Chapter 3

Diffusing and Absorbing Knowledge

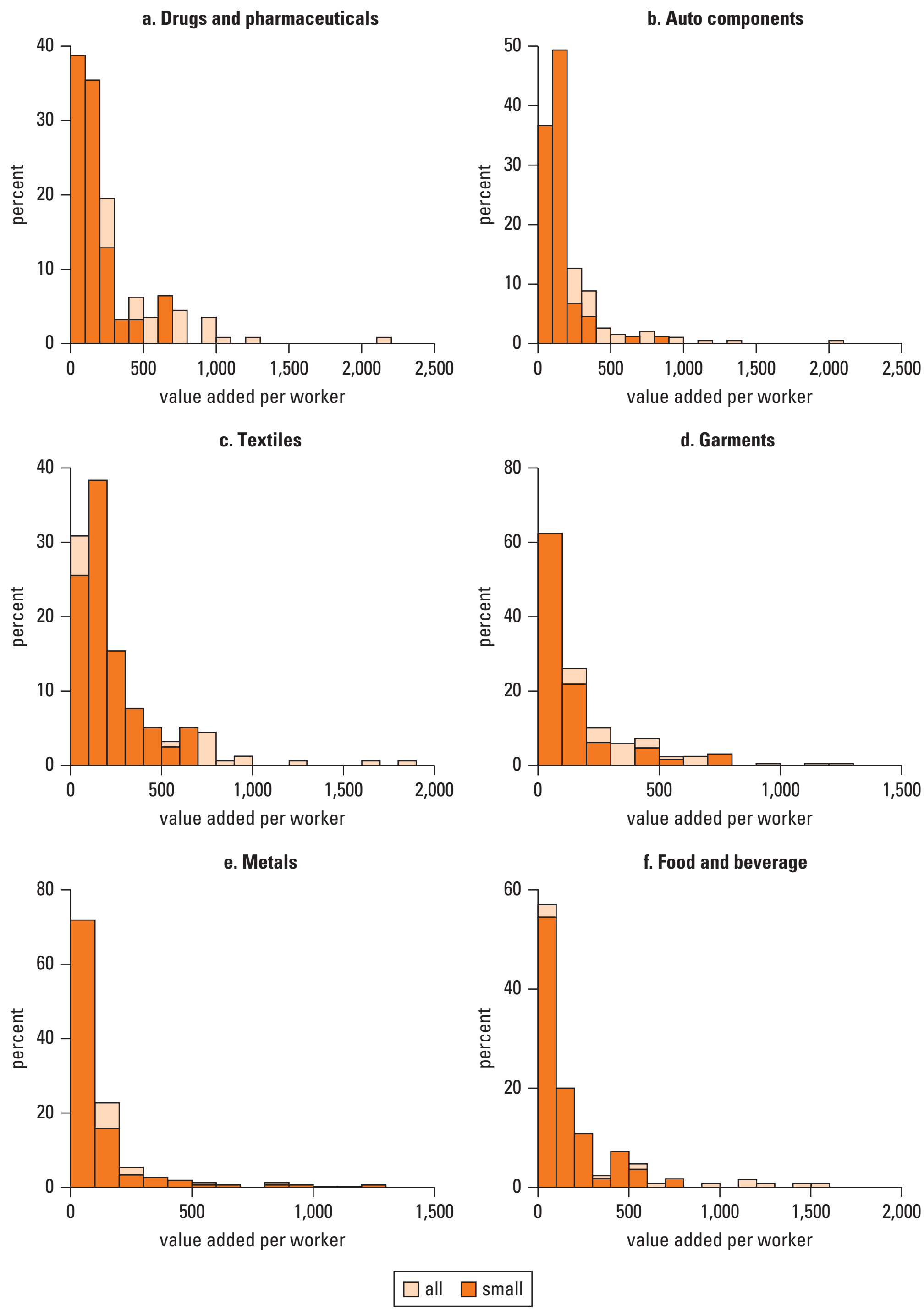
Vinod K. Goel, Carl Dahlman, and Mark A. Dutz

India could reap enormous productivity benefits if local and global knowledge were better dispersed to and absorbed by domestic enterprises. Since independence, India has invested heavily in creating an excellent science and technology infrastructure by emphasizing public research and development (R&D) institutions. But it has not done as well in absorbing the knowledge generated by this domestic R&D system. Moreover, India has not taken sufficient advantage of the potential diffusion of internationally available knowledge and technology resources, as well as local knowledge. As a result, the absorption of knowledge by most Indian enterprises has been low. Most of the knowledge that India needs to boost productivity has already been discovered and is being used elsewhere in the country or the world, but remains underused by domestic enterprises. The potential productivity gains from better diffusion and absorption are particularly promising among small firms, especially those in the informal sector—given that they typically are the least connected to knowledge about prevailing best practices.[1] The low productivity of most Indian enterprises relative to top local performers indicates the large potential gains from making better use of existing knowledge.

The skewed distribution of enterprise productivity by sector—with small enterprises lagging far behind top local performers—reflects the low absorption of existing knowledge by most, and especially small, enterprises. Productivity is a good proxy for how well enterprises use existing knowledge. Firms with higher productivity presumably have absorbed or developed superior production and management technology. As discussed in chapter 1, productivity dispersion across formal enterprises in Indian manufacturing is wide relative to comparator countries. However, given India's stark economic heterogeneity—with formal sector employment accounting for no more than 11 percent of total employment—productivity dispersion across both formal and informal enterprises is likely much wider.

Figure 3.1 shows the frequency distributions of all formal enterprises and small formal enterprises according to value added per worker in six of the sectors covered by the World Bank's 2006 Enterprise Survey. These sectors represent a typical mix of the

Figure 3.1 Distribution of Value Added per Worker in India, by Sector and Company Size, 2004
(thousand rupees)



Source: Compiled from India 2006 Enterprise Survey.
Note: US$1 = Rs 45 in 2004. Rs 500,000 = $11,100; Rs 1,000,000 = $22,200.

Indian economy. Most of the firms—and, overwhelmingly, small ones—tend to clump at the low (left) end of value added per worker, while just a few firms operate near the national technological frontier (right) end. Based on a very conservative estimate, the "adjusted" technological frontier is about five times the means in the different sectors for all firms.[2] For small formal enterprises, average productivity is much lower—with the technological frontier about 6.3 times the means, and average productivity roughly 15 percent of top local performers. Smaller informal enterprises are likely to be even less productive. Thus, absorption needs appear greatest among small enterprises, especially among the roughly 90 percent of the workforce in the informal economy.

