 ^a	1.2 ^a	1.3	1.0 ^b
3. Office machines and telecommunications equipment	0.1	—	1.0	0.8	15.2	0.6
4. Auto parts	0.0	0.0	0.1	0.1	0.7	0.1
5. Textiles	4.6	2.4	6.9	2.1	17.2	4.0
6. Clothing	4.0	1.7	8.9	2.3	24.0	2.9
II. Commercial services	—	—	—	—	2.9	1.9
1. Transports	—	—	—	—	—	—
2. Travel	—	—	—	—	4.1	—
3. Other	—	—	—	—	2.4	3.1

Source: Srinivasan 2006.

Note: — = not available.

a. Pertains to 2000.

b. Pertains to 2003.

Table 2.2 China's and India's Shares of World Imports

World imports	1980		1990		2004	
	China	India	China	India	China	India
I. Manufacturing	1.1	0.5	1.7	0.5	6.3	0.8
1. Iron and steel	2.7	1.0	2.5	1.0	8.2	1.0
2. Chemicals	2.0	—	2.2	—	6.5	—
2.1 Pharmaceuticals	—	—	0.9 ^a	—	0.8 ^a	—
3. Office machines and telecommunications equipment	0.6	0.2	1.3	0.3	11.2	0.5
4. Auto parts	0.6	0.0	0.6	0.1	1.7	0.3
5. Textiles	1.9	—	4.9	0.2	7.4	0.6 ^b
6. Clothing	0.1	0.0	0.0	0.0	0.6	0.0
II. Commercial services	—	—	2.5 ^a	2.1 ^a	3.4	2.0
1. Transports	—	—	—	—	4.2	2.2
2. Travel	—	—	—	—	3.3	2.4
3. Other	—	—	—	—	3.5	2.1

Source: Srinivasan 2006.

Note: — = not available.

a. Pertains to 2000.

b. Pertains to 2003.

Relative to China, India's formal manufacturing sector accounts for a far smaller share of GDP—less than 16 percent. Investment in new industrial capacity and industrial growth since 1990 has been slower, and exports of manufactures are a fraction of China's exports in absolute terms and are a smaller fraction of total exports. India undoubtedly has achieved competitiveness in a few manufacturing subsectors, and some of those are technologically quite advanced, but, on balance, manufacturing capability has lagged. As described later in this chapter, India's breakthrough is in the export of certain business process services and software, the tradability of which has been enhanced greatly by advances in telecommunications and the advent of the Internet.²

These developments point to ongoing and impending shifts in worldwide industrial geography. In this chapter we explore the likelihood of a continuing concentration of major industrial activities in China and India and the implications for other economies if such concentration materializes.

The balance of this chapter is divided as follows: The next section describes the size of the domestic markets in China and India, especially for the relevant manufacturing products. The third section focuses on the overall strategy and patterns of development in the two Giants, and then we briefly examine the development of a few of the leading industrial subsectors in both countries. In our concluding observations, we report on longer-term implications for China, India, and their trading partners.

Large Domestic Markets

The evolving international competitiveness of Chinese industry—and eventually of Indian industry—will depend on a number of factors, including the expansion of domestic markets, infrastructure improvements, strengthening of the innovation system, and the dynamism of major firms. Businesses and the press regularly talk about the enormous size of both the Chinese and the Indian markets, given their huge populations. Large markets create a competitive advantage for any product that has substantial economies of scale, such as white goods or automobile assembly. Scale economies can be achieved without a large domestic market by relying from the start on exports, of course, but access to the domestic market and lower entry barriers can be significant advantages. So just how large are the Chinese and Indian markets?

2. Exports not only of software and services but also of goods have benefited (Clarke and Wallsten 2006).

Table 2.3 Households Owning High-income Consumer Durables in China, 2004

Consumer durable	Number per 100 urban households	Number per 100 rural households
Washing machine	95.9	37.3
Refrigerator	90.2	17.8
Color television	133.4	75.1
Camera	47.0	3.7
Mobile phone	111.4	34.7
Automobile	2.2	—

Source: National Bureau of Statistics of China, *China Statistical Yearbook 2005*.

Note: — = not available.

For many industrial producers the size of their market is much smaller than the total GDP, however that is measured.³ Much of the purchasing power a family has is spent on food rather than on industrial products. Low-income families in both rural and urban areas do purchase manufactured products, such as garments and footwear, but they do not purchase automobiles and the more expensive consumer durables. It is precisely in the area of white and brown goods where economies of scale are important. Thus, the market for these latter household labor-saving and entertainment products is made up mainly of people in upper income groups who have high income elasticities of demand for such products and who live in urban areas in China and India or abroad. Data on the ownership of consumer durables and automobiles in China are presented in table 2.3 and for India in table 2.4.

How big is the income of these higher income groups or the “middle class” in China and India? One way to approach this question is to measure the cumulative income of the highest-income decile of the population and the share of that income spent on nonfood products. That calculation results in a market purchasing capacity of \$550 billion for China and less than \$150 billion for India.⁴ To this figure could be added the share of investment that goes to

3. For an industrial firm selling its products in the market, the purchasing power parity measure of GDP is irrelevant. A foreign firm in particular will want to know what its sales are worth in a convertible international currency, such as U.S. dollars. If a domestic firm is engaged in international trade as either a seller or buyer, it will want to know prices converted into its domestic currency using the official exchange rate. Thus, the relevant GDP concept in U.S. dollars is the one obtained by using the official exchange rate.

4. A billion is 1,000 millions.

Table 2.4 Households Owning Selected Assets in India, 2001*percent*

Asset	Total households	Urban households	Rural households
<i>Electronics</i>			
Radio, transistor	35.1	44.5	31.5
Television	31.6	64.3	18.9
Telephone	9.1	23.0	3.8
<i>Transportation vehicles</i>			
Bicycle	43.7	46.0	42.8
Scooter, motorcycle, moped	11.7	24.7	6.7
Car, jeep, van	2.5	5.6	1.3
None of the specified assets	34.5	19.0	40.5

Source: Office of the Registrar General 2003.

purchase machinery and equipment and such key inputs as steel and cement. This would result in a market for industrial products of another \$400 billion for China and \$100–150 billion for India.

Thus, industrial producers in China face a potential market of nearly \$1 trillion. Indian industrial producers face a potential market that is a quarter to a third of China's size.

Two Rapidly Industrializing Economies

What are the implications of recent trends for the future international competitiveness of Chinese and Indian industry and services and the likely resulting industrial geography?

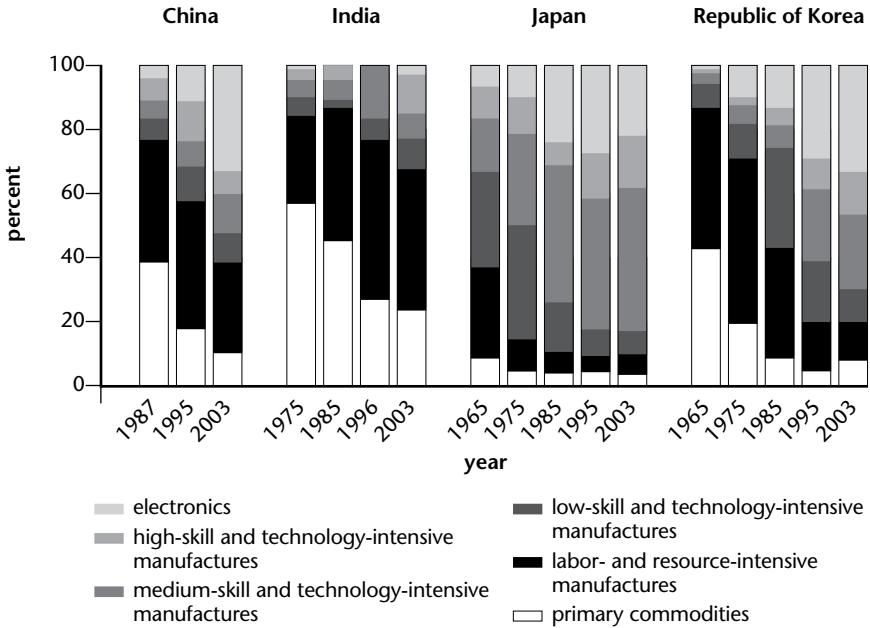
China Ascending

To begin with, China will remain primarily an exporter of manufactures over the next 10 to 15 years. Regarding imports, China is a major buyer of primary products, of sophisticated equipment, and of parts and components. China's demand for new materials and energy (discussed in chapters 1 and 5) has increased its imports from the least developed countries (see figures 2.1 and 2.2). In 2002, China absorbed \$3.5 billion in exports from those countries and was their third-ranked market (Yang 2006). The main question with respect to

