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# India
# India and the Knowledge Economy
# Leveraging Strengths and Opportunities

April 2005

World Bank Finance and Private Sector Development Unit
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**CURRENCY EQUIVALENTS**
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**Rs. 1 crore = Rs. 10 million**

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(All dollar amounts in this report are U.S. dollars, unless otherwise noted.)

## Abbreviations and Acronyms

| | |
|---|---|
| AFR | Africa Region |
| AIDS | acquired immune deficiency syndrome |
| ASEAN | Association of South East Asian Nations |
| BOP | Bottom of the pyramid |
| BPO | business process outsourcing |
| CBFL | computer-based functional literacy |
| CII | Confederation of Indian Industry |
| CSIR | Council of Scientific and Industrial Research |
| DAI | Digital Access Index |
| EIU | Economic Intelligence Unit |
| EU | European Union |
| FDI | foreign direct investment |
| FICCI | Federation of Indian Chambers of Commerce and Industry |
| GATS | General Agreement on Trade in Services |
| GCI | Growth Competitiveness Index |
| GDP | gross domestic product |
| GE | General Electric |
| GER | gross enrollment ratio |
| GERD | gross expenditures on R&D |
| GNI | gross national income |
| GSDP | gross state domestic product |
| HDI | Human Development Index |
| HIV | human immunodeficiency virus |
| HLSG | High-Level Strategic Group |
| ICS | Investment Climate Survey |
| ICT | information and communications technology |
| IFC | International Finance Corporation |
| IIT | Indian Institutes of Technology |
| IP | Internet Protocol |
| IPR | intellectual property rights |
| ISI | Information Society Index |
| ISP | Internet service provider |
| IT | information technology |
| ITES | Information technology–enabled services |
| ITU | International Telecommunications Union |
| K4D | Knowledge for Development |

| | |
|---|---|
| KAM | Knowledge Assessment Methodology |
| KE | knowledge economy |
| KEI | Knowledge Economy Index |
| MDG | Millennium Development Goal |
| MNC | multinational corporation |
| NASSCOM | National Association of Software and Services Companies |
| NIIT | National Institutes of Information Technology |
| NGO | nongovernmental organization |
| NITs | National Institutes of Technology |
| NRI | Networked Readiness Index |
| OECD | Organisation for Economic Cooperation and Development |
| PC | personal computer |
| PPP | purchasing power parity |
| R&D | research and development |
| REC | regional engineering college |
| RSE | research scientists and engineers |
| S&T | science and technology |
| SA | South Asia Region |
| SME | small and medium enterprise |
| TFP | total factor productivity |
| TNC | transnational company |
| TRAI | Telecoms Regulatory Authority of India |
| UGC | University Grants Commission |
| UNDP | United Nations Development Programme |
| USPTO | United States Patent and Trademark Office |
| VSNL | Videsh Sanchar Nigam Limited |
| WEF | World Economic Forum |
| WTO | World Trade Organization |

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# INDIA AND THE KNOWLEDGE ECONOMY

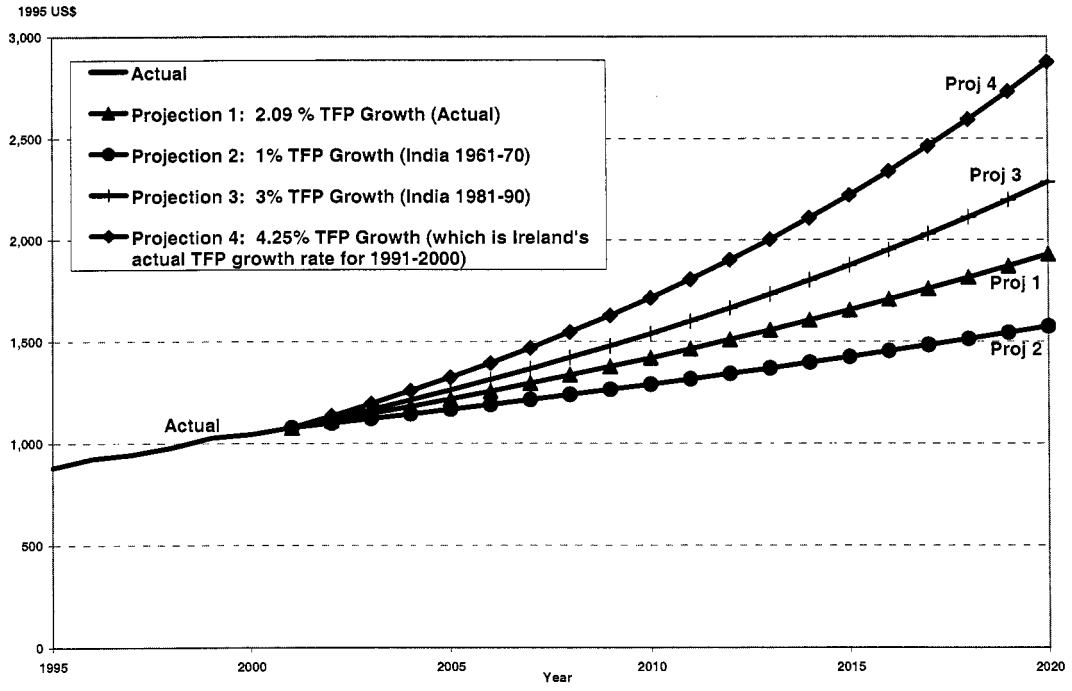
## *LEVERAGING STRENGTHS AND OPPORTUNITIES*

### EXECUTIVE SUMMARY

One of the world's largest economies, India has made tremendous strides in its economic and social development in the past two decades and is poised to realize even faster growth in the years to come. After growing at about 3.5 percent from the 1950s to the 1970s, India's economy expanded during the 1980s to reach an annual growth rate of about 5.5 percent at the end of the period. It increased its rate of growth to 6.7 percent between 1992–93 and 1996–97, as a result of the far-reaching reforms embarked on in 1991 and opening up of the economy to more global competition. Its growth dropped to 5.5 percent from 1997–98 to 2001–02 and to 4.4 percent in 2002–03, due to the impact of poor rains on agricultural output. But, thanks to a lavish monsoon that led to a turnaround in the agriculture sector, India's economy surged ahead to reach a growth rate of 8.2 percent in 2003–04. This is very much in line with growth projections cited in India's Tenth Five-Year Plan, which calls for increasing growth to an average of 8 percent between 2002–03 and 2006–07 (India, Planning Commission, 2002e). Such sustained acceleration is needed to provide opportunities for India's growing population and its even faster-growing workforce.

*Embarking on a new growth path.* India has a rich choice set in determining its future growth path. Figure A shows what India can achieve by the year 2020, based on different assumptions about its ability to use knowledge, even without any increase in the investment rate. Here, total factor productivity (TFP) is taken to be a proxy for a nation's learning capability.

**Figure A: India: Real Gross Domestic Product Per Worker, Alternative Projections, 1995–2020**




*Note:* For all four projections, capital, labor, and human capital are assumed to grow at their 1991–2000 average annual growth rates for India, that is, 5.41, 2.23, and 0.58 percent, respectively. For the growth-TFP decomposition to be more precise, labor

force figures rather than total population are used as a measure of the amount of "labor" available for use as a factor of production in the Indian economy. According to World Bank databases, in 2001 India's GDP (in 1995 U.S. dollars) was $495 billion and its population was 1.03 billion, of which only 461 million were in the labor force. As such, India's GDP per capita in 2001 was approximately $480, whereas GDP per worker was around $1,070. Annex 1 provides the theoretical framework for these TFP projections.
*Source:* Knowledge for Development Program.

Projections 1, 2, 3, and 4 plot real gross domestic product (GDP) per worker (1995 U.S. dollars) for India assuming different TFP growth rates from 2002 to 2020. Projection 4 is an optimistic scenario which is based on the actual TFP growth rate in Ireland in 1991-2000. Ireland is an example of a country that has been using knowledge effectively to enhance its growth. All things being equal, the projected GDP per worker for India in scenario 4 in 2020 is about 50 percent greater than in scenario 1. Knowledge can make a difference between poverty and wealth.

Which growth path India embarks on in the future will depend on how well the government, private sector, and civil society can work together to create a common understanding of where the economy should be headed and what it needs to get there. India can no doubt reap tremendous economic gains by developing policies and strategies that focus on making more effective use of knowledge to increase the overall productivity of the economy and the welfare of its population. In so doing, India will be able to improve its international competitiveness and join the ranks of countries that are making a successful transition to the knowledge economy.

*Embracing the knowledge economy:* The time is very opportune for India to make its transition to the knowledge economy—an economy that creates, disseminates, and uses knowledge to enhance its growth and development. The knowledge economy is often taken to mean only high-technology industries or information and communication technologies (ICTs). It would be more appropriate, however, to use the concept more broadly to cover how any economy harnesses and uses new and existing knowledge to improve the productivity of agriculture, industry, and services and increase overall welfare. In India, great potential exists for increasing productivity by shifting labor from low productivity and subsistence activities in agriculture, informal industry, and informal service activities to more productive modern sectors, as well as to new knowledge-based activities—and in so doing, to reduce poverty and touch every member of society. India should continue to leverage its strengths to become a leader in knowledge creation and use. To get the greatest benefits from the knowledge revolution, the country needs to press on with the economic reform agenda that it put into motion more than a decade ago and continue to implement the various policy and institutional changes needed to accelerate growth.

*Advantage India.* India has many of the key ingredients for making this transition. It has a critical mass of skilled, English-speaking knowledge workers, especially in the sciences. It has a well-functioning democracy. Its domestic market is one of the world's largest. It has a large and impressive Diaspora, creating valuable knowledge linkages and networks. The list goes on: macroeconomic stability, a dynamic private sector, institutions of a free market economy, a well-developed financial sector, and a broad and diversified science and technology (S&T) infrastructure. In addition, the development of the ICT sector in recent years has been remarkable. India has created profitable niches in information technology (IT) and is becoming a global provider of software services. Building on these strengths, India can harness the benefits of the knowledge revolution to improve its economic performance and boost the welfare of its people.

This report provides a "big picture" assessment of India's readiness to embrace the knowledge economy and highlights some of the key constraints and emerging possibilities confronting India on four critical pillars of the knowledge economy:

- Strengthening the economic and institutional regime
- Developing educated and skilled workers
- Creating an efficient innovation system
- Building a dynamic information infrastructure.

The report highlights that to be competitive in the global knowledge economy of the twenty-first century, India should continue to focus its efforts on further reforming its overall economic and institutional environment and improve its overall trade and investment climate. Addressing issues in this domain will be key, because it sets the overall incentive framework needed to improve performance across the economy. The report further underlines that for India to leverage its strengths and opportunities on a global scale, it needs to undertake significant reforms and investments in building education and skills, strengthening its innovation system, and further bolstering its information infrastructure. To create and sustain an effective knowledge economy, India must undertake systemic integration of reforms in the above four domains to strengthen its competitive advantage.

The following are some of the key issues that India needs to address in each of the four pillars to spur growth and innovation and, in so doing, increase economic and social welfare.

**Strengthening the Economic and Institutional Regime**

Taking advantage of the knowledge revolution's potential hinges on effective economic incentives and institutions that promote and facilitate the redeployment of resources from less efficient to more efficient uses. This fundamental pillar of the knowledge economy provides the overall framework for directing the economy. Important elements of the economic and institutional regime include macroeconomic stability, competition, good regulatory policies, and legal rules and procedures conducive to entrepreneurship and risk taking. A key feature is the extent to which the legal system supports basic rules and property rights.

India's economic and institutional regime has several strengths: flourishing entrepreneurship and free enterprise; a strong infrastructure for supporting private enterprise; capital markets that operate with greater efficiency and transparency than, for example, those in China; an advanced legal system; and an independent judiciary. Property rights are fairly secure, and the protection of private ownership is strong. The rule of law generally prevails. Corporate governance has also improved dramatically.

India has other intrinsic advantages, such as macroeconomic stability, a large domestic market, and a large and relatively low-cost and skilled workforce. It also has a critical mass of well-educated workers in engineering and science and, unlike China, abundant raw materials. All this should allow the country to emerge as a major hub for manufacturing and service industries.

Despite India's recent economic growth, a number of barriers exist, such as the multiplicity of regulations governing product markets, distortions in the market for land, and widespread government ownership of businesses that have been inhibiting GDP growth, according to some estimates by about 4 percent a year. Removing these barriers and fostering a stronger investment climate would allow India's economy to grow as fast as China's—10 percent a year—and create some 75 million new jobs outside agriculture.

India is still a relatively closed economy compared with other Asian economies, in which exports account for a much larger share of GDP (33 percent in China and 38 percent in Korea, compared with only 15 percent in India in 2003). Although this means that India is somewhat protected from global trends, the downside is that it does not benefit from stronger foreign competitive pressures to improve performance or from the ability to draw on more cost-effective foreign inputs, such as capital goods, components, products, or foreign investment, which embody more advanced knowledge. As a result, India is losing market share to its major competitors, especially China, where reforms have moved ahead much more

rapidly; therefore, to speed up trade reform and be able to export, Indian firms need to be allowed to import the materials and technology they need.

India also needs to boost foreign direct investment (FDI), which can be a facilitator of rapid and efficient transfer and cross-border adoption of new knowledge and technology. FDI flows to India rose by 24 percent between 2002 and 2003, due to its strong growth and improved economic performance, continued liberalization, its market potential, and the growing competitiveness of Indian IT industries. Even so, in 2003, India received $4.26 billion in FDI, compared with $53.5 billion for China! But India's stock is rapidly rising: the 2004 *Foreign Direct Investment Confidence Index* by A. T. Kearney (2004) shows that China and India dominate the top two positions in the world for most positive investor outlook and likely first-time investments, and are also the most preferred offshore investment locations for business process outsourcing (BPO) functions and IT services.

Successful economic development is a process of continual economic upgrading in which the business environment in a country evolves to support and encourage increasingly sophisticated ways of competing. A good investment climate provides opportunities and incentives for firms—from microenterprises to multinationals—to invest productively, create jobs, and expand. As a result of investment climate improvements in the 1980s and 1990s, private investment as a share of GDP nearly doubled in China and India. But, India needs to continue to foster a good investment climate that encourages firms to invest by removing unjustified costs, risks, and barriers to competition. One reason for India's less competitive markets is excessive regulation of the entry and exit of firms, which face stiffer requirements for obtaining permits and take much longer to get under way than do the firms in many other countries. Restrictions on the hiring and firing of workers are also a major obstacle to doing business in India. In addition, enforcing contracts is a major problem: for example, it takes more than a year to resolve a payment dispute.

So, to strengthen its overall economic and institutional regime, India should continue to address the following related to its product and factor markets and improving its overall infrastructure:

- Speeding up trade reform by reducing tariff protection and phasing out tariff exemptions. This will help Indian firms gain access to imports at world prices and would also help to encourage exports further.
- Encouraging FDI and increasing its contribution to economic growth by phasing out remaining FDI restrictions and increasing positive linkages with the rest of the economy.
- Stimulating growth of manufactured and service exports. In so doing, India could drive down global costs in services, just as China drove down global costs in manufacturing.
- Strengthening intellectual property rights (IPRs) and their enforcement. India has passed a series of IPR laws in the past few years, and their enforcement will be key to its success in the knowledge economy.
- Simplifying and expediting all procedures for the entry and exit of firms, for example, through "single window" clearances.
- Reducing inefficiencies in factor markets by easing restrictions on hiring and firing of workers.
- Improving access to credit for small and medium enterprises.
- Addressing problems in the use and transfer of land and updating bankruptcy procedures.
- Ensuring access to reliable power at reasonable cost by rationalizing power tariffs and improving the financial and operational performance of state electricity boards.
- Addressing capacity and quality constraints in transport by improving public sector performance and developing speedy, reliable door-to-door transport services (roads, rail, and ports) to enhance India's competitiveness.

- Improving governance and the efficiency of government, and encouraging the use of ICTs to increase government's transparency and accountability.
- Using ICTs for more effective delivery of social services, especially in health and education, empowering India's citizens to contribute to and benefit from faster economic growth.

### Developing Educated and Skilled Workers

Education is the fundamental enabler of the knowledge economy. Well-educated and skilled people are essential for creating, sharing, disseminating, and using knowledge effectively. The knowledge economy of the twenty-first century demands a new set of new competencies, which includes not only ICT skills, but also such soft skills as problem solving, analytical skills, group learning, working in a team-based environment, and effective communication. Once required only of managers, these skills are now important for all workers. Fostering such skills requires an education system that is flexible; basic education should provide the foundation for learning, and secondary and tertiary education should develop core skills that encourage creative and critical thinking. In addition, it is necessary to develop an effective lifelong learning system to provide continuing education and skill upgrading to persons after they have left formal education in order to provide the changing skills necessary to be competitive in the new global economy.

A strong basic education system is a necessary precondition to underpinning India's efforts to enhance further the productivity and efficiency of its economy. China's experience in this area is instructive as its emphasis on secondary education has provided it with a firm basis for expansion of manufacturing activities on a global scale. Investments in basic education are thus fundamental for countries to improve the productivity and the quality of labor and deliver the manpower needed for their development efforts. India has made substantial progress in increasing literacy and increasing primary and secondary enrollments. But the country still accounts for one-quarter of the world's 104 million children out of school. The participation of girls in the 6- to 14-year-old age group in elementary education is low. And considerable gaps exist in access to secondary education, particularly for girls. But, the Indian leadership is very committed to increasing educational attainment. The national program for universal elementary education, Sarva Shiksha Abhiyan or Education for All, was initiated in 2001, and the constitution was amended in 2002 to make elementary education a fundamental right of every child.

India also possesses a large pool of highly educated and vocationally qualified people who are making their mark, domestically and globally, in science, engineering, IT, and research and development (R&D). But they make up only a small fraction of the population. To create a sustained cadre of "knowledge workers," India will need to develop a more relevant educational system and reorient classroom teaching and learning objectives, starting from primary school. The new system would focus on learning, rather than on schooling, and promote creativity. It would also improve the quality of tertiary education and provide opportunities for lifelong learning.

Tertiary education is critical for the construction of knowledge economies. India currently produces a solid core of knowledge workers in tertiary and scientific and technical education, although the country needs to do more to create a larger cadre of educated and agile workers who can adapt and use knowledge. Efforts have been put into establishing a top-quality university system that includes many world-class institutions of higher learning that are competitive and meritocratic, such as Indian Institutes of Technology [IITs], Indian Institutes of Management, Indian Institute of Science, and the Regional Engineering Colleges [RECs]). Despite these efforts, not all publicly funded universities or other educational institutions in India have been able to maintain high-quality standards or keep pace with developments in knowledge and technology. Major steps are thus needed to ensure that India's institutions meet high-quality national (and if such services are exported, international) standards.

Measures are also needed to enhance the quality and relevance of higher education so that the education system is more demand driven, quality conscious, and forward looking, especially to retain highly qualified people and meet the new and emerging needs of the economy.

In the area of scientific and technical education, even though India produces almost 200,000 scientists, engineers, and technicians a year, it has not been obtaining the full economic benefit from this skill base, because of the mismatch between education and the labor market. The professional workforce that is emerging from India's higher education system often cannot find suitable employment due to a growing gap between their knowledge and real practice and to limited job opportunities in their fields, coupled with low salaries. Many professionals also leave the country in search of better opportunities, which leads to brain drain. This calls for an urgent effort to promote policy and institutional reforms in scientific and technical education for both public and private institutions to improve the quality and skills of India's current and future pool of technical manpower.

Skills matter more than ever in today's more competitive global market. In large countries such as India and Brazil, where the vast majority of people are unskilled and uneducated, the capabilities of the majority of the population must be enhanced for the economy to show substantial improvements. Firms and farmers alike must be able to learn and develop new skills. While not losing sight of the need for secondary and tertiary education, governments should improve the skill and education levels of the mass of people through primary and vocational education. The success of countries such as China in achieving higher growth reveals the importance of a workforce with a basic education that can be trained. This leads to the issue of skills development and training. When technology is changing, enterprises must invest in worker training to remain competitive. India too will also need to develop various job training programs to be globally competitive. These programs must be flexible, cost-effective, and able to adapt quickly to new skill demands generated by changing markets and technologies.

In addition, India should develop a system of lifelong learning, which encompasses learning from early childhood through retirement and includes formal learning (schools, training institutions, and universities), nonformal learning (structured on-the-job training), and informal learning (skills learned from family members or people in the community). In the lifelong learning model, people are motivated to learn on a continuing basis, are equipped with the skills to engage in self-directed learning, given access to opportunities for learning throughout their lives, and offered financial and cultural incentives to participate in lifelong learning.

Some of the main issues in strengthening India's education system, therefore, include the following:

- Improving the efficiency in the use of public resources in the education system, and making the education system as a whole more responsive to market needs, as well as ensuring expanded access to education that fosters critical thinking and learning skills for all, not just the elites.
- Enhancing the quality of primary and secondary education, including tackling issues related to quality and relevance, with special emphasis on ameliorating teacher vacancies and absenteeism, reversing high dropout rates, and correcting inadequate teaching and learning materials and uneven levels of learning achievement. This is especially important for India to meet the goal of providing eight years of schooling for all children by 2010.
- Ensuring consistency between the skills taught in primary and secondary education and the needs of the knowledge economy, introducing materials and methods to teach students "how to learn," rather than stressing occupation-specific knowledge.
- Reforming the curriculum of tertiary education institutions to include skills and competencies for the knowledge economy (communication skills, problem-solving skills, creativity, and teamwork) that also meet the needs of the private sector.

- Raising the quality of all higher educational institutions, not just a few world-class ones (such as the IITs).
- Improving the operating environment for education, especially higher education, which calls for a shift in the role of the government from managing the administrative aspects of higher education institutions to becoming an architect of education standards and regulations, including improving and monitoring the quality of academic programs, establishing accreditation standards and procedures, ensuring equity, and coordinating a system with multiple players and multiple pathways to learning.
- Embracing the contribution of the private sector in education and training by relaxing bureaucratic hurdles and putting in place better accreditation systems for private providers of education and training.
- Establishing partnerships between Indian and foreign universities to attract and retain high-quality staff and provide opportunities for students to receive internationally recognized credentials.
- Increasing university-industry partnerships to ensure consistency between research and the needs of the economy. This will include reforming the university curriculum to include the development of skills and competencies that better meet the needs of the private sector.
- Using ICTs to meet the double goals of expanding access and improving the quality of education.
- Investing in flexible, cost-effective job training programs that are able to adapt quickly to new skill demands generated by changing markets and technologies, aligned with the needs of firms.
- Develop a framework for lifelong learning, including programs intended to meet the learning needs of all, both within and outside the school system. This will also require greater coordination across the different government bodies responsible for various components of the education and training system and development of procedures for recognition of what is learned in different parts of the system.
- Making effective use of distance learning technologies to expand access and the quality of formal education and lifelong training.

**Creating an Efficient Innovation System**

The innovation system in any country consists of institutions, rules, and procedures that affect how it acquires, creates, disseminates, and uses knowledge. Innovation in a developing country concerns not just the domestic development of frontier-based knowledge. It relates also to the application and use of new and existing knowledge in the local context. Innovation requires a climate favorable to entrepreneurs, one that is free from bureaucratic, regulatory, and other obstacles and fosters interactions between the local and outside business world and, with different sources of knowledge, including private firms, universities, research institutes, think tanks, consulting firms, and other sources. Tapping global knowledge is another powerful way to facilitate technological change through channels such as FDI, technology transfer, trade, and technology licensing.

In India, with its relatively small formal sector, a very important part of its innovation system relates to how modern and more efficient practices can be diffused to the greatest number of users. This applies both to domestic and foreign knowledge. India has done a remarkable job of diffusing knowledge and technology, especially in agriculture. As a result of the "green revolution," India has transformed itself from a net importer to a net exporter of food grains. India's "white revolution" in the production of milk has helped it to achieve the twin goals of raising incomes of rural poor families and raising the nutrition status of the population. India should continue to build on its innovative domestic strengths and undertake efforts to improve the productivity of agriculture, industry, and services even further. This includes strengthening technology diffusion institutions, such as those related to agricultural extension and industrial extension, productivity-enhancing organizations, and technical information agencies. In India, where large disparity exists between the most and least efficient producers in any sector, considerable economic gains can also be harnessed from moving the average domestic practice to the best domestic practice, not to mention best international practice. This will require a host of efforts, including improving

the system for technical norms and standards—such as product quality, work safety, and environmental protection—that can facilitate the proper diffusion of know-how. Efforts also need to be made to improve the dissemination of technology by strengthening competition so that the most efficient firms expand and improve performance, establishing and enforcing appropriate laws, encouraging more trade among Indian states, allowing for economies of scale and scope, and facilitating the diffusion of best products through price- and quality-based competition.

India also needs to increase its efforts to tap into the rapidly growing stock of global knowledge through channels such as FDI, technology licensing, importation of capital good that embody knowledge, as well as advanced products, components, and services. Compared with countries such as Brazil and China, India is particularly weak at making effective use of these resources. These channels are important given the rapid expansion of the global knowledge. Even large advanced economies such as the United States are increasingly acquiring knowledge from beyond its borders.

To its credit, India has been taking bold steps to strengthen its R&D infrastructure, developing technological innovations and altering the mind set of its people toward better creation, acquisition and use of technology. It is endowed with a critical mass of scientists, engineers, and technicians in R&D and is home to dynamic hubs of innovation, such as Bangalore and Hyderabad. It also has vast and diversified publicly funded R&D institutions, as well as world-class institutions of higher learning, all of which provide critical human capital.

India is also emerging as a major global R&D platform; about 100 multinational companies (MNCs) have already set up R&D centers in the country, leading to the deepening of technological and innovative capabilities among Indian firms. Several Indian companies, such as Ranbaxy and Dr. Reddy's Laboratories have also started forming R&D alliances with global firms. Such collaboration presents several benefits for Indian industry, because the linkages among local firms, universities, and research institutes and the worldwide R&D network of multinationals further integrate India into global technology development. Such R&D activities have also been useful in inculcating a commercial culture among scientists, helping them to apply knowledge for productive ends. The outsourcing of high-end R&D to India is yet another new trend that is evident from the large number of established R&D outsourcing centers in India, from IT and telecom to automotive and pharmaceuticals sectors. India is also developing public-private partnerships to harness the potential of traditional knowledge to meet health and welfare needs and to reduce poverty.

Despite these accomplishments, India spends only a small fraction of its GDP on R&D. It gets very little in worldwide royalty and license fee receipts. Regarding scientific and technical articles in mainstream journals (per million people), India matches the performance of China, but the contributions of both countries are very low compared with developed countries. FDI, although increasing, is also rather low by global standards. The majority of the R&D-related inward FDI in India materialized only after the economy had been liberalized. This FDI, however small, has been creating a new competitive advantage for the country, especially in the IT domain and in industries, such as automotive. Availability of venture capital is also rather limited in India, but some signs of vibrancy are evident, and a notable venture capital investment market is emerging.

In addition, India's share of global patenting is small; therefore, despite having a strong R&D infrastructure, India is weak on turning its research into profitable applications. But, an increasing trend is discernible in the number of patents granted to companies by the Indian Patent Office, indicating greater awareness of the importance of knowledge and the value of protecting it through patents. Among Indian patents, it is the drugs and electronics industry that has shown a sharp increase in patenting in recent years. In addition, several Indian firms have registered their innovations with the United States Patent and Trademark Office (USPTO). The number of U.S. patent grants to the Council for Scientific and Industrial

Research (CSIR), for example, increased from just six in 1990–91 to 196 in 2003–04. This shows that the focus of research is shifting to patentable innovations, indicating better conceptualization of research. The recent amendments to the Indian Patent Act adopted in a move toward adhering to the intellectual property norms under Trade-Related Aspects of Intellectual Property Rights (TRIPS) has also boosted confidence among international players.

In India, some 70 percent of R&D is performed by the central and state governments, an additional 27 percent by enterprises (both public and private sector industries), and less than 3 percent by universities and other higher education institutions. In contrast, in most countries in the Organisation for Economic Cooperation and Development (OECD), the private sector finances 50–60 percent of R&D, because it increasingly has the finance, knowledge, and personnel needed for technological innovation. Firms play an even bigger role in R&D in Ireland, Japan, Korea, and Sweden. Universities also undertake research to a much larger extent in developed countries and have stronger linkages with the corporate world.

India should thus take steps to improve its innovation system further, not only by taking advantage of new knowledge created at home, but also by tapping knowledge from abroad and disseminating it for greater economic and social development. It should also improve the efficiency of public R&D and increase private R&D, as well as encourage greater university-industry linkages.

Some of the key issues to address in this domain include:

- Tapping into the growing stock of global knowledge more effectively and providing incentives for international technology transfer through trade, FDI, licensing, and personnel movements, along with informal means through imitation, reverse engineering, and spillovers.
- Attracting FDI more effectively, given the importance of FDI in the generation and dissemination of global knowledge and the role that they can have in domestic R&D. This should include removing regulations on foreign investment and encouraging FDI R&D into the country.
- Encouraging members of the Diaspora and renowned expatriates to contribute further to innovative activities by appointing them to the management boards of national research institutes, universities, and so on to facilitate the design of university programs that better suit corporate requirements.
- Motivating scientists and engineers from India working in the United States and other developed countries to enter into alliances with multinational companies and establish firms or labs to undertake R&D on a contract basis in India.
- Auditing and monitoring S&T efforts and institutional performance to identify what works well and then redeploying resources to programs that have a proven track record of success.
- Using the savings to strengthen university-industry programs by means of matching grants and other initiatives, including encouraging academics to spend sabbaticals in relevant industries so that their research meets the needs of the productive sector.
- Finding alternative sources of funding for R&D, especially as the government reduces its budgetary support for research programs. In some countries such as China, academic institutions are launching commercial ventures of their own or in collaboration with the corporate sector.
- Allowing national research institutes to collaborate with domestic and foreign firms to forge closer links with industry. One way of encouraging scientists to work closely with industry and in so doing improving linkages between technology development and application would be to provide incentives such as bonuses and a share of royalties from products created through their research.
- Paying adequate salaries and creating a proper working environment for scientists and engineers that provides them with access to capital equipment, instruments, and other infrastructure needed for R&D. Failure to compensate researchers adequately and lack of a supportive environment will only exacerbate the problem of brain drain.

- Restructuring and modernizing universities and publicly funded R&D institutions by giving them flexibility, freedom of operation, and financial autonomy.
- Increasing the intake of students into science and engineering, given the competition for recruitment of trained personnel; this may require adding colleges and universities (such as IITs or others modeled after them).
- Developing entrepreneurial skills and management training for S&T professionals to encourage them to undertake business activities.
- Encouraging the private sector to invest in R&D.
- Strengthening R&D by companies so that they can have a more demand-driven and market-oriented approach with closer collaboration among researchers, partners, and customers in developing new products and services that can be speedily brought to the market.
- Developing communication and other infrastructure for R&D, and creating an attractive environment to motivate R&D investments, including favorable tax, and other incentives.
- Establishing science and technology parks to encourage industry-university collaboration. Such parks might attract R&D work from both foreign and domestic firms if the parks are situated close to reputable academic institutions.
- Encouraging venture capital, which can also be used as an incentive for commercialization of research.
- Effectively enforcing and implementing IPR to create confidence among domestic and foreign innovators on protection of their innovations in the country.
- Promoting a national fund to support grassroots innovators, with the aim of building a national register of innovators, converting innovations into viable business plans, and disseminating knowledge of indigenous innovations, especially for job creation.
- Strengthening the emerging new model of reverse drug design to produce innovations in a more cost-effective way based on leveraging traditional knowledge with modern science and exploiting public-private partnerships.

**Building a Dynamic Information Infrastructure**

Rapid advances in ICTs are dramatically affecting economic and social activities, as well as the acquisition, creation, dissemination, and use of knowledge. The use of ICTs is reducing transaction costs and lowering the barriers of time and space, allowing the mass production of customized goods and services. With ICT use becoming all-pervasive and its impacts transformational, it has become an essential backbone of the knowledge economy. The information infrastructure in a country consists of telecommunications networks, strategic information systems, policy and legal frameworks affecting their deployment, and skilled human resources needed to develop and use it.

India's telecommunications sector has registered rapid growth in recent years, spurred by reforms to open markets, and introduced more competition. Many domestic and international private sector entrants are now providing consumers with high-quality services at low prices. As a result, some spectacular successes have resulted: more than 47 million people had mobile phones at the end of 2004! Fierce price competition has resulted in Indian mobile telephony becoming one of the cheapest in the world. This has been a boon, especially to people in India's 600,000 rural villages, which have had no access to communication through traditional means, such as fixed lines. But now, from fishermen at sea and brokers ashore in Kerala to farmers in Punjab—people in industry and farming are embracing wireless technology for economic activity and to do business and increase their profit margins. The Indian government, in keeping pace with up-to-date technological advancements, announced its Broadband Policy in 2004 to provide an impetus to broadband and Internet penetration in the country.

India can also boast of remarkable and impressive global achievements in the IT sector. According to the National Association of Software and Services Companies (NASSCOM), the Indian IT market has grown from $1.73 billion in 1994–95 to $19.9 billion in 2003–04, accounting for about 3.82 percent of India's GDP in 2003–04 and providing employment for almost a million people. India's IT services are moving up the value chain, and India is now undertaking new and innovative work, such as the management for clients of IT-related business processes. It is making an impact also in IT consulting, in which companies such as Wipro, Infosys, and Tata are managing IT networks in the United States and re-engineering business processes. In fact, Infosys was ranked the ninth most respectable IT company in the world in 2004, behind Hewlett Packard, IBM, Dell, Microsoft, AP, Cisco, Intel, and Oracle. In chip design, Intel and Texas Instruments are using India as an R&D hub for microprocessors and multimedia chips. The success of the IT industry on the whole influenced competitiveness in other sectors as well by building confidence in Indian industry, enhancing the country's brand equity in the world, and offering entrepreneurial opportunities on a global scale. In the future, it is expected that India will make inroads in areas such as financial analysis, industrial engineering, analytics, and drug research.

Several factors have contributed to India's success in the IT industry including the existence of a highly skilled, English-speaking workforce coming out of India's engineering schools and earning lower wages than European and U.S. counterparts, low dependence of IT on physical infrastructure, the Indian Diaspora, and the introduction of current account convertibility and easing of controls and regulations in the early 1990s.