The skewed distribution of enterprise productivity also reflects the potentially large productivity and output increases from diffusion and absorption of local and global knowledge. The difference between the mean productivity of most firms and that of firms with the highest productivity shows the gains that could accrue to the economy if all firms were producing at the level of local best practice. This analysis implies that the output of the Indian economy could be as much as 4.8 times higher if enterprises were to absorb and use the knowledge that already exists in the economy.[3] The absorptive needs of small enterprises and especially the informal part of the productive economy are even more significant, because their productivity is even lower. Additional efforts are needed to unleash the potential of informal enterprises (see chapter 4). Furthermore, the estimate of potential productivity gains is conservative, because it does not use the values of the most productive domestic firms operating in each sector. Moreover, local best practice is probably lower than global best practice. Thus, an economy such as India's could accrue even greater benefits if it were able to get all its firms to use techniques and knowledge closer to the global best practice of existing technology.

Spurring Enhanced Flows of Global Knowledge

The diffusion and absorption of market-relevant knowledge from abroad can occur through a number of complementary channels—including trade and foreign direct investment (FDI), direct trade of knowledge through technology licensing, and mobility of people (foreign education, foreign training of nationals, and knowledge flows driven by the diaspora, though only the last is addressed in this section).[4] The findings of a recent analysis of cross-country Enterprise Survey data—based on a sample of almost 18,000 enterprises in 43 countries—help put this section's focus on trade and FDI in perspective. There is a statistically significant, robust, positive correlation between trade and FDI and absorption as defined in this volume—namely, the acquisition of existing technologies and their adaptation to local conditions. Firms that import are more likely to absorb knowledge than firms that use only domestic suppliers, while firms that export are more likely to absorb knowledge than firms that sell only to the domestic market. In addition, firms with minority foreign participation are more likely to absorb knowledge than are domestically owned firms (see Almeida and Fernandes 2006).

Trade, Foreign Direct Investment, and Increased Openness

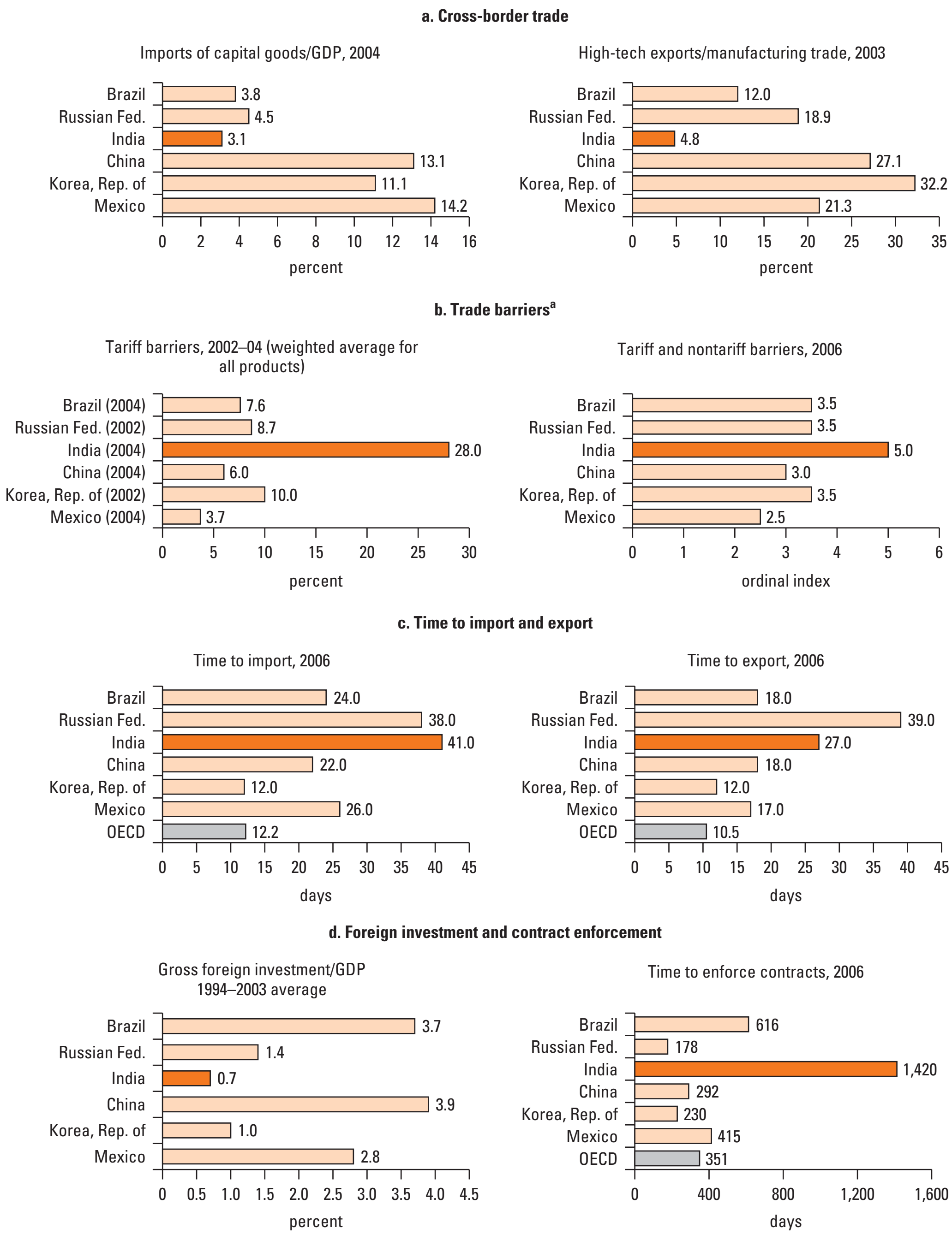
Trade and FDI openness are positively associated with innovation. Export orientation and foreign ownership are strongly and positively correlated in the India Enterprise Survey with developing new products as the output proxy for innovation. Export orientation is also positively associated with absorption of knowledge. The underlying transmission mechanisms are straightforward. Exposure to export markets both allows enterprises to learn about new technologies, new designs, and technical specifications through their interactions with foreign buyers, and provides an incentive—through enhanced rivalry—to upgrade technology more frequently. Foreign buyers also often provide technical assistance for the production of products that they want and that fit into their global supply chains.[5]