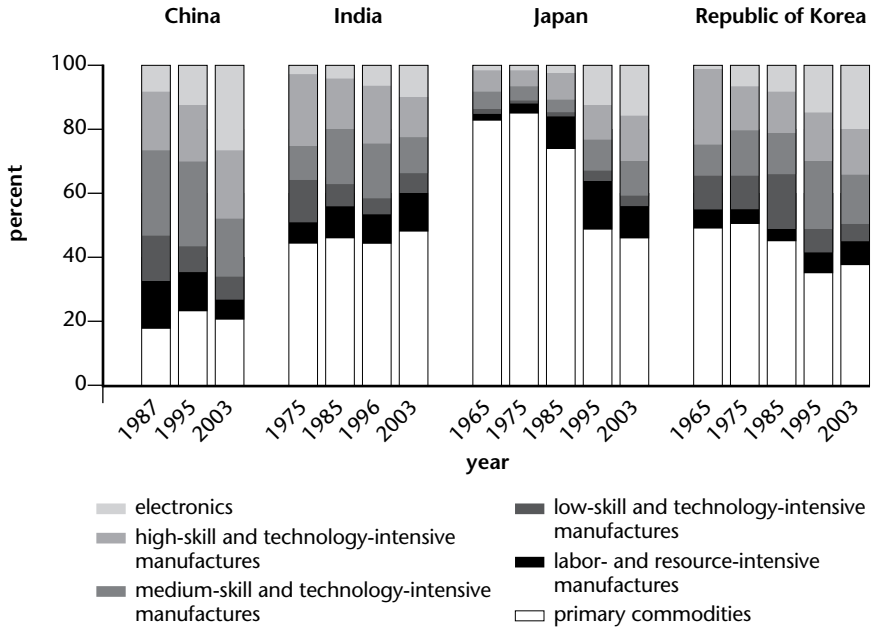
primary goods imports is the pace at which China will become a major importer of food and related agricultural products. China's grain output peaked in 1996 and 1998, and although it has fallen in absolute terms since that time, it was a net exporter of 19.9 million tons of grain in 2003 and only a small net importer of 5 million tons in 2004. Overall, however, China remained a net exporter of \$9.7 billion of food and live animals as of the end of 2004.

China imports machinery, plant equipment, and components that have fueled its massive expansion of industrial capacity and served as conduits for technology transfer. The first two imports—that is, complex capital goods bought almost exclusively from the advanced countries—are likely to continue to flow into China over the foreseeable future because, given the importance of learning, tacit knowledge, and cumulative research, the country's comparative advantage in these items will materialize only gradually. With regard to electronic components, currently the principal export of several East and Southeast Asian economies, the situation is less clear. Exports of such

Figure 2.1 Product Structure of Exports



Source: UNCTAD 2005.

Figure 2.2 Product Structure of Imports

Source: UNCTAD 2005.

components have risen steeply since 1995. China is one of the principal trading partners of the newly industrializing countries and its openness to trade is contributing to the interdependence of the East Asian region (Branstetter and Lardy 2006; Petri 2006; Yang 2006). More recently, however, elements of the supply chain are migrating to China as manufacturers of intermediates move closer to markets and final assemblers. This process, especially with regard to the auto industry, could fuel foreign direct investment (FDI) in China during the next decade.

On the export side, China is likely to remain competitive in labor-intensive products in 2010 or 2015, even as wages rise. In 2004, real wages were 2.11 times their level in 1989; and the rate of wage increase accelerated in 2004 and 2005, especially in the coastal regions—although productivity is rising as well.⁵ This trend is likely to be contained because China still has a

5. The figures cited refer to the change in the real average wage of all workers and staff so it includes both wage increases within various job categories and changes in the share of par

large surplus of 350 million agricultural workers, many of whose incomes are a small fraction of the wages earned by urban workers.⁶ To take full advantage of these underutilized workers and the lower cost of land, however, China will have to move the labor-intensive factories closer to its interior, as is being attempted now in the southwestern provinces through investment in the transport infrastructure (Chan and Gu 2006). Assuming this effort succeeds (and the process could take time), China's dominant world position in the export of textiles, garments, shoes, and toys is not likely to change much in the coming years.

China is the second-largest market for, and the largest exporter of, electronics/information and communication technology products (Ma, Ngyuen, and Xu 2006). The potential growth of these markets has attracted most of the leading multinational corporations (MNCs) producing electronics, autos, and consumer durables, as well as those in Taiwan (China) and the Republic of Korea. China's three largest exporters in 2003 were subsidiaries of Taiwanese electronics firms, such as Foxconn (Hon Hai) and Quanta. Several auto assemblers and manufacturers of auto parts have shifted their regional headquarters to China and are planning to move some of their research and design facilities as well—for example, Toyota and Volkswagen.

A recent study of China's trade by Roland-Holst and Weiss (2005) showed that the country is out-competing its neighbors in the Association of Southeast Asian Nations. The latter are losing shares in export markets although their exports continue to grow in absolute terms. Rodrik (2006b) similarly found that the growing sophistication of China poses a considerable challenge for other Southeast Asian countries.

With more than 5 million people graduating each year from senior secondary schools, the Chinese labor force is going to have a large number of people capable of taking on jobs well above the low-skilled, labor-intensive assembly operations associated with light manufactures.

China's gross enrollment rate for higher education rose from 19 percent of the relevant age cohort in 2004 to 21 percent in 2005 (Min 2006; data from

ticular job categories in the wage bill. They are based on the Chinese official wage indexes for enterprises in the urban areas (see National Bureau of Statistics of China, *China Statistical Yearbook 2005*, p. 151).

6. The marginal return to labor in 2001 was 365 renminbi (RMB) in agriculture, whereas it was 11,884 RMB in urban industry, 4,672 RMB in rural nonfarm industry, and 2,009 RMB in urban services. These data point to large distortions in the labor market, especially between agriculture and urban industry (Tan 2004).

UNESCO Institute for Statistics, 2006). Currently, China is graduating 600,000 people in science and engineering mainly at the undergraduate level. Over the next decade, the total of such graduates could be more than 5 million (“Up to the Job?” 2006). The very top Chinese students in sciences and engineering (like those from India) are competitive with the best in the world and are beginning to make a mark through scientific publications and patenting (Chen and Kenney forthcoming). The increasing stock of scientists and engineers is enabling China to enter a limited number of higher technology areas (such as nanotechnology [see Zhou and Leydesdorff 2006]) at an earlier stage of development than would be the case in a smaller country. Significant numbers of graduating students can staff world-class research laboratories abroad and should enable China to enter other high-technology fields if these experienced researchers come back to China after years of studying abroad. The lure is rising research and development (R&D), which reached 1.4 percent of GDP in 2005 (compared with 1 percent in 2000), together with numerous incentives for returnees with service and technology skills (Yusuf and Nabeshima 2006a, 2006b; Yusuf, Wang, and Nabeshima 2005).