Various forecasts have also been made on where the IT industry is heading. According to WEF's *Global Information Technology Report 2002–03* (2003), India's IT industry is expected to grow at a compounded annual rate of 38 percent to reach $77 billion by 2008—contributing to 20 percent of India's anticipated GDP growth in this period and 30 percent of its foreign exchange earnings. By that year, it is also expected to employ more than 2 million people and indirectly create another 2 million jobs! But one of the key inputs to achieving sustained growth and exports in the IT sector will be the availability of high-quality professionals in adequate numbers. India needs to maintain and enhance its competitive advantage of having abundant, high-quality, and cost-effective human resources. The country must ensure the right mix of technical, business, and functional skills in the workforce to meet the needs of individual business segments and customer markets. This requires harmonization of the demands of industry with the supply of trained manpower coming from Indian educational and training institutions.

As a result of the IT explosion and impressive progress in the telecommunications and ICT sector, it is no surprise that usage of ICTs has been growing in the country. But explosive growth of ICTs has mainly been concentrated in urban areas. As the telecommunications sector moves to a more commercial and competitive environment, the government should implement practical policies to enhance the reach of IT to groups not well served by the market. The real challenge is to promote the effective application and use of ICTs throughout the economy to raise productivity and growth, not just in a few pockets. Ensuring that the benefits of ICTs are shared by all requires an enabling environment for ICTs. Critical elements include increasing access to ICTs through widespread availability of telephones, increasingly including mobile phones, computers, and connectivity to the Internet; enhancing ICT literacy and skills among the population, more so in the rural areas; and developing ICT applications that can provide much-needed social, economic, and government services to citizens.

Some steps in enhancing India's information infrastructure in the country include the following:

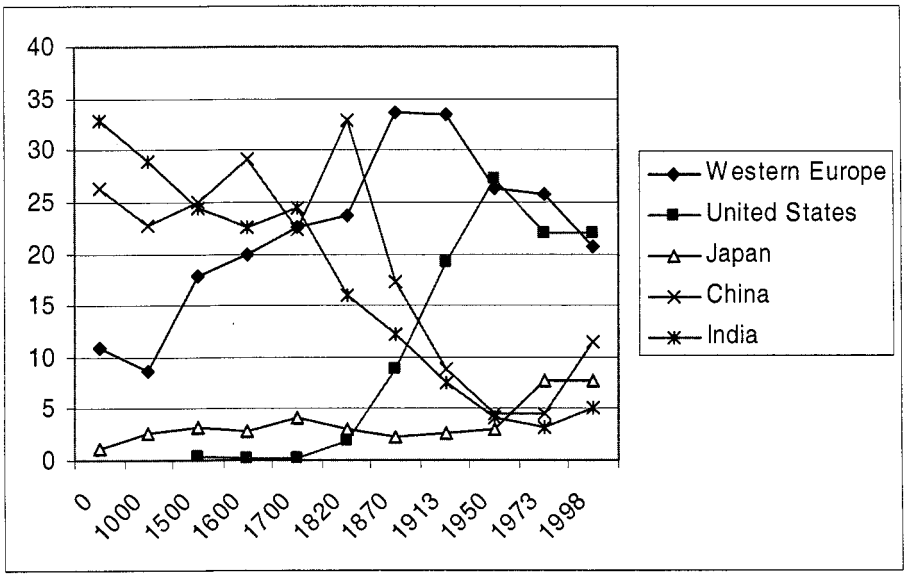
- Enhancing regulatory certainty and efficiency to facilitate new services that will enable India to reap the benefits of the convergence of existing and new technologies and enable the sector to contribute more to economic growth.

- Boosting ICT penetration by resolving regulatory issues in communications and reducing and rationalizing tariff structures on hardware and software.
- Increasing the use of ICTs as a competitive tool to improve the efficiency of production and marketing in areas such as supply chain management, logistics, information sharing on what goods are selling in the markets, responding to rapidly changing market needs, and so on.
- Moving up the value chain in IT by developing high-value products through R&D, improving the quality of products and services, marketing products and building brand equity to position the "India" brand name further, including by strengthening marketing channels with strategic global links, expanding the focus outside the United States to emerging markets in Asia, Pacific, Japan, and so on.
- Providing suitable incentives to promote IT applications for the domestic economy, as the focus currently seems to be mainly on IT services exports. This includes developing local language content and applications.
- Putting in place suitable human resource development and training initiatives, starting at the primary school and moving on to the tertiary levels to meet the expected growth of IT and other productive sectors of the economy.
- Updating syllabuses in computer engineering, electronics, and IT in various technical institutions to meet the demands of industry (curriculum in other branches of engineering should also be broadly based to include IT subjects)
- Massively enhancing ICT literacy and skills among the population at large through conventional and nonconventional means, so that people can begin to use ICTs to derive benefits, both economically and socially.
- Creating opportunities for local communities to benefit from ICTs by providing support (seed money for local innovation on low-cost and appropriate technologies), enhancing private investment in ICT infrastructure, and promoting national and international support for rural community-based access.
- Strengthening partnerships among government agencies, research and academic institutions, private companies, and nongovernmental organizations (NGOs) to ramp up the ICT infrastructure and achieve faster penetration of ICTs.
- Further developing and scaling up (in joint public-private initiatives where feasible) ICT applications, such as community radio, fixed/mobile phones, smart cards, Internet, and satellite television, to bring the benefits of connectivity to rural communities all across the country and improve the delivery of services to rural populations.
- Sharing successful applications of ICT, for example, in e-government among different Indian states. This also requires scaling up successful ICT initiatives to bring the benefits of connectivity to rural communities all across the country.
- Creating a suitable environment for the effective use of ICTs to permeate the entire economy and lead to flourishing competition and business growth. This calls for the government to continue with the economic reform agenda put in place in the past decade.

**Looking Ahead**

The notion of a knowledge economy is not new or foreign to India. India's past achievements in science, philosophy, mathematics, and astronomy reinforce the notion that the country has for millennia been a leading "knowledge society." In economic terms, India was the world's largest economy in the first millennium, producing a third of global GDP (see Figure B). By 1500 its share had declined to 25 percent, as China overtook it and Western Europe's share began to expand rapidly. India's share continued to fall after 1700 due to the collapse of the Moghul Empire, the costs of adjusting to British governance, and the rapid increase in the share of Western Europe, followed by the spectacular rise of the United States. India was a latecomer to the industrial revolution. It cannot afford to miss the knowledge revolution!

**Figure B: India: Percentage Share of Global Gross Domestic Product, Years 0-1998**
*(percent)*




*Source:* Maddison (2001).

Today, Indian policy makers are keenly aware of the challenges and opportunities that India faces in different sectors and are already starting to implement some of the key actions that are necessary to bolster India's effective transformation to the knowledge economy. Various reports, including the Indian Planning Commission's reports on *India as Knowledge Superpower: Strategy for Transformation* (2001a) and *India Vision 2020* (2002a); the President's (Dr. A. P. J. Abdul Kalam's) 2002 strategy *India 2020: A Vision for the New Millennium* (Kalam and Rajan 2002); and the High-Level Strategic Group's *India's New Opportunity, 2020* (AIMA 2003) underline ways to address India's transition to the knowledge economy.

India, thus, has already developed a vision and strategies to address its transition to the knowledge economy. In the main, its initiatives have, however, largely been developed around the three functional pillars of the knowledge economy (education, innovation, and ICTs). But to get the maximum benefits from investments in these areas, these initiatives must be part of a broader reform agenda, because some elements of India's current economic and institutional regime are constraining full realization of India's potential. India will, for example, not reap the full benefits of its investments in increasing education, ramping up ICTs, or even doing more R&D, unless its broader institutional and incentive regime stimulates the most effective use of resources in these areas, permits their deployment to the most productive uses, and allows entrepreneurial activity to flourish to contribute better to India's growth and overall development.

It is hoped that this report will help stimulate, through a consultative process, a greater sense of the importance of the emerging policy agenda on the knowledge economy in India. India's effective transformation to a knowledge economy calls for it to act in many different policy domains, deepening, complementing, or reorienting ongoing reforms to use knowledge efficiently and sustaining development in the long term to achieve inclusive growth. India needs to recognize that many policy reforms leading to a knowledge-based economy will not yield results overnight. It will thus need to make some tough choices in the short term; yet, other reforms will be of a medium- to long-term nature.

It is clear, however, that going ahead with such an ambitious agenda in India first and foremost requires raising massive awareness and consultation among all interested stakeholders in government, the private sector, and civil society on the need and plans for such a transformation. Creating a shared vision among all parties on ways to accelerate India's progress toward the knowledge economy is thus important, as well as commitment on the part of all stakeholders to stay the course in order to manage such a transition effectively. Effective leadership will be key to articulating this vision, through the involvement of all stakeholders. It also requires that the country develop a "virtuous" cycle between growth and the reform process.

Moving to a knowledge economy, however, is not only about stimulating such a reform agenda from the top. What will be needed is trial-and-error experimentation on what works in a bottom-up fashion and what does not work in the Indian context as well as scaling up successful bottom-up initiatives. The process requires that India constantly monitor its achievements and adjust its strategy in light of changing conditions.

**Launching a Process**

To make this agenda even more action oriented, an important signal needs to be given, as is amply demonstrated by the experience of other countries highlighted above. A concrete way to begin this process would be to designate a national "knowledge" champion to advance the knowledge economy agenda in India by integrating the economic reform agenda with initiatives already taking place in more functional areas.

A very appropriate national champion to coordinate and orchestrate the necessary knowledge-related actions across the various domains would be the Prime Minister's office. In fact, recently, the Prime Minister has proposed the setting up of a Knowledge Commission to leverage various knowledge networks to make India a knowledge engine of the world. This function could, for example, organize a Knowledge Economy Task Force, headed by the Prime Minister and comprising stakeholders from government, the private sector, academia, think tanks, research organizations, and NGOs. The main objective of the task force would be to determine ways of coordinating action involving diverse stakeholders to tackle key reforms in the four pillars of the knowledge economy and sequence the investments necessary to move India successfully into the knowledge economy of the twenty-first century. Some examples of cross-cutting knowledge economy issues that the task force could address include:

- In the past decade, India has undertaken major economic reforms; as a result, its growth rate has increased from 3.5 percent in the 1950s to 1970s to approximately 6 percent between the 1980s and 2002. During much of this period, however, China has been growing at about 10 percent. What are the fundamental reforms needed to unleash India's tremendous entrepreneurial potential and benefit from more active participation in the global knowledge economy to achieve this higher rate of growth sustainably? What actions are necessary to bring in a much larger proportion of the population into the modern sector? What special initiatives have to be undertaken to marshall knowledge to improve the livelihoods of the poor?
- India has the advantage of a highly skilled human resource base, which has gained world renown. It also has world-class institutions that train this world-class manpower, but on a limited scale. What would it take to ramp up such institutions even further so that India can become a leader in education and training, not only in IT and software, but also more generally in high-skill areas that can provide greater outsourcing services to the world?
- An increasing number of multinational corporations are currently working with Indian firms to contract and subcontract high-end R&D. How can India become a global leader in innovation in its

own right, not only in IT-related areas in which it has carved out a global niche, but also in other knowledge-intensive industries, such as pharmaceuticals and biotechnology?

- India is a leading exporter of IT services and software, but has not yet fully harnessed the potential of ICTs at home to reduce transaction costs and improve efficiency. As it has a large local market and many needs, what will it take for India to exploit this capability on a larger scale domestically and help the country leapfrog even more rapidly into the knowledge economy of the twenty-first century?

Dealing with the kinds of illustrative issues highlighted above requires prioritization and working with many different interest groups, which is not an easy task; thus, some guiding principles for the Knowledge Economy Task Force would include the following:

- Defining priorities and establishing budgets
- Adopting systemic, integrated approaches for the different policy planks at all levels of government
- Mobilizing state governments, which are key to the Indian economy and its modernization
- Multiplying experiments and publicizing concrete initiatives that clearly exemplify the move to a knowledge-based economy.

The role of the Prime Minister's office would be to put in place a robust mechanism to facilitate, monitor, and scale up successful initiatives.

In sum, India is well positioned to take advantage of the knowledge revolution to accelerate growth and competitiveness and improve the welfare of its citizens and should continue to leverage its strengths to become a leader in knowledge creation and use. In the twenty-first century, India will be judged by the extent to which it lays down the appropriate "rules of the game" that will enable it to marshal its human resources, strengths in innovation, and global niches in IT to improve overall economic and social development and transform itself into a knowledge-driven economy. Sustained and integrated implementation of the various policy measures in these domains would help to reposition India as a significant global economic power, so that it can rightfully take its place among the ranks of countries that are harnessing knowledge and technology for their overall economic development and social well-being.

**A Final Note**

This report presents an outside view of India's position on the global scale, recognizes India's achievements, but sees a tremendous potential that is yet to be unleashed. What is needed is an India-led process of coordination and integration of the different reforms, combining those in the economic and institutional regime with the many initiatives that are actually being undertaken in more functional areas, as covered in many Indian strategy reports. Consolidating and launching these can only be done through a domestic process of consultation, stakeholder awareness, and buy-in to get backing for the necessary reforms to implement the various actions needed to leverage India's potential. It is hoped that this perspective serves as an additional vote of confidence to help catalyze such an integrated and well-grounded process.

# 1. INDIA AND THE KNOWLEDGE ECONOMY: OPPORTUNITIES AND CHALLENGES

One of the world's largest economies, India has made tremendous strides in its economic and social development in the past two decades. After growing at about 3.5 percent from the 1950s to the 1970s, the country's economy expanded during the 1980s to reach an annual growth rate of about 5.5 percent by the end of the decade. In 1991 India embarked on a new development strategy and introduced policies designed to improve its growth prospects and increase its integration into the global economy. Recognizing that comparative advantage in the new economy will shift to those who have the ability to create, adapt, and use knowledge to spur growth and innovation, India went forward with a series of reforms in the 1990s: opening up more sectors to private investment, encouraging foreign direct investment (FDI), significantly reducing red tape, further liberalizing trade policy and the exchange rate regime, and reforming capital markets, leading to an improved investment climate. As central controls have receded, states have also acquired more freedom to maneuver, and some, such as Andhra Pradesh, Karnataka, and Maharashtra, have shown progress in encouraging private investment.

India is now poised to realize even faster growth. The time is, therefore, opportune for the country to make further progress toward a knowledge economy—one that create, disseminates, and uses knowledge to enhance its growth and development. To this end, it is important for India's leaders and interested stakeholders to assess India's overall knowledge readiness. How well is it addressing key issues in making effective use of knowledge for development? How does India compare with the rest of the world on what can be called four pillars of the knowledge economy: the economic and institutional regime (including governance), education and human resources, the innovation system, and information infrastructure? This chapter reviews India's current economic context, the importance of knowledge in an increasingly dynamic and competitive global environment, and the opportunities and challenges India faces in becoming even more knowledge based.

## The Current Economic Context

Under India's revised development strategy, the country has continued to make good progress in increasing incomes and improving living standards. The poverty incidence decreased from 44.5 percent in the 1980s to 26 percent in 2000,[1] and the overall literacy rate increased from 44 percent to 65 percent in the same period. FDI inflows rose from virtually nothing in the 1990s to $4.26 billion in 2003, although they are still low compared with China, which attracted $53.5 billion in the same year. In the 1990s India also made progress on the Millennium Development Goals (MDGs)[2] of eradicating poverty and hunger, increasing primary enrollment, promoting gender equality, reducing child mortality, and improving access to water and sanitation (UNDP 2003) (Box 1-1).

[1] This is based on an international poverty line of $1 per day, with adjustments for purchasing power across countries. The poverty incidence of 26 percent is based on estimates of the Government of India (World Bank 2003d).

[2] The MDGs commit the international community to an expanded vision of development and have been commonly accepted as a framework for measuring development progress. The goals are to *(a)* eradicate extreme poverty and hunger, *(b)* achieve universal primary education, *(c)* promote gender equality and empower women, *(d)* reduce child mortality, *(e)* improve maternal health, *(f)* combat HIV/AIDS, malaria, and other diseases, *(g)* ensure environmental sustainability, and *(h)* develop a global partnership for development. For more information, go to http://www.developmentgoals.org/.

**Box 1-1: Assessing India's Progress on Millennium Development Goals in the 1990s**
Significant reduction in poverty and improvements in literacy and school enrollments were achieved in India in the 1990s. Poverty fell by 1.2 percentage points a year and the enrollment rate among primary-aged children grew by 1 percentage point a year. Forecasting the likelihood of India achieving the MDGs by their target dates is difficult, because the desired outcomes will require coordinated interventions across many sectors. Nevertheless, a comparison between *actual* progress in the 1990s and *needed* progress to achieve MDGs is useful. Targeted reductions in poverty will be achieved if poverty levels continue to fall by at least 0.7 percentage points a year. Progress in primary school enrollment rates, however, must accelerate to 1.5 percentage points a year to achieve the relevant MDGs. Compared with poverty and education, progress in health indicators was slower in the 1990s; rapid acceleration is necessary if India is to reach the stated goals by 2015.

It is worth noting that all 15 of the largest states (accounting for more than 90 percent of India's population), including the three large and poor states—Uttar Pradesh, Bihar, and Madhya Pradesh—showed progress in reducing poverty (including rural poverty) and by and large improving social indicators. As better-performing states have made faster progress, however, poverty and illiteracy have become more concentrated in India's large and poor states. Although Uttar Pradesh, Bihar, and Madhya Pradesh accounted for 41 percent of India's poor in the early 1990s, this figure had risen to nearly 50 percent by the end of the 1990s. India cannot achieve the MDGs without widening economic opportunities and overcoming barriers to more rapid poverty reduction and better human outcomes in these poorer states.

*Source:* World Bank (2004a).

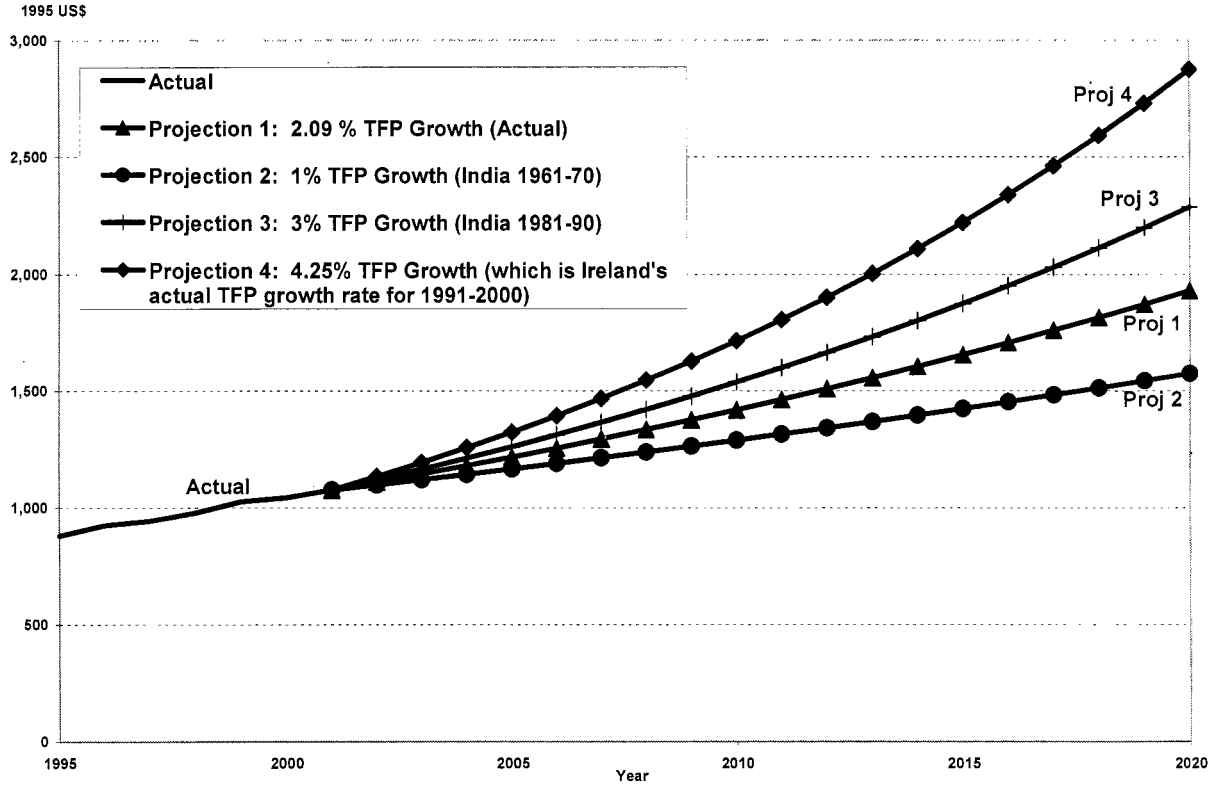
*Embarking on a new growth path.* After significant economic expansion in the 1980s, India increased its rate of growth to 6.7 percent between 1992–93 and 1996–97; this dropped to 5.5 percent from 1997–98 to 2001–02, and 4.4 percent in 2002–03, due to the impact of poor rains on agricultural output. But, thanks to a lavish monsoon that led to a turnaround in the agriculture sector, in 2003–04, India's economy surged ahead to a growth rate of 8.2 percent. This rate is very much in line with growth projections cited in India's Tenth Five-Year Plan (India, Planning Commission 2002e), which calls for increasing growth to an average of 8 percent between 2002–03 and 2006–07.[3] Such sustained acceleration will be needed to provide opportunities for India's growing population and its even faster-growing workforce.[4]

India could experience continued high growth in the future. Figure 1-1 shows what India can achieve by the year 2020, based on different assumptions about its ability to use knowledge. Here, total factor productivity (TFP) is taken to be a proxy for a nation's learning capability.

[3] India's Tenth Five-Year Plan is available at http://planningcommission.nic.in/plans/planrel/fiveyr/welcome.html.
The investment bank Goldman Sachs forecasts that, although growth in the next 50 years will slow sharply in the world's six big, rich countries (United States, Japan, United Kingdom, Germany, France, and Italy) and in Brazil, Russia, and China, India will continue to have an average annual growth of more than 5 percent throughout this period. By 2032 its GDP will be bigger than Japan's! By 2050 India has the potential of raising its national income per capita in dollar terms by 35 times the current level (Wilson and Purushothaman 2003).

[4] During the present decade, one estimate suggests that India's labor force will expand by 50 percent more than all of East Asia's (including China's) taken together *(The Economist* 2004d).

**Figure 1-1: India: Real Gross Domestic Product Per Worker, Alternative Projections, 1995–2020**




*Note:* For all four projections, capital, labor, and human capital are assumed to grow at their 1991–2000 average annual growth rates for India, that is, 5.41, 2.23, and 0.58 percent, respectively. For the growth-TFP decomposition to be more precise, labor force figures rather than total population are used as a measure of the amount of "labor" available for use as a factor of production in the Indian economy. According to World Bank databases, in 2001 India's GDP (in 1995 U.S. dollars) was $495 billion and its population was 1.03 billion, of which only 461 million were in the labor force. As such, India's GDP per capita in 2001 was approximately $480, whereas GDP per worker was around $1070. Annex 1 provides the theoretical framework for these TFP projections.
*Source:* Knowledge for Development Program.

Projections 1, 2, 3, and 4 plot real gross domestic product (GDP) per worker (1995 U.S. dollars) for India assuming different TFP growth rates from 2002 to 2020. Projection 4 is an optimistic scenario which is based on the actual TFP growth rate in Ireland in 1991-2000. Ireland is an example of a country that has been using knowledge effectively to enhance its growth.

- Projection 1 assumes a TFP growth rate of 2.09 percent, which was the average TFP growth rate for India for 1991–2000. In this case, real GDP per worker increases by 79 percent, from $1,077 in 2001 to $1,930 in 2020.
- Projection 2 assumes a TFP growth rate of 1 percent, which was the average TFP growth rate for India for 1961–70. In this case, real GDP per worker increases by 46 percent to $1,575 in 2020.
- Projection 3 assumes a TFP growth rate of 3 percent, which was approximately the average TFP growth rate for India during 1981–90. In this case, real GDP per worker increases by 112 percent to $2,286 in 2020.
- Projection 4 assumes a TFP growth rate of 4.25 percent, which was the average TFP growth rate for Ireland during 1991–2000. Ireland is an example of a country that has been using knowledge

effectively to enhance its growth. In this case, real GDP per worker in India increases by 167 percent to $2,875 in 2020.

India has, therefore, a rich choice set in determining its future growth path. All things being equal, the projected GDP per worker in the optimistic scenario 4 in 2020 is about 50 percent greater than in scenario 1. This illustrates the tremendous difference that can be made by developing strategies that focus on making more effective use of knowledge to increase the overall productivity of the economy. Knowledge can make the difference between poverty and wealth.

*Modernizing the economy.* Some interesting changes have occurred in the broad structural composition of the Indian economy in the past six years. Table 1-1 shows that the share of agriculture decreased from 26.5 percent to 22 percent of GDP in 1997–2003 and that of manufacturing decreased from 17.7 percent to 17.2 percent, whereas the share of services increased from 45.8 percent to 50.8 percent in the same period.

**Table 1-1: India's Gross Domestic Product by Sector, 1997–2003**
*(percentage share of total)*

| | 1997–98 | 1998–99 | 1999–2000 | 2000–01 | 2001–02 | 2002–03 |
|---|---|---|---|---|---|---|
| Agriculture | 26.5 | 26.4 | 25.0 | 23.8 | 23.9 | 22.0 |
| Industry | | | | | | |
| *Mining* | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | 2.4 |
| *Construction* | 5.0 | 5.0 | 5.1 | 5.2 | 5.1 | 5.3 |
| *Electricity, gas, and water* | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.4 |
| *Manufacturing* | 17.7 | 17.0 | 16.7 | 17.2 | 16.8 | 17.2 |
| Services | 45.8 | 46.6 | 48.3 | 48.9 | 49.5 | 50.8 |

*Source:* EIU (2004c).

Compared with countries such as Brazil and China, where the share of agriculture is rather limited (accounting for 6 percent and 15 percent of GDP, respectively, in 2002), India's economy still depends significantly on agriculture. Manufacturing has a less prominent role in India, accounting for a little more than 17 percent of GDP in 2003, compared with more than 43 percent of GDP for China. In addition, no significant increase in India's penetration of world markets in industrial products has been observed in the past decade. As a result, growth in manufacturing employment has averaged only about 2 percent a year since the mid-1990s, most of this in the unorganized sector. The organized manufacturing sector provides only about 7 million jobs today, and fewer than one million workers transition out of agriculture every year. These trends will have to be reversed for India to accelerate growth to meet the targets set out in the Tenth Five-Year Plan (World Bank 2003d).

The emergence of services, however, as the most dynamic sector in the Indian economy has in many ways been a revolution (Box 1-2). The most visible and well-known dimension of the takeoff in the services sector has been in software, information technology–enabled services (ITES), including call centers, design, and business process outsourcing (BPO) services. Growth in services, however, has been much more broadly based than information technology (IT); in the 1990s growth was the strongest in business services, telecommunications, financial and community services, and hotels and restaurants. Nevertheless, tremendous scope exists for future rapid growth in the Indian service economy, provided that deregulation of the services sector continues. Despite these achievements, it should be noted that employment growth in the Indian services sector has been quite modest, underscoring the importance of achieving rapid industrial and agricultural growth (Gordan and Gupta 2003 and World Bank 2004j).

**Box 1-2: India Undergoes a Services Revolution**

India's exports of services grew by 17 percent a year throughout the 1990s—almost twice the 9 percent growth rate of the services sector as a whole, which itself accounted for nearly 60 percent of India's overall economic growth. It is estimated that, if the growth trend in services from 1995–2000 persists, by 2009–10 India's exports of services would not only exceed exports of goods, but the country would export more services than China, South Korea, Brazil, and Singapore combined!

A large part of the dynamism in the services sector is due to factors such as the high income elasticity of demand for services, cost-reducing and variety-enhancing technological advances, and changes in the method of organizing production favoring increased outsourcing. Access to a growing external market for services and the gradual, although partial, liberalization of the domestic economy has also played a significant role. Trade liberalization in services, both in India and internationally, has provided access to a growing external market for services for Indian firms, while also attracting FDI in services to India. FDI in services grew by 36 percent in 2001, almost twice the rate of growth in India's nonservices FDI. IT-related services accounted for 34 percent of India's services exports in 2001–02, up from 19 percent in 1997–98.

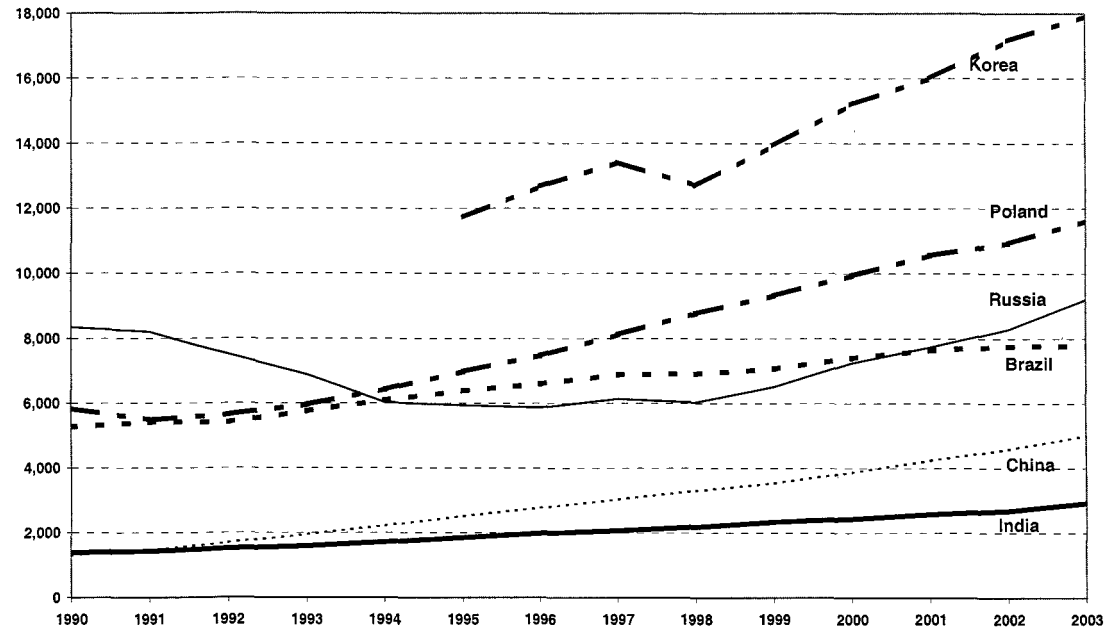
Going forward, securing the gains delivered by India's "services revolution" demands deeper reforms at home, combined with a more aggressively outward-looking negotiating stance in international trade talks. India must address on the external front the problem of actual and potential protectionism and domestically the persistence of restrictions on trade and investment and weaknesses in the regulatory framework. Liberalized services such as IT and telecommunications have attracted significant investment and have grown faster and created more jobs than the protected services sectors. The current round of World Trade Organization (WTO) negotiations also offers India a remarkable opportunity to eliminate existing barriers to its services exports and prevent introduction of new ones. But, liberalization must also deliver benefits to the poor and weak sections of society to give them access to the improved opportunities offered by India's services revolution. One model is the universal service fund already set up in the telecommunications sector, in which part of the revenue is set aside to finance service provision in more remote areas without undermining overall efficiency. The following steps would help India sustain its services revolution and build a more competitive domestic economy, both of which underpin the country's prospects for continued economic growth and poverty reduction:

- Take a far more aggressive position in international negotiations on the General Agreement on Trade in Services (GATS), and seek to lock in the current open international trade regime for cross-border trade in services.
- Seek liberal access for the strictly temporary movement of skilled professionals as employees of trans-border companies or to fulfill services contracts. Creation of a service provider visa with streamlined and transparent procedures would facilitate movement for these provider classes.
- Open professional services, such as accountancy and legal services, and retail distribution to international competition, and eliminate restrictions on trade in financial and telecommunications.
- Reduce discretion in issuing of licenses and permits, and eliminate unnecessary red tape that inhibits efficient operation of firms, capital movement, and productivity.
- Reduce restrictions on the operation of domestic firms in road transport, financial, accountancy, and construction services.
- Improve regulation in health and education to protect the interests of Indian consumers and help Indian service providers secure access to foreign markets.

*Source:* World Bank (2004j).

*Comparing India globally.* By global measures, India's economy is still relatively small: with 17 percent of the world's people, India accounts for less than 2 percent of global GDP and 1 percent of world trade. Impressive as its growth performance has been, it has lagged behind China's, which had an average annual GDP growth rate of 9.8 percent in 1991–2003 (and 9.2 percent between 1980-1990). Figure 1-2 shows that India's GDP per capita has been increasing, albeit at a much lower rate than in China or Brazil.

**Figure 1-2: Gross Domestic Product Per Capita (Purchasing Power Parity), India and Comparators, 1990–2003**
*(current international U.S. dollars)*




*Source:* World Bank staff analysis undertaken using World Bank internal database.

Even though growth has been noteworthy and India has improved its performance on the Human Development Index (HDI)[5]—moving from 132nd place in 1997 to 127th in 2001—the country is facing many new challenges. The new threat of HIV/AIDS is spreading quickly (approximately 4.58 million Indians are currently infected with HIV and 600,000 have the disease *(The Economist* 2004g). Unemployment, although still low by international standards (4.4 percent, compared with 9 percent in Brazil and 3 percent in China), is increasing, especially in rural areas. Progress has also been uneven across different regions of the country. Evidence of divergence in per capita incomes exists across states; richer states are increasing incomes faster than poorer ones. As a result, poverty is present in the rapidly growing cities as well as the vast rural areas, but increasingly concentrated in the country's more slowly growing states: Bihar, Madhya Pradesh, Orissa, and Uttar Pradesh (World Bank 2003d).

Chapter 1 has so far highlighted recent economic trends that impact India as it moves to become knowledge based. But, what progress has India made and how ready is it to move forward in the effective use of knowledge for development? How does India now compare with the rest of the world in what can be called the "knowledge revolution"? To answer these questions, it is important first to review why the knowledge economy is so important to development policy and the key elements of the knowledge revolution, including the four "pillars" that support the knowledge economy.