Similarly, importers can more easily upgrade technology by incorporating into their production processes state-of-the-art imported machinery, equipment, and other inputs that embody global knowledge. And to the extent that multinational corporations (MNCs) are endowed with more advanced technologies, they can transfer it to their subsidiaries through FDI. Recent research validates these benefits. For instance, in addition to the aforementioned research based on cross-country Enterprise Survey data, there is evidence that imports of intermediate inputs are positively correlated with enterprise and aggregate productivity, and that foreign knowledge embodied in imported inputs from countries with large R&D stocks has a positive effect on aggregate total factor productivity (TFP) in developing countries (see Kasahara and Rodriguez 2005; Lumenga-Neso, Olarreaga, and Schiff 2005; and Coe, Helpman, and Hoffmaister 1997).

On the export side, there is evidence of a learning-by-export effect (see Alvarez and Lopez 2005; Fernández and Isgut 2006). More broadly, there is cross-country evidence of a positive correlation between trade openness and the speed at which countries adopt new technologies and invest in R&D.[6] On FDI, there is India-specific evidence that foreign firms are more likely than domestic firms to absorb new technologies (see Vishwasrao and Bosshardt 2001). In addition, there is evidence from the United Kingdom that firms more integrated with global markets are more likely to innovate, largely by making better use of available scientists and researchers (Criscuolo, Haskel, and Slaughter 2005).

Although Indian enterprises have benefited from the significant liberalization of the past 15 years, the country needs to further open trade for its enterprises to benefit as much as do comparator countries. Imports of capital goods are an important way to access global knowledge. As highlighted in chapter 1, enterprises of all sizes in the India Enterprise Survey indicate that capital goods were the most frequent source for absorbing new knowledge. However, as can be seen in figure 3.2a, imports of capital goods relative to GDP are lowest in India among comparator countries: Brazil, the Russian Federation, China, the Republic of Korea, and Mexico. High-technology exports as a share of total manufactured exports (figure 3.2b) are also significantly lower in India than in comparator countries—preventing a large number of Indian enterprises from interacting with and learning from global buyers of more sophisticated products.

Figure 3.2 Openness to Global Flows of Products and Capital in Various Countries



Source: World Bank 2006a, 2006b.

Note: OECD = Organisation for Economic Co-operation and Development.

a. For the graphs in this section, the lower the number, the more open the trade regime to imports and exports.

The low share of imports is closely related to trade barriers that, while having been ratcheted down from liberalization efforts, remain higher relative to comparator countries. Although India has been liberalizing its trade barriers, comparator countries have been liberalizing theirs even more—giving their enterprises a competitive advantage relative to Indian enterprises in accessing global knowledge. As shown in figure 3.2c, tariffs in India remain three to almost eight times higher than in comparator countries, while combined tariff and nontariff barriers (figure 3.2d) are significantly higher.

India's low openness to foreign trade is also driven by procedural requirements and implementation obstacles for exporting and importing (figures 3.2e and 3.2f). Trading across borders is slow and complex in India, which is ranked 139th of 175 countries in trade costs for exporting and importing a standardized cargo of goods. In particular, India needs to improve the time needed to comply with import procedures, which at 41 days (requiring 15 separate documents for imports) stands in stark contrast to 22 days in China, 24 in Brazil, 38 in Russia, and 12 on average in OECD countries (World Bank 2006a).

India also needs to build on its increasing openness to FDI so that enterprises can benefit as much as possible from FDI-related knowledge flows. Reforms since the mid-1980s, and particularly since 1991, have liberalized India's FDI regime, with most sectors falling under the automatic route of 100 percent FDI being allowed since 2000. In recent years most FDI has gone to electrical equipment (electronics and information technology), telecommunications, transport (automobiles and automotive components), chemicals and pharmaceuticals, and the service sector (financial, information technology, and business process outsourcing services), with most recently a focus on the R&D side of these sectors.

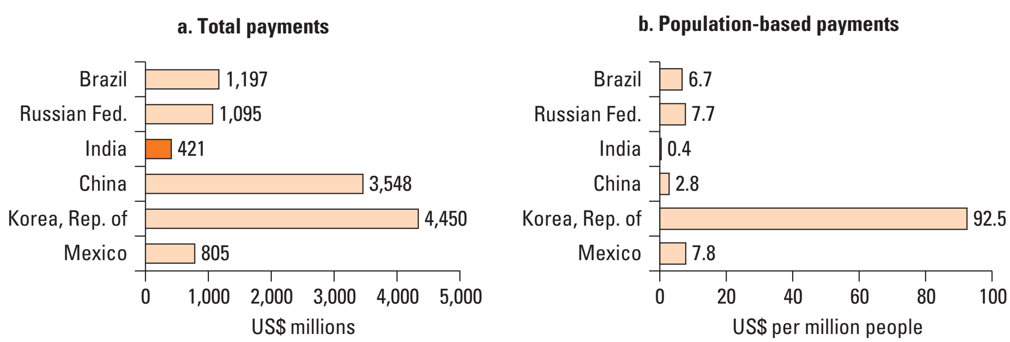
Despite these inflows, however, India continues to attract little FDI relative to comparator countries (figure 3.2g). Among the most prominent deterrents are infrastructure bottlenecks and cumbersome bureaucratic processes—including weak contract enforcement, which the government recognizes. Slow contract enforcement and inefficient courts are inimical to FDI because they create an uneven playing field and unpredictable environment that inhibit new entrants such as foreign investors and small businesses.[7] Of the 10 areas of everyday business measured by the World Bank's annual *Doing Business* report, this is where India lags behind. It is among the four countries worldwide with the longest court delays, at 1,420 days to enforce a contract (figure 3.2h). This is at least partly linked to India's abnormally high number of related procedures, at 56—compared with 31 in Russia and China, and 22 on average in OECD countries.