There remains a question about the quality of the graduates from many Chinese tertiary institutions. Based on surveys by McKinsey, that quality does not seem to be particularly high. Only 10 percent are considered sufficiently well trained to be hired by MNCs in China (“China’s Hi-Tech Success” 2005). These graduates (along with graduates in less technical fields) have to staff managerial and technical jobs in more than 200,000 industrial enterprises, a wide variety of service sector businesses, government agencies, and universities.

What Is India’s Model for Catching Up?

As noted above, relative to China, the Indian business environment has been less conducive to the growth of manufacturing and exports, and this is immediately apparent from the stark contrast in absolute numbers from the two countries as well as from the shares of manufacturing production and the volume of exports of manufactures (see figure 2.1). Hence, for a country of its size, India’s impact on the rest of the world has been modest—at least as measured by population. Among its exports of manufactures, only textiles has achieved a scale sufficient to impinge on the prospects of other Asian countries, producers elsewhere, and the market for raw cotton. IT-enabled services is the only other area in which Indian exports have established a substantial and growing presence. Because of the still relatively small size of its economy

and its modest level of industrialization, India's imports of raw materials, machinery, intermediate products, and consumer goods are fewer than those of Brazil, Mexico, and Korea (which were approximately comparable in size using constant dollars in 2004).

It is certainly true that India's global footprint has expanded since the beginning of the century. Looking forward, its economy and trading relations will become more visible on the global stage, but even a doubling of GDP in 10 years will result in an economy that is less than two-thirds the size of the Chinese economy today, in nominal dollars. India's future impact on the rest of the world needs to be taken seriously, however, because it has the labor resources, a growing base of human capital, the domestic market potential, and the nascent industrial strength to become an industrial powerhouse that is comparable to China today. Whether this actually materializes and India begins significantly influencing the fortunes of other countries and natural resource use, global externalities will depend on the country's competitiveness and on the dimensions of a number of industrial subsectors. This outcome appears unlikely.

Were India to proceed along the growth path chalked by the dynamic and fast-growing East Asian economies, then manufacturing would lead the way. Given its factor supplies, India would need to expand its labor-intensive consumer industries rapidly while building the basic materials industries (such as petrochemicals and metallurgy) and the downstream engineering and transport industries. Moreover, although the domestic market is and would remain a major outlet for all these industries, rapid growth would likely rest on FDI in manufacturing industries and on success in export markets (as is the case in China).⁷ If India is to conform to the East Asian model, the share of manufacturing in GDP (currently less than 16 percent) would need to double possibly within 15 years. That would call for sector growth rates in the double-digit range, which also would help generate urgently needed jobs ("Risks Mount" 2006), and for export of a significant portion of the output produced.

A second and untried model would project growth on the basis of high and accelerating expansion of the services sector fueled by domestic and international demand. It certainly is plausible that key services subsectors could lead growth. Overall, services is by far the largest part of the Indian economy (50 percent); some parts have been expanding at a rapid clip and

7. The low level of FDI in Indian industry, relative to Chinese industry, has influenced the development of the manufacturing sector and growth of exports (Huang and Khanna 2005; Mukherji 2005; Swamy 2005).

there is much scope for increased investment and gains in productivity (Gordon and Gupta 2005).

These two models have different implications for global industrial geography and for India's impact on the rest of the world. Which model is more likely rests again on the future industrial capability of key subsectors, their competitiveness, and demand for their products—domestic and foreign.

It is easier to tackle the second model. Around 1990, India's services sector had a share in total GDP similar to that of other countries at an equivalent income level. Since then, it has risen at an above-average pace, and the share in 2005 was a bit above the norm for lower-income countries. Business services and software have spearheaded this growth, and Indian firms in those areas now rank among the largest in the world. IT services account for 6 percent of the services sector GDP as a whole, and in fiscal 2004/05 had revenues of \$30 billion ("Now for the Hard Part" 2006). Exports reached \$12 billion in fiscal 2003/04. Both turnover and exports have risen swiftly since 2000, averaging 30 percent and 31 percent a year, respectively. Employment too has climbed and is now a respectable 3 million, concentrated in five or six urban centers. In other words, the performance in the past five years is remarkable in the context of the Indian economy, but the IT sector is still fairly small, and the capability of the services sector as a whole does not extend much beyond software application development and maintenance and low-value-added processing services (financial, legal, medical, accounting, and others). Instead of computer architecture and operating systems design, the sector is dominated by call center services, professional services, document entry and transcription, and software maintenance activities. That this has been achieved in a short span of time points to the latent capability that could evolve rapidly if spurred by the activities of India's homegrown firms such as TCS and Infosys and by MNCs that are expanding their presence in India. Intel's largest chip design center is in Bangalore, and both IBM and Cisco Systems have opened major chip design facilities there. Advanced Micro Devices and Texas Instruments are planning to follow (Arora and Gambardella 2004; "Big Players in Chip Design" 2006; D'Costa 2006). It is also worth noting that India accounts for only 3 percent of world exports of business services.

Software and IT-enabled Services

The roots of the Indian software/business-processing services sector reach back to some decisions made many decades ago and to other developments in

the more recent past. In early 1950, the first Indian Institute of Technology (IIT), modeled on the Massachusetts Institute of Technology, was established at Kharagpur in West Bengal. Six other IITs were set up in selected cities across the country after the Indian Institute of Technology Act passed in 1956. The seven IITs, with a total enrollment in 2004 approaching 30,000 (17,000 undergraduate and 13,000 graduate students), have provided India with the nucleus of a world-class technological elite. These schools and other training institutions (such as the six Indian Institutes of Management and several Indian Institutes of Information Technologies in conjunction with the universities) have provisioned India's labor markets with engineering, management, and IT-relevant skills.

India's capacity to train accredited engineers rose from 60,000 in fiscal 1987/88 to 340,000 in 2003. For IT professionals, it rose from 25,800 to 250,000 over the same period (Arora and Gambardella 2004). In addition, the many graduates from the IITs who work abroad or previously have studied and worked abroad have contributed to the growth of the IT services industry in three substantive ways. First, the quality of their training and skills has created a positive reputation in North America, the United Kingdom, and beyond. Second, many former graduates, having acquired further education and experience abroad, have returned to India and are setting up their own businesses or working for local or multinational firms operating in India. In fact, 71 of 75 MNCs operating in Bangalore's software park were headed by Indians who had lived overseas, and many of the smaller companies are owned by Indian entrepreneurs presently living in the United States. Third, the Indian diaspora of professional and business people has shown great initiative in creating opportunities for Indian firms and in funneling contracts to them. As a source of capital and of expertise and guidance on technologies, the Indian diaspora is second only to the efforts of Chinese citizens overseas. Much like their Chinese counterparts, expatriate Indians have become increasingly adept in playing the roles of intermediaries, venture capitalists, and angel investors with secure footholds in strategic clusters, such as Silicon Valley (California) and the Boston (Massachusetts) area (Saxenian 2006).

Indian firms were motivated to look overseas for business because the domestic market for their services was very limited in the 1980s and 1990s. The links forged with major U.S. companies that established subsidiaries in India led to a buildup of contract work for American firms. The work, usually done on-site by Indian professionals, focused on software enhancement and maintenance, the writing of code, engineering design, and other related

projects that harnessed specific plentiful and very-low-priced skills.⁸ The shortage of computer hardware in India, caused by steep duties and other import restrictions, also made on-site work at the facilities of American companies necessary.