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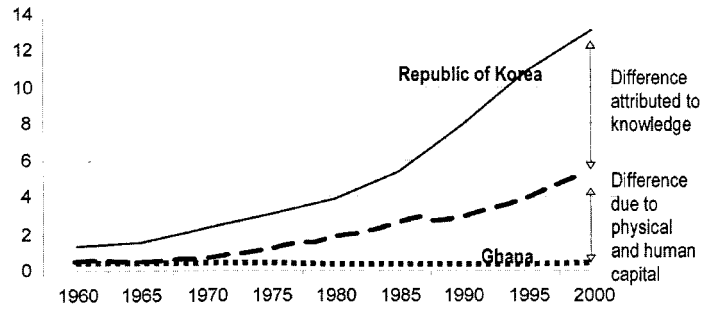
[5] The HDI is a composite index developed by UNDP that measures the average achievements in a country in three basic dimensions of human development: a long and healthy life, as measured by life expectancy at birth; knowledge, as measured by the adult literacy rate and combined gross enrollment ratio for primary, secondary, and tertiary schools; and a decent standard of living, as measured by GDP per capita in purchasing power parity (PPP) U.S. dollars. For more information, see http://hdr.undp.org/statistics/indexes/about_hdi.cfm.

## Knowledge is Key in an Increasingly Dynamic and Competitive Global Environment

In the global knowledge economy of the twenty-first century, India's development policy challenges will require it to use knowledge more effectively to raise the productivity of agriculture, industry, and services and reduce poverty. This is because the application of knowledge, as manifested in areas such as entrepreneurship and innovation, research and development (R&D), and people's education and skill levels, is now recognized as one of the key sources of growth and competitiveness in the global economy. Although knowledge has always been at the core of any country's development process, increased speed in the creation and dissemination of knowledge is making it even more important in development strategy. Figure 1-3 illustrates the importance of effective use of knowledge in Ghana and Korea. Nearly 40 years ago their per capita incomes were almost the same; since then, Korea has increased its per capita income by a factor of 8.9 in real terms, due mainly to more effective use of policy and technical knowledge, whereas Ghana has decreased its per capita income by almost a factor of 0.1.

**Figure 1-3: Growth in Per Capita Income for Korea and Ghana, 1960–2000**
*(per capita income, in thousands)*




*Source:* World Bank (1999).

Knowledge is more important today than ever, as the twin forces of globalization and technological advances are spurring an ongoing knowledge revolution. This revolution manifests itself in many ways: closer links between science and technology (S&T), greater importance of innovation for economic growth and competitiveness, increased importance of education and lifelong learning, and more investment in intangibles (R&D, software, and education); the latter is even greater than investments in fixed capital. At the same time, of course, a revolution in information and communications technology (ICT) is increasing worldwide interdependency and connectivity. These trends have led to increased globalization and competition: although trade represented 38 percent of world GDP in 1990, this ratio had risen to 57 percent in 2001.

This dynamic process is creating constant restructuring at the global, country, sector, and firm levels, raising tremendous possibilities for enhancing growth and competitiveness, but also carrying the risk that countries or firms and organizations will fall behind if they cannot keep up with the pace of rapid change. Consequently, countries' competitiveness depends more than ever on their ability to access, adapt, utilize, and create knowledge.

The term "knowledge economy" has been coined to reflect this increased importance of knowledge for economic development. Despite the hype that has surrounded the concept, the idea of a knowledge economy is not in itself entirely new. Use of knowledge has always been a critical ingredient of economic success; however, its importance has increased in recent times to the point that knowledge has become the key driver of economic competitiveness and success. Improved knowledge has led to increasing productivity, and the creation and application of new technologies has increased the range of products and services and brought revolutionary change to virtually all markets and sectors.

The knowledge economy is often taken to mean only high-technology industries or ICTs, but the more important question is how economies are using appropriate knowledge to improve productivity and increase welfare. Creation of new knowledge and use of existing knowledge can be relevant in a variety of circumstances, manifesting not just as leading-edge scientific discoveries, but, more generally on how to do things better. For example, application of new techniques to subsistence farming can significantly increase yields and use of information and logistical services can allow traditional craft sectors to serve much wider markets than before.

*Embracing the knowledge economy.* In short, a knowledge economy is one that creates, disseminates, and uses knowledge to enhance its growth and competitiveness. Successful transition to a knowledge economy is founded on four essential pillars (Box 1-3).

**Box 1-3: Four Pillars of the Knowledge Economy**

1. *An economic and institutional regime* that provides incentives for the efficient creation, dissemination, and use of existing knowledge
2. *An educated and skilled population* that can create and use knowledge
3. *An efficient innovation system* of firms, research centers, universities, consultants, and other organizations that can tap into the growing stock of global knowledge and assimilate and adapt it to local needs, as well as to create relevant new knowledge
4. *Dynamic information infrastructure* that can facilitate the effective communication, dissemination, and processing of information.

*Source:* Knowledge for Development Program.

Making effective use of knowledge in any country requires developing appropriate policies, institutions, and investments and coordination across these four pillars, because of the strong interdependencies that exist among them. The economic and institutional regime is in a sense the most critical pillar of the knowledge economy, because it provides the context for the effectiveness of the other three functionally focused pillars (education, innovation, and ICTs).

*Advantage India.* India can count on a number of strengths as it strives to transform itself into a knowledge-based economy: it has a good base of skilled human capital, especially in the sciences; a democratic system; widespread use of English; macroeconomic stability; a dynamic private sector; institutions of a free market economy; a local market that is one of the largest in the world; a well-developed financial sector; and a broad and diversified S&T infrastructure. In addition, development of the ICT sector in recent years has been remarkable. India has created profitable niches in IT and is becoming a global provider of software services. It is a sought-after venue for services in global production chains, all the way from call centers, financial accounting, and database production to international firms that are using India in banking, insurance, technology and telecoms, engineering, and business services. As a result, India's software and service exports totaled an impressive $12.5 billion in 2003–04 and the IT industry contributed an estimated 3.82 percent of India's GDP in 2003–04. In terms of state-led efforts, the state of Andhra Pradesh is developing Hyderabad into a "cybercity" and establishing an impressive "e-governance" infrastructure.

India is also becoming a sought-after destination for R&D, and multinationals are increasingly investing in Indian science. Nearly 100 multinational corporations (MNCs) have R&D facilities in India. General Electric, for example, has 1,800 people in its R&D center in Bangalore, a quarter of whom have Ph.D.s! Although China remains the top destination for FDI in the world, a recent 2004 survey by A.T. Kearney has India in third place, just behind the United States at second. A new S&T policy has been formulated in India to spur innovation and R&D to meet national needs in the new era of globalization. India itself has great strengths in biotechnology and pharmaceuticals; companies such as Biocon, Ranbaxy, and Dr. Reddy's Laboratories are at the forefront of research and drug discovery. In addition, a huge reservoir of creativity exists in traditional knowledge and local entrepreneurship, which is being encouraged by various measures (including a recently created National Innovation Foundation). A series of laws on intellectual property rights (IPRs) have been passed in the past two years and on January 1, 2005, India introduced a patent regime that makes it WTO compliant. India is thus well placed to embrace the knowledge economy and enhance its position on the global stage, as is amply demonstrated in the following section.

**Assessing India's Opportunities and Challenges in the Knowledge Economy**

To create and sustain an effective knowledge economy, countries must put in place appropriate arrangements to grow, become more competitive, and increase welfare. This process initially means understanding their relative strengths and weaknesses and then acting on them to develop appropriate policies and investments to give direction to their ambitions, as well as devising mechanisms to monitor progress against the goals set.

*Benchmarking India's overall knowledge readiness.* The World Bank Institute's interactive web-based Knowledge Assessment Methodology (KAM) (http://www.worldbank.org/kam) is a tool that helps to benchmark a country's position relative to others in the global knowledge economy. The KAM includes several quantitative and qualitative variables that compare an economy with its neighbors, competitors, or other countries that a country wishes to emulate on the four pillars of the knowledge economy: economic and institutional regime, education and human resources, innovation, and ICTs. The KAM helps to identify problems and opportunities that a country faces in making the transition to a knowledge economy and where it may need to focus policy attention or future investments. The unique strength of the KAM is its cross-sectoral approach, allowing users to take a holistic view of a wide range of relevant factors, rather than focusing on just one pillar.

The 2005 version of the KAM includes 80 quantitative and qualitative variables for a group of 128 countries, which includes most of the developed economies of the Organisation for Economic Cooperation and Development (OECD) and more than 90 developing countries. Annex 2 provides more information on the KAM, including the normalization procedure used to rank countries.

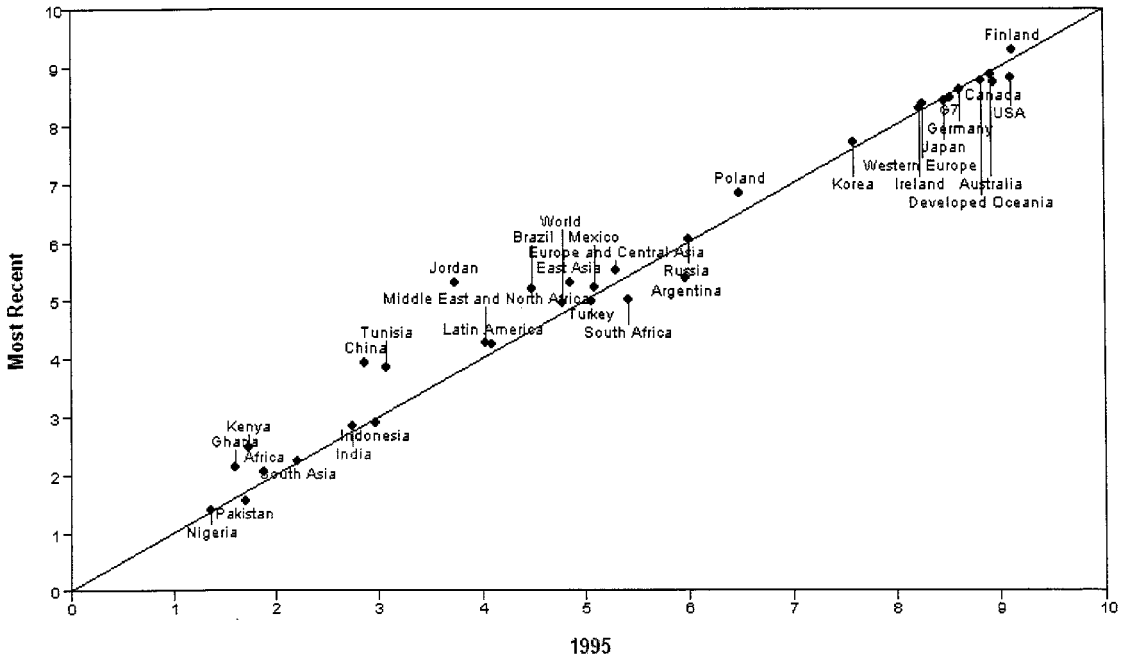
This section benchmarks India with comparator countries and assesses the challenges and opportunities facing the country in the four interrelated pillars of the knowledge economy. Using the KAM, the benchmarking exercise compares India with the South Asia Region (India, Sri Lanka, Bangladesh, Pakistan, and Nepal), as well as large global players and competitors (such as Brazil and China), and advanced and emerging economies (such as Korea, Poland, and Russia). Korea is an example of a country that in 40 years transformed itself from a low-income country to a leading one based on knowledge and innovation. Poland was chosen because it is a large economy that is successfully pursuing a transition from a socialist to knowledge-based, market-driven economy. India and Russia share some structural characteristics: not only are they both large economies at advanced stages of the transition to market-oriented systems, but they also share important similarities on the various knowledge economy pillars. For example, in education, both have a highly skilled workforce, especially in the sciences and

engineering, but their economic and institutional environments suffer from certain weaknesses that prevent them from fully harnessing the benefits of knowledge for growth and development.

The following charts paint a preliminary picture of India's knowledge preparedness from the mid-1990s to the early years of this decade (for the latest years that data are available). Figure 1-4 highlights the Knowledge Economy Index (KEI), which is the average of the performance scores of a country or region on the four pillars of the knowledge economy. Three variables are chosen as proxies for each of the four pillars that constitute the KEI:

- *Economic and institutional regime:* tariff and nontariff barriers, regulatory quality, and rule of law
- *Education and human resources:* adult literacy rate (percent age 15 and above), secondary enrollment, and tertiary enrollment
- *Innovation system:* researchers in R&D, patent applications granted by the U.S. patent and Trademark Office (USPTO), and scientific and technical journal articles (all weighted per million people)
- *Information infrastructure:* telephones per 1,000 persons, computers per 1,000 persons, and Internet users per 10,000 persons.

**Figure 1-4: Knowledge Economy Index, India, Comparators, and the World, 1995 and Most Recent Period**



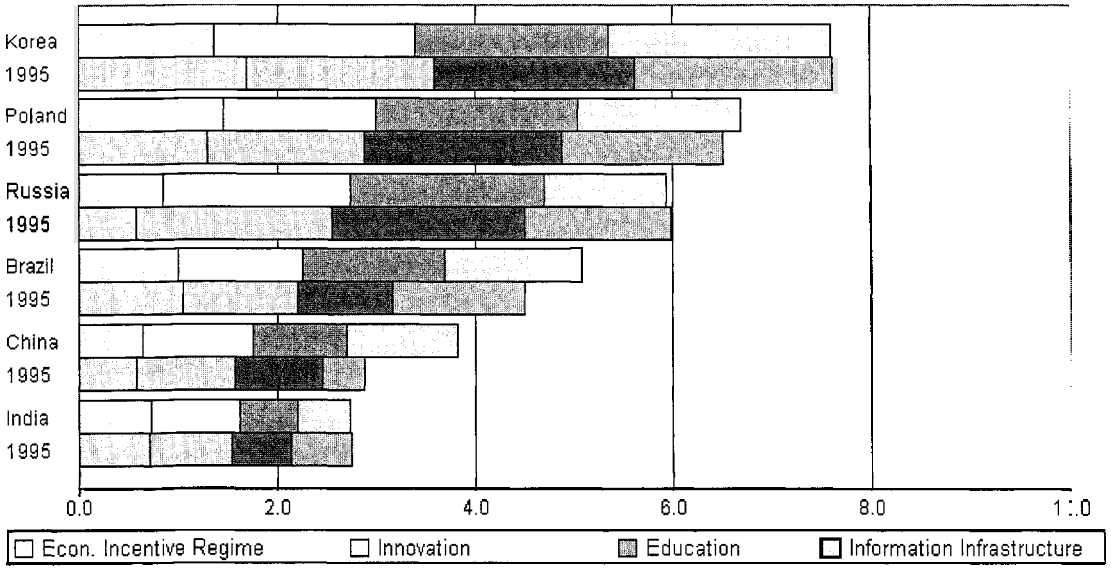

*Note:* Countries above the 45-degree line have improved their position in the KEI for the most recent period for which data are available relative to their position in 1995 (or closest available date in the mid-1990s) and vice versa for countries below the line.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

Figure 1-4 shows that India occupies the top of the bottom third of the distribution on the global knowledge economy map, suggesting that more could be done to harness knowledge for its development. India leads the South Asia and Africa Regions in terms of the KEIs between 1995 and the most recent period for which data are available. India has also slightly improved its relative position during this period, as have all other comparator countries albeit to different degrees. China, Brazil, and, to some

extent, Poland have improved their positions relative to 1995 by far greater margins than have Russia or Korea.

*Rating India's performance.* Using the KAM, it is also possible to see how India has performed on the four individual pillars of the knowledge economy, using the KEI in relation to chosen comparators. In Figure 1-5, the two bars represent the aggregate KEI score for a selected country for the most recent years for which data are available and for 1995, split into the four pillars (see legend at the bottom of Figure 1-5). Each colored band represents the contribution of a particular pillar to a country's overall knowledge readiness. Annex 3 presents overall KEIs as well as those for each pillar for India and comparators.

**Figure 1-5: Cross-Country Comparison on the Four Pillars of a Knowledge Economy, India and Comparators, 1995 and Most Recent Period**




*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam

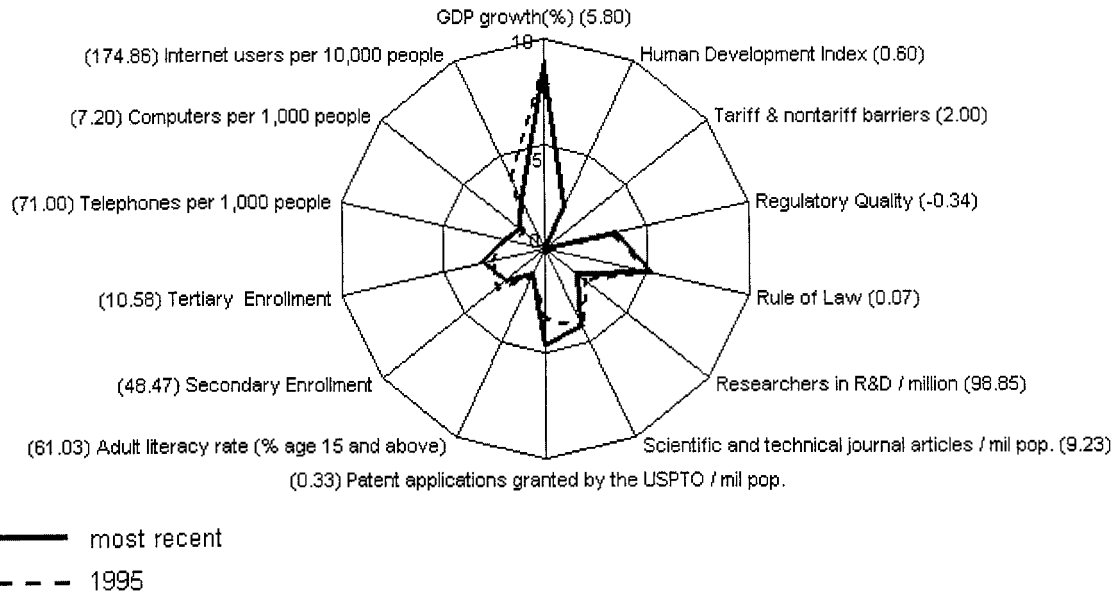
Figure 1-5 shows the dramatic improvements made by countries on their overall preparedness for the knowledge economy during this period. Korea leads the pack, which is not surprising, as it is one of the leading countries in the world making progress in its transition to the knowledge economy, followed by Poland, Russia, Brazil, China, and India. All countries, except Korea and India, have improved their most recent performance since 1995. India has slightly worsened its most recent overall KEI score compared with 1995 due to slightly declining performance in the education pillar, but more so due to weak performance in the information infrastructure pillar. India contrasts strongly with China on the latter, as China has succeeded remarkably in improving its information infrastructure in the past half decade or so.

The scorecard in Figure 1-6 is yet another way to look at India's performance relative to the 128 countries included in the KAM between 1995 and the most recent period for which data are available. (See annex 4 for scorecards for Brazil, China, Korea, Poland, and Russia.) The scorecard includes three variables for each of the four pillars of the knowledge economy, as well as two variables relating to performance: GDP growth and the HDI.

When a country's performance seems to have declined in the most recent period—that is, the scorecard shows it falling behind, as the scorecard shows for some variables for India—this decline can happen for two reasons:

- A country may have lost ground in absolute terms (which often occurs on education enrollment rates).
- Even if the country has made a several-fold improvement, it could still fall behind, because the world may on average have improved much more significantly. This often happens with information infrastructure penetration ratios, because of the very fast rate of change globally in this sector.

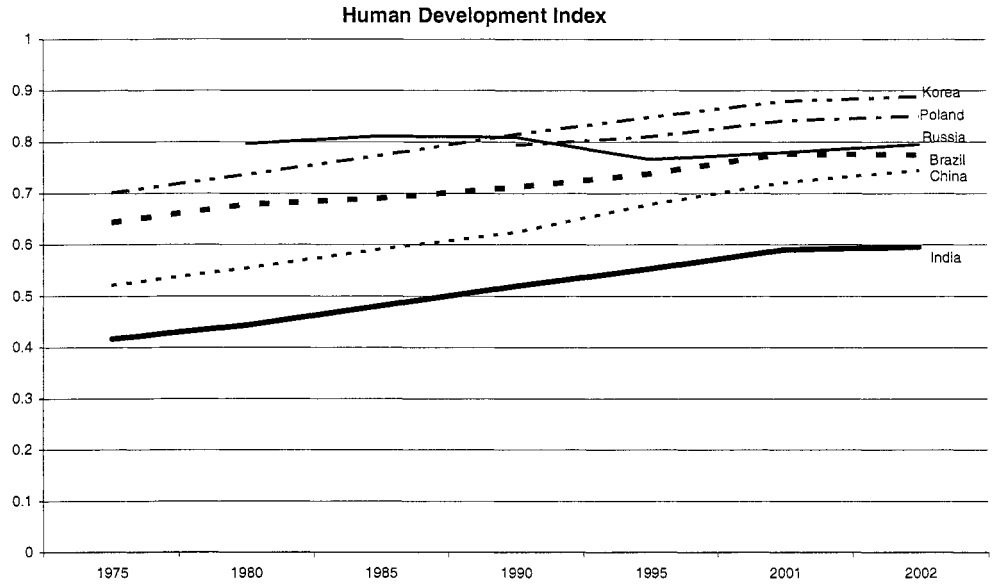
**Figure 1-6: India's Knowledge Economy Scorecard on Selected Variables, 1995 and Most Recent Period**




*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10 for 128 countries. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for India for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

Figure 1-6 rightly showcases India's strong GDP growth in the past six to seven years. The country has also made steady progress on the HDI between 1995 and 2002. India's performance in the HDI is even more evident in the data in Figure 1-7, although all the comparator countries have been improving their performance and are placed higher than India for the same period.

**Figure 1-7: Progress on the Human Development Index, India and Comparators, 1975–2002**



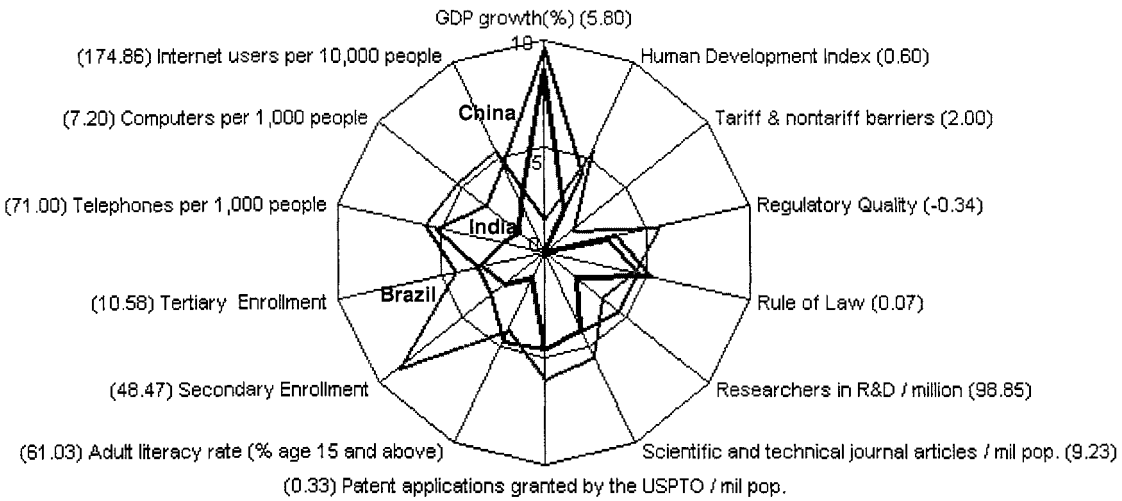

*Source:* World Bank internal database.

The scorecard in Figure 1-6 and the underlying data presented in annex 5 for Brazil, China, and India show that India's overall development pattern does has not appear to have changed much in terms of the knowledge economy during the past half decade. Looking at the four pillars of the knowledge economy at two points in time—1995 and the most recent date for which data are available—reveals the following key points:

- In India's *economic and institutional regime,* the country has not demonstrated significant changes, as evidenced by the unchanged scores on tariff and nontariff barriers. The rule of law has improved slightly, but regulatory quality has witnessed a slight decline in the past half decade or so.
- In *education,* India has improved its adult literacy, but slightly worsened its most recent performance in secondary enrollments due to stagnation of these ratios in this period, while many other countries, notably Brazil, more than doubled their secondary enrollments. India, however, has made noteworthy strides in increasing its tertiary enrollment ratio. India led China in terms of its gross enrollment ratio (GER) for tertiary education until 1999, after which China surpassed India. In 2001 India had a tertiary GER of 11.6 percent, compared with 12.7 percent for China.
- India's *innovation system* does not show great improvement; in fact, India has seen a small deterioration in terms of researchers in R&D per million people as well as scientific and technical journal articles per million people; however, in terms of patent applications granted by USPTO per million people, India has seen a notable improvement. It must be noted, however, that the three variables shown in Figure 1-6 are all scaled by population, and India does have significant innovation competencies in terms of absolute size (see chapter 4 for more detail). In the knowledge economy, size does matter and large countries such as India do have a critical mass in research capacity that is essential for spurring innovation.
- Regarding *information infrastructure,* India has made impressive advances in ICTs due to considerable improvements in telephones (fixed plus mobile, in which India has experienced a boom in mobile telephony), computer penetration, and, most laudably, Internet users. Yet, the scorecard in Figure 1-6 shows deteriorating performance for this pillar. Why? Even though India has made a

several-fold improvement in its information infrastructure penetration ratios in *absolute* terms in the past few years, it has fallen behind in *relative* terms, because the world on average has moved faster and improved much more significantly. The contrast is even more striking by *overlaying* India's most recent performance with those of its two closest competitors, Brazil and China (Figure 1-8). Both Brazil and China have made much stronger leaps in enhancing their information infrastructures than India, as evidenced by the variables for telephones, computers, and the Internet; they have also improved on the other pillars.

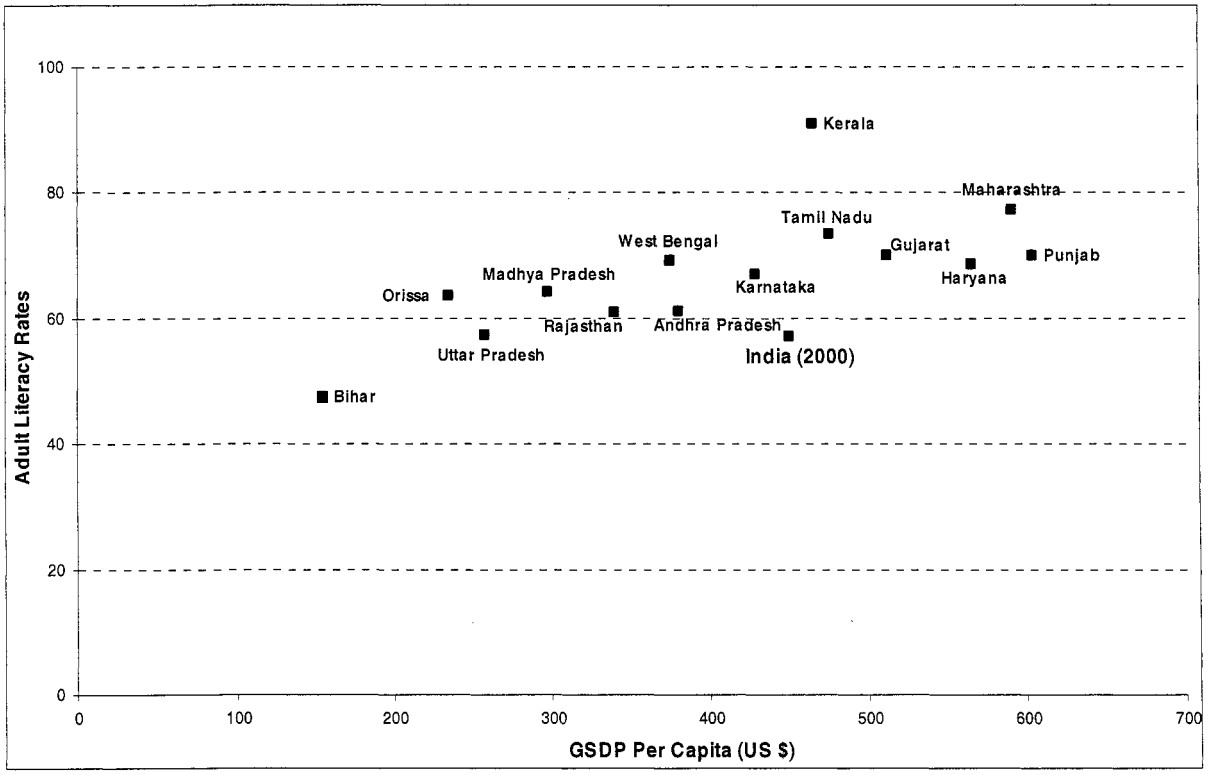
**Figure 1-8: Knowledge Economy Scorecards on Selected Variables for Brazil, China, and India, Most Recent Period**




*Note:* Values in parentheses denote actual values for India for the most recent period for which data are available. Each of the 80 variables in the KAM is normalized on a scale of 0 to 10. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

*Acknowledging knowledge disparities among Indian states.* So far, the chapter has focused on India's position as a whole on the global knowledge economy. But, India is a country of great diversity with many states leading the way in embracing the knowledge economy and others lagging behind. At this stage, disaggregated data related to overall knowledge readiness of various Indian states are unfortunately not available. A rough idea of the diversity that exists among states can be gleaned from Figure 1-9, which provides a snapshot of the performance of selected Indian states based on two proxy variables: gross state domestic product per capita and literacy rates. The figure shows that some states, such as Maharashtra and Punjab, have almost one and a half times the per capita income of India and others such as Kerala have very high literacy rates, comparable to those in some middle-income countries. Yet others, such as Bihar have less than half the average per capita income of India and very low literacy rates. Moreover, great diversity exists within states.

**Figure 1-9: Gross State Domestic Product and Literacy Rates for Indian States, 1999–2000**




*Note:* Data for India represent its GDP and adult literacy rates as a whole for 2000.
*Source:* World Bank staff analysis undertaken using World Bank internal database.

## Other Global Comparisons with India

A variety of recently developed international benchmarking comparisons attempt to rank countries' preparedness for the knowledge economy. Most of them suggest that India can do much more to strengthen its overall global competitiveness.

*Global competitiveness ranking.* The World Economic Forum (WEF) is often cited: its *Global Competitiveness Report 2004–2005* (WEF 2004a) assesses the comparative competitive strengths and weaknesses of 104 industrialized and emerging economies. The report includes two major competitiveness indexes—the Growth Competitiveness Index (GCI) and the Business Competitiveness Index (BCI)—which are designed to enhance understanding of the key factors that determine economic growth and explain the greater success of some countries than others in raising income levels and opportunities for their respective populations and, in so doing, joining the upper ranks of international competitiveness.

*The Growth Competitiveness Index* (GCI) is intended to gauge the ability of the world's economies to achieve sustained economic growth in the medium to long term. The GCI identifies three important areas in the evolution of growth in a country: quality of the macroeconomic environment, state of public institutions, and level of technological readiness. In 2004 Finland was the most competitive economy of 104 countries, holding this position for the third time in the past four years. It is very well managed at the macroeconomic level, but also scores very high in measures assessing the quality of its public institutions. Furthermore, the private sector shows a high proclivity for adopting new technologies and nurturing a culture of innovation. The United States ranked second: its overall technological supremacy was partly

offset by weaker performance in areas that capture the quality of its public institutions and the stability of its macroeconomic environment. In terms of other countries, in 2004 Korea ranked 29th and China 46th. *India came in at 55th*, mainly because it has outperformed many countries in terms of its strong economic growth in recent years, followed by Brazil at 57th and Poland at 60th. India also ranked 55th (of 102 countries) in 2003.

Delving into the reasons for India's ranking shows that its macroeconomic environment and quality of public institutions (two of the three components measured by the index), for which India is ranked 52nd and 53rd, respectively, are slightly stronger than its average ranking. These overall ranks are boosted by several strong areas in the macroeconomic environment, such as the facility of obtaining access to credit (for which India ranked 2nd) and low expectations of a recession (also ranked 2nd). In terms of the quality of public institutions, judicial independence and property rights (where India ranked 32nd and 34th, respectively) are also considered competitive advantages for India.

In the technology component of the GCI, India ranked 63rd of 104 countries. Although India fared well in prevalence of foreign technology licensing (where it ranked 8th) and government prioritization of ICT (ranked 9th), it still held a comparatively lower position in terms of ICT, for which it is disadvantaged by the number of cellular telephones (ranked 94th) and Internet hosts (ranked 91st) (WEF 2004b). Again, this fact underscores the point that, even though India has been making tremendous strides in improving its information infrastructure, the world as a whole has moved ahead much faster, so that in relative terms, India has fallen behind.

*The Business Competitiveness Index* (BCI) emphasizes a range of company-specific factors that are conducive to improved efficiency and productivity at the micro level. The BCI complements the medium-term, macroeconomic approach of the GCI and evaluates the underlying microeconomic conditions defining the current sustainable level of productivity in each of the countries covered. The underlying concept is that, although macroeconomic and institutional factors are critical for national competitiveness, they are necessary but not sufficient factors for creating wealth (which is created at the micro level by companies). The BCI comprises two subindexes: one focuses on company operations and strategy ranking and the other on the quality of the business environment in which a nation's firms compete.

India has greatly improved its performance on the BCI in the latest WEF 2004–05 report. *India ranked 30th in 2004,* compared with 37th in both 2002 and 2003 and 36th in 2001. In the 2004 rankings, India did better than Brazil (38th), China (47th), Poland (57th), and Russia (61st). In the subindexes, India ranked 30th in company operations and strategy and 32nd in the quality of the national business environment; thus, despite marked improvement in India's overall BCI ranking, the subindexes show that India has more to do in business environment and company sophistication, public administration effectiveness, and marketing to enhance its overall business competitiveness.