Further opening to trade and FDI would allow enterprises to gain more from global knowledge flows. A national innovation program and the opportunity for more Indian enterprises to benefit from global knowledge through greater openness in trade and FDI could provide a constructive context for further liberalization. A good starting point would be raising awareness of the economywide benefits from liberalization so far. Among the clearest of these benefits are the productivity increases and jobs created in information technology (IT) and IT-enabled services and business process outsourcing, and in sectors that have benefited from the most openness to free trade and FDI. Recommendations for increased trade integration include expediting trade liberalization, with short-run priorities including extending duty drawbacks on imported inputs for exporters, strengthening export promotion for increased entry into global supply networks, and reducing procedural requirements for both exporting and importing. Recommendations for increased FDI include opening the remaining eligible sectors to such investment and setting up a one-stop shop for foreign investors. Key policy actions affecting both trade and FDI include simplifying related bureaucratic procedures, along with improving the functioning of the court system to create faster, more predictable contract enforcement.

Intellectual Property Flows and Technology Licensing

Technology licensing is a key channel of domestic and global knowledge absorption, yet it is underused in India. The direct trade of knowledge through technology licensing and other agreements is another way to acquire domestic and global knowledge. Based on the India Enterprise Survey, licensing and turnkey operations from domestic and international sources are an uncommon way of acquiring new technologies: only 2.7 percent of enterprises cite this as their most important channel for absorbing technology—with 1.7 percent relying on domestic sources and 1.0 percent relying on international sources. Across all the enterprises in the sample, only 8.3 percent (predominantly medium and especially larger enterprises) reported paying royalties or license fees to domestic or foreign companies. According to aggregate figures on royalty and license fee payments, India lags comparator countries in both absolute levels and relative terms, having spent only $420 million in 2004—compared with $3.5 billion in China and $4.5 billion in Korea, translating to $0.4 per million people relative to $2.8 in China and $92.5 in Korea (figure 3.3).

Figure 3.3 Openness to Global Flows of Intellectual Property in Various Countries, as Measured by Royalty and License Fee Payments, 2004



Source: World Bank 2006b.

Box 3.1 Technology Licensing Contracts

Nonautomatic (licensing through government channel)

- Technology transfers where payments exceed the limits allowed under automatic approvals (see below)
- Technology collaborations in sectors not permitted under the automatic FDI route, cases involving reserved items by the Ministry of Small Scale Industries, and industrial licenses requiring government approval
- Payments for hiring foreign technicians; deputizing Indian technicians abroad; and testing indigenous raw materials, products, and indigenously developed technologies in foreign countries

The last category of payments is governed by separate Reserve Bank of India procedures and rules, and is not covered by the foreign technology collaboration approvals. Similarly, payments for imports of plant, machinery, and raw materials are not covered by foreign technology collaboration approvals.

Automatic approvals

- Lump-sum payments under $2 million
- Royalty payments limited to 5 percent for domestic sales and 8 percent for exports—subject to a total payment of 8 percent on sales over a 10-year period
- The period for payment of royalties cannot exceed 7 years from the commencement of commercial production or 10 years from the date of agreement (whichever is earlier).

Source: Authors.

Although regulations on technology transfer have been liberalized significantly, scope remains for reducing barriers to technology licensing contracts. Foreign technology transfers and collaborations are licensed under two channels. The more restrictive channel is through the government, which requires approvals from authorities (box 3.1). There is scope for significant liberalization in these categories, shifting most to the automatic channel. The second channel, automatic approvals (box 3.1), is less restrictive. However, here again, there is scope for considerable liberalization by raising or removing some of these limits, subject to a facilitation rather than a control approach.

The government should consider strengthening support infrastructure for technology licensing, including through the possible creation of a global technology acquisition fund. Innovation—especially absorption but also creation—requires access to extant intellectual property (IP) from established firms. The low current reliance by Indian enterprises on technology licensing, while partly due to weak local "innovate or perish" competition-type incentives, may also be due to market failures associated with information asymmetries, lack of knowledge of what technologies are available for licensing, where to tap them, how best to negotiate licensing terms, synergies from joint purchase and use of intellectual property, and the learning-by-doing nature of purchasing such technology rights or know-how.

As part of efforts to strengthen support infrastructure for technology licensing (including expansion of TIFAC's patent facilitation program, discussed in chapter 2), the government may wish to explore establishing a public-private technology acquisition fund (with minority public share) to support the acquisition of patents and other rights to early-stage technologies and related know-how to fill gaps in India's knowledge base. Such a fund could expedite commercialization of products where a particular piece of IP is missing locally but available internationally, reduce costs of acquiring the IP, and otherwise help create better (and cheaper) products for sale on global markets. By focusing on filling gaps in IP, this approach would not be picking winners but rather building on what IP is already locally known and available. By being structured as an autonomous public-private partnership, the fund would incite motivations parallel to those of the private sector. The fund would be a repository of both the skills to negotiate reasonable licensing and know-how acquisition terms from international holders of IP and the skills to devise appropriate payment structures for acquirers of it.[8]

Talent Flows and the Diaspora

India's diaspora provides an important opportunity for further tapping into global knowledge flows. About 2 percent of India's population (20 million people of Indian origin) lives abroad, earning roughly two-thirds of India's GDP (Kuznetsov 2006). India's high-tech diaspora is a unique, well-documented network that can take credit for some of India's high-tech success. Indians are among the most successful immigrant communities in U.S. history, with more than 2 million currently living in the United States. Some 200,000 Indian-American families are headed by millionaires, and the median annual income of U.S. residents of Indian origin is $60,093—much higher than the median U.S. income of $38,885 (Ministry of External Affairs 2004). Two-thirds of foreign-born Indian-Americans have university degrees—three times the figure for Americans as a whole. More than 20 percent of U.S. information technology firms were started by Indian immigrants, and about 44 percent of these immigrants hold managerial or professional positions. The diaspora has been active in helping India through remittances, networks, access to knowledge and markets, and other resources. The old "brain drain" problem has become a great "brain gain" opportunity.

The diaspora has had a significant impact as investors and mentors, catalysts for policy change, and direct sources of returning talent. Indian expatriates have played a critical role in spurring India's software and business process outsourcing boom.

These developments have led to a second crucial expatriate role, with Indian expatriates becoming senior executives at many major U.S. corporations—such as IBM, General Electric, Intel, Microsoft, Cisco, and American Express. In nearly every instance where these companies invested in or outsourced work to India, a well-placed expatriate executive crucially influenced the decision. In part, the individual's own success supported the emerging positive reputation of Indian engineers. And in part, the individual's direct experience with India gave that individual credibility in vouching that India's infrastructure and bureaucracy problems could be overcome.