The falling cost of telecommunications and the vistas opened by the Internet made it feasible to outsource a host of services: back-office services, all types of information processing, engineering, some kinds of retail, and medical services. Companies based in the United States have taken a lead in outsourcing services.⁹ Not many countries had India's mix and volume of skills and English language capabilities. Moreover, Indian IT professionals and companies had the added advantage of long exposure and involvement with U.S. companies that took the lead in adopting IT, in reengineering corporate structures, and in outsourcing services.¹⁰ It was during this period that more Indian firms began to enter the field, and IT services clusters (for instance, in the software parks) began to take shape in Bangalore and other cities with a concentration of engineering talent (Arora and Athreye 2001). The growth of the industry, however, was spearheaded by a number of medium-size firms established much earlier. The first, Tata Consulting Services, was created in 1968; Wipro in 1980; Infosys in 1981; and Satyam in 1987. The leading firms now account for the lion's share of turnover and exports (Khanna and Palepu 2004). Only one-fourth of the top 20 exporters are foreign multinationals. Thus, the past association dating back to the 1980s and reinforced by the presence of thousands of Indian professionals in the United States, gave Indian firms a flying start in the global marketplace, and it accounts for the heavy dependence on exports and on the U.S. market. The government helped by containing the rates for telecommunication services and modifying India's stringent labor laws to give IT firms greater flexibility in hiring and laying off workers.

As the IT sector has expanded, one of the most serious constraints that has emerged is the shortage of needed technical and managerial skills, which goes

8. The Y2K threat and the euro conversion greatly expanded the demand for technicians to write code and debug software.

9. Only 3 percent of India's retail business is conducted by large chain stores and in shopping centers (although such chains as Big Bazaar and Pantaloons and malls such as Phoenix-Mills are multiplying). By comparison, 20 percent of China's retail business is conducted in such venues. ("Here Comes" 2005).

10. During the period 1999–2001, roughly half of the petitions for H1B visas (work authorization for skilled workers in the United States) were granted to Indians (Cooper 2006).

in tandem with high and disruptive labor turnover. Thus, India needs to invest heavily in skills and in technology, and firms will need to cultivate links with universities and research institutes if they are to sustain high growth rates.¹¹ The quality of technical graduates in India also leaves much to be desired. Possibly 20 percent are world-class and, according to a recent survey, three-fifths are “lamentable” (“Now for the Hard Part” 2006; “Up to the Job?” 2006). Other middle-income countries also are looking to services to provide economic momentum and jobs—Brazil, the East European economies, Mexico, and the Russian Federation. China is producing more engineers and IT technicians than India; and ambitiously is expanding its IT-enabled services and software sectors, assisted by FDI from Indian IT firms (“Watch Out, India” 2006). India also can expect to encounter strong competition from Ireland, Israel, several European countries, and the United States as it pushes into the high-value end of IT, as it now is attempting—for instance, with digital signal processing software. Hence, projecting the likely future geographical distribution of business and IT services is no easy matter. It is beginning to seem, however, that other South and Southeast Asian economies and those from Eastern Europe and Latin America will have to struggle to find lucrative niches in an IT services market dominated by MNCs and Indian firms.

Other Services

India’s banking, finance, telecommunications, and hotel and restaurant services have grown at or near double-digit rates (Gordon and Gupta 2005). There is plenty of scope for developing India’s finance, telecom, commercial and retail, medical, moviemaking, and logistics services on the strength of buoyant domestic and overseas demand. Each of these industries also stands to benefit from advances in IT that will raise productivity and generate demand for the firms supplying the services. It is an open question, however, whether India is likely to emerge within the next decade as a significant exporter of any of these services. India’s economy is only a sixth as monetized as China’s economy. India holds 1 percent of the global financial assets, but less than one-half are in the form of bank deposits (Farrell and Key 2005). India’s banking and finance sector, although improving and apparently more dynam-

11. Only a small fraction of those employed by the IT industry have more than five years’ experience (“Now for the Hard Part” 2006; “Up to the Job?” 2006).

ic than China's, remains inefficient by international standards, and Indian institutions have not made any headway overseas.

Telecommunications also is a domestic industry, even though India has created a production base for hardware technologically attuned to the needs of lower-income countries. But unlike Chinese firms such as Huawei and ZTE, Indian companies have yet to venture abroad, to offer the kind of full-service packages (including financing) that Chinese firms now offer, and to invest significant sums equal to 8–10 percent of sales in R&D to stay abreast with the frontrunners in this rapidly advancing field (“Global Transformation” 2006).¹²

Moviemaking is a thriving national industry, and India is the biggest producer of films in the world. This industry also caters to the large overseas Indian diaspora and has acquired a niche market in some of the Middle Eastern countries as well. But it has yet to broaden its appeal to consistently reach a global audience and compete with Hollywood or with producers in Greater China (China, Hong Kong [China], and Taiwan [China]) and Korea, despite the international acclaim enjoyed by a few movies (most notably *Bend It Like Beckham*).

Very recently, Indian firms have begun supplying IT services for the international movie industry and producers of video games (for example, for cell phones)—a business that could grow in line with the demand for special effects and video content. With the exception of the business services processing and software industries, it is far from obvious that India is positioned to make a mark in the global market with its services industry, at least during the next 10 years.

Prospects of Key Manufacturing Industry

It is very likely that the impact of China and India on the geography of the world's tradable services industry will be modest and not especially disruptive. The same cannot be said for manufacturing if India picks up speed. And so we come back to the conventional manufacturing sector-led model of development that underlies the development of China and other East Asian economies.

Whether Indian manufacturing can become the principal leading sector and whether India can join China as a leading industrial economy will depend largely on the medium-term performance of a number of manufacturing

12. Indian software firms' average investment in R&D as a percent of sales in 2000 was 3.5 percent (Radhakrishnan 2006).

Table 2.5 Industry Exports as a Percentage of Total Exports, China and India

Industry export	1995	2000	2004
<i>China</i>			
Pharmaceutical products	1.1	0.7	0.6
Iron and steel	3.5	1.8	2.3
Electrical equipment	5.9	9.7	10.0
White goods	0.7	1.1	1.3
Road vehicles	1.8	2.6	2.8
Textiles	26.0	21.4	16.2
<i>India</i>			
Pharmaceutical products	2.3	2.8	2.9
Iron and steel	3.0	2.9	6.0
Electrical equipment	1.3	1.8	1.9
White goods	0.0	0.0	0.1
Road vehicles	2.8	2.0	2.8
Textiles	27.0	27.2	17.4

Source: United Nations Commodity Trade Statistics database, accessed via the World Bank's World Integrated Trade Solution (WITS) software.

Note: Textiles is defined as the combination of 26, 65, and 84 of Standard International Trade Classification (SITC), Rev. 3. White goods is defined as the combination of 7751, 7752, 7753, and 7758 of SITC, Rev. 3. Pharmaceutical products, iron and steel, electrical equipment, and road vehicles are defined, respectively, as 54, 67, 77, and 78 of SITC, Rev. 3.

subsectors in both countries, and on the parallel development of infrastructure in India particularly.¹³

The pertinent subsectors are textiles and clothing, white goods, pharmaceuticals, autos and auto parts, steel, and electronics. Together, these subsectors account for close to a third of the merchandise exports of both India and China (see table 2.5), as well as for 48 percent of the sales of industrial products in China and 41 percent of industrial employment (see table 2.6).

13. Power shortages are a major concern for Indian firms. A survey of Indian manufacturing firms in 2003 revealed that 61 percent still rely on their own generators for electricity. In China the share is 27 percent. The same survey also found that firms in India faced an average of 17 significant power outages a month, far more frequent than in Malaysia (1 a month) or China (fewer than 5 a month). The loss from power outages in India was 9 percent of total output, compared with 2 percent in China (World Bank 2004a), and electricity costs twice as much as in China. Deficiencies in infrastructure provisions are costing India 3–4 percentage points in lost growth (“An Urgent Political and Moral Imperative” 2006).