*Globalization ranking.* Globalization also adds to the pressures for economies to strengthen their international competitiveness. Debate continues on whether countries should globalize and whether globalization can be a positive force for development. Whatever the stance, it seems that globalization is here to stay. Many countries, including China, have decided that opening up their economies to trade in goods and services is one way to lift their people out of poverty. These countries are now focusing their efforts on how to globalize in the most stable and advantageous manner; some prefer to go faster, and some more slowly.

*The Globalization Index,*[6] developed by A. T. Kearney and *Foreign Policy* magazine, uses several indicators spanning IT, finance, trade, personal communications, politics, and travel to determine a country's ranking. The 2004 Globalization Index ranked 62 countries for 14 variables grouped in four baskets:

- *Economic integration:* trade, foreign direct investment, portfolio capital flows, and investment income
- *Technological connectivity:* Internet users, Internet hosts, and secure servers
- *Personal contact:* international travel and tourism, international telephone traffic, and remittances and personal transfers (including worker remittances, compensation to employees, and other person-to-person and nongovernmental transfers)
- *Political engagement:* memberships in international organizations, personnel and financial contributions to U.N. Security Council missions, international treaties ratified, and governmental transfers.

The 62 countries ranked account for 96 percent of the world's GDP and 84 percent of the world's population. Ireland ranked as the most global nation followed by Singapore in the 2004 rankings. The 2003 index (among 62 countries) placed *India at 56th place,* behind China at 51st, but just ahead of Brazil at 57th, indicating that India was opting for a rather gradual approach in terms of its integration into the global economy. But the 2004 survey shows *India slipping further to 61st place*, behind Brazil at 53rd and China at 57th.

In terms of the four subcategories that comprise the Globalization Index, India ranked 51st in the economic ranking, 53rd in the personal ranking, 55th in the technological ranking, and 57th in the political ranking. Other comparator countries ranked as follows in the 2004 Globalization Index: Poland (31st), Korea (32nd), and Russia (44th).

**Road Map for the Report: Strengthening the Four Pillars of the Knowledge Economy**

This chapter has highlighted recent economic trends that will impact India's economy, the importance of the knowledge economy in development, and overall opportunities and challenges India faces as it moves toward becoming knowledge based. The next four chapters (2–5) delve into specific challenges India faces in strengthening each pillar of the knowledge economy, identifying relative strengths and weaknesses in each and capturing factors that can contribute to India's effective transition to a knowledge economy. Each chapter includes a benchmarking assessment, comparing India's current position with those of relevant comparator countries, issues and recent developments relating to each pillar, measures to strengthen that pillar, and a summary of issues and recommendations.

Following this review of the four pillars, chapter 6 summarizes several Indian initiatives on the knowledge economy and looks at ways of developing a consultative process to stimulate a greater sense of the importance of the emerging policy agenda on the knowledge economy in India to enhance its growth and competitiveness. The chapter highlights the need for coordination among government (both central and state), the private sector, and civil society for India to harness knowledge and expertise for the benefit of all.

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[6] The 2004 Globalization Index is available at http://www.foreignpolicy.com/story/files/story2493.php?PHPSESSID=0190a1349088fbc190e4e2475333399d.

# 2. ECONOMIC AND INSTITUTIONAL REGIME, INCLUDING GOVERNANCE

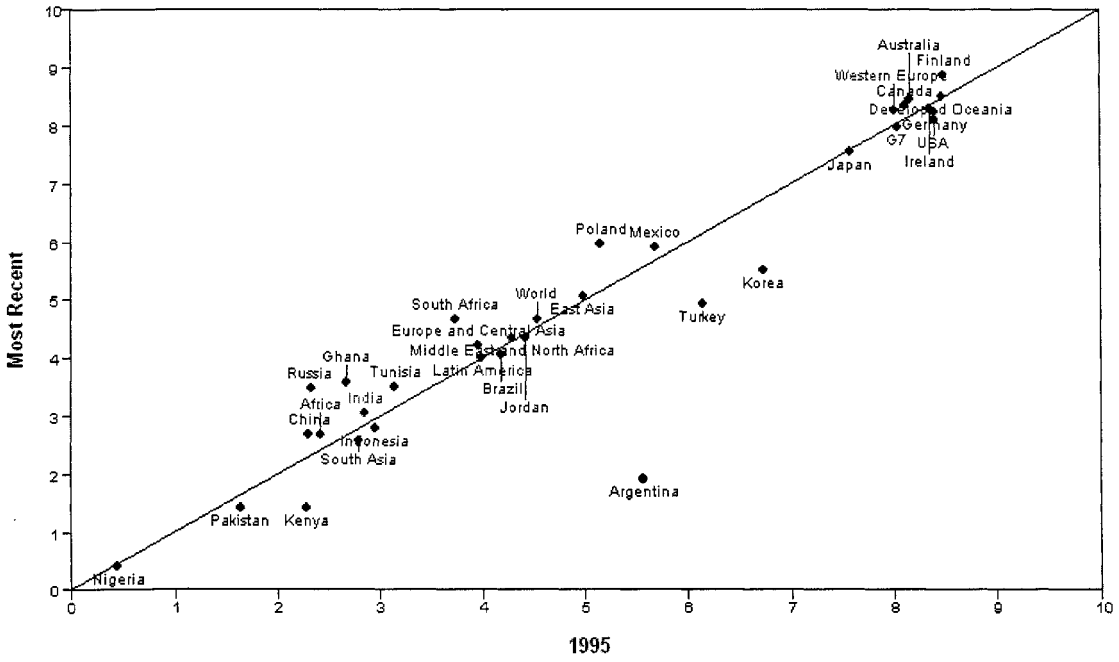
Taking advantage of the potential offered by the knowledge revolution hinges on having an effective economic incentive regime and institutions that promote and facilitate the redeployment of resources from less efficient to more efficient uses. The economic and institutional regime allows organizations, people, and institutions to adjust to changing opportunities and demands in flexible and innovative ways. This is the first and, in a sense, fundamental pillar of the knowledge economy, because in the absence of a strong economic incentive and institutional regime that deploys resources to productive uses, it is possible to have a strong educational base, highly developed R&D infrastructure, or global niches in IT, but miss out on the full benefits of these achievements.

Key elements of the economic and institutional regime include macroeconomic stability, competition, regulatory policies, and legal rules and procedures that are conducive to entrepreneurship and risk taking. A key feature is the quality of government, because its integrity and effectiveness determine the basic rules of a society. Another important element is the extent to which the legal system supports basic rules and property rights. An effective economic and institutional regime includes having a competitive environment that stimulates improved economic performance, a financial system that mobilizes and allocates capital to its most productive uses, flexible labor markets including support for improving the skills of the labor force, and effective safety nets to facilitate adjustment to constant restructuring. This chapter looks at key elements of the economic and institutional regime for India, including governance issues.

**Benchmarking the Economic and Institutional Regime**

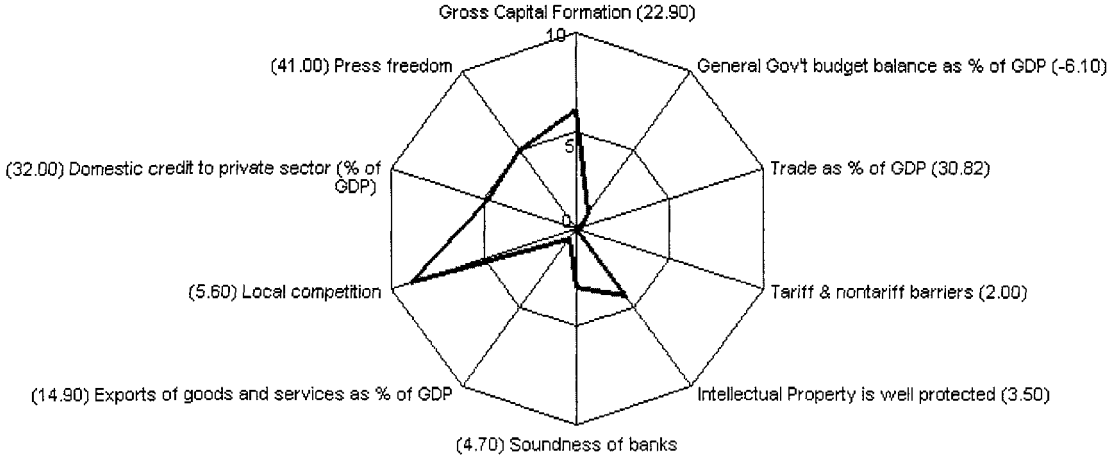
Compared with the rest of the world, India has improved its relative position on this pillar (Figure 2-1). India leads the South Asia and Africa Regions, as well as China on its economic and institutional regime between 1995 and the most recent period for which data are available. Huang and Khanna (2003) cite several strengths of India's economic and institutional regime compared with China: democracy; a tradition of entrepreneurship; a much stronger infrastructure supporting private enterprise; capital markets that operate with greater efficiency and transparency than in China; a legal system, although not without substantial flaws, that is considerably more advanced; flourishing entrepreneurship and free enterprise; and an independent judiciary. Property rights are not fully secure, but the protection of private ownership is certainly far stronger than in China; the rule of law, a legacy of British rule, generally prevails; and corporate governance has improved dramatically.

**Figure 2-1: India and the World: Positions in the Economic Incentive Regime, 1995 and Most Recent Period**




*Note:* Countries above the 45-degree line have improved their position in the economic incentive regime for the most recent period for which data are available relative to their position in 1995 (or closest available date in the mid-1990s) and vice versa for countries below the line.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

**Figure 2-2: India's Scorecard on the Economic Incentive Regime, Selected Variables, Most Recent Period**




*Note:* Each of the 80 variables in the KAM, including qualitative surveys on certain variables by the World Economic Forum, is normalized on a scale of 0 to 10 for 128 countries. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for India for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

Figure 2-2 shows several variables that are related to India's economic and institutional regime as presented in the KAM. Annex 6 provides the scorecards for other comparator countries for this pillar. Figure 2-2 shows that India is characterized by relatively low levels of investment—23 percent compared with Korea's 31 percent and China's 39 percent—but its investment rates are comparable to those of Poland, Russia, and Brazil (all between 21 and 22 percent). Trade as a percentage of GDP is not high (almost 31 percent compared with 55 percent in China, but better than about 29 percent in Brazil); its exports of goods and services at about 15 percent, although comparable to Brazil at 15.5 percent, are less than half those in China (33 percent). India is a relatively closed economy, as shown by its low ranking on tariff and nontariff barriers. Qualitative surveys on certain variables by the World Economic Forum included in Figure 2-2 suggest that India has much more to do to strengthen its intellectual property rights regime. India also ranks rather low on the soundness of banks, but does much better when it comes to the intensity of local competition in the country, in which it outshines all comparator countries. India does have a free and diverse press, published in Hindi, English, and vernacular languages. In 2001, for example, 5,638 daily newspapers operated with a combined circulation of 57.8 million copies and 45,974 periodicals with a total circulation of 56.9 million (EIU 2003a).

**Benchmarking Governance**

Governance can be broadly defined as the set of traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored, and replaced; capacity of the government to formulate and implement sound policies effectively; and respect of citizens and the state for the institutions that govern economic and social interactions among them. In recent years, many measures have been developed to capture governance dimensions in countries. The World Bank Institute has developed succinct "snapshots" that trace six areas of governance for almost 200 countries from 1996 to the present (World Bank 2002b). These include the following:

- *Regulatory quality* measures the incidence of market-unfriendly policies, such as price controls or inadequate bank supervision, as well as perceptions of the burdens imposed by excessive regulation in areas such as foreign trade and business development.
- *Rule of law* measures the extent to which agents have confidence in and abide by the rules of society. These include perceptions of the incidence of both violent and nonviolent crime, effectiveness and predictability of the judiciary, and enforceability of contracts.
- *Government effectiveness* combines into one grouping perceptions of the quality of public service provision, quality of the bureaucracy, competence of civil servants, independence of the civil service from political pressures, and credibility of the government's commitment to policies.
- *Voice and accountability* relate to various aspects of the political process, civil liberties, and political rights, and measures the extent to which citizens of a country are able to participate in selection of governments. Also included are indicators measuring the independence of the media.
- *Political stability* measures perceptions of the likelihood that the government in power will be destabilized or overthrown by possibly unconstitutional means or violent means.
- *Control of corruption* corresponds to "graft" measures of corruption and is measured by the frequency of "additional payments to get things done" and the effects of corruption on the business environment.

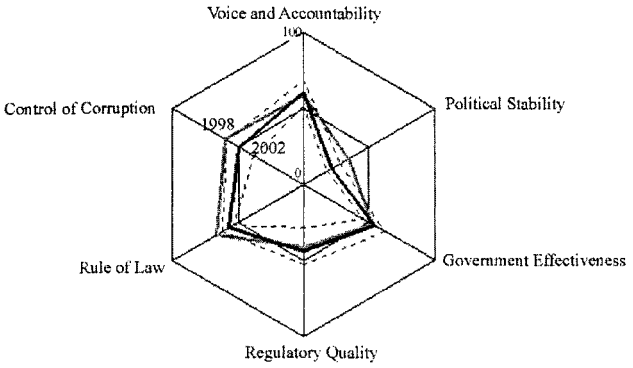
Figure 2-3 presents governance charts for *(a)* India between 1998 and 2002, *(b)* India compared with the South Asia Region (2002), and *(c)* India compared with countries at its level of income (2002) (annex 7 presents the underlying data).

These figures show a mixed picture of the various governance indicators for India.[7] In Figure 2-3a, between 1998 and 2002 India maintained its rankings on only three of the six variables: government effectiveness, regulatory quality, and voice and accountability, but fell on the other three. Short-term determinants of changes between 1998 and 2002 in political stability may include escalating tension with Pakistan, especially after the terrorist attack on the Indian Parliament in December 2001. Perceptions of a decline in the rule of law could be fueled by civil unrest caused by riots in Gujarat in February 2002 (Freedom House 2003), fear of armed conflict with Pakistan, and rise in organized crime and extortion, particularly in Mumbai. The low ranking on control of corruption could result from frustration with the ability of government to sanction corrupt officials through formal channels. The Indian press and public opinion have increasingly been particularly concerned about problems of corruption in public life. These are, of course, only tentative and possible explanations for these rankings and, therefore, deserve further analysis.

Regarding regional and income-level comparisons, Figure 2-3 *(b)* and *(c)* for 2002 show that India leads the South Asia Region as well as the low-income countries on all governance dimensions, except for political stability. The reasons for this are hard to discern, but one possible explanation may be that the data for these variables were taken from a time in the recent past when tensions with Pakistan were escalating. Again, this aspect deserves further analysis.

**Figure 2-3: Governance Comparisons: India (1998 and 2002), with South Asia (2002), and with Low-Income Countries (2002)**

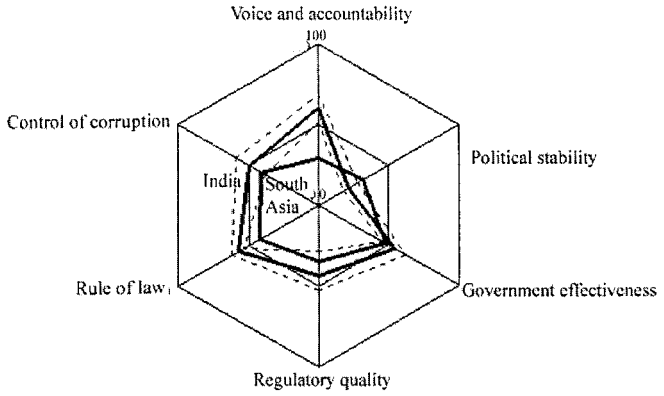
***(a)* India: 1998 and 2002**




Comparison between 2002 (inside black line) and 1998 (outside gray line)

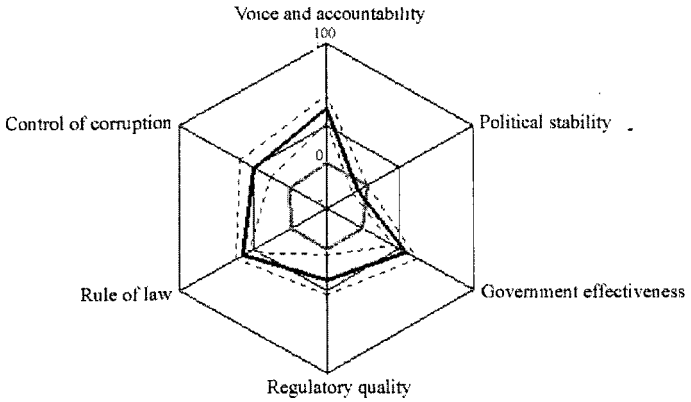
[7] The governance indicators presented in Figure 2-3 (a, b, and c) reflect the statistical compilation of responses on the quality of governance given by a large number of enterprise, citizen, and expert survey respondents in industrial and developing countries, as reported by a number of survey institutes, think tanks, NGOs, and international organizations. Countries' relative positions on these indicators are subject to margins of error that are clearly indicated; consequently, precise country rankings should not be inferred from these data. The 2002 confidence range at 90 percent is depicted by the dotted lines (Kaufmann, Kraay, and Mastruzzi 2003).

*(b)* **India and South Asia, 2002**




Comparison of India (outside black line) with regional average (South Asia, inside gray line) and country's percentile rank (0-100)

*(c)* **India and Low-Income Countries, 2002**




Comparison of India (outside black line) with income category average (low income, inside gray line) and country's percentile rank (0-100)

*Source:* Kaufmann, Kraay, and Mastruzzi (2003).

## Issues and Recent Developments in the Economic and Institutional Regime

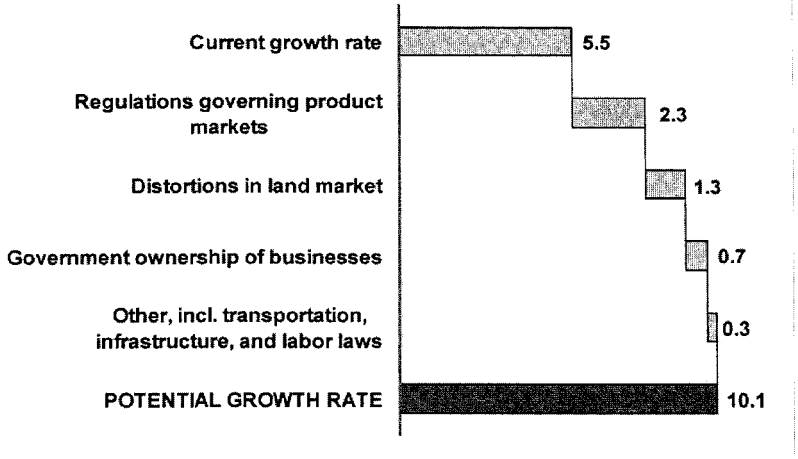
India has tremendous possibilities for increased economic growth. The country is endowed with several intrinsic advantages: macroeconomic stability, a large domestic market, a large and relatively low-cost and skilled workforce that should allow the country to emerge as a major hub for manufacturing and service industries, a critical mass of well-educated workers in engineering and science, and abundant raw materials. India's growth, however, is hampered by several factors: declining productivity of the public sector, relatively low integration into the global economy, limited levels of FDI, an investment climate that needs strengthening, and weak infrastructure. Whether India can achieve the ambitious target of increasing its growth rate to an average of 8 percent between 2002 and 2007, as set out in its Tenth Five-

Year Plan (India, Planning Commission 2002e), is crucially dependent on progress it can make in each of these areas.

Given the importance of the economic and institutional regime for the functioning of the economy as a whole, this section reviews issues and recent developments related to this pillar that are critical to India's progress toward becoming a knowledge economy.

*Dismantling barriers to growth.* For the past decade, India's GDP has been growing at approximately 6 percent a year, compared with 10 percent in China. Keeping this in mind, in 2001 the *McKinsey Global Institute* examined India's economy to see what was holding it back and which policy changes would accelerate its growth to match that of China (Di Lodovico and others 2001). The study found three main barriers to faster growth in India: multiplicity of regulations governing product markets, distortions in the market for land, and widespread government ownership of businesses (Figure 2-4).[8]

**Figure 2-4: Eliminating Barriers for Faster Growth in India**
*(percent)*




*Source:* Based on a chart in Di Lodovico and others (2001).

The authors contend that these three barriers have a depressing effect, because they protect Indian companies from competition and thus from pressures to raise productivity. The authors calculate that these three barriers together inhibit GDP growth by more than 4 percent a year. Removing them would free India's economy to grow as fast as China's, that is, at 10 percent a year. Some 75 million new jobs would be created outside agriculture, enough not only to absorb the rapidly growing workforce, but also to reabsorb the majority of workers displaced by productivity improvements. In addition, if each Indian

[8] For the study, the authors examined 13 sectors in detail: two in agriculture, five in manufacturing, and six in services, which taken together, accounted for 26 percent of India's GDP and 24 percent of its employment. The study notes the following points: *(a)* Product market barriers include unfairness and ambiguity of policies; uneven enforcement; a number of products that are reserved for small enterprises; restrictions on FDI in certain sectors of the economy such as retailing, which closes off fruitful sources of technology and skills; and licensing requirements that stifle competition. These rules and policies governing different sectors of the country's economy impede GDP growth by 2.3 percent a year. *(b)* Close to 1.3 percent of lost growth a year results from distortions in the land market, which include unclear ownership; counterproductive taxation; and inflexible zoning, rent, and tenancy laws. *(c)* Government ownership of businesses is yet another barrier, as government-controlled entities still account for around 43 percent of India's capital stock and 15 percent of employment outside agriculture. Their labor and capital productivity levels are well below those of their private competitors, because public-sector managers experience little performance pressure. India's electricity sector is an example of inefficient government control. The study estimates that privatizing state electricity boards would save government subsidies amounting to almost 1.5 percent of GDP and oblige managers to improve their financial and thus operational performance (Di Lodovico and others 2001).

state could attain best practice in India in terms of investment climate, the economy could grow about an estimated 2 percentage points faster.

The McKinsey report outlines various policy changes that would help dismantle these critical barriers to higher productivity and growth. The report suggests eliminating the practice of reserving products for small-scale manufacturers, rationalizing taxes and excise duties, establishing effective and procompetitive regulation as well as powerful independent regulators, reducing import duties, removing restrictions on foreign investment, reforming property and tenancy laws, and undertaking widespread privatization.

*Raising public sector productivity.* Another major constraint to achieving higher rates of GDP growth in India is the low level of productivity of the large Indian state sector. The state employs 70 percent of the 27 million workers in organized employment in India, which constitutes less than 7 percent of total employment. Most public-sector enterprises are overstaffed, debt ridden, and inefficient. A high level of unionization has also restricted labor reforms, which has deterred potential investors. Promises to implement the "exit policy," which would permit owners of enterprises that employed up to 1,000 staff to shed workers without government approval, as well as to allow contract employment, have not been fulfilled. The government, however, has made a modest, yet decisive, beginning in privatizing public enterprises by selling some major companies in the past two years. India's private sector companies have also responded positively to the reform process; mergers in several sectors have helped to improve efficiency (EIU 2003a).

*Deepening India's integration into the global economy.* The 1990s has seen progressive integration of the Indian economy into the global economy, albeit on a gradual scale. In the early 1990s, liberalization of investment, trade, and foreign exchange regimes stimulated industrial and services growth and investment. The real depreciation of the rupee after the 1990–91 crisis promoted exports, and reduction of import barriers allowed more foreign goods into the country.

But, as has been noted, India is still a relatively closed economy compared with other Asian economies, where exports account for a much larger share of GDP (33 percent in China and 38 percent in Korea, compared with only 15 percent in India in 2003). India is, therefore, somewhat protected from global trends; the downside is that it does not benefit from stronger foreign competitive pressures to improve performance or from the ability to draw on more cost-effective foreign inputs, such as capital goods, components, products, or foreign investment, which embody more advanced knowledge. As a result, India is losing market share to its major competitors, especially China where reforms have moved ahead much more rapidly.

Tariff protection in India is still higher than in most developing countries (Table 2-1).To speed up trade reform and be able to export, Indian firms need to be allowed to import the materials and technology they need.

**Table 2-1: Custom Duty Rates in India and Other Developing Countries, Various Years**

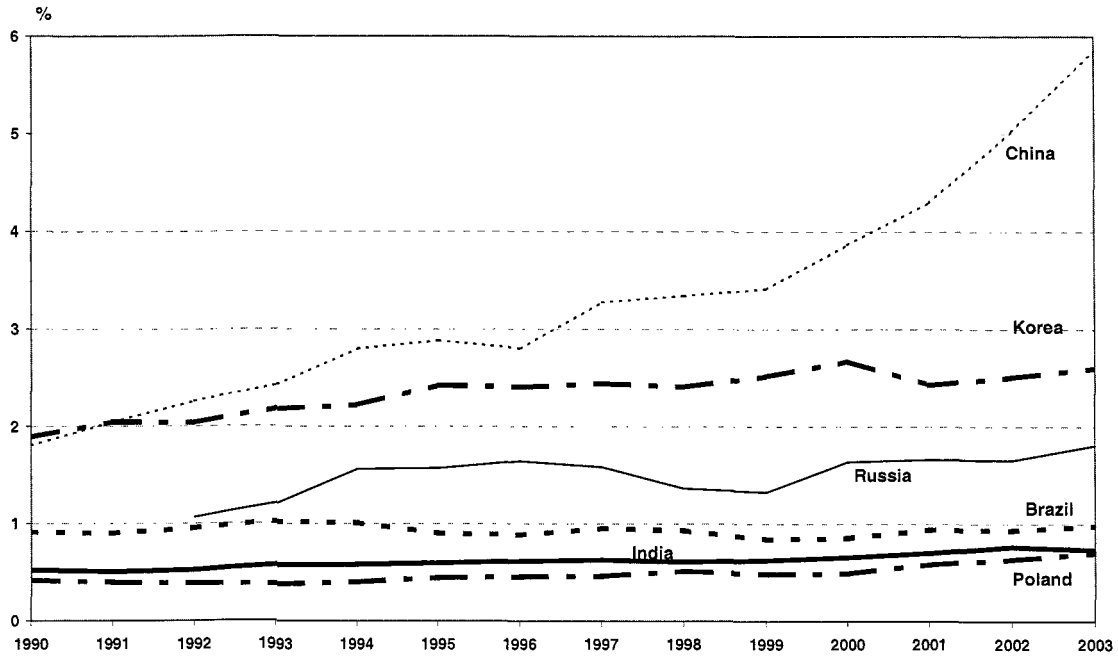
| | All Goods | Agriculture | Manufacturing |
|---|---|---|---|
| India 2001/02(CD only) | 32.3 | 41.7 | 30.8 |
| India 2002/03(CD only) | 29 | 40.6 | 27.4 |
| India 2002/03(CD+SAD: est.) | 35 | 47.1 | 33.3 |
| India 2003/04(CD+SAD: est.) | 32.7 | 46.8 | 30.7 |
| Brazil 2000 | 14.1 | 12.9 | 14.3 |
| China 2000 | 16.3 | 16.5 | 16.2 |
| South Korea 2000 | 12.7 | 47.9 | 6.6 |
| 105 developing countries (1996–2000) | 13.4 | 17.4 | 12.7 |

*Notes:* Unweighted average rates. CD = customs duty, SAD = special additional duty.
*Source:* World Bank (2003d).

Greater import liberalization by reducing average import tariffs and phasing out tariff exemptions so Indian firms can gain access to imports at world prices would also help further encourage exports. The government has many well-justified concerns about the policies of other countries that create barriers to imports from India. India is one of the most active developing countries in raising these concerns in international forums, such as the WTO. Although India has some bargaining leverage to gain concessions from other countries, it should also use the WTO process to advance domestic reforms and protect them from local pressure groups. In particular, the government should move aggressively to reduce import tariffs to a single rate (e.g., 10 percent) in the next few years and phase out remaining tariff exemptions, specific tariffs, and antidumping duties (World Bank 2003d).

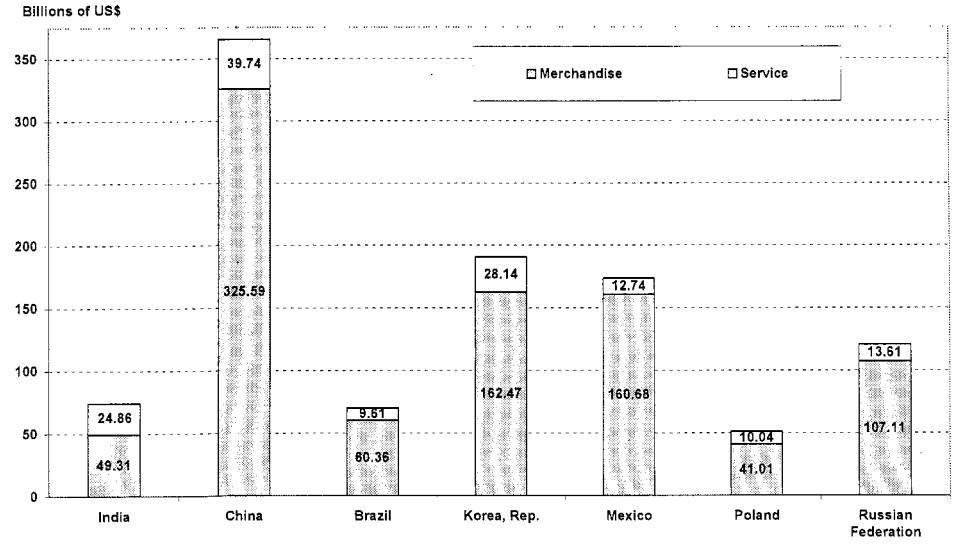
*Encouraging exports.* As shown in Figure 2-5, India's share of world merchandise exports is very modest: it increased from 0.5 percent in 1980 to 0.73 percent in 2003, compared with an increase from less than 1 percent to 5.86 percent for China during the same period. Figure 2-6 shows the distance that India needs to cover to match China's performance in terms of merchandise exports. In 2002 China's merchandise exports totaled a high $325.6 billion as opposed to $49.3 billion for India. Except for Poland, all other comparator countries do better than India.

**Figure 2-5: Share of World Merchandise Exports, India and Comparators, 1990–2003**
*(percent)*




*Source:* World Bank staff analysis undertaken using World Bank internal database.

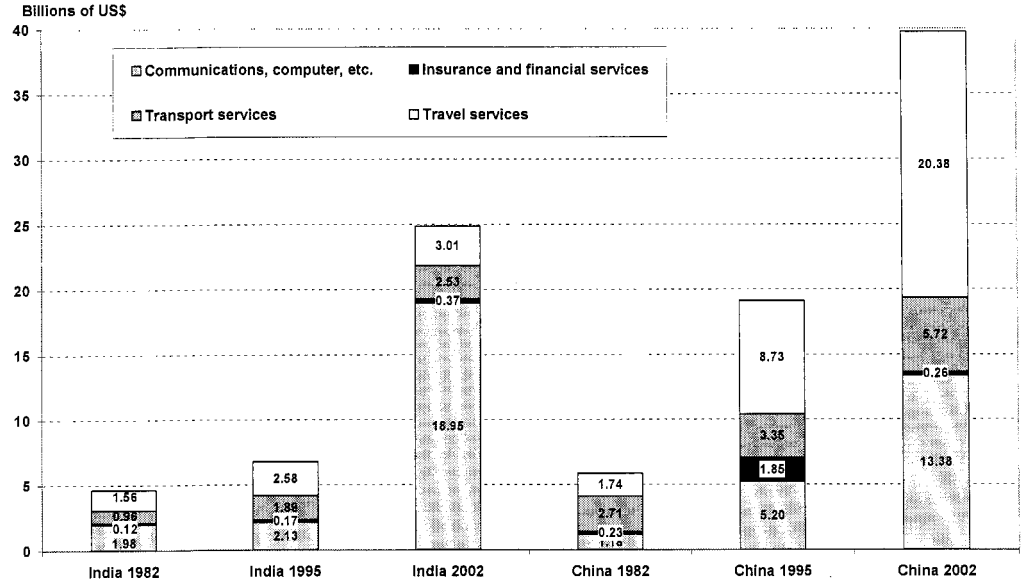
**Figure 2-6: Merchandise and Service Exports, India and Comparators, 2002**




*Source:* World Bank SIMA Database.

In terms of service exports, even though the gap exists, it is comparatively not as large between India and China, as in the case of merchandise exports. This is borne out in Figure 2-7, which shows the evolution of India's service exports among 1982, 1995, and 2002. India has been making rapid strides recently, especially in the communications and computer sector, as amply evident from the 2002 data. China, on the other hand, has been making rapid progress in recent years in ramping up its services exports, in particular, in the travel services sector.

**Figure 2-7: Service Exports, India and China, 1982, 1995, and 2002**




*Source:* World Bank SIMA Database.

*Stimulating foreign direct investment.* FDI is a proven facilitator of rapid and efficient transfer and cross-border adoption of new knowledge and technology. Their complementary and catalytic role in a world of increased competition and rapid technological change can be valuable for spurring growth.[9] If size of the market and growth potential are two important factors in attracting FDI investments into an economy, India's potential is quite promising. But, even though FDI has increased several times compared with before liberalization of the economy, the numbers are still fairly small on a global scale. After reaching a high of 1 percent of GDP in 2001, gross FDI in India as a share of GDP fell to 0.7 percent in 2002, much lower than in China (4.7 percent) or Brazil (4.4 percent) (Figure 2-8).

The recently released *World Investment Report 2004* (UNCTAD 2004) indicates that FDI flows to India rose by 24 percent between 2002 and 2003, due to its strong growth and improved economic performance, continued liberalization, market potential, and growing competitiveness or Indian IT industries. In 2003 India received $4.26 billion in FDI, compared with $53.5 billion for China.[10] China's FDI flows are primarily capital intensive, whereas Indian FDI flows are smaller and skill intensive, concentrated in IT areas.

UNCTAD has also developed an *Inward FDI Performance Index*, which ranks countries by the FDI they receive relative to their economic size, calculated as the ratio of a country's share in global FDI inflows to its share in global GDP (UNCTAD 2004).[11] Among the major developing countries, China is ranked 37th—an improvement from its previous rank of 50th, and India is ranked 114th—a gradual improvement compared with 121st in the previous year.