In addition, some expatriates have returned to India for one to two years to supervise U.S. investments or outsourcing contracts, helping to train and manage to U.S. performance standards. Kanwal Rekhi, one of the founders of TiE (The IndUs Entrepreneurs, a global nonprofit network dedicated to advancing entrepreneurship), embarked on a well-publicized series of speeches and interviews in India in which he challenged the government and locals to pursue modernizing reforms. With the increasing FDI in India's IT and electronics industries, many Indian technology professionals have returned home. More than 30,000 technology professionals have returned to India since 2004 (Rai 2005). Their inducements include Western management practices and work cultures, liberal pay packages, and good career prospects, reinforced by a weak IT job market in the United States during 2001–04. Fresh Indian talent in many U.S. universities is also lured back to India. In 2005, of the 2,300 employees at General Electric's John F. Welch R&D Center in Bangalore, 700 were Indians who had returned in recent years. Most significantly, returning Indians routinely establish their own firms, rather than return to work for big multinational corporations or local firms.

The government could play a catalyzing role by strengthening the support infrastructure for diaspora knowledge initiatives. To help unleash the benefits of India's innovation potential, the government of India may wish to explore new initiatives that exploit the huge talent of the Indian diaspora. The public policy rationale of these initiatives is based on information asymmetries and uncaptured synergies from activities whose social benefits exceed their private ones. Activities could include joint research projects; spin-offs; short visits and seminars; assistance in formulating innovation strategies and methodologies; program design, implementation, and evaluation; institutional reviews; participation in teaching at management bodies of key institutions; mentoring; and liaisons with technology institutions and markets. To deliver on the promise of a diaspora-facilitated circle of economic growth and reform, a new generation of diaspora initiatives may be desirable. This could include establishing a more formal diaspora network (following the highly successful Global Scot, a network of 850 influential Scots abroad managed by the Scottish Enterprise), and building on existing groups that aggregate this population's talent and capital for use in India through a dedicated fund that could, among other activities, enrich innovation policy program and institutional design; enrich the management of scientific institutions and programs; provide teaching, consultancy, and mentoring resources for Indian innovators; and assist in the commercialization of Indian IP within India and abroad.

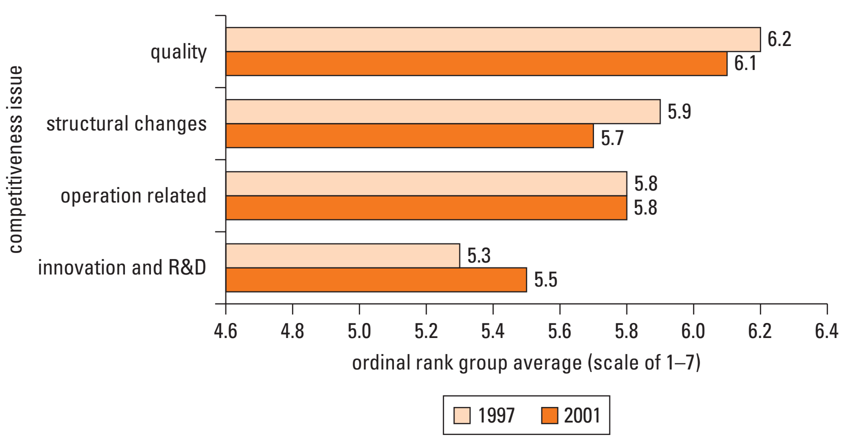
Improving the Diffusion and Absorption of Metrology, Standards, Testing, and Quality Services

Standards and quality are closely linked to innovation and productivity. Quality standards supported by a national metrology, standards, testing, and quality (MSTQ) system can contribute to enterprise competitiveness, innovation, and trade. They do so by improving information flows and allowing customer differentiation, thereby promoting quality and enhancing competition. Standards also embody technology, acting as a channel for technology diffusion and so enhancing productivity. The importance of metrology—especially with respect to trade—is fast increasing given increasing globalization and trade of subcomponents and services, making it more complex than traditional arm's-length transactions.

As reported in chapter 1, the World Bank's 2006 Enterprise Survey suggests a positive association between enterprises that have received an internationally recognized quality certification and available indicators of innovation outputs, such as developing new product lines and upgrading existing product lines. On the innovation input side, indicators of absorption—such as acquiring knowledge through the use of new machinery and equipment or seeking technology transfer through licenses—are also positively associated with having received quality certification. Innovation outputs in India, in turn, are positively associated with productivity. Beyond India, empirical studies based on international trade models find that harmonized or shared standards are trade promoting, while idiosyncratic national standards can create a competitive disadvantage for exporters. Evidence from other countries also suggests that standards can contribute to enterprise productivity.[9]

Quality is a key competitive priority for Indian enterprises. Surveys of Indian manufacturing enterprises highlight the strategies adopted to improve their competitiveness (Chandra and Sastry 2002). Figure 3.4 shows the relative importance given to four sets of issues by Indian firms over two surveys, conducted in 1997 and 2001.

Figure 3.4 Competitive Priorities of Manufacturing Enterprises, 1997 and 2001



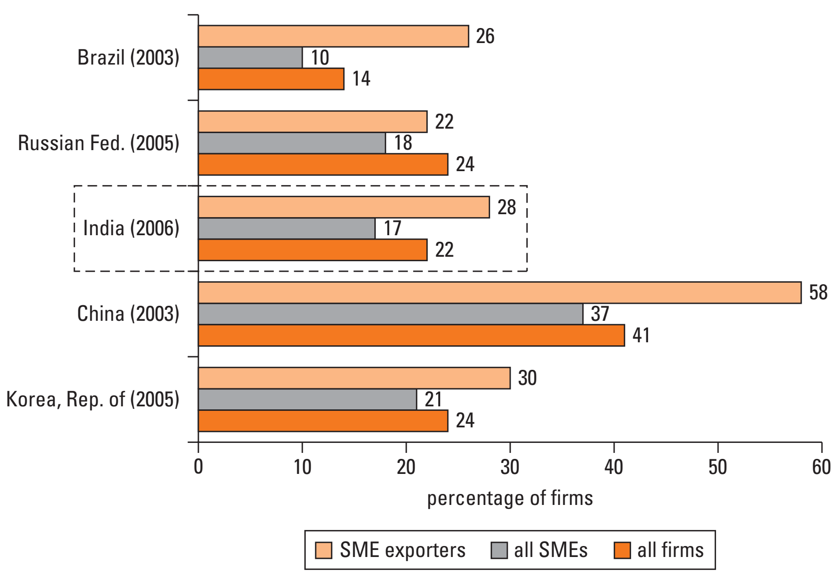
Source: Chandra and Sastry 2002.