Textiles and Clothing

Textiles and clothing account for 7 percent of world exports. China is the leading producer, followed by India. China's advantage derives from its integration with the global production network through foreign investment and direct contacts with the retailers in Organisation for Economic Co-operation and Development countries. Wal-Mart, for example, purchased \$18 billion worth of goods from China in 2004. In contrast, Indian firms have far less direct contact with the retailers (Whalley 2006).

In 1950, India was a leading exporter of cotton textiles, but thereafter it lost ground and the industry's fortunes only began to reverse course when reforms were introduced in the early 1980s (Roy 2004). Now, India's textiles and clothing sector is the second-largest employer, with 35 million workers responsible for 20 percent of industrial production (Ananthakrishnan and Jain-Chandra 2005). However, India's textile industry still trails well behind that of China. In 2005, exports of textiles and garments amounted to \$9.5 billion and \$7.5 billion, respectively, versus China's respective \$77 billion and \$40 billion. The average firm in India's formal sector often has been constrained from fully exploiting scale economies and new technologies; little foreign capital has flowed into the sector; and because Indian firms are less well integrated into global production networks than are Chinese firms, they have benefited less from technology transfer. Hence, the productivity level of India's textiles and clothing sector is only 35 percent that of the United States, whereas China's is 55 percent (Ananthakrishnan and Jain-Chandra 2005). The overall productivity of India's apparel industry is 16 percent that of producers in the United States (Padhi, Pauwels, and Taylor 2004).

As with several other Indian industries, the partial dismantling of domestic regulations and of the Multifiber Arrangement (MFA) have created openings that firms are rushing to exploit. Indian exports—some of which compete against exports from China—are rising and the two countries are moving to dominate the world market to an even greater extent than in the past. Both increased their market shares in the European Union, Japan, and the United States in 2005. China's gains were larger because Chinese producers had invested in anticipation of the lifting of quotas and were better prepared and more competitive ("Air-conditioners Wilt" 2005; "India: China Eats" 2005; Yang 2006). As the backloaded MFA phaseout started in 1995, China was able to take advantage of the phased removal of quotas on various apparel categories, even though it was not yet a member of the World Trade Organization (WTO). India did not (Srinivasan 2003a, 2006).

Table 2.6 Indicators of All State-owned and Non-state-owned Enterprises in China, by Industrial Sector, 2004

Sector	Enterprises		Industrial products		Employees	
	Number	Percent of total	Sales revenue (billion yuan)	Percent of total	Number (millions)	Percent of total
Manufacture of textiles	17,144	7.8	934.7	5.0	5.19	8.5
Manufacture of textile wearing apparel, footwear, and caps	10,901	5.0	388.0	2.1	3.20	5.3
Manufacture of raw chemical materials and chemical products	15,172	6.9	1,198.3	6.4	3.16	5.2
Manufacture of medicines	4,397	2.0	321.3	1.7	1.19	1.9
Smelting and pressing of ferrous metals	4,947	2.3	1,590.7	8.5	2.61	4.3
Manufacture of transport equipment	9,389	4.3	1,327.2	7.1	3.28	5.4
Manufacture of electrical machinery and equipment	11,760	5.4	1,005.6	5.6	2.99	5.0
Manufacture of communication equipment, computers, and other electronic equipment	6,638	3.0	2,146.3	11.4	3.33	5.5
Subtotal of these selected sectors	80,348	36.7	8,912.1	47.8	24.95	41.1
National total	219,463	36.6	18,781.5	47.5	60.99	40.9

Source: National Bureau of Statistics of China, *China Statistical Yearbook 2005*.

Note: Firms included in the tables are those with sales of 5 million yuan or more.

Even if there is a full liberalization, India may not soon be able to take advantage of the opportunities made available because Indian firms remain hampered by suboptimal scales of production, labor market rigidities, and other impediments to trade, particularly with respect to logistics (Schiff et al. 2006).¹⁴ The minimum delivery time from India to the United States is 24 days, compared with 18 days from Thailand, 15 days from China, 12 days from Hong Kong (China), and 3 days from Mexico. In addition, customs delays on imports eat up 10 days in India, compared with 7 days in Korea and Thailand (Ananthkrishnan and Jain-Chandra 2005).

Looking ahead, India—and China—very likely will remain among the most competitive producers of garments and textiles because of their elastic labor supplies, assuming that labor laws and shortages do not push up wages more rapidly than what has occurred over the previous decade. There is considerable latitude for raising productivity, quality, and design in the industry. Niche products surely will continue to offer opportunities for suppliers in other countries.¹⁵ But even against the high-value textiles and fashion garments produced by Italy, pressure from China and India will mount because of the levels of investment, the design and engineering skills being mobilized locally and from overseas sources (as the design industry is becoming globalized and design services can be outsourced), the increasing sophistication of domestic consumers, and the immense domestic markets. This is strikingly supported by China's capacity to diversify its product offerings in textiles and enter new markets. Since 1990, at the 10-digit level the number of textile product varieties has risen from 6,602 to 12,698 (World Bank Office 2006).

White and Brown Goods

The market for white goods worldwide amounted to more than \$100 billion in 2002. One-third of demand for large appliances was from the Asia Pacific region, of which half came from China, the fastest growing market (Nichols and Cam 2005). Seeing the opportunities, foreign firms are entering the Chinese market; and in durables, such as washing machines, their market share has in-

14. Even large firms, such as Gokaldas, are unwilling to expand employment because it is difficult to lay off workers ("Now for the Hard Part" 2006).

15. For instance, knitwear from Bangladesh and carpets from Pakistan have held up well so far in the U.S. and European Union markets after the abolition of the MFA (Whalley 2006).

creased from 15 percent in 2000 to 25 percent in 2003 (Nichols and Cam 2005). General Electric and other such firms are planning to shift a third of their production capacity to Asia, with China the primary destination.

Similarly, the Indian market is expanding and domestic producers, such as Godrej and Videocom, and MNCs have created two large clusters to produce white goods in Noida (near Delhi) and Pune (near Mumbai), with help from government-provided incentives. The household ownership rate for refrigerators in India was just 15 percent in 2004 and it was low for other durables (“Japanese White Goods” 2006). Haier is attempting to enter the Indian market where Korean producers (such as market leader LG and Samsung) currently have a strong presence. In 2004, LG announced plans to make India its second-largest global production base after China (Nichols and Cam 2005). The company already accounts for more than a quarter of the market for air conditioners and color televisions, and more than a third of the market for washing machines, refrigerators, and microwaves (“Now for the Hard Part” 2006). Sanyo will start marketing white goods in India, using existing partnerships with local distributors for their TVs (“Sanyo Seeks India Boost” 2006). Sharp and Toshiba are planning to do the same (“Sharp India Chalking Out” 2006; “Toshiba Forays” 2006).

In the past, local production was the rule worldwide because of freight costs. Given that freight charges are typically quoted with reference to cubic capacity, it is relatively expensive to ship finished white goods over a long distance, especially larger goods (Nichols and Cam 2005), so the size and growth opportunities of the domestic market determined how the white goods industry developed. However, low wages and production costs coupled with the adoption of modern technology has enabled China to export refrigerators and wine coolers to the United States (Nichols and Cam 2005). Parallel to the increase in trade of finished goods, intraindustry trade has increased, reflecting the development of global production networks for white goods.¹⁶

Although demand is strong, especially from China and India, the unit price of white goods has been in decline, and firms are adopting a number of strategies to cut labor costs, to outsource, to strip production down to an assembly operation, and to bring in modern management techniques (especially total quality management) to reduce the number of defects (Nichols and Cam 2005). Others are trying to move up the technology ladder by offering

16. For instance, Maytag dishwashers assembled in the United States use motors made in China (by GE) and wire harnesses from Mexico (Nichols and Cam 2005).

more functions in each unit, better designs, integration with the whole kitchen as a system, and even Internet-enabled refrigerators (Nichols and Cam 2005).