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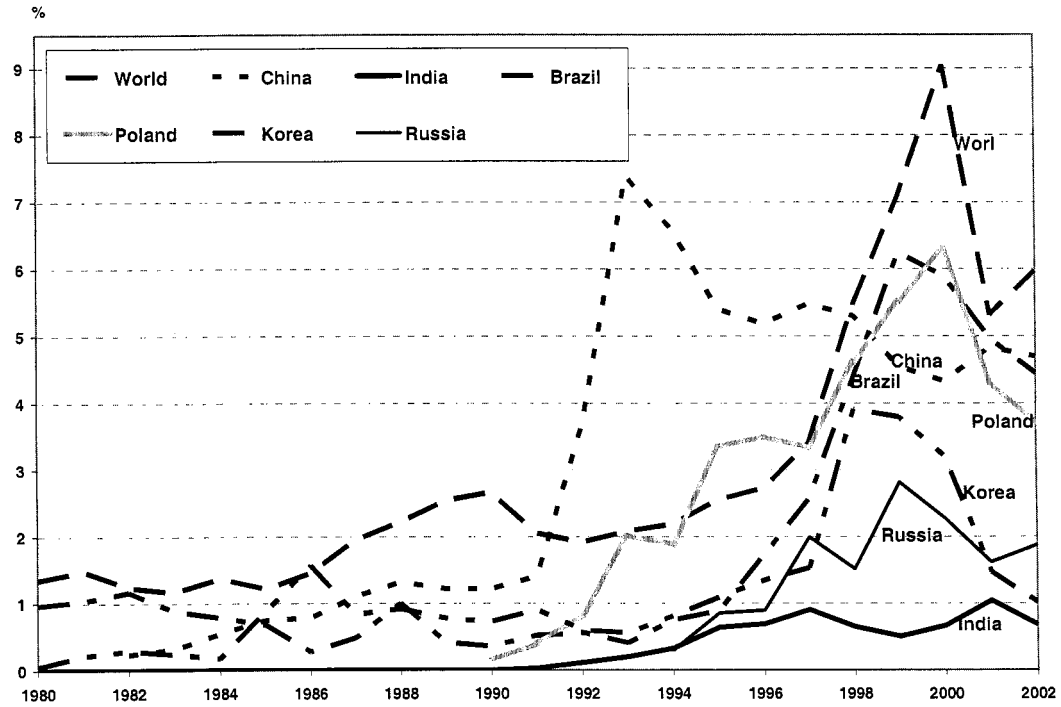
[9] Although it is true that FDI may transfer production capabilities quickly and efficiently, it may not necessarily transfer design or innovation capability, particularly when the parent company uses affiliates to exploit the local market in the host country. It is thus very important for a country to not just attract foreign investment, but develop policies that can encourage significant positive spillovers to the economy in terms of training local personnel, developing backward and forward linkages, improving quality, and contributing to access to global technology, management, markets, and distribution systems.

[10] For all of China's success in attracting FDI, the way China's FDI is measured raises some concerns. Many analysts have pointed to the possibility of "round tripping": much of what is counted as FDI in China is actually Chinese investment that goes to Hong Kong and Singapore and comes back as FDI, to take advantage of more preferential treatment given to foreign investments. According to a recent article in *The Economist* (2005), besides FDI, India attracts several billion dollars a year in portfolio investment ($9 billion in 2004. It also draws in billions of dollars in deposits from nonresident Indians ($33.3 billion in 2004). Adding this up, India is not so far behind China—especially if one allows for Chinese domestic investors "round tripping," that is, using foreign vehicles to take advantage of tax breaks.

[11] These index rankings are, of course, quite different from those given by the values of FDI inflows. For instance, despite being the largest recipient of FDI, the United States has always ranked comparatively low relative to its GDP. In 2003 it ranked 112th, a sharp deterioration compared with the previous period when it ranked 92nd. The decline reflects a sharp drop in inward mergers and acquisitions, whereas GDP remained relatively steady.

**Figure 2-8: Gross Foreign Direct Investment as Percentage of Gross Domestic Product for India, Comparators, and the World, 1980–2002**




*Note:* The spike experienced by the world in 2000 was due to a peak in mergers and acquisitions in many developed countries.
*Source:* World Bank SIMA Database.

The 2004 *Foreign Direct Investment Confidence Index* by A. T. Kearney (see http://www.atkearney.com/shared_res/pdf/FDICIOct_2004_S.pdf ) also highlights China's continued attractiveness for FDI. But India's stock is rapidly rising: it is ranked third in this most recent survey (up from sixth a year ago), just behind the United States. According to the survey, China and India dominate the top two positions for most positive investor outlook, likely first-time investments, and most preferred offshore investment locations for BPO functions and IT services. Compared with other large emerging markets, China and India are cited by chief executive officers (CEOs) as the most attractive FDI destinations in the short term (next three years) and well into the future, beating markets such as Brazil, Mexico, and Poland for medium-term attractiveness ten years out; however, according to the survey, global investors view these two destinations as distinctly different markets: China as the world's leading manufacturer and fastest growing consumer market and India as the world's business process and IT services provider with longer-term market potential. In terms of the kinds of activities that will be moved offshore to China and India, investors indicated that China leads in manufacturing, whereas India leads in IT, business processing, and R&D investments. Investors favor China over India for its market size, access to export markets, government incentives, favorable cost structure, infrastructure, and macroeconomic climate. These same investors, however, cite India's highly educated workforce, management talent, rule of law, transparency, cultural affinity, and regulatory environment as more favorable than China's.

Several plausible reasons exist for the FDI gap between China and India. China's total and per capita GDP are higher, making it more attractive for market-seeking FDI. Its higher literacy and education rates also suggest that its labor is more skilled, making it more attractive to efficiency-seeking investors. It also has a large domestic market and an environment from which it is easy to export. China also has an advantage in terms of its infrastructure. Compared with India, China has ten times as much of expressway

(30,000 kilometers or 19,000 miles) and six times as many mobile and fixed-line telephones per 1,000 people. The cost of power is also about 39 percent lower in China than in India *(The Economist* 2005).

China's success in attracting FDI is no doubt also partly attributable to the fact that it has a wealthy Diaspora. From 1985 to 1996, two-thirds of China's FDI came from Hong Kong, Macau, and Taiwan. India also has an impressive Diaspora, which seems to be growing more important. Box 2-1 highlights this fact and notes that India's conducive economic and institutional regime should allow it to attract greater FDI by tapping the Diaspora in the future. India also has an advantage in technical manpower, particularly in IT. Its better English language skills serve as an attraction for FDI, and India has a vibrant domestic enterprise sector. In addition, the Indian government is planning to open some more industries for FDI and further relax the foreign equity ownership ceilings.

**Box 2-1: Foreign Direct Investment: A Tale of Two Countries**

India has not attracted anywhere near the amount of FDI that China has. Huang and Khanna (2003) note that this disparity reflects in part the confidence international investors have in China's prospects and their skepticism about India's commitment to free market reforms. But the FDI gap is also a tale of two Diasporas. China has a large and wealthy Diaspora that has long been eager to help; in contrast, the Indian Diaspora has been much less willing to invest back home. India, however, has managed to spawn a number of firms in the most cutting-edge, knowledge-based industries (in software, Infosys and Wipro and, in pharmaceuticals and biotechnology, Ranbaxy and Dr. Reddy's Laboratories). In 2002, the Forbes 200, an annual ranking of the world's best small companies, included 13 Indian firms, but just four from mainland China.

China has been far bolder with external reforms, but has imposed substantial legal and regulatory constraints on indigenous, private firms, mainly to prevent private domestic businesses from challenging China's state-owned enterprises. India has developed much stronger infrastructure to support private enterprise. Its capital markets operate with greater efficiency and transparency than do China's. Its legal system, although not without substantial flaws, is considerably more advanced. It is true that privatization is proceeding at a glacial pace, but the government has ceded its monopoly on long-distance phone service, some tariffs have been cut, bureaucracy has been trimmed a bit, and a number of industries have been opened to private investment, including investment from abroad. As a consequence, entrepreneurship and free enterprise are flourishing. In a survey of leading Asian companies by the *Far Eastern Economic Review,* India registered a higher average score than any other country in the region, including China. (The survey polled more than 2,500 executives and professionals in a dozen countries, who were asked to rate companies on a scale of one to seven for overall leadership performance.) Only two Chinese firms had scores high enough to match India's top ten list. All of the Indian firms were wholly private initiatives, whereas most of the Chinese companies had significant state involvement.

According to the authors, democracy, a tradition of entrepreneurship, and a decent legal system have given India the underpinnings necessary for free enterprise to flourish. Although India's courts are notoriously inefficient, they at least comprise a functioning independent judiciary. Property rights are not fully secure, but the protection of private ownership is certainly far stronger than in China. The rule of law, a legacy of British rule, generally prevails. These traditions and institutions have proved an excellent springboard for the emergence and evolution of India's capital markets. In their article, the authors refer to World Bank data that showed that only 52 percent of the Indian firms surveyed reported problems in obtaining capital, compared with 80 percent of the Chinese companies polled. As a result, Indian firms relied much less on internally generated finances: only 27 percent of funding came through operating profits, compared with 57 percent for the Chinese firms.

Corporate governance has improved dramatically. In a survey of 25 emerging market economies conducted in 2000 by Credit Lyonnais Securities Asia, India ranked sixth in corporate governance and China 19th. The advent of an investor class, coupled with the fact that capital providers, such as development banks, are themselves increasingly subject to market forces, has bolstered the efficiency and credibility of India's markets. Apart from providing the regulatory framework, the Indian government has taken a back seat to the private sector in credit allocation. In China, in contrast, bureaucrats remain the gatekeepers, tightly controlling capital allocation and severely restricting the ability of private companies to obtain stock market listings and access the money they need to grow. These policies have produced enormous distortions, while preventing China's markets from gaining depth and maturity.

Compounding the problem are poor corporate governance and the absence of an independent judiciary.

The question remains: If India has so clearly surpassed China at the grassroots level, why is India's superiority not reflected in the numbers? Part of the reason may be that India's economic reforms only began in earnest in 1991, more than a decade after China began liberalizing. India has had to make do with a national savings rate half that of China's and 90 percent less FDI. Moreover, India is a sprawling, messy democracy; China, on the other hand, has enjoyed two decades of relative tranquility and has been able to focus almost exclusively on economic development. The real issue, of course, is not where China and India are today, but where they will be tomorrow. The answer will be determined in large measure by how well both countries utilize their resources.

*Source:* Huang and Khanna (2003).

Although China has benefited from an FDI-led growth strategy, India has clearly placed its bets on building domestic capacity. But, even so, despite the improvement in India's policy environment, multinational FDI interest remains rather narrow, even in promising areas such as IT and communications technology. Various reasons exist for the continued caution of foreign and Indian investors. Structural impediments to investment in India have been eased but not removed; they include restrictive labor laws that make it hard to shed staff. Despite improvements in some areas, the deficiencies in India's infrastructure—roads, electricity, and water supply—have not been fixed. Laws complicating land transactions and the labyrinthine intricacies and glacial pace of litigation are further deterrents, as is a cumbersome and corrupt bureaucracy that adds time and cost to almost any commercial project. The Indian government has also had a rather cautious approach to opening the economy further in recent years, as it wishes to avoid a repetition of the balance-of-payments crisis of the early 1990s. Domestic vested interests, concerned about their ability to compete against foreign companies, are said to increasingly resist further trade liberalization. These interests must be balanced with India's ambitions to harvest the benefits of increased international trade and FDI to spur continued growth. Box 2-2 provides examples of sectors in which FDI is permitted in India and China.

**Box 2-2: Foreign Direct Investment Policies in India and China**

India limits foreign investment in some sectors of the Indian economy, such as insurance and the media, to a minority stake. In others, such as retail, it is not allowed. The recent FDI Survey 2004 by the Federation of Indian Chambers of Commerce and Industry (FICCI) identified five areas in which a dedicated effort by the government would result in strong FDI inflows into India in the near to medium term. These include IT and related services, chemical and chemical products, rubber and plastic products, electrical machinery and apparatus, and the services sector. In India, FDI is not permitted in atomic energy and railway transport. In the power sector, FDI up to 100 percent is allowed for all activities, except nuclear power. In infrastructure, such as roads and highways, FDI up to 100 percent is permitted. In the area of telecoms, in 2000 national long-distance service was opened to competition; in 2002 international long distance and Internet telephony opened to competition, and in 2004 the government announced its broadband policy. The government also recently decided to raise FDI in the telecoms sector from 49 percent to 74 percent.

China's accession to the WTO in 2001 has led to the introduction of more favorable FDI measures. With further liberalization in the services sector, China's investment environment may be further enhanced. For instance, China will allow 100 percent foreign equity ownership in such industries as leasing, storage and warehousing, and wholesale and retail trade by 2004; advertising and multimodal transport services by 2005; insurance brokerage by 2006; and transportation of goods (railroad) by 2007. In retail trade, China has already opened and attracted FDI from nearly all the big-name department stores and supermarkets, such as Carrefour, Makro, Metro, 7-Eleven, and Wal-Mart). In addition to removing trade-related investment measures (TRIMs), China is also opening its service sectors, including financial.

*Sources: The Economist* (2005); FDI Survey 2004, FICCI (http://www.ficci.com/ficci/surveys/fdi-survey.pdf); "India's Investment Policies and Outlook," a presentation by Umesh Kumar, Joint Secretary, Ministry of Commerce and Industry, Department of Industrial Policy and Promotion at the OECD-India Investment Roundtable, New Delhi, October 19, 2004 (http://dipp. nic. in/md investment 191 004.pps); Krishnadas (2005); UNCTAD (2003); and OECD (2003).

*Harnessing the benefits of FDI.* Research by the McKinsey Global Institute (Farrell and Zainulbhai 2004) indicates that the FDI in India has had a positive impact on the economy. The introduction of foreign competition in IT, business-process outsourcing, and the automotive industry has prompted Indian companies to revamp their operations and boost productivity, leading some of them to be globally competitive and, in the process, contributing to job creation. The *World Investment Report 2004* noted, for example, that GE Capital was saving $300 million annually by outsourcing services from India, while giving employment to 12,000 people. Consumers in India have also benefited from lower prices, better quality, and a wider selection of products and services, while domestic demand has increased in response to lower prices, for example, in the automotive industry (Box 2-3). India needs to build on the momentum in the automobile industry and replicate this success across the economy. The challenge is to increase competition in the economy, focus on creating jobs that add higher value, and replacing less productive companies with lower-value-added activities with more productive ones.

**Box 2-3: Moving Up the Value Chain: India's Automobile Industry**

According to the McKinsey Global Institute, instead of spending tax money to offer financial incentives to foreign investors, governments should use funds to improve transportation networks, power grids, and telecommunications lines. Policy makers must boost competition in the broader economy so companies are compelled to improve their operations, adopt best practices, innovate, and move up the economic value chain. Too often, developing countries concentrate on special economic zones or preferred export industries, while competition languishes in the remaining sectors. Price controls, tariffs, licensing requirements, and other product regulations limit market entry and reduce competition.

As India's $5 billion auto industry demonstrates, the gains from removing these stifling regulations can be dramatic. Twenty years ago, two state-owned carmakers—Hindustan Motors and Premier Automobiles Limited (PAL)—dominated the market and offered few choices. In 1983 the government allowed Suzuki Motor to take a minority stake in a joint venture with the small state-owned automaker Maruti Udyog, and in 1992 nine more foreign automakers were allowed to invest in India. This infusion of new capital and technology created serious competition for the two incumbents, eventually forcing PAL out. The industry, one of the fastest growing in the world, now produces 13 times more cars than it did 20 years ago. Tata Motors hit a milestone in 2004 by exporting 20,000 cars to the United Kingdom, to be sold under the MG Rover brand. Meanwhile, prices for consumers in India have fallen by 8 to 10 percent annually, unleashing a burst of demand and allowing steady employment despite rapidly rising productivity. In view of the greater competitive intensity in the market, India may be better positioned than China to become a low-cost auto-manufacturing base. None of this would have been possible had India's carmakers remained isolated from the world.

*Source:* Farrell, Puron, and Remes (2005) and Farrell and Zainulbhai (2004).

*Customizing market entry strategies.* According Jain, Manson, and Sankhe (2005), multinational companies are often successful, precisely because they can replicate products and processes and even market-entry strategies across multiple markets. In India, however, the performance of the multinationals has been mixed. Many of the MNCs notable for their strong performance elsewhere have yet to achieve significant market positions (or even average industry profitability) in India, despite a significant investment of time and capital in its industries. The reason is that the market entry strategies that have worked well for these companies elsewhere—bringing in tried and tested products and business models from other countries, leveraging capabilities and skills from core markets, and forming joint ventures to tap into local expertise and share start-up costs—are less successful in India.

According to the authors, the most successful multinationals in India have been those that did not merely tailor their existing strategy to an intriguing local market, but instead customized their products and practices to the Indian market. In short, they have resisted the instinct to transplant to India the best of what they do elsewhere, even going so far as to treat the country as a bottom-up development opportunity. With less of a focus on initial entry and with a long-term view of what a thriving Indian business would

look like, the more successful companies have been investing time and resources to understand local consumers and business conditions: *(a)* tailoring product offers to the entire market from high-end to middle and lower-end segments, *(b)* localizing product offerings to meet Indian consumer preferences, *(c)* reengineering supply chains, for example, by buying components from cheaper Indian suppliers, rather than importing more expensive ones from their usual suppliers elsewhere, *(d)* even skipping the joint-venture route, because many times, the local partner has not been in a position to invest enough resources to enlarge the business as quickly as desired by the MNC, and *(e)* including an Indian CEO in their local operations who is capable of tailoring products, supply chains, and distribution systems to the local markets. These companies have also been flexible and participated in the evolving regulatory process in India as, for example, has happened several times to regulations governing the mobile-telephony sector in India. Many companies have reaped rewards. Of the 50-plus multinational companies with a significant presence in India, the nine market leaders who have taken this customized approach, including British-American Tobacco, Hyundai Motor, Suzuki Motor, and Unilever, have an average return on capital employed of around 48 percent. Even the next 26 have an average return on capital employed of 36 percent.

**Measures to Strengthen the Economic and Institutional Regime**

The above discussion has described a number of strengths and weaknesses in India's evolving economic and institutional regime. Areas in which policy reform could address some of the barriers to faster economic growth are discussed below, including improving the efficiency of government, encouraging a more conducive investment climate; improving competitiveness by strengthening IPRs and their enforcement; raising access to venture capital; encouraging the private sector to invest, not only to promote growth, but also expand opportunities for the poor; attracting greater FDI; and tackling infrastructure issues.

*Improve the efficiency of government.* As mentioned, the public sector in India is quite large and rather unproductive. It is important to reduce the role of government in publicly owned productive enterprises and to improve the efficiency of government in its core functions. The latter requires administrative and procedural reforms. One possibility is also to use ICTs more efficiently in carrying out government functions, including for the delivery of social services such as education and health (see Chapter 5).

India currently stands at the threshold of a unique opportunity regarding governance and public management reform.[12] It has recently approved a "National Action Plan for E-Governance (2003–07)," which addresses key governance issues at both central and state levels (see http://www.mit.gov.in/actionplan/about.asp). The plan lays the foundation and provides the impetus for long-term growth of e-governance in the country. It seeks to create the right governance and institutional mechanisms, set up the core policies and infrastructure, and implement a number of projects at the center and state levels to create a "citizen-centric" and "business-centric" environment for governance.

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[12] Documents such as the Report of the Conference of Chief Ministers (1997), the Report of the Fifth Central Pay Commission (1997), the Second Report of the Expenditure Reforms Commission on Optimizing Government Staff Strength; and the Draft Approach Paper to the Tenth Five-Year Plan (2001) articulate a fairly integrated and coherent vision for change. Similar principles are endorsed by various state commissions, in such documents as Andhra Pradesh's "Vision 2020," the report of Karnataka's Administrative Reforms Commission and Governance Strategy and Action Plan, and Uttar Pradesh's policy papers on governance and civil service reforms, as well as by Maharashtra's One-Man Committee on Good Governance. Taken together, such documents envision change along several general themes, which are related and mutually reinforcing, including efforts to limit the size, scope, and orientation of government; streamlining organizational structures and decision-making processes; reforming human resource management practices; improving transparency; enhancing responsiveness and accountability; promoting integrity; and improving service delivery. An effective program of civil service reform also includes measures to improve citizens' access to information, strengthen accountability, and reduce political interference (Excerpted from Robert Beschel, unpublished manuscript).

Many Indian states are also tackling core governance issues such as public expenditure management, civil service reform, anticorruption, transparency and right to information, and enhanced accountability. The government of Uttaranchal, for example, is beginning to implement an e-governance program, which will involve business process reengineering of various departments and government services to ensure better delivery of development services to the people (State of Uttaranchal 2003). Wholehearted implementation of these reforms, including sharing of successful experiences across states, could lead to a sea change in the performance of the Indian public service, making it more efficient and effective in delivering public services to citizens.

*Encourage a more conducive investment climate.* A crucial ingredient for economic growth is creation of productive jobs and new businesses that can generate wealth, while expanding opportunities for poor people. The discussion above has demonstrated that companies must be able to adjust to new market conditions and seize opportunities for growth. Cumbersome regulations frequently take this flexibility away (as amply highlighted below on the costs of doing business in India). Productive businesses thrive where government focuses on the definition and protection of property rights, but when the government heavily regulates every aspect of business activity, businesses operate in the informal economy. Regulatory intervention is particularly damaging in countries where its enforcement is subject to abuse and corruption.

Successful economic development is a process of successive economic upgrading in which the business environment in a country evolves to support and encourage increasingly sophisticated ways of competing. According to the World Bank (2004l), a good investment climate provides opportunities and incentives for firms—from microenterprises to multinationals—to invest productively, create jobs, and expand and, thus, plays a central role in growth and poverty reduction. Such an investment climate encourages firms to invest by removing unjustified costs, risks, and barriers to competition. Investment climate improvements in the 1980s and 1990s helped to nearly double private investment as a share of GDP in China and India (Box 2-4).

**Box 2-4: Investment Climate Improvement: Lessons from China and India**

China and India illustrate some simple lessons about strategies for making investment climate improvements and the importance of even modest initial reforms. China and India have both grown impressively in recent years, greatly reducing poverty. China's growth is officially reported at an average of 8 percent a year for the past 20 years, and the share of its population living on less than $1 a day fell from 64 percent in 1981 to less than 17 percent in 2001. India's growth has increased from an average of 2.9 percent a year in the 1970s to 6.7 percent by the mid-1990s, and the share of its population living on less than $1 a day fell from 54 percent in 1980 to 26 percent in 2000.

Yet neither country has an ideal investment climate. China only recently gave constitutional recognition to private property, and its banking sector is plagued by nonperforming loans. And India has problems in its power sector. Both countries unleashed growth and reduced poverty through what appeared to be fairly modest initial reforms. China began with a rudimentary system of property rights that created new incentives for a substantial part of its economy. India began with early efforts to reduce trade barriers and other distortions that covered a significant part of its economy. In both cases the reforms addressed important constraints and were implemented in ways that gave firms confidence to invest. And the initial reforms have been followed by ongoing improvements that addressed constraints that were less binding initially and also reinforced confidence in the future path of government policy.

*Source:* Excerpted from World Bank (2004l). The poverty incidence of 26 percent is based on estimates of the Government of India. More details are available in World Bank (2003d).

Private sector companies in India point to a variety of burdens that weigh more heavily on them than their competitors: the cost of power, which is two to three times higher than elsewhere; the cost of borrowing; red tape and the corruption that goes with it; onerous sales and local taxes; slow and expensive transport;

and inflexible labor markets (*The Economist* 2000). Correcting these weaknesses constitutes much of the government's reform program. Some progress has been made (especially in telecommunications infrastructure), but more needs to be done to make the environment more stable and attractive to, in turn, make companies more competitive.

Efforts are needed to improve India's overall investment climate "writ large."[13] In India the potential gains to growth from removing key investment climate bottlenecks range from an estimated 2 to 4 percent a year. In addition, as mentioned earlier, India's Tenth Five-Year Plan (India, Planning Commission 2002e) has set ambitious targets for GDP growth (an average of 8 percent per year in the next decade) and employment creation (100 million new jobs) to reduce poverty substantially. This requires a step up in domestic investment, particularly in private investment, coupled with improved productivity. To sustain an 8 percent growth rate in the long term, while reducing poverty, India must raise its investment rate to about 30 percent from the current 23 percent. This rise would, in turn, require steep increases in the ratio of private sector investment to GDP and particularly in the industrial and service sectors, which have the greatest potential to provide high-wage employment for the labor force now working in agriculture. This will have much to do with the quality of India's investment climate at the national and subnational levels and will also be influenced by how investors rate India's investment climate with other investment destinations in Asia.[14]

Another recent report by the World Bank and International Finance Corporation (IFC) *Doing Business in 2005: Removing Obstacles to Growth* (2004b) looks at the regulation of businesses in depth and investigates the effect of regulation on economic outcomes. The analysis is done on starting a business, hiring and firing of workers, registering property, getting credit, protecting investors, enforcing contracts, and closing a business—all critical ingredients of an effective investment climate. These indicators are used to analyze economic and social outcomes, such as productivity, investment, informality, corruption, unemployment, and poverty, and identify what reforms have worked, where, and why.

The *Doing Business in 2005* report and related database[15] show that in China the average time taken to secure the necessary clearances for a startup or complete a bankruptcy procedure is much smaller than in India. In India, entrepreneurs go through 11 steps to launch a business within 89 days on average, at a cost

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[13] For India and other developing countries to do well, a host of other institutional factors and policies classified under the broad heading "investment climate" must complement good macro and trade policies. The quantity and quality of investment flowing into any country depends on investor expectations and uncertainties on returns. Three broad and interrelated components can shape these expectations:

- A set of macro or country-level issues concerns economic and political stability and national policy on foreign trade and investment and refers to macroeconomic, fiscal, monetary, and exchange rate policies as well as political stability.
- The issue of efficacy of a country's regulatory framework, as far as firms are concerned, relates to the issues of entry or starting a business, labor relations and flexibility in labor use, efficiency and transparency of financing and taxation, and efficiency of regulations concerning the environment, safety, health, and other legitimate public interests. The question is not whether to regulate, but whether such regulations are designed in incentive-compatible ways, avoid adverse selection and moral hazard, serve the public interest, are implemented expeditiously without harassment and corruption, and facilitate efficient outcomes.
- The quality and quantity of available physical and financial infrastructure (such as power, transport, telecommunications, and banking) and finance. When one surveys entrepreneurs about their problems and bottlenecks, they will often cite infrastructure issues such as power reliability, transport time and cost, and access and efficiency of finance as key determinants of competitiveness and profitability (World Bank 2002c).

[14] The World Bank is conducting investment climate surveys (ICSs) for various Indian states. In 2003 ICSs were conducted in 12 states: Andhra Pradesh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal. It should be noted, however, that employment in the formal sector in India is very small (as mentioned, there are 27 million workers in organized employment in India) and most business surveys are based on the responses of industries in the formal sector, which constitute only the tip of the iceberg. India is still largely an agricultural economy with a large section of the population in rural areas: this important structural fact must be taken into account in designing these surveys.

[15] Data are available at http://rru.worldbank.org/DoingBusiness/.

equal to 49.5 percent of gross national income (GNI) per capita. Starting a business in India requires about the same number of permits as in China (12), but in China it takes less than half the time (41 days) on average to take care of all procedures and at a much lower cost (14.5 percent of GNI per capita). India also has one of the more regulated labor markets in the world, and restrictions on the hiring and firing of workers greatly impede doing business. India's overall Rigidity of Employment Index is 48, higher than in China (30), but lower than in Brazil (72). In a World Bank–Confederation of Indian Industry (CII) survey (World Bank 2002c), the typical firm reported it had 17 percent more workers than desired and could not adjust its workforce to a preferred level due mainly to labor laws and regulations. These regulations are a key reason why firms are reluctant to take on new employees. In addition, in both India and Brazil, it takes more than 10 years to go through bankruptcy proceedings, in contrast to less than six months in Ireland and Japan and 2.4 years in China. Furthermore, Indian labor laws allow firms far less latitude with their employees than labor code does in China, Brazil, Mexico, or Russia. On the positive side, India's manufacturing firms face fewer tax and regulatory inspections than firms in China and Brazil, and it takes fewer days in India to clear customs. Annex 8 provides a detailed snapshot of the business climate in India by identifying specific regulations and policies that encourage or discourage investment, productivity, and growth.

Various indicators of investment climate also show substantial improvement in India between 2000 and 2003. A comparison of key investment climate indicators (the investment climate survey [ICS] of 2000 with the ICS of 2003) shows the reported overstaffing rate in Indian firms decreased from 16.8 percent to 10.9 percent, indicating more flexible labor markets. Inspections per year declined from 11.7 in 2000 to 7.4 in 2003; in the same period, senior management time spent on business regulations and inspectors fell from 16 to 14.2, reflecting fewer day-to-day bureaucratic hassles. The average number of days to clear customs fell from 10.3 in 2000 to 7.3 in 2003. Critical infrastructure indicators have also shown notable improvements. For example, 69 percent of the firms surveyed in 2000 reported using their own generators, because they could not rely on power from the public grid. By 2003 this number had fallen to 61 percent (World Bank 2004d). Box 2-5 delves into more detail on the views of the private sector in Brazil, China, and India on certain aspects of the investment climate that have an impact on productivity and growth.[16]

[16] Based on investment climate surveys jointly carried out by the World Bank and the Confederation of Indian Industry (CII) during March to July 2003, covering a random selection of 1860 manufacturing establishments sampled from 40 cities in 12 Indian states, namely, Andhra Pradesh, Delhi, Gujarat, Haryana, Kerala, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal. Based on shares in aggregate sectoral output, the bulk of the sample was drawn mainly from eight industries: garments, textiles, leather, drugs and pharmaceutical, electronic goods and equipment, electrical white goods, auto parts, food processing. The survey instrument was a written questionnaire, which shared key modules with ICS that the World Bank has sponsored in other countries including China and Brazil, the countries used as comparators to India in this report. For more information, see World Bank (2004d).

**Box 2-5: Role of Investment Climate: The Private Sector View in India, China, and Brazil**

Figure a

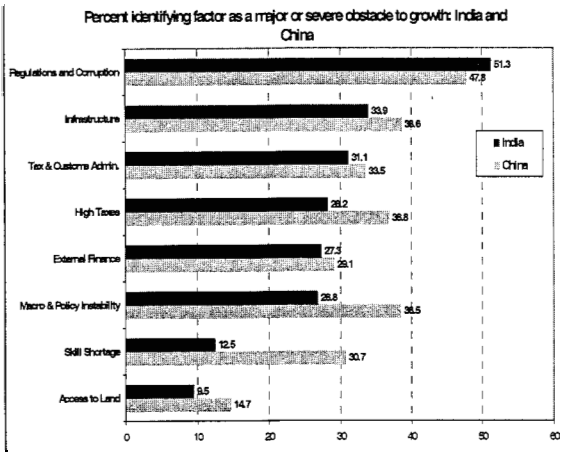
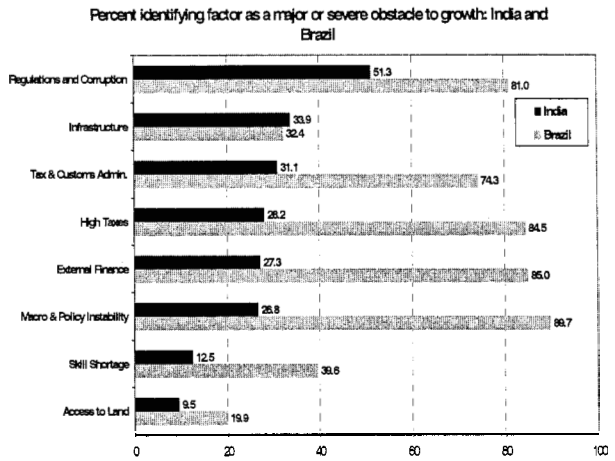



Figure b




*Note:* The data for Brazil and India are for 2003. The data on China are for 2002.

The World Bank recently undertook a study to see how the investment climate reform priorities of India's industrial business community compares with those of its counterparts in China and Brazil. In figure a, these priorities are compared with those of respondents to the China ICS. The bars show the proportion of respondents who identified investment climate deficiencies as major or severe obstacles (the following scale was used: 0 = no obstacle, 1 = minor obstacle, 2 = moderate obstacle, 3 = major obstacle and 4 = severe obstacle). The comparison shows that regulation and corruption draw complaints from the largest percentage of respondents in India and China, followed by infrastructure and tax and customs administration. One difference seems to be the significantly greater weight that Chinese respondents attach to macroeconomic instability and skill shortages. In figure b, India's figures are compared with those from the ICS of Brazil. They show that, although India's private sector seems to have more or less the same reform priorities as China's, those priorities seem to diverge significantly from Brazil's, where macroeconomic instability and problems with finance and high tax rates are at the top of the list, even above regulation and corruption. In terms of skills, one in eight businesses in the India ICS sample identifies skill shortages as a major obstacle to the expansion of their businesses. A comparison of the number of days needed to fill a skilled-job vacancy in India and Brazil suggests that skill shortages are not as ubiquitous or biting a problem in Indian industry as they appear to be in China and Brazil. An Indian firm reports filling a skilled vacancy within three days as opposed to six in Brazil. This does not necessarily mean that India has a larger pool of skilled workers than China or Brazil, only that there are more skill shortages in the other two countries. This is possibly due to the demand for skills in those countries is greater, which would also be consistent with their higher investment rates in more skill-intensive industries. That India apparently faces fewer skill shortages than China is not, therefore, necessarily a plus for the current investment climate in India.

Existing business survey data provide no evidence that Indian industry suffers from a greater burden of government regulation of routine industrial activities or industrial relations or bears a greater cost in tax and customs administration. The proportion of Indian businesses that identify these as major problems is not larger than that of Chinese or Brazilian businesses. As mentioned, objective indicators, such as the frequency of official visits, the time that management spends dealing with regulations, delays in customs clearance, and so on are also not higher for India than they are for China. Yet, secondary sources also show that Indian businesses do lose out more than their counterparts in China or Brazil on account of the greater burden of entry and exit regulation they bear. Indian businesses also lose out due to costly and unreliable power supply that also ties up a significant part of their assets in running their own generators to minimize the cost of these outages. Significant evidence also exists, again from secondary sources, that Indian industry might be losing more in productivity due to the absence of a well-functioning market in urban land rights, which has made land use rights account for a higher proportion of business costs in India than in East Asia. These deficiencies in India's investment climate are important, because they impact industrial productivity and thus need to be tackled so that the private sector can be an even greater engine of growth.