Quality remains the top competitive priority of Indian firms. The priority assigned by firms to quality and structural changes (which include ability to change product mix, fast delivery capabilities, and low price capabilities) has increased since 1997—indicating that enterprises recognize the importance of making changes in manufacturing systems, processes, and practices to enhance competitiveness. But the priority that surveyed enterprises have assigned to invention and R&D has fallen since 1997. This has implications for long-term competitiveness because manufacturing needs to be backed by new product introductions and new processes, both domestically and in exports.

The absorption of quality in India and the use of its MSTQ system appear to be low relative to comparator countries. Figure 3.5 presents evidence from available comparator countries in response to World Bank Enterprise Survey questions about whether enterprises have received an internationally recognized quality certification (such as ISO 9000, 9002, or 14000, or sector-specific certifications such as those by the international food safety management entity Hazard Analysis and Critical Control Points). Results are reported controlling for differing percentages of small, medium, and large enterprises across surveys by weighting countries relative to India's size. For coverage of quality certification across all enterprises, India is in the middle of this group at 22 percent of enterprises, having adopted quality certification ahead of Brazil (14 percent), just behind Russia and Korea (both at 24 percent), but significantly below China (41 percent). Coverage of quality certification is lower across all countries by smaller enterprises.

Given the expected strong positive correlation between adopting internationally recognized quality certifications and exporting, and the stronger likelihood for larger

Figure 3.5 Enterprises with Internationally Recognized Quality Certification



Source: World Bank Enterprise Surveys.

Note: SME = small and medium enterprise.

firms to adopt such standards, results are also reported for small and medium exporters. Here, India's position at 28 percent of enterprises being certified is insignificantly different from those of Brazil (26 percent), Russia (22 percent), and Korea (30 percent)—but significantly below that of China (58 percent). Informal interviews conducted in preparing this volume support the implication of low absorption of quality in India—namely, that the use of MSTQ services, especially by smaller enterprises, is quite low. The reasons cited for low use include a lack of incentives in an insufficiently competitive environment in many sectors, low awareness about the benefits of MSTQ services, relative high costs and low availability of services economywide, outdated facilities, and a poor customer service orientation of main providers.

India's standards and quality system is serviceable but dominated by the public sector—and use by private enterprises is low. India has a fairly well-developed system of MSTQ institutions and regulations, meeting most international requirements. But some of its facilities are old (such as metrology and testing labs), and others lack adequate capacity (such as for accreditation and conformity assessments) to meet the needs of fast-growing, modernizing Indian enterprises:

- The National Physical Laboratory is the apex body in metrology and has good coverage in physical metrology. However, its labs are scattered in many old buildings, and in most cases have old equipment and lack adequate skilled staff.
- The Quality Council of India is an autonomous body responsible for establishing and operating the National Accreditation Structure for conformity assessment bodies. It also handles registration of quality management personnel and training organizations. But its coverage is not widespread: many testing and conformation bodies set up by various ministries are outside its mandate.
- The National Accreditation Board of Testing and Calibration Laboratories has more than 650 accredited calibration and testing laboratories in the public and private sectors.
- The Bureau of Indian Standards is engaged in the formulation of Indian standards, certification, and product testing. It is the inquiry point for the World Trade Organization (WTO) and training. Under the WTO, health, safety, and environmental regulations are the government's responsibility. However, several sectors are not under such regulation in India, such as telecommunications, toys, and fire safety equipment.

Taking into account the high potential for growth of smaller enterprises, as measured by productivity, output, employment, and exports, in 1999 the government created a special ministry that in 2001 was split into the Ministry of Small Scale Industries and the Ministry of Agro and Rural Industries. Box 3.2 presents some of the initiatives to promote quality supported by the Ministry of Small Scale Industries. However, as with government programs seeking to foster absorptive capacity, there is insufficient evidence on the reach, use, and effectiveness of these programs.

Box 3.2 Ministry of Small Scale Industries: Selected Metrology, Standards, Testing, and Quality Initiatives

Many countries have designated a nodal agency to coordinate government interventions to support small and medium enterprises (SMEs). In India, a separate "medium enterprises" sector is not defined. The Small Industries Development Organization, under the Ministry of Small Scale Industries, serves as India's nodal development agency for small enterprises. It focuses on providing support in the following areas:

- Technology and promotion, including MSTQ support and technology upgrading (see box 3.3)
- Marketing, including subcontracting exchanges, vendor development, bar coding, and participation in international fairs
- Entrepreneurship development, including training at national institutes and entrepreneurship development courses
- Promotion of self-employment, including a program for unemployed youth sponsored by the Ministry of Agro and Rural Industries
- Infrastructure, including upgrading of industrial estates
- Facilitation, including product reservation, SENET (Small Enterprise Information and Resources Network for Electronic Information support), incentives for backward areas, and national awards for entrepreneurship and quality.

Quality-related support and promotion schemes by the Small Industries Development Organization include the following:

- *Testing centers.* Four regional testing centers (New Delhi, Mumbai, Kolkata, Chennai) and seven field testing stations (Jaipur, Hyderabad, Kolhapur, Pondicherry, Bhopal, Bangalore, Chenganacherry) provide enterprises with quality-related testing services, calibration services (including those covered under ISO 9000, to meet their mandatory requirements), and assistance in meeting export-related quality requirements. The centers and stations also provide training in testing and calibration to strengthen worker skills, and coordinate with the Bureau of Indian Standards and other technical testing and inspection organizations on matters related to standardization of products for small enterprises. The four regional testing centers have been accredited by the National Accreditation Board of Testing and Calibration Laboratories. Their performance over the past five years has been relatively stable, achieving 65–70 percent self-sufficiency each year. The performance of the field testing stations improved during this period, with the self-sufficiency ratio rising from 67 percent in 2001–02 to 88 percent in 2005–06 (and reaching 93 percent in 2004–05).
- *Testing laboratories run by associations of the Ministry of Small Scale Industries.* A scheme initiated in 2001 helps establish testing centers for industry associations and modernize and expand quality marking centers for state governments. The scheme provides matching grants of 50 percent (up to Rs 50 lakh, about $120,000) to set up the centers.