China

In 1981, the urban penetration rate of refrigerators and washing machines per 100 families in China was only 0.2 and 6.0, respectively. The “big three” home appliances at that time were the bicycle, the wristwatch, and the sewing machine (Zhao, Nichols, and Cam 2005). In 20 years, the penetration rate of white goods in China increased dramatically to reach 87 refrigerators and 92 washing machines per 100 urban families in 2002. In some cities, such as Beijing, the penetration rate that year was 107.4 refrigerators and 102.8 washing machines per 100 families (Zhao, Nichols, and Cam 2005). Although the urban market is fast becoming saturated, white goods ownership among rural households is still low, with 13.6 refrigerators and 29.9 washing machines per 100 rural families (Zhao, Nichols, and Cam 2005).

In the early 1980s, most firms were small-scale state-owned or collectively owned enterprises. To meet the rising demand, these firms imported factories from Italy and Germany. By the mid-1990s, more than 100 lines were imported. With government encouragement during the 1990s, more successful enterprises started to acquire other companies, forming several large, well-known firms (such as Haier, Kelon, Meiling and Little Swan), reflecting the worldwide trend in consolidation (Zhao, Nichols, and Cam 2005). By 2002, the market share of the top five firms had risen to 60 percent in refrigerators and 68 percent in washing machines. The market for air conditioners also is becoming less crowded. Twenty-seven brands were withdrawn in 2001, leaving 69 by 2005. At the end of 2006, only 20 brands may be left (“Air-conditioners Wilt” 2005). These successful firms also are relying heavily on exports. For example, Galanz exports 65 percent of its microwave ovens and is becoming a major producer of air-conditioning units (Sull and Wang 2005; “An Alpha Delta” 2006). Changhong Electric also is expanding its production of air conditioners (“Telecoms and Technology” 2006). But many of the Chinese producers depend on foreign firms for such key items as compressors.

Haier, now the fourth-largest white goods manufacturer in the world, was the first Chinese manufacturing firm to invest abroad in 1999 (“Haier to Cre-

ate” 2006).¹⁷ It is also the first Chinese firm to hire an international advertising agency to establish its brand (“Chinese Fridge Magnate” 2005), and now has dozens of factories scattered overseas.

India

India’s white goods industry is at an earlier stage of development, relative to China’s industry. Exports are insignificant and there is no Indian equivalent to China’s Haier prowling international markets. Protectionism, slow-growing demand from the middle class, little FDI until recently, subscale production, and inadequate supplies of electricity have combined to keep India out of the running. Demand from the middle class is picking up now, and the white goods industry has seen double-digit growth in recent years. The market size for white goods is about Rs. 80 billion (\$1.76 billion).

MNCs are expanding their manufacturing capacity in India, but the country’s slow start means that producers based in India are unlikely to be exporting substantial quantities of finished products for some time. The export of components, however, is feasible. China has established a lead in white and brown goods, and it could be that it will extend its lead over India as MNCs transfer more technology and expand capacity through FDI in China.

Pharmaceuticals

Pharmaceuticals is one of India’s brightest prospects and is underpinned by strong entrepreneurship in the private sector; the abundance of skills in chemistry, biology, and chemical engineering; and the long-term mastering of complex process technologies made possible until recently by the absence of intellectual property protection for foreign pharmaceutical products under Indian law (Chaudhuri 2004). Here again China is a close match, although its corporate capability is weaker than India’s. India is the fourth-largest producer of pharmaceuticals by volume—the 13th in terms of value—and for several compelling reasons it is likely not only to retain this ranking over the next decade but also to expand its global market share (Grace 2005). China is the

17. This investment was in a factory in South Carolina (United States). Haier plans to expand the existing factory with additional investment amounting to \$150 million. Furthermore, it plans to invest in an R&D facility in the United States (“Haier to Create” 2006).

second-largest producer of pharmaceutical ingredients and generic drugs in terms of value after the United States (with 5 percent of world output in 2004 valued at \$54.4 billion) (“China: Pharmaceuticals Sector” 2005). Remarkably, Chinese firms have shown less initiative in this field than in others, although they exported \$4 billion worth of products (including traditional medicines) in 2004 and are beginning to move into the neighboring fields of biotechnology and stem cell research (Fernandez and Underwood 2006).

In addition to graduating 15,000 chemists each year, India has the corporate muscle to invest in R&D and to test and market drugs. Firms such as Ranbaxy, Cipla, Dr. Reddy, Wockhardt, and Nicholas Piramal have the size and the experience to embark on substantial research activities involving drug discovery, a significant departure from their past practice of imitating drugs produced abroad and selling mainly in the market for generics.¹⁸ Indian companies currently account for \$8 billion of the \$48 billion global market for generic drugs (“Selling Generics” 2006). The presence of these homegrown firms and the many MNCs beginning to locate some of their research in India (such as Novartis and GlaxoSmithKline) is creating a dynamic environment. India’s huge size, numerous hospital facilities, and capacity to conduct drug trials involving large and heterogeneous populations are additional advantages over smaller countries like Singapore and Korea, which also are engaged in the development of new drugs and procedures. Developing a drug in India can cost as little as \$100 million, compared with a cost of \$1 billion or more in the United States. China shares these advantages with India and is beginning to exploit them (see Yusuf and Nabeshima 2006b).

Outside of the United States, India now has the largest number of manufacturing plants approved by the U.S. Food and Drug Administration, and with the newly strengthened intellectual property regime, that is a firm basis for future growth.¹⁹ Again, the competition is likely to be among the advanced countries, China and India, and possibly Brazil, with other countries certain to be squeezed by the presence of the big players in an industry where size matters greatly at several levels.

18. Until the revision of intellectual property rights in 2005, Indian firms were able to manufacture generic versions of medicines developed in other countries without waiting for those drugs’ patents to expire.

19. It is surprising, however, that a survey by Bain and Company in 2006 found that pharmaceutical executives felt China was the more attractive site for low-cost manufacturing of drugs (“China Looms Large” 2006).

Autos and Parts

Traditionally, automobile firms have tended to prefer local assembly to exporting because of the bulkiness of the finished cars and the need to comply with local regulations that often differ substantially among countries. This is not to say that trade in the automobile sector is insignificant. On the contrary, it is growing at double-digit rates, especially trade of more sophisticated and expensive parts.

In 2004, the Chinese share of automotive products exports was a mere 0.7 percent, and that of India was 0.2 percent (Noble 2006). The Indian production of automobiles (in 2004/05, close to \$9 billion) could climb to approximately \$40 billion in 2015, with \$20–25 billion of that total exported. Production of automobiles in China was \$60 billion in 2003. By 2015, China's export of automobiles could be as much as \$120 billion (Noble 2006). India seems to have a comparative advantage in exporting small cars.²⁰ The recent entry of Chinese producers such as Chery and Geely could change the picture, however, as could the strategies of MNCs to use China as a base for producing and exporting small cars, including hybrids (Ma, Ngyuen, and Xu 2006).²¹ China and India are modernizing their auto industries through joint ventures with foreign firms. Virtually all the major international auto manufacturers have set up facilities in China and some (for example, Honda, Hyundai, and Toyota) are entering India ("Honda to Invest" 2006). The Indian government partnered with Suzuki in the early 1980s to form a joint venture, Maruti Udyog, and began delicensing the auto components industry (Gokarn and Vaidya 2004).²² In 1993 India ended the licensing of foreign automobile ventures, and in 2001 it lifted almost all the restrictions on FDI in the automobile industry. Tariffs have remained high, however, at 100 percent on vehicles and 35 percent on their parts. In contrast, tariffs in China declined to 25 percent on vehicles and 10 percent on parts after its accession to the WTO (Noble 2006).