*Source:* World Bank (2004d).

*Improve competitiveness in other ways.* The productivity dispersion of firms in India demonstrates the need to continue the process of regulatory reform, easing the ability of firms to enter, expand, and exit as they adjust to a more competitive environment. As India moves from creating, acquiring, and adapting knowledge to becoming a generator and user of new knowledge and technologies, it needs to take care of some special issues that are becoming particularly important in terms of the broader business environment:

- *Strengthen intellectual property rights and their enforcement.* This issue is becoming increasingly important in knowledge-based economies and being driven by the mounting costs of R&D for new products or processes, shortening of product life cycle, rapid growth in international trade in high-tech products, and internationalization of the research process. India has passed a series of intellectual property rights laws in the past two years, whose enforcement will be key. In the *World Competitiveness Index 2004,* produced annually by IMD International, India ranks 47th of 60 countries and regions in terms of patent and copyright protection.[17]
- *Improve access to venture capital.* Such access is important to the success of knowledge-based businesses. India has a burgeoning venture capital industry: in fact, in the same World Competitiveness Index, India ranks 24th (again, of 60 countries and regions) in terms of availability of venture capital for business development.
- *Encourage the private sector to invest, create jobs, and improve productivity, not only to promote growth, but also expand opportunities for poor people.* The private sector can be a real engine of jobs and services for the poor. C. K. Prahalad (2004) argues that companies must revolutionize how they do business in developing countries such as India if both sides of that economic equation are to prosper. He offers insights on consumer needs in poor societies and opportunities that exist for the private sector to serve important public purposes, while enhancing its bottom line (Box 2-6).

**Box 2-6: Tapping Entrepreneurial Capabilities and Buying Power of the Poor**

C. K. Prahalad (2004) writes that the real source of market promise is not the wealthy few in the developing world or even the emerging middle-income consumers: it is the billions of aspiring poor who are joining the market economy for the first time. He exhorts large companies to use their resources, scale, and scope to cocreate solutions to problems that lie at the bottom of the pyramid (BOP)—those 4 billion people who live on less than $2 a day. This requires mobilizing the investment capacity of large firms, the knowledge and commitment of nongovernmental organizations (NGOs), and the communities that need help to cocreate unique solutions to help the BOP. To sustain energy, resource, and innovation, the BOP must become a key element of the central mission for large private-sector firms. The poor must also become active, informed, and involved consumers. Cocreating a market around the needs of the poor can help to reduce poverty.

To do this, all players—NGOs, large domestic firms, MNCs, government agencies, and most important, the poor—must come together to solve problems. The focus should be on the active, underserved consumer community, as the four to five billion poor people become part of the system of inclusive capitalism, an economic opportunity valued globally at $13 trillion a year. The process must start with respect for BOP consumers as individuals and assume that consumers are equally important joint problem solvers. This sets the basis for a profitable win-win situation. In being served by big business, the poor "win" by being empowered to choose and are freed from paying the currently widespread "poverty penalty." In shanty towns near Mumbai, for example, the poor pay a premium on everything from rice to credit, often five to 25 times what the rich pay for the same services. Prahalad provides 12 cases in a wide variety of businesses in which the BOP is becoming an active market, bringing benefits to consumers. The cases represent a variety of industries: from retail in Brazil and health and financial services in India, to housing in Mexico.

To be profitable, firms must reengineer products to reflect the very different economics of the BOP: small unit

[17] IMD International's *World Competitiveness Yearbook 2004* includes 51 countries and nine regional economies for a total of 60 countries and regions.

packages, low margin per unit, and high volume. Big businesses need to swap their usual incremental approach for an entrepreneurial mind set, because BOP markets need to be built, not simply entered. Products must be available in affordable units. Most sales of shampoo in India, for example, are of single sachets. Rethinking distribution networks may be necessary to, among others, involve entrepreneurs from among the poor. Despite skeptics, leading firms are now grappling with how to serve the BOP on a big enough scale and how to transfer what works from one part of the world to another.

*Source:* Adapted from *The Economist* (2004f) and Prahalad (2005).

*Attract greater FDI.* A recent study by Farrell and Zainulbhai (2004) highlighted steps the Indian government could take to encourage foreign investment (Box 2-7). The Indian government should ideally try to attract those types of investments that can contribute strongly to the Indian economy.

**Box 2-7: Building on Success: Attracting Foreign Investment in India**

A McKinsey Global Institute (MGI) report by Farrell and Zainulbhai highlights that India's economy has made real progress, but further liberalization will be needed to sustain its growth. The country now has 40 million people looking for work, and an additional 35 million will join the labor force in the next three years. Creating jobs for these people will require more dynamic and competitive industries across the economy, as well as opening up to foreign competition; thus, to build on its successes, the Indian government must lower trade and foreign investment barriers still further in the following ways:

- Tariff levels should be cut to an average of 10 percent, matching those of India's neighbors in the ASEAN. Although progress has been made on tariffs, the government still prohibits imports of many goods and protects inefficient companies from foreign competition. To provide incentives to companies to improve their operations, the government should first lower duties on capital goods and inputs, and then, in several years, reduce them on finished goods.
- Foreign-ownership restrictions should also be lifted throughout the economy as well, except in strategic areas, notably defense. At present, foreign ownership is not only prohibited in industries such as agriculture, real estate, and retailing, but also limited to minority stakes in many others, such as banking, insurance, and telecommunications.
- India's government should reconsider the expensive but often ineffective incentives it offers foreign companies to attract foreign investment. These resources would be put to better use improving the country's roads, telecom infrastructure, power supply, and logistics. MGI's research found that the government often gives away substantial sums of money for investments that would have been made anyway. For example, it has waived the 35 percent tax on corporate profits for foreign companies that move business-process operations to India, even though the country dominates the global industry. Moreover, state governments often conduct unproductive bidding wars with one another and give away an assortment of tax holidays, import duty exemptions, and subsidized land and power. MGI surveys show that foreign executives place relatively little value on these incentives and would rather that the government invest resources in developing infrastructure.
- Interviews with foreign executives showed that India's labor laws deter foreign investment in some industries. For example, software and business-outsourcing companies are exempt from many labor regulations, such as those regarding hours and overtime. Without these exemptions, it would be impossible to perform back-office operations in India. To attract foreign investment in labor intensive industries, the government should therefore consider making labor laws more flexible.

*Source:* Excerpted from Farrell and Zainulbhai (2004).

*Tackle infrastructure issues.* A critical part of the overall investment climate in any country relates to the state of its infrastructure. The poor condition of India's infrastructure has often been cited as a major hindrance to economic growth.

Transportation is clearly an area in which India's infrastructure does not meet that of its regional neighbors. Only 56 percent of roads are paved in India, compared with an average of 88 percent in most East Asian countries. The total container volume handled at all the Indian ports combined is lower than that passing through Shanghai! A comparison of the freight traffic of Indian and Chinese railways shows India lagging way behind. Rail freight as a percent of traffic units is only 5 percent in India, compared with 79 percent in China. The transportation costs associated with shipping a container of textiles to the United States are more than 20 percent higher for India compared with Thailand and 35 percent higher compared with China. Variations in maritime distances explain only a small part of the gap. Delays and inefficiencies in the ports, in particular, in customs, account for a higher share of the difference in port productivity. These international comparisons demonstrate the clear need for India to focus on improving its physical infrastructure and port efficiency.

Access to reliable power at reasonable cost is another prime concern for most Indian businesses. Industry surveys have found that acute power shortfalls, unscheduled power cuts, the erratic quality of power supply (low voltage coupled with fluctuations), delays, informal payments required to obtain new connections, and very high industrial energy costs seriously constrain Indian industry and have serious implications for overall industry performance and competitiveness. Across India, the shortfall in 2001–02 was estimated at 7.5 percent for energy and 13 percent for peak demand with substantial variations across states in the availability and reliability of supply. Not only does industry receive irregular and low-quality power, but must pay tariffs much above the cost of supply. Much of this is due to cross-subsidization of power tariffs by state governments and widespread power theft (commonly referred to as "transmission and distribution losses"). Industry ends up paying an average tariff of Rs. 3.81 per kilowatt-hour, whereas the average cost of public power supply is Rs. 3.50 per kilowatt-hour. Industrial tariffs for high-tension industries are 8–9 cents per kilowatt-hour, among the highest in the world, compared with 6 cents in Brazil and Thailand and 3–4 cents in China. Typical rates in Western Europe range from 6 to 7 cents a kilowatt-hour.

In addition, the 2003 ICS found that, on average, manufacturers in India face nearly 17 significant power outages per month, compared with one per month in Malaysia and fewer than five in China. About 9 percent of the total value of firm output is lost due to power breakdowns—compared with 2.6 percent in Malaysia and 2.0 percent in China. The frequency and average duration of outages are such that generators are standard industrial equipment in India, accounting for as much as 30 percent of a business's power consumption in many cases. Moreover, India's combined real cost of power is 74 percent higher than Malaysia's and 39 percent higher than China's.

The paucity, unreliability, and poor quality of power from the public grids has also forced a greater proportion of Indian firms to operate their own (captive) generators, further increasing the cost of power borne by industry and reducing firm-level competitiveness. Some 69 percent of the manufacturing firms surveyed across India in 2000 had their own power generator; even though this number had fallen to 61 percent by 2003, it was still higher than in Malaysia (20 percent), China (27 percent), and Brazil (17 percent). Although large firms can bear such costs, small and medium enterprises (SMEs) suffer severely. The typical Indian SME has its own generator, tying up one-sixth of its capital. This stunts the growth of the SME sector.

For all these reasons, power sector reform is now widely accepted as fundamental to improving business performance in India. Urgent priorities include rationalizing power tariffs, establishing statutory

regulatory authorities, and implementing a phased reduction in cross-subsidies that operate against industrial consumers.[18]

India has made considerable progress in the telecommunications sector in the past few years. Most business surveys report that Indian firms are reasonably satisfied with the state of the country's telecommunications infrastructure. As discussed in chapter 5, India's performance has been improving in this area, although India lags globally behind China and other comparators on many ICT-type indicators.

**Summary of Issues and Recommendations**

The above discussion has highlighted a host of policy reforms in India's economic and institutional regime so the country can embrace knowledge better to enhance growth and competitiveness. Key areas include improving the efficiency of government by reducing its role in publicly owned productive enterprises and using ICTs more efficiently for carrying out government functions, including for the delivery of social services such as education and health. In addition, three specific interrelated sets of regulatory and institutional reforms are important in improving India's investment climate:

1. *Remove product market distortions and for the startup and exit of firms.* Tariff protection in India is still substantially high. To create a level playing field for investment, both domestic and foreign, India needs to put in place trade policy reforms to enhance industrial sector performance. It should thus speed up trade reform by undertaking the following:

    - Reduce average import tariffs, and phase out tariff exemptions, specific tariffs, and antidumping duties
    - Reform customs administration to reduce clearance times
    - Reduce the role of government ownership in the economy, and increase competition in product and service markets
    - Eliminate preferential policies for small-scale players
    - Implement a full and uniform value-added tax
    - Reduce entry and exit barriers to manufacturing industries
    - Phase out remaining limits on FDI, including the ban on FDI in the retail sector
    - Streamline regulation of business startups and bankruptcy procedures
    - Improve overall protection and enforcement of IPRs.

2. *Improve factor markets.* For firms to be able to innovate and take advantage of new opportunities, it is important that the smooth working of factor markets complement entry and exit procedures. The movement of labor and capital from less to more productive activities is central to realizing the benefits of greater competition and openness. Improving the efficiency of factor markets includes the following:

    - Ease restrictions on hiring and firing of workers
    - Reform labor regulations, for example, extending the flexibility to adjust labor use to firms in the 100–1,000 employee range
    - Improve SME access to credit (large creditworthy borrowers have benefited from the recent decline in interest rates, but the lack of access to adequate, timely credit on competitive terms continues to constrain SMEs development)

[18] For more information on issues discussed in this section, see World Bank (2002c and 2004d).

- Make finance more affordable by undertaking financial sector reforms to improve access and reduce the spread between deposit and lending rates
- Improve the venture capital market by reducing restrictions on capital funds, and open up to full participation of foreign investors
- Update the bankruptcy framework and procedures to improve the allocation of resources and access to credit
- Ease restrictions and reduce taxes and extreme regulatory burdens on the use and transfer of land, because (as argued in the McKinsey report) land market distortions account for approximately 1.3 percent of lost growth per year.

3. *Alleviate key infrastructure bottlenecks,* including the following:

   - Reform the power sector, rationalize power tariffs, and implement a phased reduction in cross-subsidies that operate against industrial consumers
   - Introduce time-of-day tariffs for industries with peak and off-peak rates
   - Improve the financial and operational performance of power utilities by unbundling and commercializing state electricity boards, independent regulation, and improved sector governance
   - Address capacity and quality constraints in the transport sector by improving public sector performance (for roads and rail), mobilizing private sector investment (including better cost recovery for roads), phasing out price distortions (for rail), and improving the efficiency of existing capacity (for ports).

In sum, even though India has been reforming its overall economic and institutional regime in the past decade, its growth in the future will need to be more productivity based by increasing the efficiency of investments in physical capital and in knowledge. Although this chapter has mainly focused on the modern sector, a gigantic part of the Indian economy requires overall upgrading. Tremendous benefits can be achieved in terms of overall growth if India can put in place the appropriate mechanisms to use and diffuse modern and new technologies throughout the economy, while tapping global knowledge to raise the overall technological performance of the economy.

Economic incentives and institutions are extremely critical, because they set the overall rules of the game for an economy to progress in response to the rapidly changing challenges and opportunities brought about by the knowledge economy. Further strengthening of this pillar of the knowledge economy in India will not only free the economy to take full advantage of the rapid advances in global knowledge and technology and continually redeploy resources to the most productive uses, but will also allow the country to obtain higher returns on the resources that are being invested in education, innovation, and the information infrastructure. Achieving these higher returns will depend on redefining the role of the Indian government and in constantly reorienting its overall development strategy to meet the new challenges.

# 3. EDUCATION AND HUMAN RESOURCES

Education is the fundamental enabler of the knowledge economy. Well-educated and skilled people are key to creating, sharing, disseminating, and using knowledge effectively. The knowledge economy of the twenty-first century demands, in addition to traditional "hard" skills such as literacy (the "3Rs") and, more recently, ICT competencies, a new set of skills that includes "soft" skills such as communication skills, problem-solving skills, creativity, and teamwork. Although soft skills were previously required of persons in managerial positions, they are increasingly important for all workers in the emerging knowledge economy, This is because, although at the center of the knowledge economy are what Peter Drucker refers to as "knowledge workers"—people with considerable theoretical knowledge and learning, such as doctors, lawyers, teachers, accountants, and engineers—the most striking growth will be in knowledge technologists. They include computer technicians, software designers, analysts in clinical labs, manufacturing technologists, and paralegals, who spend far more time working with their hands than with their brains, but this manual work is based on a substantial amount of theoretical knowledge that only can be acquired through formal education, not apprenticeship. Just as unskilled manual workers in manufacturing were the dominant social and political force in the twentieth century, knowledge technologists are likely to become the dominant social and perhaps political force in the next decades (Drucker 2001b).

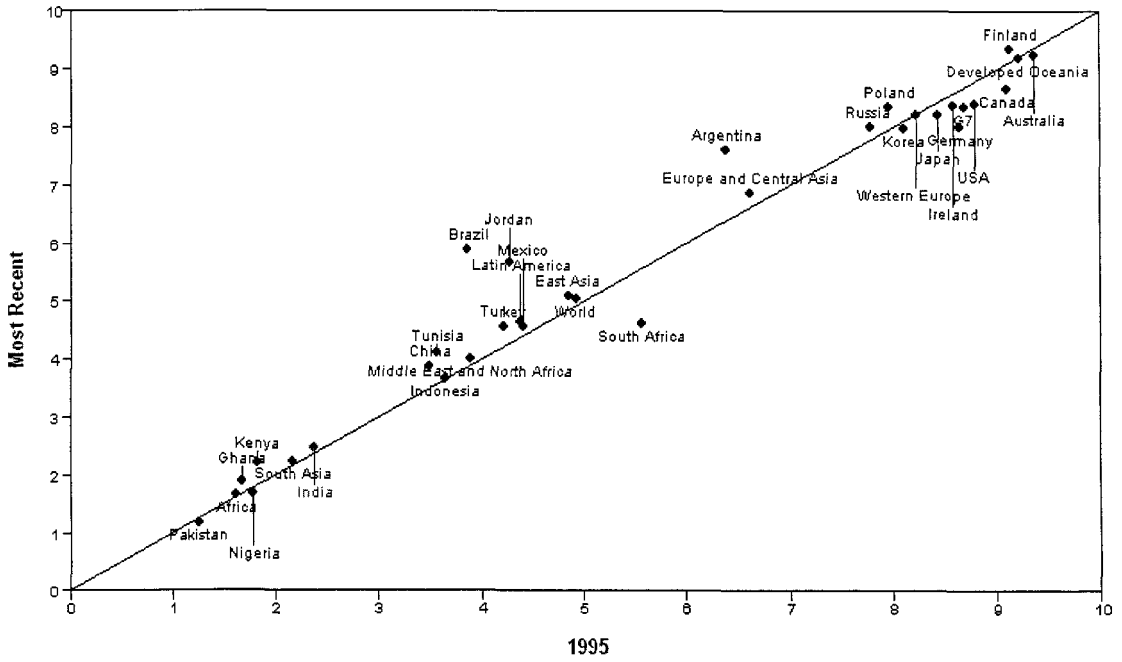
The development of a knowledge economy requires a flexible education system. It begins with basic education that provides the foundation for learning; continues with secondary and tertiary education that develops core, including technical, skills, and encourages creative and critical thinking that is key to problem solving and innovation; and extends into a system of lifelong learning. A lifelong learning system is one that encompasses learning from early childhood to retirement and includes formal training (schools, training institutions, and universities) and nonformal learning (on-the-job training, and skills learned from family members or people in the community). The basic elements of such a system are comprehensiveness, new basic skills (acting autonomously, using tools interactively, and functioning in socially heterogeneous groups), multiple pathways, and multiple providers.

A large pool of highly educated and vocationally qualified people in India are making their mark at home and abroad in science, engineering, IT, and R&D, but they make up only a small fraction of India's population. To become a knowledge economy, India needs to keep developing its human capital base and creating knowledge workers to contribute to its growth, development, and competitiveness in the global economy. Holistic reforms will be necessary to reorient classroom teaching and learning objectives, starting as early as primary school and extending through secondary and tertiary education. India must make its education system more attuned to the characteristics of the new global environment, by focusing on learning rather than schooling, and creating an enabling environment that promotes creativity, improves the quality of basic and tertiary education, and provides opportunities for lifelong learning.

**Benchmarking Education**

Figure 3-1 shows that India has marginally improved its position relative to other countries on the education pillar during the past half decade. It leads the South Asia and Africa Regions, but lags behind Brazil and China. India also significantly trails behind Poland, Russia, as well as Korea, which has a formidable record in education, especially tertiary, in which it outperforms many OECD countries.

**Figure 3-1: Benchmarking Education: India, Comparators, and the World, 1995 and Most Recent Period**

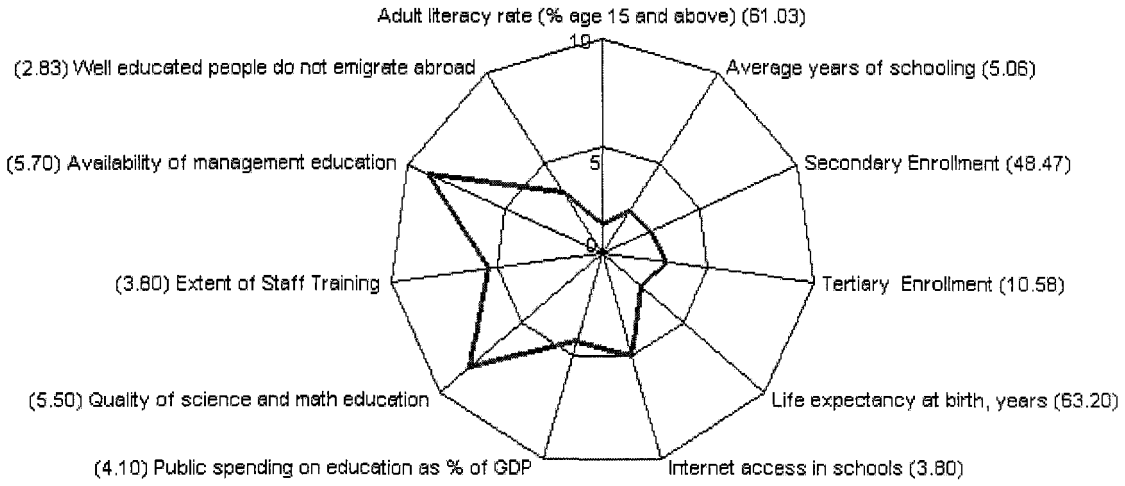



*Note:* Countries above the 45-degree line have improved their position in education for the most recent period for which data are available relative to their position in 1995 (or closest available date in the mid-1990s) and vice versa for countries below the line.

The detailed education scorecard for India presented in Figure 3-2 (and for comparator countries in annex 9) shows a mixed picture: even though India has made progress in increasing literacy (age 15 and older), its average years of schooling at 5.06 years, although higher than in Brazil (4.88 years), are nonetheless lower than those of China (6.35 years), not to mention Poland (9.84 years), Russia (10.03 years), and Korea (10.84 years). The same is true for secondary enrollments, for which India's performance lags behind all comparator countries. Here, Brazil, in particular has made laudable strides in ramping up secondary enrollments in the past few years. In addition, India trails all comparators in terms of tertiary enrollments.

Qualitative rankings from WEF for India included in Figure 3-2 and those presented in annex 9 for comparator countries, however, show that India has several advantages in relation to education and human resources: it ranks quite highly compared with China and Russia on Internet access in schools. India is ahead of all comparator countries when it comes to the quality of math and science education as well as management education, which is available in first-class business schools. In addition, India is ahead of China, Russia, and Poland on its approach to human resources in terms of investment in staff training. This seemingly rosy picture, however, must be taken with a grain of salt, because despite perceived positives, its well-educated people do tend to emigrate abroad, more than all other comparator countries.

**Figure 3-2: India's Scorecard on Education, Selected Variables, Most Recent Period**




*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10 for 128 countries. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for India for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

### Issues and Recent Developments in Education and Human Resource Development

India's transition to the knowledge economy will be determined by whether its people can create, share, and use knowledge effectively. In moving forward, India needs to combine educational reforms oriented to raising participation, equity, and quality at the school and higher education levels with lifelong learning and training programs that can provide the labor force with the necessary skills to be fully engaged in the knowledge economy. This section reviews some important trends in education and human resource development in India and highlights some important issues related to strengthening India's overall educational system.

*Enhancing literacy.* Rates of literacy among the population (aged seven years and older) have risen considerably in India in the past ten years. The 2001 census recorded literacy rates of 65.4 percent, up from 52.2 percent in 1991. The male literacy rate is 75.9 percent (up from 56 percent in 1981), compared with 54.2 percent for women (30 percent in 1981). The gap between male and female rates has therefore narrowed from 28.8 percent in 1991 to 21.7 percent in 2001. Considerable regional variations exist, however: Kerala has a literacy rate of 91 percent, whereas Bihar's is only 48 percent (EIU 2003a).

The constraints in the country's path to reducing adult illiteracy are many: the size and diversity of its population, the time it takes by conventional methods to teach a person to read and write, high dropout rates, lack of trained teachers, and inadequate infrastructure. Some innovative new ways exist, however, in which illiteracy is being tackled in India at low cost using ICTs, as is illustrated by the computer-based functional literacy program initiated by the Tata Group (Box 3-1). Initiatives such as these will need replication on a massive scale throughout India to contribute significantly to reducing illiteracy in the country.

**Box 3-1: Reducing Illiteracy: The Computer-Based Functional Literacy Program**

The computer-based functional literacy (CBFL) program initiated by Tata Consultancy Services (TCS) of the Tata Group tries to overcome illiteracy through the innovative use of IT. It has the potential to help resolve India's adult illiteracy problem and to make 90 percent of India functionally literate in three to five years. The CBFL project uses a mixture of methods—teaching software, multimedia presentations, and printed materials—to teach an uneducated person to read in a fraction of the time it takes to do this by conventional means. It employs animated graphics and a voiceover to explain how individual alphabets combine to give structure and meaning to various words. The project focuses exclusively on reading and teaches a person to read within a span of 30 to 45 hours spread across 10 to 12 weeks. The emphasis is on words, rather than alphabets, and the process is styled to suit the learner. Because the program is multimedia driven, it does not need trained teachers. This also reduces the cost of eradicating illiteracy. The TCS course uses puppets as the motif in the teaching process and has been designed from material developed by the National Literacy Mission, established by the Indian government in 1988 to help eradicate adult illiteracy and is tailored to fit different languages and even dialects.

In terms of results, those coming through the program can acquire a 300–500 word vocabulary in their own language and dialect. This is enough for everyday requirements, such as reading destination signs on buses, straightforward documents, and even newspapers. The program sets people on the path to acquiring other literacy skills, including writing and arithmetic ability. Such infrastructure could also make similar material available, for example, concerning healthcare or agriculture.

The program's potential in India can be gauged by its success in Andhra Pradesh, where it is now operational in 415 centers and has helped at least 8,500 people. Looking ahead, setting up a network to monitor the project and its growth and to share information and get feedback is important. The project should also expand throughout the country, because no one organization can solve India's illiteracy problem by itself. It requires participation of multiple actors, including the government, private sector companies, and NGOs.

*Source:* The Tata Group (2005).

*Raising school enrollments.* A strong basic education system is a necessary precondition to underpin India's efforts to enhance further the productivity and efficiency of its economy. China's experience in this area is instructive: its emphasis on secondary education has provided a firm basis for global expansion of the country's manufacturing activities. Investments in basic education are thus fundamental for countries to improve the productivity and quality of labor and deliver manpower needed for development.

Table 3-1 shows the enrollment of students in primary, secondary, and tertiary education and illustrates the large expansion in student intake that has taken place at all levels in India. The rate of enrollment in primary schools in India has increased in the past decade, from 97 percent of the eligible age group in 1990 to 99 percent in 2001 (Figure 3-3). The corresponding rate for secondary schools

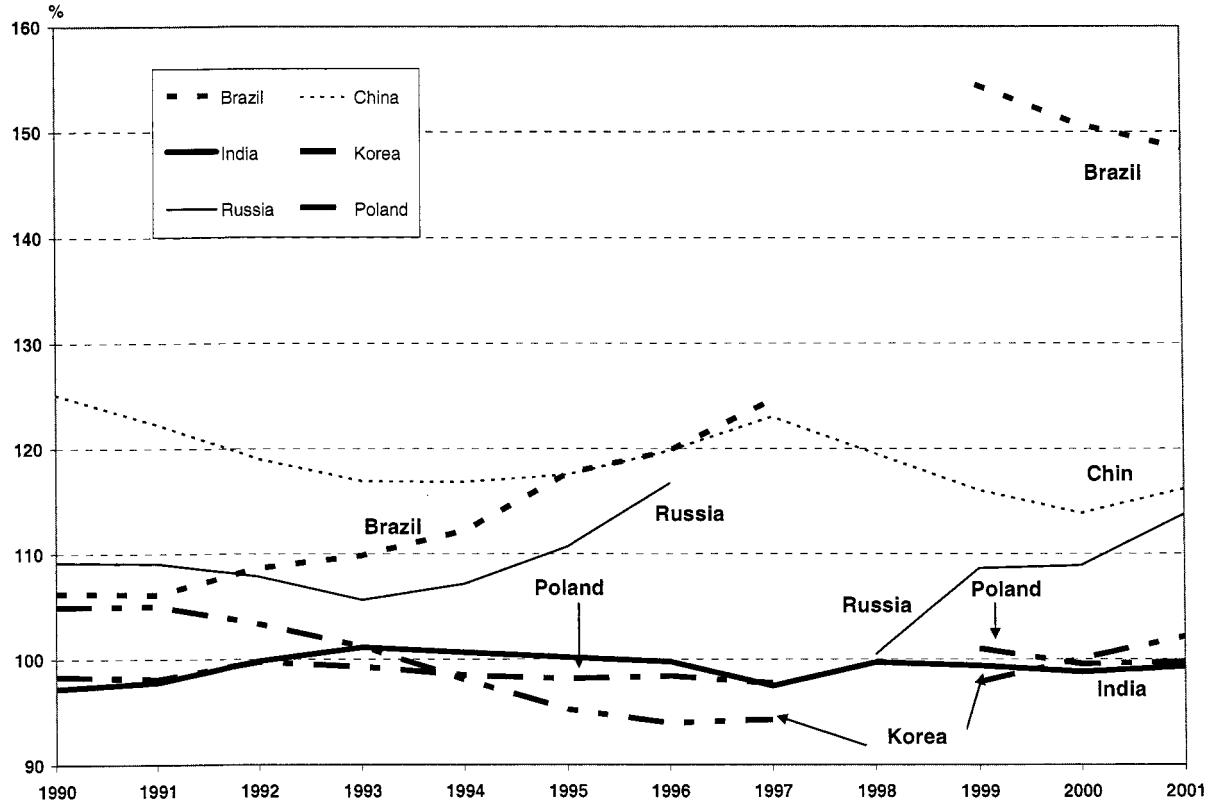
Figure 3-4) rose from 44 percent in 1990 to 50 percent in 2001, but is still lower than other comparators, such as China (67 percent in 2001) and Brazil, which has made tremendous improvements in the past decade and reached 107 percent of the eligible age group in 2001.

**Table 3-1: Enrollment by Educational Stages in India, 1990–91 and 2001–02**
*(millions)*

| Stages | 1990–91 | 2001–02 |
|---|---|---|
| Primary (grades 1–5) | 97.4 | 113.9 |
| Upper Primary (grades 6–8) | 34.0 | 44.8 |
| Secondary (grades 9–12) | 19.1 | 30.5 |
| Tertiary | n/a | 9.2* |

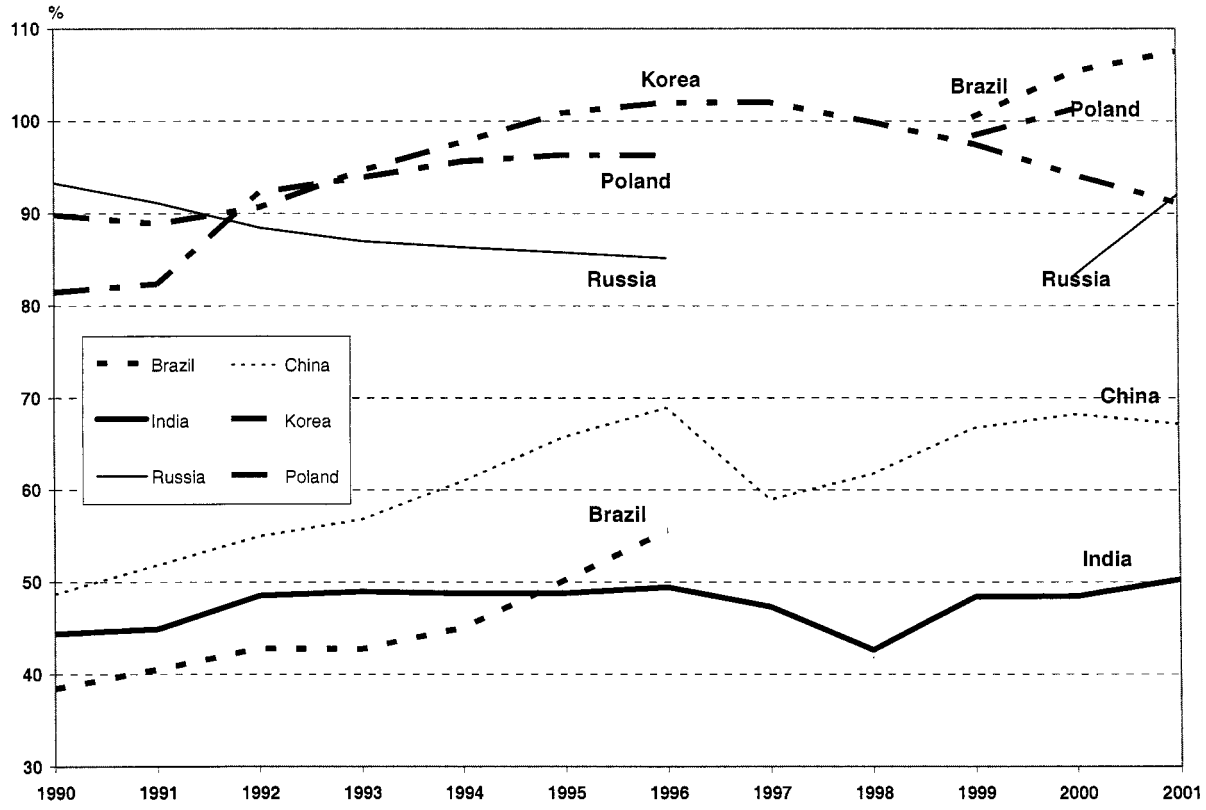
*Note:* This includes more than 1 million students enrolled in nine state open universities and 64 institutes of correspondence courses, including the Indira Gandhi National Open University.
*Sources:* Education Statistics, Department of Education, Government of India, http://www.education.nic.in/htmlweb/edusta.htm (for primary, upper primary, and secondary education). The figure for tertiary education is from the University Grants Commission (http://www.ugc.ac.in).

**Figure 3-3: Gross Primary Enrollment Rates, India and Comparators, 1990–2001**
*(percent)*




*Note:* Discontinuous lines are due to unavailability of data for certain years.
*Source:* World Bank internal databases.

**Figure 3-4: Gross Secondary Enrollment Rates, India and Comparators, 1990–2001**
*(percent)*




*Note:* Discontinuous lines are due to unavailability of data for certain years.
*Source:* World Bank internal databases.