(continued)

Box 3.2 continued

- *ISO 9000 awareness program.* This is a one-day program of awareness and five-day motivational and educational program on total quality management and the ISO 9000 total quality system, organized by Training Resource Centers and Small Industries Service Institutes (see box 3.3). As a result of the programs, the number of small enterprises availing themselves of the benefits of reimbursement increased from 122 through the end of Eighth Plan to 1,384 through March 2001.
- *Incentive scheme for ISO 9000 and ISO 14001 certifications.* This scheme reimburses charges for acquiring ISO quality management and environmental management certification, covering 75 percent of the costs (up to Rs 75,000, about $1,800).
- *National awards for quality products.* Annual awards are given to encourage small-scale entrepreneurs to upgrade the quality of their products, develop new technologies and designs, and deliver technological improvements. The first, second, and third prizes carry (besides a trophy and certificate) cash awards of Rs 25,000, Rs 20,000, and Rs 15,000, respectively, or between $350 and $600. The awards are given to entrepreneurs in each applicant state or Union Territory.

Source: Authors, based on information at http://ssi.nic.in/.

India should modernize its MSTQ infrastructure to international standards to meet the needs of its growing economy. The government should undertake the following:

- Review the functioning of all MSTQ programs, including their governance and management structures and effectiveness—with a view to improving their operational effectiveness and maximizing synergies between initiatives sponsored by various line ministries, with a focus on the Ministry of Small Scale Industries.
- Increase industry awareness of MSTQ services and their importance, including through better interaction with industry organizations and incentives (such as matching grants) for SMEs to use MSTQ services and obtain national and ISO certifications.
- Create a world-class metrology infrastructure (separating it from the National Physical Laboratory) with state-of-the-art metrology laboratories, including modern buildings and equipment, and upgraded staff skills. This move should be accompanied by specialized metrology capabilities developed in existing national labs—such as food-related metrology at the Central Food Technological Research Institute and biology metrology at the Centre for Cellular and Molecular Biology.
- Strengthen other MSTQ institutions such as the Quality Council of India, accreditation boards, and other bodies.

- Increase private participation in testing and accreditation labs. Most government accreditation and testing labs should be considered for privatization or at least private management.
- Review areas under regulation to identify uncovered sectors—for example, toys and health services have almost no standards regulations, yet affect a huge part of the Indian population.
- Consider bringing under the purview of the Quality Council of India many accreditation programs set up and managed by various ministries, to foster national consistency and avoid conflicts of interest.
- Encourage and support participation by Indian scientists and MSTQ personnel (public and private) in international technical committees, working groups, workshops, and seminars.

Strengthening the Absorptive Capacity of Micro, Small, and Medium Enterprises

A useful way to help less-productive enterprises better absorb knowledge is to create an environment where they can learn from more productive firms. Larger firms tend to be better at absorbing knowledge and are more likely to have innovative outputs (see chapter 1). Of course, it is not realistic to expect all Indian firms to operate at the level of more efficient, typically larger firms. Constraints include the skills and education of managers; skills of workers; age and technological vintage of firm equipment and processes; access to capital, information, and other inputs; and access to customers and marketing strategies. Enterprises need to have the capacity to search for appropriate knowledge, evaluate different technologies, modify off-the-shelf technologies for use, and integrate these new technologies into their production processes.

These are not easy tasks, especially for smaller enterprises lacking established buyer-seller networks. Among other factors, a dense network of links to larger (foreign or domestic) enterprises may be a critical prerequisite for the emergence of dynamic smaller enterprises. A business environment that facilitates commercial transactions for all firms—large and small—and helps build links with other smaller enterprises and with dynamic larger enterprises as qualified suppliers appears important for promoting better economywide knowledge absorption.

Although the government has introduced a range of programs to promote technology absorption by smaller enterprises, including support for cluster development, no quantitative analysis exists on their effectiveness. The policies, programs, and schemes administered by the Ministry of Small Scale Industries to help small enterprises link up with large ones—to increase productivity and competitiveness—include a number of technology initiatives to help them assess options and receive support for upgrading technology.[10] As a key strategy for enhancing the productivity and competitiveness of small enterprises, the ministry is supporting cluster development as part of its new Small Industries Cluster Development Program. The idea behind the cluster approach is not to pick winners but rather to support enterprises that show market potential. Thus, the selection of clusters requires evidence on the viability of the cluster and the vibrancy of local support institutions, together with the existence of gaps in technology, product quality, common facilities, skills upgrading, and marketing support. Although this program—and a range of others described in box 3.3—seem to be addressing relevant needs, spending by the Small Industries Development Organization on technology upgrading seems small relative to economywide needs. More important, systematic and independent assessments of each program should be undertaken to offer recommendations for scaling up or downsizing.

The absorptive capacity of smaller enterprises should be further strengthened, among other ways, by expanding support programs—but only after their effectiveness has been ascertained. TIFAC and the Ministry of Small Scale Industries recently initiated a joint, cross-ministerial program for upgrading selected SME clusters, with

Box 3.3 Ministry of Small Scale Industries: Selected Technology Upgrading Initiatives

The ministry's technology support includes a variety of mechanisms to provide enterprises with information and support about technology options:

- *Tool rooms and tool design institutes.* To help enterprises upgrade their technology, the Small Industries Development Organization has set up 10 facilities equipped with the latest imported equipment—such as for computer-aided design (CAD), computer-aided manufacturing (CAM), and computer numerically controlled (CNC)—as well as other tools meeting international standards.
- *Product and process development centers.* Six facilities for different industries (such as fragrance and flavor development, glass, electronics, and design of electrical measurement instruments) advise enterprises on how to improve quality and productivity through R&D, product design, product and process improvements, and common facilities.