FDI from multinational corporations is spurring the emergence of parts manufacturers in China (some of them foreign affiliates) (Noble 2006; Raws-

20. Just seven years after it started production, Tata Motors was making net pretax profits of 10 percent and was the largest group in the Tata business empire ("Today India" 2005).

21. In 2004, 15 percent of the production was exported (Balakrishnan et al. 2006). China was a net exporter of vehicles in 2005, to about 10,000 ("Figures Show China" 2006). Most of the exports were minivans sent mainly to the Middle East, but this is likely to change with increasing exports of sedans.

22. The earliest entry was by General Motors, assembling Chevrolets in India in 1928 (KPMG International 2006).

ki 2006). China is acquiring an edge in the international market for auto parts with exports of \$0.3 billion in engines, \$3.25 billion in auto parts and bodies, and \$1.35 billion in tires, compared with \$1.4 billion in 2004/05 for India for these products combined (Balakrishnan et al. 2006). The assemblers and first-tier suppliers (Sutton 2004) in both countries are able to manufacture products of sufficient quality, no matter where they are produced, and are able to export their products.²³ The distribution of observed defects confirms the view that first-tier suppliers to newly arrived carmakers in China and India already are operating close to world-class standards (Balakrishnan et al. 2006). India's auto industry, however, is handicapped by a significant cost disadvantage relative to China: costs are close to 20 percent higher in almost all the parts and component production.

In both China and India, auto assemblers are facing difficult times in procuring parts of sufficient quality from the lower-tier suppliers (Noble 2006). With pressure coming mainly from the MNCs, the Indian automobile parts industry recently has redoubled its efforts to improve quality, to streamline the delivery system (just-in-time delivery), and to improve the efficiency of its factory operations (Balakrishnan et al. 2006).

In its push to raise the level of technology, China is ahead of India. The automobile industry is one of the most R&D-intensive industries.²⁴ The list of top R&D spenders includes many of the well-known automakers, some of which have transferred a portion of their R&D activities to China. Chinese automakers slowly are increasing their R&D spending as well. For instance, Geely claims to invest more than 10 percent of revenues in R&D (Noble 2006). By comparison, Tata Motors spends approximately 2 percent of revenues on R&D, and Maruti Udyog spends only 0.48 percent.²⁵ This may change because Indian engineering and metalworking firms, such as Bharat Forge, are gearing up to provide high-value products and services in conjunction with software houses—particularly products with embedded software. In this regard, India may be several steps ahead of China.

Both China and India are beginning to worry about the environmental impact of their rapid motorization, and they share similar concerns about energy

23. Most of India's automotive exports are by the international first-tier suppliers (Balakrishnan et al. 2006).

24. Among the top 10 firms in terms of R&D spending, 5 are automotive firms, led by DaimlerChrysler (United Kingdom 2005).

25. The market share of Maruti Udyog is 54.5 percent in passenger cars, with the capacity to produce 500,000 units annually ("Smooth Drive" 2006).

security and dependence on imported oil. As a result, the Giants may be able to help push the technological frontier for fuel-efficient, small, and clean cars made with predominantly recyclable material and parts, but only if they set and enforce appropriate environmental standards and encourage the formation of closed-loop supply chains (Gallagher 2006; Noble 2006). Toyota recently began assembling its Prius hybrid car in China, a technology well suited for China's cities and a technological direction appropriate for a world in which petroleum consumption threatens to overtake the feasible growth in supplies.²⁶

Steel

China's steel production passed 349 million tons in 2005, making it by far the largest producer in the world (with 31 percent of the global share) and the fourth-largest exporter (with sales of 27 million tons approximately on par with imports).²⁷ The significant developments with portent for the future are China's extremely rapid increases in capacity (25 percent between 2004 and 2005 alone); the increasing concentration of production in large-size modern plants (although many small, antiquated facilities remain); and the growing technological capacity to produce high-quality construction steel, stainless, galvanized, and coated steels, and flat products for burgeoning downstream transport and durable goods industries.²⁸ These developments point to declining imports and the scope for higher exports.

Compared with China, India's total output and per capita consumption are small. By fiscal 2004/05, India was producing 38 million tons of steel, and its exports of 3.8 million tons approximately balanced imports of 3.2 million tons. As India enlarges its transport, engineering, and white goods industries and modernizes its severely backward infrastructure, the demand is likely to rise as sharply as it has in China. Thus, it is realistic to expect India to produce 55–60 million tons of steel by 2010 and as much as 120–130 million tons by 2015.

The production trends in China and India will have consequences for the rest of the world. One such consequence is that the Giants' capacity expansion will add enormously to the demand for iron ore and coking coal (unless

26. Hyundai is planning to market a hybrid version of its Accent in China by 2008 ("Automotive" 2006).

27. In December 2005, China became a net exporter.

28. Closing down small inefficient plants and consolidating production in a few giant firms is a government objective ("Attempting a Steel Revolution" 2005).

production of steel plummets elsewhere) and, to the extent that this demand cannot be met through the development of local mines and associated transport facilities, it will spill over into imports. Second, Indian production still largely consists of mild steels, as does China's to a lesser extent. Only Tata's most modern plant is beginning to meet the needs of the auto industry for hot-rolled steel.²⁹ A considerable amount of investment, learning, and gains in process technologies might be needed even before China and certainly before India can meet the requirements of their own advancing transport and engineering industries. For the above reasons, India is not likely to emerge as a significant exporter of steel—especially high-tech and specialty steels—during the next decade. It is more likely, if infrastructure, housing, and industrial development take off, that for a time both India and China will be importers of certain types of specialized steels. China, however, is sure to ascend the ranks of steel exporters, edging out the 35 members of the European Union and possibly Russia within five years.

Electronics

Competition, globalization, indigenization, and powerful policy factors have been the forces driving the electronics industries in China and India. Further impetus, at least for China, has come from the outsourcing of manufacturing from Europe, Japan, Taiwan (China), and the United States in the 1990s. However, the development of each country's electronics industry has been shaped by different industrial policies.

India's policy framework has focused on technological self-reliance and has assigned a limited role to foreign investment and to the development of electronic components manufacturing, which has contributed to the success of the industry in Taiwan (China) (Joseph 2004). The Indian Electronics Commission established in 1971 promoted protectionist policy measures to control production capacity, investment, and imports. The strategy channeled development of the industry to the public and small-scale sectors, and regulated the entry and operation of foreign capital and technology. Discontent with the policies emphasizing self-reliance, and with restrictive industrial policies in general has led to a gradual liberalization of the electronics industry (Gokarn, Sen, and Vaidya 2004).

29. Tata's earnings before interest, tax, depreciation, and amortization were \$293 per ton in 2005, three times the industry average ("Tata Steel Girds" 2006).

By fiscal 2004/05, India produced \$11.1 billion of electronics hardware, a third of which was for consumer electronics. The production of color TVs leads the increase in consumer electronics production, with more than 10 million units made in fiscal 2004/05. The production of color TVs gradually is shifting toward flat-screen units (based on tubes), and more advanced liquid-crystal display (LCD) and plasma flat-panel models. This is happening in China, too, although mastering the latest generation of this technology is proving difficult for domestic producers there. Backward links have encouraged investment in some types of component manufacturing. For example, India is the world's third-largest manufacturer of optical storage media, with 18.5 percent of the global market. Approximately 80 percent of the production is exported to 82 countries.

The shipment of personal computers (PCs) in India reached 2.34 million units in the first half of fiscal 2005/06, a 36 percent increase compared with the same period in fiscal 2004/05. The growth of computer production is driven by businesses and various government agencies widely adopting PCs and by the development of affordable broadband connections. There now are 800,000 broadband subscribers, but this number is expected to increase to 10 million by the end of 2007, further fueling the demand for PCs.