Despite the accomplishments, India still accounts for one-quarter of the world's 104 million out-of-school children. The quality of education—widespread teacher vacancies and teacher absenteeism, high dropout rates, inadequate teaching and learning materials, and uneven levels of learning achievement—is of great concern. It is important to note, for the education MDGs, girls in the 6- to 14-year-old group still exhibit relatively low participation in elementary education. Beyond this age group, considerable gaps exist in provision and access to secondary education, again particularly for girls. But, the Indian government's leadership and commitment to increasing educational attainment has been strong. In 2002 an amendment to the Indian Constitution made elementary education a fundamental right of every child. The national program for universal elementary education, Sarva Shiksha Abhiyan (Education for All), began in 2001. This program is intended to provide eight years of schooling for children in the 6- to 14-year-old group by 2010 and pays special attention to gender and social equity and inclusive education. The program, which the government wholly owns, is designed for a large federal system, with a decentralized framework for service delivery and a built-in accountability mechanism at the school and community levels. The emphasis on quality reinforces the drive to improve access, efficiency, and equity. Achieving the program's goals would not only realize the Indian government's development objectives, but also help to meet the global MDG for education by enrolling one-quarter of the world's out-of-school children.

*Expanding primary and secondary education.* Four main school types for primary and secondary education exist in India: *(a)* schools run by the government (central, state, or local government), *(b)* those run by local bodies, *(c)* those run by private management, but with heavy government influence and funded largely by government grants-in-aid and known as "private-aided" or just "aided" schools, and *(d)* those under private management and run without state aid and known as "private unaided" schools. The latter run entirely on fee revenues and receive little government interference in matters such as teacher recruitment.[19] Table 3-2 shows the distribution of primary, upper primary, and secondary schools in India under these different types of management and highlights the growing importance of private education at all levels of the education system.

**Table 3-2: Percentage of Schools under Different Types of Management in India, Various Years**

| | *Years* | *Government* | *Local Body* | *Government and Local Body* | *Private Aided* | *Private Unaided* |
|---|---|---|---|---|---|---|
| *Primary schools (Grades 1–5)* | 1973–74 | 50.88 | 42.47 | 93.35 | 5.01 | 1.64 |
| | 1986–87 | 41.37 | 51.71 | 93.08 | 4.34 | 2.57 |
| | 1996–97 | 47.78 | 43.88 | 91.66 | 3.34 | 5.00 |
| | 2001–02* | 47.45 | 43.47 | 90.92 | 3.07 | 6.01 |
| *Upper Primary Schools (Grades 6–8)* | 1973–74 | 50.71 | 26.86 | 77.57 | 17.75 | 4.67 |
| | 1986–87 | 42.79 | 32.33 | 75.12 | 16.30 | 8.58 |
| | 1996–97 | 46.41 | 29.13 | 75.54 | 10.25 | 14.20 |
| | 2001–02* | 47.36 | 29.05 | 76.41 | 7.81 | 15.77 |
| *Secondary Schools (Grades 9–12)* | 1973–74 | 26.54 | 10.85 | 37.39 | 57.02 | 5.59 |
| | 1986–87 | 37.49 | 7.73 | 45.22 | 44.79 | 9.99 |
| | 1996–97 | 38.96 | 6.74 | 45.70 | 36.20 | 18.10 |
| | 2001–02* | 36.16 | 6.29 | 42.45 | 33.99 | 23.56 |

* Provisional data.
*Source:* Education Statistics, Department of Education, Government of India (http://www.education.nic.in/htmlweb/edusta.htm).

In particular, Table 3-2 shows that:

- For *primary schools,* the share of government plus local body–managed schools has been falling with time (from 93.35 percent in 1973–74 to 90.92 percent in 2001–02). The contribution of private schools (aided and unaided) has been small, but increasing over the years and was highest in the year 2001–02 (9.08 percent). Of these, the percentage of primary aided schools has been slowly decreasing, while the percentage of unaided schools has been increasing. By 2001–02, the share of private unaided schools was about 6 percent.
- For *upper primary schools,* the government again has continued to manage a majority of these—from almost 51 percent in 1973–74 to 47 percent in 2001–02. Government and local body schools

[19] More information on school types is available in Dyson, Cassen, and Visaria (2004).

together account for about 77 percent of all upper primary schools in 2001–02. The private sector (aided and unaided) schools also remained more or less stable from 22.42 percent in 1973–74 to 23.58 percent in 2001–02; however, the share of private aided schools fell by almost half, whereas that of private unaided schools more than tripled to 15.77 percent between 1973–74 and 2001–02!

- For *secondary schools,* during 1973–74 to 2001–02, the maximum number of these schools were under private management; however, a declining trend in private-aided schools has been observed, while the percentage of private unaided schools has been increasing. By 2001–02, they had increased their share by more than four times to reach 23.56 percent of secondary schools.

It seems that accelerated educational progress in the 1990s was partly due to the contribution made by the rapidly growing private school sector, which represents increased private expenditure on education by households. Analysts suggest various reasons for why households increasingly bypass free public schools to send their children to private fee-charging schools. Reasons given rarely include the lack of a government-funded school in the vicinity, but more frequently the perceived better quality of private schooling. In addition, unlike government primary schools, private schools provide active teaching: when investigators visit these schools, teachers are almost always in class and teaching. If the fiscal squeeze in state budgets continues in the future, parents who can afford it will turn increasingly to private schools to educate their children. The private sector is thus likely to continue to grow relative to the public education sector (for more information, see Dyson, Cassen, and Visaria 2004).

To meet the challenge raised by private education providers, some state governments are trying to improve the relevance and quality of education provided in government schools. For example, one promising experiment relating to provision of IT training in high schools is taking place in Andhra Pradesh: the government has contracted with the National Institutes of Information Technology (NIIT) to provide training in computers to more than 300,000 high school students in 663 government schools. This has involved setting up modern computer classrooms in each of these schools, for a total of more than 8,000 computers, and rolling out computer education classes. NIIT is also working to enhance the skill base of people at large in Andhra Pradesh by using these schools to provide state-of-the-art computer education to local citizens after school hours. NIIT's computer training engagement has now spread to more than 2,000 government schools covering more than 750,000 students in India, including 371 schools in Tamil Nadu, 700 schools in Karnataka, and about 100 schools each in Punjab and West Bengal (NIIT 2002).

*Spending on education.* Table 3-3 highlights that expenditure composition is skewed toward the secondary level and to an even higher extent toward tertiary education in India and also in China. It is important to note that unit costs rise progressively and significantly among primary, secondary, and tertiary education levels across all education systems. This variation reflects in large part higher salaries and more sophisticated infrastructure, that is, laboratories, technologies, and so on, required to deliver education at these levels.

**Table 3-3: Spending on Education, India and Comparators, 2001**

| Country | GDP per capita, U.S. dollars, 2003 | Public expenditure per student (as percent of GDP per capita) | | |
|---|---|---|---|---|
| | | Primary | Secondary | Tertiary |
| India (2000) | 563 | 13.71 | 23.01 | 85.76 |
| Brazil (2001) | 2,788 | 10.75 | 9.98 | 48.49 |
| China (1998) | 1,094 | 6.58 | 12.56 | 89.13 |
| Korea (2000) | 12,634 | 18.38 | 16.84 | 7.37 |
| Poland (2000) | 5,487 | 28.81 | 11.82 | 16.10 |
| Russian Federation (2001) | 3,022 | n.a. | n.a. | 9.60 |

*Note:* The abbreviation "n.a." means not available. Data for tertiary expenditure for Korea are for 2001.
*Source:* World Bank internal database.

Given a distinctive feature of India—where a sophisticated academic tradition coexists with mass poverty—it is perhaps not surprising that tertiary education is expensive in terms of GDP. This does not mean, however, that tertiary education is a high priority use of public money. University fees have generally been on the low side, and universities should evaluate the extent to which they can hike fees, at the same time taking into account of the needs of poorer students. Private sources should be encouraged to contribute to a greater extent to higher education, and more public resources should be allotted for primary and secondary education. Some measures to improve use of public resources in primary and secondary education include the following:

- *Involve communities and parents to monitor and evaluate school performance to a much greater degree.* Making schools more accountable is critical, even to the extent of giving parents, through local school committees, the right to hire and fire teachers. Box 3-2 highlights the experience of community-government partnership for education in Madhya Pradesh.
- *Encourage competition in education.* In Kerala, for example, substantial subsidies are given for transportation for students. Parents can shop around for better schools, which fosters competition among schools for enrollments, providing critical revenue.
- *Give more autonomy to schools to attract teachers and students.* Higher levels of government can help by establishing more regular measurement of attendance, learning outcomes, and other information needed to evaluate student progress.
- *Use distance education technologies to improve and increase access to primary and secondary and vocational education.* Given the paucity of adequately trained and qualified teaching staff in semi-urban and rural areas, these technologies could be a cost-effective mechanism to providing educational opportunities to more students (World Bank 2003d).

**Box 3-2: Community-Government Partnership Helps Get Millions into School: The Case of Madhya Pradesh**
In the past decade, Madhya Pradesh's Education Guarantee Scheme (EGS) dramatically improved access to primary education, especially for children from very poor households and in scattered settlements. The program is built on community demand and participation and guarantees a fast-track approach to basic education by linking it with local self-government institutions.

The EGS was designed specifically to address the issue of access. Between July 1997 and July 2000, 26,571 EGS schools were created (42 percent of them in tribal areas) catering to 1,233,052 children (47 percent girls and 44 percent tribal children), of which 91 percent were from "scheduled caste," "scheduled tribe," and other socially disadvantaged communities. As of June 2003 the program appointed a total of 31,815 *Gurujis* (teachers), who were identified by the community and trained by the education department of the government. The most significant impact of EGS has been a sharp reduction in the absolute numbers of out-of-school children: from 1,315,000 (boys) and 1,604,000 (girls) in 1996 to 346,000 (boys) and 428,000 (girls) in 2002–03. Female literacy increased by 20.93 percent in the decade.

This program was based on community demand and managed by local self-government institutions. The Government of Madhya Pradesh ensured continuation of the program through a motivated team of officials for the decade starting in 1993–94. From its outset, the EGS was positioned as a large-scale program, not just a small innovation. The Government of Madhya Pradesh allocated adequate financial resources on elementary education. Other innovative sources of funding included the "Fund a School" program in 2000, in which anyone could log on to the Web site and adopt a school; funds were directly credited into the bank account of the school concerned. The EGS created institutional structures for including poor rural children by providing a forum for articulation of demand for education through the Panchayat, a mechanism to forward that demand through local self-government structures, public commitment by the government to establish EGS primary schools, and mechanisms for continued participation of the community and the Panchayat in management and supervision. Another innovation was the government's pledge to meet its obligation of providing an EGS school within 90 days and provide training and academic support to the teacher identified by the community. The EGS program demonstrates that when poor people are confident that their voice will be heard and they can exert a positive influence, their enthusiasm to participate in local governance goes up.

*Source:* Ramachandran (2004).

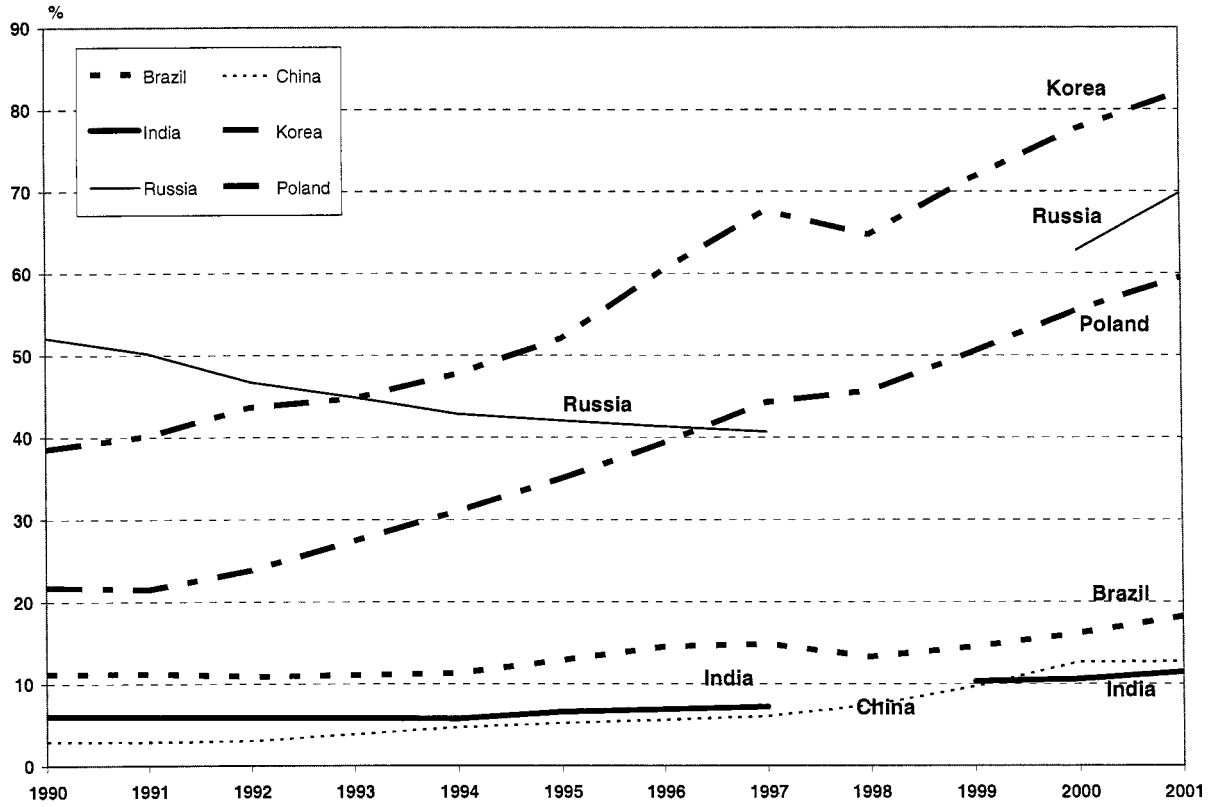
In sum, ensuring consistency between the skills being taught in primary and secondary education and the needs of the knowledge economy will only help to strengthen India's human resource base further. This requires that materials and methods also be introduced to teach students "how to learn" instead of stressing occupation-specific knowledge. India could do well to learn from the experiences of other countries, such as Brazil, that have made rapid progress in increasing secondary enrollments and improving the quality of their secondary education systems.

*Boosting tertiary and technical education.* Tertiary education is critical for the construction of knowledge economies. Tertiary education is a broader notion than it used to be, incorporating most forms and levels of education beyond secondary schooling and including both conventional university and nonuniversity types of institutions and programs. Tertiary education also means new kinds of institutions, work-based settings, distance learning, and other arrangements and now puts the focus as much on demand as it does on supply. In other words, it is more student led than in the past and has new implications for stakeholders, institutions, and resource planning (Wagner 1998). A recent World Bank report states that "tertiary education is necessary for the effective creation, dissemination, and application of knowledge for building technical and professional capacity. Developing countries are at risk of being further marginalized in a highly competitive world economy, because their tertiary education systems are not adequately prepared to capitalize on the creation and use of knowledge" (World Bank 2002a).

India currently produces a solid core of knowledge workers in tertiary and technical education, although the country needs to do more to create a larger cadre of educated and agile workers who can adapt and use

knowledge. Figure 3-5 shows that until 1999 India led China in terms of its gross enrollment ratio (GER) for tertiary education, after which China surpassed India. In 2001 India had a tertiary GER of 11.4 percent compared with 12.7 percent for China. According to recent sources, China's gross enrollments were in the range of 13–15 percent in 2003,[20] and some estimates suggest that they have increased even further to about 20 percent by 2004. Whatever the estimates, it is clear that, in the past few years, China has surpassed India in this domain and is continuing to make rapid progress. But even so, India and China are no match for Poland and Korea, which had impressive tertiary GERs of 59 percent and 82 percent, respectively, in 2001.

**Figure 3-5: Gross Tertiary Enrollment Rates, India and Comparators, 1990–2000**
*(percent)*




*Note:* Discontinuous lines are due to unavailability of data for certain years.
*Source:* World Bank internal databases.

[20] According to China's National Statistics Bureau (2003), gross enrollment in China's higher education system was 13 percent for 2002–03. In a recent paper, Levin and Xu (2003) indicate that increased government investment, diversified resources, and improved efficiency have produced rapid expansion in terms of both teaching and research in the past several years. For a long time, the college entrance examination was the most ferocious battlefield for Chinese students and the GER was consistently below 7 percent. It was especially difficult to get into key national universities, where the ratio of admissions to acceptances is even more selective. Within six years (1996–2002), however, this ratio has more than doubled. The authors cite the latest numbers from a January 2003 report from the Chinese Ministry of Education showing that the ratio reached more than 15 percent of the corresponding age group (18–22 years old) in the past year.

In India, according to India's Planning Commission (2001b), the university system in India provides access to only 5.75 percent of the estimated population in the 18–24 age group. In 1999–2000, of a total estimated population of 134 million in the 18–24 age group, only 7.73 million were enrolled in colleges and universities. The nonformal system (distance and open learning) accounts for only a small percentage of the total enrollment in higher education. Of the 7.73 million students enrolled in colleges and universities, distance education and correspondence courses covered only about 1 million students.

The numbers, however, belie some laudable achievements in the field of tertiary education in India. The country has some 272 universities, 58 "deemed" universities, 12,600 colleges, and many world-class institutions of higher learning that are competitive and meritocratic (such as Indian Institutes of Technology [IITs], Indian Institutes of Management, Indian Institute of Science, and the regional engineering colleges [RECs]).[21]

*Alleviating constraints in tertiary education.* Despite the efforts put into establishing a top-quality university system, not all publicly funded universities or other educational institutions in India have been able to maintain high-quality standards or keep pace with developments in knowledge and technology. Even within tertiary institutions, such as the University of New Delhi, the quality varies significantly across its multiple colleges. Subsidies for tertiary education and a system of positive discrimination have skewed the education system; a great number of students are accepted on the basis of caste or religion rather than ability. A key challenge is addressing the academic needs of students of much more mixed abilities than was the case in the past when only the best prepared students (generally from the upper classes) had access. This has important internal efficiency implications. Poor prior academic preparation of many students contributes to often high repetition and dropout rates. This situation exacts a high cost on the system, not only raising average outlays per student graduating, but further circumscribing places available for other students who wish to pursue higher-level studies. One approach meriting consideration is widening the choices of institutions available to meet tertiary education demands and needs. Of special note is potential development of a community college system, including possible conversion of some lower-quality, lower-performing university-affiliated colleges. This approach holds substantial promise for helping students from poorer academic backgrounds to get remedial support and build study skills to enable them to transfer into bona fide universities.

Today, many tertiary education institutions in India are constrained by an explosion in enrollments, poor and inadequate academic and physical infrastructure, limited financial support from the government, the struggle between quality and quantity, and, most important, an overall bureaucratic regulatory and management framework built on numerous controls. Over the years, the Indian education system as been heavily subjected to government regulation. Government intervention has generated a range of regulations on provision of educational services, rendering the system inflexible in meeting market needs. In the tertiary education sector, universities lack autonomy in management and academic affairs, student enrollments and admissions, fee levels, and so on. In addition, poor remuneration and infrastructure mean that most tertiary educational institutions are not able to attract or retain high-quality faculty members. Many tertiary-level institutions are faced with faculty shortages due to noncompetitive pay packages and mediocre faculty quality. Only half the faculty in professional institutions have a postgraduate degree, and few have a doctoral degree. Another major weakness of India's tertiary education system is the existing tenure system, which "guarantees" lifetime employment opportunities and provides adverse incentives for those who would like to engage in innovative research. The current system also makes the existing talent pool in academia less mobile and competitive, which, in turn, affects the quality of education delivered, ability of these institutions to attract high-quality students, and potential of students to attain the high learning outcomes required in a knowledge economy.

In the area of quality assurance and accreditation, major steps are needed to ensure that India's institutions meet high-quality national (and if such services are exported, international) standards. The heavy centralization of the accreditation process by the National Accreditation Board currently leads to long wait lists and a very bureaucratic process, with one chance to pass or fail. The best accreditation systems worldwide emphasize the need for institutions to undertake continual self-evaluation and

[21] The number of universities (in 2000) is from http://www.Indiastat.com. The number of colleges (in 2002) is from the University Grants Commission (http://www.ugc.ac.in).

monitoring and view the process as ongoing; recommendations ensuing from various phases serve as valuable guides for institution strengthening. Private universities in India are also not accredited, a situation that needs remedying, because these institutions are increasingly becoming providers of highly skilled personnel and knowledge workers. A stronger competitive environment for all universities thus needs to be cultivated, because this will help to create greater diversification and responsiveness to student needs, as well as meet the competitive needs of the economy.

Steps to enhance the quality and relevance of higher education also need to taken. This is especially important, because according to the University Grants Commission (UGC), some 9.3 million students in India are currently pursuing undergraduate and graduate degrees and 85 percent of these only receive a general degree, which is not enough to convert these students into effective knowledge workers; thus, to make education more attuned to the needs of the marketplace, recent plans have been announced to have "clubbed education," in which students would not only get a general degree, but also utility-oriented education. The plan is to increase the duration of undergraduate education from three to four years (3+1 structure), in which the last year would be spent in an allied professional subject, and a student would get two degrees at the end of four years.[22]

Another area that holds promise for attaining desired quality improvements is that of establishing partnerships among Indian universities to optimize available resources and between Indian universities and foreign ones. This holds potential not only for upgrading by pooling library and other resources and attracting and retaining high-quality faculty via interpartner exchange programs, but also affords the opportunity for students to receive widely sought internationally recognized credentials. The Indian School of Business in Hyderabad, established and operating jointly with two outstanding U.S. business schools—the Kellogg School of Management and Wharton School—and with the London Business School in the United Kingdom, is a prime example.

The Indian government is also quite concerned about the rapidly increasing establishment of real and virtual campuses of foreign universities in the country. Many foreign universities are clearly widely perceived to offer (although not necessarily the case) a higher-quality education and—not unimportant—externally recognized credentials than Indian institutions. Such competition may serve as a powerful catalyst to effect needed quality-enhancing tertiary education reforms throughout India's own system. This trade also presents India with substantial, as yet not fully or well-exploited, opportunities to export its own tertiary education as well as attract many more foreign (well-paying) students into its system.

*Improving science and technology education.* India has one of the world's largest systems of postsecondary technical science and engineering education. As a result, it has one of the largest stocks of scientists, engineers, and technicians in the world. But a study by the World Bank (2000) detailed several major deficiencies in India's scientific and technical manpower development system that urgently need to be addressed if India is to fulfill its huge potential for economic prosperity. These include overcentralization and lack of autonomy and accountability of institutions, as most have little authority on faculty appointments, student admissions, structure and contents of programs, student performance evaluation, and financial management. In terms of physical infrastructure, technology and infrastructure support is poor in many tertiary education institutions, especially in laboratories, communication lines, computer and IT, as well as in library linkages. In addition, resource constraints prevent attracting the best to academic careers, the quality and relevance of the curriculum is in general poor, and quality assurance mechanisms are weak.

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[22] From a presentation made by Arun Nigavekar, chairman, University Grants Commission at the workshop on "India and the Knowledge Economy: Leveraging Strengths and Opportunities," November 9, 2004, New Delhi (http://www.worldbank.org.in/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/INDIAEXTN/0,,contentMDK:20279055~menuPK:295602~pagePK:141137~piPK:141127~theSitePK:295584,00.html).

Although the Indian system includes a few well-known and world-class institutions of international standing, such as IITs and the Indian Institute of Science, it thus has hundreds of newly established engineering colleges that are yet to meet quality norms and standards. At the apex of the technical education institutions in the country are the IITs. India also has some front-ranking universities and institutions for engineering and applied sciences education, such as the Indian Institute of Science, University of Roorkee, Jadavpur University, and Anna University. The government has also established, in partnership with states, 17 RECs with a primary focus on high-quality engineering practice. These colleges along with about 30 well-established state colleges and government-aided private colleges form the second tier of leading technical institutions. The RECs are followed by some 500 government/government-aided and self-financing engineering colleges offering only degree programs and some 1,100 polytechnics offering diploma programs. Most of these institutions operate under strict control of the State Directorates of Technical Education and the affiliating universities or State Boards of Technical Education. Although IITs and a few other first-tier institutions offer world-class education and training in engineering and technology incorporating "best practices," a large number of institutions offer rather outdated programs (prescribed by their affiliating university/board) with inflexible structures and content. Within each category of public, privately aided, and private unaided institutions, wide variation in quality exists. Quality assurance mechanisms are weak, and programs in less than 15 percent of institutions are accredited by the National Accreditation Board. IT is not used significantly for teaching. No more than 6 percent of institutions have any noteworthy research activity. Institutions are essentially unconnected to the industries and sectors in which their graduates find employment (World Bank 2000).

*Matching education with labor market needs.* Even though India produces almost 200,000 scientists, engineers, and technicians a year (Table 3-4), it has not been obtaining the full economic benefit from this skill base because of the mismatch between education and the labor market. The professional workforce emerging from India's higher education system often cannot find suitable employment due to a growing gap between knowledge and real practice and to limited job opportunities in professional fields, coupled with low salaries. Many of them also leave the country in search of better opportunities, which leads to brain drain.

**Table 3-4: Scientific and Technical Personnel from Indian Universities by Level of Qualification, 1979, 1989, and 1995**

| (Number) | | | | | |
|---|---|---|---|---|---|
| | | Qualification | | | |
| **Field** | | *Graduates* | *Post Graduates* | *Doctorates* | *Total* |
| *Science* | *1979* | 99749 | 17638 | 2262 | 119649 |
| | *1989* | 134366 | 24591 | 3044 | 162001 |
| | *1995* | 139257 | 23807 | 3155 | 166219 |
| *Engineering and Technicians* | *1979* | 18364 | 3155 | 506 | 22025 |
| | *1989* | 28927 | 4560 | 560 | 34047 |
| | *1995* | 32250 | 3667 | 546 | 36463 |

*Source: Research and Development Statistics 2000-01, Ministry of Science and Technology, Government of India*

*Reversing brain drain.* One of the indicators of international mobility is the number of Indian students entering the United States. This number has increased considerably, from around 15,000 Indian students in 1990 to almost 50,000 in 2001. Almost 80 percent of the Indian students who enrolled in tertiary education in various OECD countries in 2001 went to the United States. In 1999, 165,000 Indian residents in the United States had science and engineering as their highest degree. They accounted for 13 percent of the total number of foreign-born U.S. residents with science and engineering as their highest degrees,

more than any other country. India also accounted for a high share of foreign-born residents residing in the United States in 1999 with a science and engineering doctorate: 16 percent or 30,000 people, which is second only to China. Moreover, Indians comprised almost 7 percent of people granted entry as permanent residents in the United States in 2001 (Khadria 2004a).

So not only does India have to deal with the problem of the high outflow of the tertiary educated workforce, but those who leave also tend to be the best of their cohort. Vast outflows of highly skilled health professionals are among the prime examples: 49 percent of graduates of the All-India Institute for Medical Sciences, the country's best medical school, emigrated in the 1990s. But there are some positive signs are evident of a reverse brain drain from the United States back to India. According to the U.S. National Science Foundation, after peaking in the mid-1990s, the number of doctoral students from India, China, and Taiwan with plans to stay in the United States has begun to fall (Broad 2004).

It is important to differentiate between the "virtuous" and vicious cycles of human capital flows. Recent developments have shown that India has become a major international center for the recruitment of high-quality IT staff. Many IT workers leave, but many return, and both flows generally lead directly and indirectly to significant knowledge transfers and linkages across business entities that benefit Indian society as well as individuals. A recent OECD paper also describes the results of two specific surveys targeting highly skilled Indians: one of IT professionals in Bangalore and the second of health professionals (doctors and nurses) in New Delhi on their motivations for emigrating, experiences abroad, reasons for coming back to India, and perception of their current situation. The findings of both case studies show that young IT professionals as well as medical professionals want to go abroad mainly to gain professional experience, which they think will be highly valued in India when they come back. In addition, they are encouraged by higher earnings, perks, and high quality of life in the host country. Unlike the IT professionals as well as most doctors, however, the majority of prospective nurses want to settle down abroad permanently, because they do not perceive their career prospects to be bright in India. Only some of the doctors are prepared to settle abroad permanently if they get a chance. The fact that none of the respondent professionals in Bangalore gave priority to the idea of settling abroad highlights a unique aspect of Bangalore becoming a "corridor" for migration (outward and inward) of Indian human resources in science and technology, which is not the case for health professionals from New Delhi. IT professionals in Bangalore believe they have growing opportunities for career growth in India in general and Bangalore in particular (Khadria 2004b).

With time, the above developments have no doubt exacted costs. Many of the highly skilled people who migrate from India have been educated at publicly financed tertiary institutions. Their migration means public resources have subsidized high-level human capital formation for developed countries. The United Nations Development Programme's (UNDP's) *Human Development Report 2001* estimates a loss of $2 billion a year in resources due to emigration of computer professionals to the United States alone. The report states that each year about 100,000 Indians are expected to emigrate to the United States, when India has invested between $15,000 and $20,000 in educating each one of them; the Indian government's investments in education are thus subsidizing industrial country economies, particularly the United States! Many questions arise: how can India be compensated for this fiscal cost, and is it possible to demand compensation from host country governments? According to the UNDP report, the simplest administrative mechanism would be to impose a flat tax—an exit fee paid by the employee or the firm at the time the visa is granted. The tax could be equivalent to the fees charged by headhunters, which generally run about two months' salary. Assuming annual earnings of $60,000, this would amount to a flat exit tax of $10,000, or approximately $1 billion annually. The report also cites several alternatives for taxing flows of human capital:

- *Requirement for loan repayment.* Each student in tertiary education is given a loan (equivalent to the subsidy provided by the state), which must be repaid if the student leaves the country.

- *A flat tax.* Overseas nationals pay a small fraction of their income annually, for example, 1 percent.
- *U.S. model.* Individuals are taxed on the basis of nationality, not residence (this would require negotiating bilateral tax treaties).
- *Cooperative model.* A multilateral regime allows automatic intergovernmental transfers of payroll taxes or income taxes paid by nationals of other countries.

As with all taxes, each of the above involves trade-offs between administrative and political feasibility, and the revenue potential that can be garnered as a result of these measures.

### Measures to Strengthen Education and Human Resources

Although India has significant areas of strength in its educational system and human resource development, the country must still address key areas of reform so education will support the new knowledge economy. These include enhancing basic education, overhauling tertiary education, remedying weaknesses in science and technology education, promoting policy and institutional reforms for scientific R&D, strengthening skills development and training, encouraging lifelong learning, enhancing the role of government, and involving the private sector in education, training, and human resource development.

*Enhance basic education.* Skills matter more than ever in today's competitive global market. In large countries such as India and Brazil, where the vast majority of people are unskilled and uneducated, the capabilities of the majority of the population must be enhanced for the economy to show substantial improvements. Firms and farmers alike must be able to learn and develop new skills. While not losing sight of the need for secondary and tertiary education, governments should improve the skill and education levels of the mass of people through primary and vocational education. The success of countries such as China in achieving higher growth reveals the importance of a workforce that has a basic education and can be trained.

Table 3-5 highlights the educational attainment of the population in China and India in 1980–2000.

**Table 3-5: Educational Attainment of the Total Population Aged 15 and Older, India and China, 1980–2000**

| Country | Year | Population | Highest level attained | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|
| | | over age 15 (1000s) | No Schooling | First level | | Second Level | | Post-Secondary | | Years of School |
| | | | | Total | Complete | Total | Complete | Total | Complete | |
| | | | (Percentage of the population aged 15 and over) | | | | | | | |
| India | 1980 | 423306 | 66.6 | 12.6 | 4.7 | 18.5 | 5.4 | 2.4 | 0.7 | 3.27 |
| | 1990 | 542391 | 55.8 | 20.5 | 7.6 | 20.5 | 5.6 | 3.3 | 1.7 | 4.10 |
| | 2000 | 680072 | 43.9 | 28.2 | 10.5 | 23.8 | 6.5 | 4.1 | 2.2 | 5.06 |
| China | 1980 | 642693 | 34.0 | 31.3 | 11.8 | 33.7 | 9.9 | 0.9 | 0.6 | 4.76 |
| | 1990 | 837940 | 22.2 | 34.6 | 13.0 | 41.3 | 13.5 | 1.9 | 1.4 | 5.85 |
| | 2000 | 958997 | 18.0 | 33.9 | 12.8 | 45.3 | 14.8 | 2.8 | 2.1 | 6.35 |

*Source:* Barro and Lee (2001).

It shows that in 1980, China already had a higher share of population with schooling than India: 66.6 percent compared with 34 percent. So, it is not surprising that China had a higher average educational attainment level in 2000 of 6.35 years compared with 5.06 years in India. In the past 20 years, it is impressive that India was able to more than double the share of population with completed primary education from 4.7 percent to 10.5 percent. China, however, was able to increase the share of population with completed secondary education by 50 percent from 9.9 percent in 1980 to 14.8 percent in 2000, compared with an increase from 5.4 percent in 1980 to 6.5 percent in 2000 in India.

India, therefore, faces a big challenge in extending secondary education and providing skills to the population at large so they are able to contribute to the economy. In addition, as India's population continues to grow, to turn the potential of this very young population into an asset, India needs to provide people not only with primary education, but increasingly secondary and even tertiary education, as well as requisite skills so they are able to participate effectively in the knowledge economy.

*Overhaul tertiary education.* The Indian tertiary education system needs to become more demand driven, quality conscious, and forward looking to retain highly qualified people and meet the new and emerging needs of the economy. Some actions that can help to develop a vibrant tertiary education sector in the country include the following:

- Empower higher education institutions in academic, administrative, financial, and managerial matters, and expand and develop more high-quality institutions (such as IITs) to satisfy the demand for postsecondary technical and engineering education.
- Create a rating mechanism for tracking all higher education institutions, based on a transparent set of parameters related to education delivered and infrastructure available. Such rating information would be useful in evaluating the performance and progress to date of these institutions and should be freely available to any student desiring it (see Box 3-3 for a recent UGC initiative in this area).