Technology promotion schemes include the following:

- *Small Industries Cluster Development Program.* Launched in 2005, this program (formerly the Integrated Technology Upgrading and Management Program) addresses the productivity concerns of small enterprises, and applies to any cluster where there are common production methods among enterprises. The program includes a technology diagnostics and needs study, scouting for appropriate technologies, facilitation of research to adapt available technology, intervention at one enterprise so nearby enterprises can see and feel the impact of technology upgrading, training, and dissemination. The Ministry of Small Scale Industries does not contribute more than 80 percent of the total cost of any cluster project, up to a

(continued)

Box 3.3 continued

ceiling of Rs 10 crore ($240,000) per project. The pioneering enterprise has to bear 50 percent of the costs of setting up the demonstration plant.

- *Technology Resource Centers.* In 2001, 21 Small Industries Service Institutes were converted into technology resource centers to help enterprises that want to upgrade their technology, by providing information about state-of-the-art technology, lists of machine suppliers, quality standards and consultants, and Internet access to electronic journals, catalog downloads, and advanced search facilities, as well as organizing technical training programs.
- *Mini tool rooms and training centers.* The central government assists state governments through 90 percent grants for machinery and equipment costs for new mini tool rooms and 75 percent grants for upgrading existing mini tool rooms. Mini tool rooms and training centers help enterprises gain access to required tools to absorb new technologies, provide training in tool design, provide consultancy and information to solve problems related to tooling, and act as common facilities to assist enterprises in product and prototype development.
- *Technology Bureau for Small Enterprises.* This bureau provides technology information (online databases on technology options), match-making (networking and assistance in drafting agreements and preparing business plans), finance syndication (loans, venture capital, and interest-free loans to meet initial expenditures in the pretechnology absorption stage), and business collaboration (support for exporting technologies), as well as support services (arranging consultancy services and visits of overseas experts, and coordinating buyer-seller meetings). The bureau is a joint initiative between the United Nations Asian and Pacific Center for Transfer of Technology, the Small Industries Development Bank of India, and the Small Industries Development Organization.
- *Credit-Linked Capital Subsidy Scheme for technology upgrading.* This scheme aims to facilitate technology upgrading by providing upfront capital subsidies to small enterprises for modernizing their production equipment and techniques. The ceiling on loans is Rs 1 crore ($24,000), and the subsidy rate is 15 percent. The Small Industries Development Bank of India and the National Bank for Agriculture and Rural Development are the nodal agencies for the scheme's implementation.

Source: Authors, based on information at http://ssi.nic.in/.

the goal of making them globally competitive.[11] One direction for further programmatic reform is to explore collaboration through public-private partnerships with universities, labs, and private corporations, to help ensure that knowledge provided to local SME clusters is constantly refreshed, reflects international best practice, and is as market-driven as possible. Such programmatic support should also be linked with complementary initiatives to build appropriate skills and education, to ensure more effective absorption.[12] However, when deciding which programs to expand and which to downsize or close, quantitative assessments of their reach, use, and effectiveness are essential. This should be a short-term priority. Based on such evaluations, programs that appear effective could be candidates for expansion, while ineffective programs should be discontinued, with funds reallocated flexibly across programs depending on periodic reassessments of their effectiveness.

Notes

For questions or further information, please contact Vinod K. Goel (vgoel@worldbank.org), Mark A. Dutz (mdutz@worldbank.org), or Carl Dahlman (carl.dahlman@gmail.com)

1. To be aligned as closely as possible with "small-scale industrial undertakings"; as defined by the Ministry of Small Scale Industries, small enterprises are defined here as those employing 15 or fewer workers. Although small-scale industries are defined according to assets (for example, where investment in fixed assets in plants and machinery does not exceed Rs 10 million), average employment per unit in urban areas is 10 staff, with urban beverage and tobacco producers leading with 31, followed by textile producers at 18, and basic metal industries at 13.
2. To reduce false readings from poor data, the top and the bottom 1 percent have been dropped from the sample. An "adjusted" maximum was then calculated for each sector, at the point where the distribution begins to look more like a normal distribution; these "adjusted" frontiers are roughly 60 percent of the actual maximums.
3. This point is just to illustrate the importance of using existing knowledge. It is unrealistic to expect that all firms could operate even at the level of the better domestic firms. Getting to those higher levels would require investments in physical, human, and management capital that are not costless. In addition, it cannot be assumed that output could be almost quintupled and that it could be sold, or that all workers would remain employed if there were such tremendous increases in productivity.
4. This section focuses on direct knowledge flows to enterprises engaged in international activities, not the subsequent spillovers to other local enterprises through demonstration effects, labor turnover, or copying and reverse engineering.
5. See Westphal, Rhee, and Purcell (1981) on how important this was for upgrading technology for firms in the Republic of Korea.
6. See Comin and Hobijn (2004) on the former, Lederman and Maloney (2003) on the latter.
7. Figure 10.1 in *Doing Business 2007* (World Bank 2006a) shows the negative correlation between FDI and time to enforce a contract. Qian and Strahan (2006) find that small businesses get better financial terms on loans when contracts can be enforced quickly and cheaply. Cooley, Marimon, and Quadrini (2004) find that new technologies are adopted faster when courts are efficient, because new businesses—as the predominant innovators—do not have the clout that larger firms do to resolve disputes outside the courts.
8. For instance, rather than structuring payments as burdensome upfront, prelaunch start-up costs, allow payments through equity or from future revenue streams from use of the technology.
9. Swann, Temple, and Shurmer (1996) find that standards have a positive effect on intra-industry trade exports and imports between Germany and the United Kingdom. Adopting 100 additional British standards raises the U.K. export/import trade ratio by roughly 14 percent. Blind and Jungmittag (2005) find that specifically harmonized standards enhance German trade. Regarding the productivity link, DTI (2005) reports that standards contributed to roughly 13 percent of the growth in labor productivity in the United Kingdom between 1948 and 2002.
10. See www.smallindustryindia.com/thrustareas/technology.htm.
11. Seven sectors have been identified for initial detailed assessments: casting, sporting goods (Jalandhar, Punjab), scientific instruments (Ambala, Haryana), rural pottery, low-end surgical instruments (Kolkata), diesel pumps and electrical motors (Rajkot, Gujarat), and agricultural tools (Karnal, Haryana). The studies will assess technology products and processes in each

sector relative to international best practice, identify gaps (use of new materials, skill deficiencies, market requirements and competition, and availability and use of existing programs and initiatives), and suggest possible interventions to bridge identified gaps, including involvement of academia or R&D institutions.

12. See complementary recommendations in chapter 5.

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