China's path to achieving a flourishing electronics sector approximates the development in other newly industrialized economies. For decades China has attached strategic importance to the electronics sector and has developed electronics capability over the course of a succession of "five-year plans" (FYPs). Initially the push was to meet defense needs, those of the industrial sector, and to a lesser degree, those of households for electronic appliances, mainly radios. With increasing consistency the country has compelled foreign investors to transfer technology to local producers, and this strategy gradually is yielding results (Rodrik 2006b). The seventh (1986–90), eighth (1991–95), and ninth FYPs (1996–2000) witnessed a dramatic surge in the production of consumer electronic products, with an average annual growth rate of approximately 66 percent. By the ninth FYP, the output of the electronics sector amounted to \$72 billion, and exports had climbed to approximately \$35 billion. In addition to its manufacturing capability, China strengthened its technological capacity through investment in R&D, and it was able to develop a number of products, such as very-large-scale integration devices, the Panda ICCAD system, and rewritable compact discs. This period also witnessed the emergence of new companies, such as Changhong Electric, Tsinghua Tongfang, Caihong Electronics, Panda, and Lianxiang, and numerous Taiwanese

transplants, all of which have since enabled China to become the leading manufacturer of color TVs, LCDs, laptop computers, PCs, color tubes, program-controlled switchboards, cell phones, display devices, and monitors (Pecht and Chan 2004).³⁰

By leveraging its low-cost labor supply and the impetus gained from WTO accession, China has doubled the scale of the electronics industry, which now accounts for more than 8 percent of industrial output. In India the electronics subsector accounts for less than 3 percent of a much smaller industrial sector.

In little more than a decade, China has made the transition from limited production of low-quality electronic items to a place in the global production chain for a wide spectrum of components and finished products (Fernandez and Underwood 2006). Today there are more than 10,000 foreign-invested firms in China, and it is likely that many more foreign component producers will relocate there because of lower labor costs, tax incentives, a large domestic market, and adequate infrastructure.³¹ Companies like Intel and Motorola have taken the lead in promoting electronics R&D in China. Intel has opened a test and assembly plant in Chengdu, and Motorola is investing more than half a billion dollars in an R&D facility in Beijing. Leading Taiwanese firms, such as Foxconn Hon Hai Precision and Quanta, are doing the same. Chinese universities, too, have created links with institutes/universities abroad and are attempting to gain access to advanced technologies. The future of China's electronics industry lies in its ability to transform from a still relatively low-skilled, labor-intensive sector toward an IT-enhanced electronics manufacturing sector (Sigurdson 2005).

Conversely, India's shortcomings in both the private and public sectors have been marked by a strong reliance on imported technology and inadequate R&D. A shift from import-induced to R&D-induced technology would

30. Although Chinese companies are catching up, the principal exporters of the high-end electronics products, such as laptop computers and digital video discs, are Taiwanese companies (for example, FoxConn, Techfront, and Magnificent Brightness) (Branstetter and Lardy 2006).

31. Yang (2006) has predicted a further expansion of China's processing trade assisted by the International Technology Agreement, a part of the WTO accession. Yang, however, does not anticipate a shift of high-value components to China for some time. Foreign firms in China receive a tax exemption during their first two years and a 50 percent reduction of the full rate for three years due after the first profitable year. This is in contrast to Japan and the United States, where corporate tax rates are 42 percent and 35 percent (federal rate), respectively (Pecht and Chan 2004).

be beneficial for the electronics industry there. India is now, belatedly, attempting to overcome shortcomings by making significant concessions to export-oriented firms, and so has experienced an increase in exports. But liberalization is also leading to competition from imports and to a decline in profits across industry branches. The Indian electronics industry must now compete with China to gain a share of the gap left by the newly industrialized countries, all the while maintaining its lead in the export of electronics software.³²

Concluding Observations

This bird's-eye view of the Giants' industrial capabilities leads us to the following observations on the evolution of global industrial geography. First we observe that the rapid buildup of industrial capability in China across a wide range of subsectors is quite remarkable. It shows how the codification of technology; its diffusion through FDI and trade; and its harnessing by investment in human capital, plant and equipment infrastructure, and organizational skills have changed the rules of the game. Catching up and leapfrogging have become easier if countries have the policy determination and the ability to mobilize capital and build the infrastructure to generate skills. Second, larger countries do enjoy scale economies and are better placed to attract FDI and induce MNCs to transfer technology. China has achieved a commanding lead in major low-, medium-, and high-tech industries that it may be in a position to consolidate and enlarge over the next 15 years (Lall and Albaladejo 2004; Roland-Holst and Weiss 2005; and Devlin, Estevadeordal, and Rodríguez-Clare 2006). Although many complex capital goods, components, and products that are design and research intensive are likely to remain the preserve of the advanced countries, China's industrial strength could put pressure on manufacturing industries in middle- and low-income countries and force them to rethink, narrow, and focus their industrial ambitions. Survival in those economies will depend on achieving industrial and innovation capability that equals or exceeds China's. Innovation may drive competitiveness, and other countries must match or exceed China's own investment in its innovation system.

32. Signs that India is attracting the MNCs are supported by IBM's announced intention to invest \$6 billion in India and by the investment of \$3.9 billion by Microsoft, Intel, and Cisco ("IBM to Build" 2006).

India is likely to be a major force in the software, business processes, and consulting industries (including design and engineering services), competing not so much with such leaders as Germany, Japan, and the United States as with the mid-range and lower-end players (including China, which soon might enjoy an edge in terms of technical skills volume). India is certain to build manufacturing capability but, at least during the coming decade, there is only a slim prospect that it will emerge as a China-scale exporter of mass-produced consumer products in such key industries as electronics, autos, and auto parts. India more likely could become a force in certain kinds of engineering products and services that leverage its skill base, including software skills. India's many institutional bottlenecks, gaps in its infrastructure, and emerging shortages of skills will remain as drags on industrial advance ("India: Poor Infrastructure" 2006).

There is no doubt that China will be a formidable competitor for labor-intensive manufactures that depend on a semiskilled, disciplined, low-wage workforce for at least another decade, and if the domestic and international regulatory environment allows it, India can become a major competitor in this area as well.³³

The world market of manufactures and business services, however, is not going to be divided between China and India as the main suppliers while the rest of the world specializes in products based on natural resources and arable land. The world has not repealed the theory of comparative advantage. China's success in so many areas of manufacturing points to the forces that gradually are going to change China's competitive position. Wages in the coastal areas of China already are rising to a level sufficient to reduce the country's competitiveness at the labor-intensive end. Moving these plants to areas where wages are still low will postpone the day when China must abandon many of these sectors, but the rapid movement of workers to China's cities will raise incomes in the countryside and thereby will force up wages in the nation's interior as well. With the right policies, Indian low-wage manufacturers (along with those in other low-wage countries) may be major beneficiaries of China's rising wages, just as China benefited from the rapid increase in wages in Korea, Taiwan (China), and Hong Kong (China) over the past 20-plus years. Although India could become a major world exporter on the

33. Recent trends also suggest that the Giants could develop significant bilateral trade links as well (Wu and Zhou 2006).

scale of China and, over time, experience rapidly rising wages, that is not a realistic prospect in the next 10 years.

Finally, one must be careful not to assume that because China and India can produce hundreds of thousands of scientists and engineers each year, they soon will dominate the high end of all manufactures and services worldwide. Because the Giants are very large countries with rapidly expanding modern industrial and service sectors, they require a large number of engineers and scientists to staff a wide range of domestic activities. China and India will be able to create (and in some cases already have created) world-class research in the more advanced technologies, but they have the qualified personnel to do this in only limited areas.