**Box 3-3: Increasing Transparency in Indian Higher Education**
The University Grants Commission began the Higher Education Information Systems Project to develop a transparent and comprehensive information system on the following:

- Monitoring of grants
- Collection of relevant data from various institutions for statistical analysis consistent with international standards
- Recognition and management of institutions and programs based on their level of competence and performance
- Management of university and college admissions to bring transparency into the process
- Research project management
- Expertise and facilities database to improve the interface between academia and society.

The UGC project will also, particularly with industry, monitor the relevance of various curricula offered by universities to industry and develop a Graduates Registration and Information System (Gratis), a labor market information system. Gratis would assign a unique number to each student who enters the Indian higher education system, link such numbers with subsequent qualifications acquired, and develop and establish a qualification-skill-competency card integrated with the multipurpose cards.

*Source:* University Grants Commission (http://www.ugc.ac.in/new_initiatives/hisp.html).

- Reduce generic subsidies and introduce scholarships and aid schemes targeted to meritorious and economically weaker students.
- Orient the curricula of Indian universities (which remain academic and rather rigid) toward developing the "knowledge technicians" required by industry. Curricula should also emphasize development of soft skills, such as teamwork, networking, language, and knowledge-sharing skills at higher education institutions.
- Provide Intranet and Internet connectivity to universities and colleges to enable free flow of knowledge and information to help enhance access as well as the quality of higher education. In this direction, India has developed an Education and Research Network (ERNET) to connect and provide Internet service provider (ISP) services to educational institutions all across the country for academic and research purposes and create a backbone for the flow of teaching and learning support materials. The network architecture consists of campuswide local area networks at universities, a terrestrial

backbone linking universities, and a broadband satellite network. In addition, the UGC-INFONET has a communications backbone of 8 Mbps, which will be upgraded to 1 Gbps.[23] Varied bandwidth will be given to universities: from 528 Kbps to 2 Mbps. Campus local area networks (LANs) will be set up that will provide free access to students and teachers.[24]

- Use distance learning technologies to expand access and quality of formal education and also of post-formal education and training (Box 3-4).

**Box 3-4: Expanding Distance Education in India**

During the Ninth Five-Year Plan (1997–2002), the Indira Gandhi National Open University (IGNOU) expanded its Regional Centers and Study Centers Network, increasing enrollment of distance learners in open and distance education. IGNOU has 1.2 million students on its rolls and offers 72 programs. The emphasis in the Tenth Plan (2002–07) is on increasing access to disadvantaged groups and underdeveloped regions and setting up open universities in Indian states that do not yet have them. IGNOU offers education, training, and extension programs and also acts as the national nodal agency for the maintenance of standards in distance education in the country. It has established a Distance Education Council that acts as nodal agency for the distance education system at the tertiary level. It has also adopted an integrated multimedia instruction strategy consisting of print materials and audiovisual programs, and supported by counseling sessions at its study centers throughout the country. In January 2000 it launched a 24-hour educational TV channel called Gyan Darshan, which telecasts educational programs from the primary school to the tertiary level. The Tenth Five-Year Plan proposed expansion of the activities of Gyan Darshan (TV channel) and Gyan Vani (radio broadcast) to include 40 FM radio stations.

*Source:* India, Planning Commission (2001b).

- Harness ICTs for teacher training and content development at all levels. For example, the IBM Knowledge Factory in Bangalore and UGC are working on developing five educational multimedia resource centers for content development. Intel and Microsoft are also working with UGC on teacher training and the development of electronic content.[25]
- Develop programs that are flexible and in line with the needs of the market and communities, including through the recent UGC initiative to increase undergraduate education from three to four years, in which the last year is spent mastering professional subjects that meet the new needs of the economy.
- Encourage foreign investment in establishing higher educational institutions. For instance, Motorola is collaborating with the Pune Institute of Advanced Technologies and is offering a postgraduate degree in advanced telecommunication engineering with a software focus. Such new colleges can help to introduce specialized subjects as demanded by the market.

*Remedy weaknesses in science and technology education.* A consensus is developing on the need for a major systemic education reform strategy in India for science and technology. The strategy involves the following sequential interdependent elements: empowering institutions (with full accountability); utilizing resources optimally; mobilizing additional financial resources; establishing effective quality assurance mechanisms; networking of institutions to enhance capacity, improve quality, and promote excellence;

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[23] Mbps stands for millions of bits per second or megabits per second and is a measure of bandwidth (the total information flow for a given time). Depending on the medium and the transmission method, bandwidth is also sometimes measured in the Kbps (thousands of bits or kilobits per second) range or the Gbps (billions of bits or gigabits per second) range.

[24] From a presentation by Arun Nigavekar, chairman, University Grants Commission at a workshop on "India and the Knowledge Economy: Leveraging Strengths and Opportunities," November 9, 2004, New Delhi. (http://www.worldbank.org.in/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/INDIAEXTN/0,,contentMDK:20279055~menuPK:295602~pagePK:141137~piPK:141127~theSitePK:295584,00.html).

[25] Ibid. Arun Nigavekar, November 9, 2004, New Delhi.

establishing better and closer linkages with industry and community; and increasing access and reducing regional imbalances (for more information, see World Bank 2005a).

Several reforms have been undertaken to date in this direction. In an effort to upgrade further the large number of science and engineering colleges in the country to quality standards closer to those of India's world-class IITs, the government in its Tenth Five-Year Plan (India, Planning Commission 2002e) decided, as part of ongoing restructuring of engineering education in India, that 17 RECs with great potential will be expanded, modernized, given full academic and administrative autonomy, and converted to National Institutes of Technology (NITs), with a "deemed-to-be-university" status in most cases or as colleges with full academic autonomy, each with powers to award its own degrees.[26] Several State Colleges of Engineering have also been given greater autonomy, some also with "deemed-to-be-university" status.

Still bolder steps can be taken. According to a recent article by Prof. M. A. Pai (2004), given the great demand for science, engineering, and technology studies, the number of four-year engineering colleges has grown since 1980 from 158 to 1,208, partly as a consequence of the demand for engineers in various sectors of the economy including IT, but also due to the limited expansion of the IIT system (India currently has seven IITs), and mushrooming of capitation fee (self-financing) colleges. The intake in the four-year, engineering degree–granting institutions is now 350,000 per year. Each year, of a pool of more than 150,000 applicants appearing for the Joint Entrance Examination, approximately 3,500 are typically absorbed into the seven IITs; thus, IITs barely account for 2.3 percent of the total applicants that apply through the Joint Entrance Examination. Those who do not get into the IIT system participate in quite a few entrance exams in places all across the country to get into engineering colleges, the quality of which are rather poor compared with an IIT.

So, given such pent-up demand and an immense pool of students with high aptitudes, expansion of high-caliber institutions, such as the IITs is warranted, so they can become the hubs of national education chains. For a start, several NITs and front-ranking universities/institutions for engineering and applied sciences education such as the University of Roorkee, Jadavpur University, and Anna University can readily impart IIT-type education with minor adjustments to their curricula. Institutions such as the Birla Institute of Technology and Sciences, for example, have already accomplished this and are now considered on par with the IITs; therefore, many NITs can be elevated to IIT status by giving them full autonomy as well as financial resources. With involvement of IITs, the curricula of NITs must of course be brought in line with those of the IITs as a mandatory step before giving them IIT status. This raises several issues for IITs. On the one hand, they could be concerned about diluting their brand name. This need not be the case: the state of California, for example, has ten universities under the University of California banner; although all of them have comparable undergraduate programs in engineering, they are distinct in terms of their research and thus get calibrated and ranked. In Mexico, the Tec de Monterrey (in MIT of Mexico) has expanded from one campus in northern Mexico to 32 campuses around the country today, while maintaining very high-quality standards throughout the system. The IITs themselves are making international forays to take advantage of interest from foreign universities looking to link with world-class Indian institutions. IIT-Bombay has linked with the National University of Singapore, which paves the way for the former to offer master's degrees in technology-level courses to students in Singapore. In the same vein, the Indian Institute of Management–Bangalore has also made plans to set up an international campus in Singapore (Iype 2005). The IITs thus have great potential to become important players in the international higher education market.

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[26] For more information, see the Higher and Technical Education Section of India's Tenth Five-Year Plan at http://planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/v2_ch2_5.pdf.

*Promote policy and institutional reforms for scientific R&D.* The above discussion is also relevant to the ability of India's universities to produce enough high-quality scientists and technologists to meet the country's demand for scientific R&D. This calls for urgent efforts to promote policy and institutional reforms in scientific and technical education for both public and private institutions to improve the quality and skills of India's current and future pool of technical manpower. The reasons to do this are especially compelling, because India has witnessed a spurt in opening of R&D establishments by MNCs in the high-tech areas of IT, information sciences, software engineering, biotechnology, telecommunication, and power management. In addition, an increasing number of call centers that need to cater to international customer satisfaction have opened up, and large international business houses are establishing increasing numbers of manufacturing units in such areas as automotive industries, entertainment electronics, power control equipment, and so on. These developments rest on the assumption that high-level skilled manpower is either available or can be generated or trained to the required levels at relatively low cost by the Indian educational system. Although India does have such manpower, more needs to be done to foster the development of such skills.

In an effort to meet this need, in 2002, India initiated a Technical and Engineering Education Quality Improvement Program with World Bank assistance to support production of high-quality technical professionals through reforms in the technical/engineering education system to raise productivity and competitiveness in the Indian economy (for more details, see World Bank 2002d). The program's objective is to implement several reforms in the existing education system focusing on governance and financing of institutions, promotion of excellence through competitive funding, networking of institutions for better utilization of resources, closer interaction with the local community and economy, and improved capacity of education system management. The program has now gone into effect in 13 states, which have agreed to implement major systemic and institutional reforms. Only institutions that have agreed to implement reforms are eligible to compete for financial support, and a total of 130 eligible institutions have been selected to date on a competitive basis for such support.

*Strengthen skills development and training.* When technology is changing, enterprises must invest in worker training to remain competitive. They are more likely to do so when their workers are better educated to start with, because that lowers the cost of acquiring new skills. Despite the demonstrated gains in productivity from training, not all employers provide it. Training involves costs: in materials, time, and foregone production. Weak management, high training costs, inability to exploit scale economies in training, poor information on benefits of training, market imperfections, and the absence of competitive pressures are all reasons that firms provide too little training (UNDP 2001).

India will also need to develop various job training programs to be globally competitive. These programs must be flexible, cost-effective, and quickly adaptable to new skill demands generated by changing markets and technologies. India could learn from the experiences of some MNCs, such as GE, that have set up training programs for their large pool of talented scientific and technical talent in India. According to GE, investing in learning and training enables it to hire and retain talent and expertise, and the company invests nearly $1 billion each year worldwide in career development of its employees (Box 3-5).

**Box 3-5: General Electric Actively Promotes Organizational Learning, Including in India**

Intellectual capital is considered GE's most valuable asset. Investment in career development is key for professionals to improve significantly their on-the-job performance, enhance their personal and professional development, and, in turn, accelerate the growth of the company. Every year, GE invests worldwide nearly $1 billion—about the size of GE-India's gross revenues from domestic operations—in career development, both on the job and through leadership programs. This is a three-step process that rests on infrastructure, systems and processes, and, most important, culture. Some highlights follow:

- In 2002 faculty from Crotonville (GE's U.S. training center) and senior GE leaders delivered more than 3,500 training man-days to more than 1,500 GE leaders in India.
- To meet other training needs, GE has a separate training delivery organization, which serves all the 25 GE business entities in India. Training focuses on specific competencies such as Six Sigma and communication skills among others. Added to this, individual businesses host their own training functions, focused on developing competencies and enhancing skills specific to that business.
- GE has also invested substantially in digitizing and leveraging the capabilities of the Internet to support its learning needs. Launched in September 2002, the e-Learning initiative provides courses in areas such as leadership, communication, customer relationships, and personal finance planning among others. More than 2,000 man-days of learning have been delivered every month to employees in India through e-Learning. "Inside GE," the corporate Intranet, is used to access information, projects, tools, resources, and best practices instantly from any GE business located in any part of the world.
- To share knowledge, learning, and global initiatives with Indian professionals in other organizations and to learn from them, GE India has launched an Internet portal (http://www.gecareersindia.com) that features best practices and an interactive forum for raising queries with experts in GE.
- On the systems and processes side, the company has set up councils, such as the finance, human resources, sourcing, and IT councils, in which employees from different GE businesses meet regularly and exchange ideas.

Considering that GE India comprises 30 legal entities, representing 16 different businesses in India, across practically every segment of industry, these forums are the glue that binds the company together. GE also has a robust mechanism for cross-business moves of talented employees. In the past 12 months alone, more than 140 managers have moved across GE businesses in India. But at the heart of this diversified organization is a culture that actively promotes and demands organizational learning, from other businesses, functions, and employees.

*Source:* Zachariahs (2003).

*Encourage lifelong learning.* The importance of knowledge and innovation in economies is increasing, as is demand for new competencies. The formal and nonformal education and training systems need, therefore, to evolve into lifelong learning systems. People now need access to learning on an ongoing, continuous basis; this requires a stronger alignment of institutions and policies with the new demands of the economy to create a high-performance, learner-driven system of education and to promote lifelong learning.[27]

According to a World Bank report (2003g), a lifelong learning framework encompasses learning throughout life, from early childhood through retirement. It includes formal learning (schools, training institutions, and universities), nonformal learning (structured on-the-job training), and informal learning (skills learned from family members or people in the community). It allows people to access learning opportunities as they need them. In this model, people are motivated to learn on a continuing basis, equipped with the skills to engage in self-directed learning, given access to opportunities for learning throughout their lives, and offered financial and cultural incentives to participate in lifelong learning. The approach is based on the centrality of the learner, defined to include both the individual and collective

[27] See http://www.congress-lifelonglearning.org/frameset.htm.

entities, such as the enterprise, the economy, and society at large. Table 3-6 provides a summary of the differences between lifelong learning and traditional education systems.

**Table 3-6: Characteristics of Traditional and Lifelong Learning Models**

| *Traditional Learning* | *Lifelong Learning* |
|---|---|
| The teacher is the source of knowledge. | Educators are guides to sources of knowledge. |
| Learners receive knowledge from the teacher. | People learn by doing. |
| Learners work by themselves. | People learn in groups and from each other. |
| Tests prevent progress until students have completely mastered a set of skills and to ration access to further learning. | Assessment is used to guide learning strategies and identify pathways for future learning. |
| All learners do the same thing. | Educators develop individualized learning plans. |
| Teachers receive initial plus ad hoc in-service training. | Educators are lifelong learners. Initial training and ongoing professional development are linked. |
| "Good" learners are identified and permitted to continue their education. | People have access to learning opportunities throughout their lives. |

*Source:* World Bank (2003g).

Developing countries such as India face specific challenges in developing such systems. These include expanding coverage to achieve universal access to basic education as well as increased access to secondary and tertiary provision; improving the linkages between formal and informal education systems and the labor market; raising the quality of learning; and expanding access to learning opportunities beyond initial formal schooling. Policies are needed to ensure that education and training systems together respond to the needs of the knowledge economy and facilitate lifelong learning.

In India, several policy statements have been made on the need to create adult and lifelong learning opportunities (UNESCO 2002), but not many concrete policy actions have been undertaken. In addition, several ministries, such as the Ministries of Education, Human Resource Development, and Labor, are involved in providing education, learning, and training opportunities, leading to fragmentation of the system; thus, a coherent picture is needed of the division of responsibilities to move the lifelong system forward in a systematic way. India should, thus, work to put in place programs intended to meet the learning needs of all, both within and outside the school system, in a variety of settings and using new technologies such as ICTs, so that people have the means and incentives to learn throughout their lifetimes.

China has already recognized the need to develop its lifelong learning system. It is grappling with the challenges of providing massive training to its large labor force, which has relatively low educational attainment, and at the same time upgrading the quality of its educational system to impart to students the necessary skills to compete in the knowledge economy. India could do well to learn from China and the experiences of other advanced countries (such as the United Kingdom[28]) to develop an architecture and framework for lifelong learning.

*Enhance the role of the government.* The above discussion highlights the key role of government in the education system, not as a controller, but as the architect of systemwide education standards and regulations. The government should address equity issues for poor and needy students through the use of

[28] The UK's National Grid for Learning (http://www.ngfl.gov.uk/) provides educational resources on the Internet for all types of learners.

scholarships, vouchers, and low-interest loans for private education. It should be involved in improving the quality of public education, develop accreditation mechanisms, and ensure overall coordination and evaluation of the multiple providers of different levels of education and skills. It should also closely examine the efficiency of the allocation of public resources to education, as well as the efficiency in the use of these resources. To promote quality and accountability, the government should make the system more transparent and increase availability of educational policy information and statistics to the public.

*Involve the private sector.* The private sector must also play an increasingly important role in improving education quality, because government cannot by itself afford to finance increases in access and, at the same time, increase quality. It would be important in India to review the rationale for government funding of institutions at different levels and find a way get more private resources to meet the financing challenges of expanding the educational system. In particular, the private sector may be willing and students could afford to enter many parts of the higher education sector, especially with appropriate student loan schemes.[29] China, for example, has been quite successful in mobilizing private funds for education. One-quarter to one-third of the costs of public higher education are covered by tuition payments by households.

In India, a variety of private higher educational institutions have been set up in the country, many without government accreditation. Box 3-6 provides information on two leading private sector initiatives in education in India; the first one is not accredited, in contrast to the second.

[29] The extent to which certain parts of the higher education system should be privatized is a matter of considerable debate. The Bank's own thinking (most recently reflected in World Bank 2002a) underscores that tertiary education "confers important public goods that are essential to development and poverty reduction—goods that must be accessible to all strata, to all peoples, and to both men and women." It further recognizes its role in constructing knowledge economies and democratic societies as "more influential than ever." Tertiary education institutions are the main training grounds for teachers and health professionals, among others. They often serve as centers of research and development. In this context, strong arguments exist for some public financing of tertiary education, albeit the optimum share remains in question and is often related to the adequacy of public financing to meet primary and secondary education needs. Nonetheless, most within the education community strongly advocate increased government attention to expanding access, quality, and relevance of tertiary education, whether through direct financing or ensuring the enabling conditions and incentives are in place to motivate and facilitate greater private investment in tertiary education.

**Box 3-6: Reaping the Potential of Private Higher Education in India**

*International Institute of Information Technology ($I^2IT$).* This institution, located in Pune was conceived as having a global perspective in bringing to the fore innovation and leadership in advanced IT education and research. The institution is designed to foster innovation and an entrepreneurial way of thinking and attracts students not only from India, but Korea, Russia, Indonesia, and Thailand. $I^2IT$ offers full-time master's degree programs in advanced information technology and management. Its courses have been designed and developed under the guidance of an internationally acclaimed panel of leaders and innovators leading the IT industry and advanced IT research and are delivered by active practitioners of IT. $I^2IT$ has also embarked on worldwide collaborations with universities, research laboratories, and industries, including the Russian-Indian Centre for Advanced Computing Research in Moscow, Korea University and Sahmyook University in Korea, University of South Florida and Dominican University in the United States, Groupe ESSCA in France and Hungary, University of Padjadjaran in Indonesia, and Mae Fah Luang University in Thailand.

*Manipal.* Tucked away in the Malabar Coast of Southwest India, Manipal is the nucleus of 53 educational institutes, including two universities, 27 professional colleges, affiliated institutes, and numerous primary and high schools. Thousands of students also study in Manipal institutions situated in India in Sikkim and Mangalore, as well as in Nepal, Malaysia, and Dubai. Manipal has graduated more than 20,000 students and has an ever-increasing enrollment number of more than 30,000 students. The Manipal Academy of Higher Education was born when its professional colleges were granted university status in July 1993. The academy was the first institute in the private sector to be recognized as a "deemed university" by the Government of India.

Manipal's affiliation with other centers of learning across the globe has facilitated the exchange of knowledge and culture through student and faculty exchange programs. Students from more than 32 countries worldwide seek education at culturally diverse Manipal. Degrees from Manipal are recognized in more than 40 countries. Twinning programs, in which a student completes the first two years of education at Manipal and then completes the course at a U.S., Australian, or other university, which confers the degree, are also extremely popular. An example is the Melaka-Manipal Medical College, set up in Malaysia. This was the first Indo-Malaysian joint venture in private medical education. It has a five-year twinning program that leads to a medical degree. The first phase, lasting two and a half years is conducted at the Manipal campus in India. The second phase, of the same length, is conducted at Melaka. Since 2003, more than 200 Malaysian doctors have graduated from the college.

*Sources:* "International Institute of Information Technology," http://www.isquareit.ac.in; "Manipal Academy of Higher Education," http://www.manipal.edu/index.htm, and a presentation by J. S. Nagra entitled "Public Private Partnership: Melaka-Manipal Medical College" at the "Higher Education Summit: Roadmap for the Future," December 1–2, 2004, New Delhi, http://www.ficci.com/ficci/media-room/speeches-presentations/2004/dec/Nagra.ppt.

India thus needs to have a more integrated and coordinated approach with the private sector, where appropriate. The government should encourage private financing of education and training and should help to leverage India's strengths in private education. It should put in place accreditation systems for private education and training providers and should develop an effective system for assessing and certifying vocational qualifications. The agenda is large, but some positive steps have been made in this direction. For example, to diversify funding sources for higher education, the fee structure has been enhanced for some professional disciplines (medicine, engineering, and so on), combined with subsidies for poorer students. In technical education, 50 percent of institutions are privately funded, a trend that should be encouraged. Box 3-7 shows the experience of the Monterrey Institute of Technology, which is partnering with the private sector in Mexico to develop curricula that better meet the needs of the private sector and is also trying to reach students with low financial resources.

**Box 3-7: Transforming Established Systems: The Monterrey Institute of Technology**
The Monterrey Institute of Technology (Tec de Monterrey) in Monterrey, Mexico, is a premier private education organization comprising a network of 33 campuses all across the country. It is a franchise system of local campuses, each financed and governed by local private sector leaders. Its Virtual University is a worldwide leader in distance learning, championing a continuing education agenda all across the Spanish-speaking world and making inroads into such giant markets as China.

To reach students with limited financial resources, the institute launched a spin-off, Millennium University (Universidad TecMilenio), which was designed to combine the high quality associated with the Tec de Monterrey brand of education with dramatically lower costs. By May 2004 approximately 6,500 students were enrolled; per student costs are approximately three times lower than in the parent organization. By 2010 TecMilenio plans to enroll 100,000 students. What are the main factors that allowed the institution to reduce costs dramatically without compromising quality?

- The curriculum is designed and often delivered through the management of private sector firms.
- TecMilenio shares offices with some of these firms, so students and teachers often work, learn, and teach in the same location.
- Distance education is highly utilized to offer the best professors and courses.
- Pedagogy is based on problem-solving and conceptual tests; yet, testing is standardized and centralized.
- Remuneration for teaching depends on testing results of students.
- A small management structure draws on carefully selected professors from Tec de Monterrey staff and translates industry needs into pragmatic curricula. In this way, vested interests of professors, who sometime use the same teaching materials for decades, are curbed: content is determined by industry needs.

*Source:* Staff of World Bank's Knowledge for Development Program and Universidad TecMilenio (http://www.tecmilenio.edu.mx/).

## Summary of Issues and Recommendations

India must keep on building a cadre of technicians, professionals, and knowledge workers who will be the backbone of the knowledge-based economy. Some actions to improve the quality and relevance of the education system, especially higher education, but also harness human resources at all levels include the following:

- Improve the efficiency in the use of public resources in the education system, and make the education system as a whole more responsive to market needs, as well as ensure expanded access to education that fosters critical thinking and learning skills for all, not just the elites.
- Enhance the quality of primary and secondary education, including tackling issues related to quality and relevance, with special emphasis on ameliorating teacher vacancies and absenteeism, reversing high dropout rates, and correcting inadequate teaching and learning materials and uneven levels of learning achievement. This is especially important for India to meet the goal of providing eight years of schooling for all children by 2010.
- Ensure consistency between the skills taught in primary and secondary education and the needs of the knowledge economy, introduce materials and methods to teach students "how to learn," rather than stressing occupation-specific knowledge.
- Reform the curriculum of tertiary education institutions to include skills and competencies for the knowledge economy (communication skills, problem-solving skills, creativity, and teamwork) that also meet the needs of the private sector.
- Raise the quality of all higher educational institutions, not just a few world-class ones (such as the IITs).

- Improve the operating environment for education, especially higher education, which calls for a shift in the role of the government from managing the administrative aspects of higher education institutions to becoming an architect of education standards and regulations, including improving and monitoring the quality of academic programs, establishing accreditation standards and procedures, ensuring equity, and coordinating a system with multiple players and multiple pathways to learning.
- Embrace the contribution of the private sector in education and training by relaxing bureaucratic hurdles and put in place better accreditation systems for private providers of education and training.
- Establish partnerships between Indian and foreign universities to attract and retain high-quality staff and provide opportunities for students to receive internationally recognized credentials.
- Increase university-industry partnerships to ensure consistency between research and the needs of the economy. This will include reforming the university curriculum to include the development of skills and competencies that better meet the needs of the private sector.
- Use ICTs to meet the double goals of expanding access and improving the quality of education.
- Invest in flexible, cost-effective job training programs that are able to adapt quickly to new skill demands generated by changing markets and technologies, aligned with the needs of firms.
- Develop a framework for lifelong learning, including programs intended to meet the learning needs of all, both within and outside the school system. This will also require greater coordination across the different government bodies responsible for various components of the education and training system and development of procedures for recognition of what is learned in different parts of the system.
- Make effective use of distance learning technologies to expand access and the quality of formal education and lifelong training.

# 4. INNOVATION SYSTEM

The innovation system plays an important role in acquiring, creating, adapting, and disseminating knowledge, which is crucial for success in the knowledge economy. The innovation system in any country consists of the network of institutions, rules, and procedures that affect how the country acquires, creates, disseminates, and uses knowledge. Innovation in a developing country does not just concern domestic development of knowledge on the global "frontier." It also concerns the application and use of existing knowledge to the local context. For countries such as India that are still far behind the global frontier in many sectors, tapping into and making effective use of existing global knowledge will have a greater economic impact than developing frontier knowledge.

It merits attention that the concept of "innovation" encompasses not only "technological innovation," that is, diffusion of new products and services of a technological nature into the economy, but equally includes nontechnological forms of innovation, such as "organizational" innovations. The latter include the introduction of new management or marketing techniques, adoption of new supply or logistic arrangements, and improved approaches to internal and external communications and positioning.

The concept of a national innovation system rests on the premise that understanding the linkages among the various actors involved in innovation are key to improving a country's technology performance. These actors include private enterprises, universities, research institutes, think tanks, consulting firms, and others. The innovative performance of a country depends to a large extent on how these actors relate to each other as elements of a broader system. Linkages can take the form of joint research, personnel exchanges, cross-patenting, licensing of technology, purchase of equipment, and a variety of other channels.

In the context of developing countries, innovation should be understood as something new to a local context. Three major forms of innovation exist (Aubert 2005):

- Local improvements based on adoption of technologies that are more or less available worldwide or locally ("technology adoption" from a global perspective)
- Buildup of competitive activities with some adaptation to existing technologies ("technology adaptation")
- Design and production of technologies of worldwide significance ("technology creation" from a global perspective).

In a developing country such as India, where the formal sector is relatively small, an important part of its innovation system concerns the diffusion of modern and more efficient practices to the greatest number of users. This applies to both domestic and foreign knowledge. India has done a remarkable job of diffusing knowledge and technology, especially in agriculture. As a result of the "green revolution," India has transformed itself from a net importer to net exporter of food grains. India's "white revolution" in the production of milk has helped it achieve the twin goals of raising incomes of rural poor families as well as the nutrition status of the population. India now needs to continue to undertake efforts to improve the productivity of agriculture, industry, and services even further. Such efforts must include strengthening technology diffusion institutions, such as agricultural and industrial extension agencies, productivity-enhancing organizations, and technical information agencies, as well as expansion of more efficient firms, specialized suppliers of capital goods and inputs, and consulting and technology services.

In any sector in developing countries such as India, a large disparity usually exists between the most and least efficient producers; therefore, considerable economic gains can be harnessed from moving the average domestic practice to the best domestic practice, not to mention best international practice. A host of efforts would be required:

- Improving the system for technical norms and standards—such as product quality, work safety, and environmental protection—to facilitate proper diffusion of know-how
- Increasing dissemination of technology by strengthening competition so that the most efficient firms expand and improve performance, and establishing and enforcing appropriate laws
- Encouraging more trade among Indian states
- Allowing for economies of scale and scope
- Facilitating diffusion of best products through price- and quality-based competition.

This chapter focuses on the more formal R&D and innovation efforts in India, beginning with benchmarking of India's innovation system.

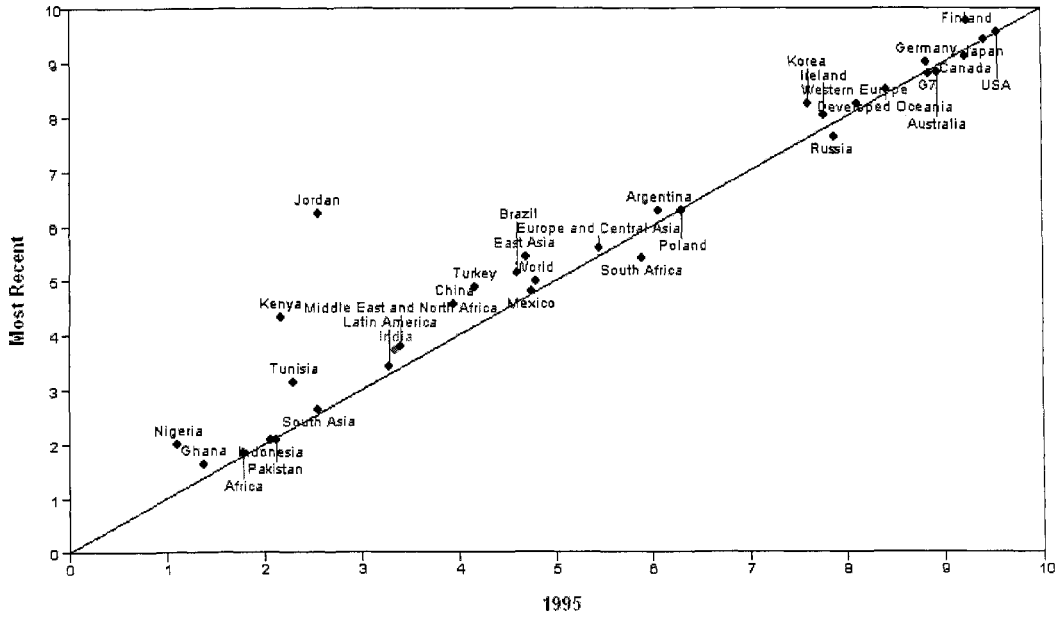
**Benchmarking Innovation**

India generally has great strengths in R&D, scientists and engineers, and technical publications, but weaknesses in patents that can be spun off into commercialization; therefore, despite a strong R&D infrastructure, India is weak on turning its research into profitable applications. Figure 4-1a shows that, when scaled by population, India does better than the Africa, South Asia and the Latin America Regions, but lags behind Brazil, China, and other comparators in the innovation area. In terms of absolute size, however, India is placed in a far more advantageous position, because the country is endowed with a large critical mass in its research and innovative capacity. Figure 4-1b thus shows that, in terms of absolute size, India's R&D personnel inputs not surprisingly are considerably higher than even those of Western Europe. More broadly, India's stock of scientific and technical personnel increased by 59 percent from 4.8 million in 1991 to 7.7 million in 2000.[30]

[30] Based on a presentation by Vijay Kelkar entitled "India: The Coming Golden Age" at the World Bank on October 28, 2003.

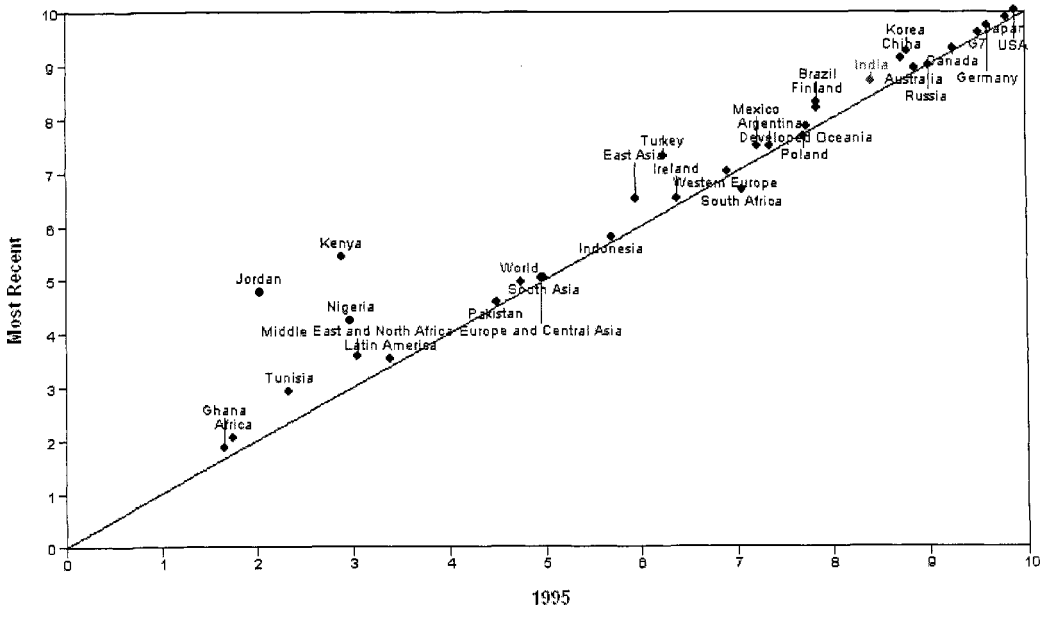
**Figure 4-1: Innovation by Population and Absolute Size, India and the World, 1995 and Most Recent Period**

**a. Scaled by Population**




*Note:* Countries above the 45-degree line have improved their position in innovation for the most recent period for which data are available relative to their position in 1995 (or closest available date in the mid-1990s) and vice versa for countries below the line.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

**b. Absolute Size**

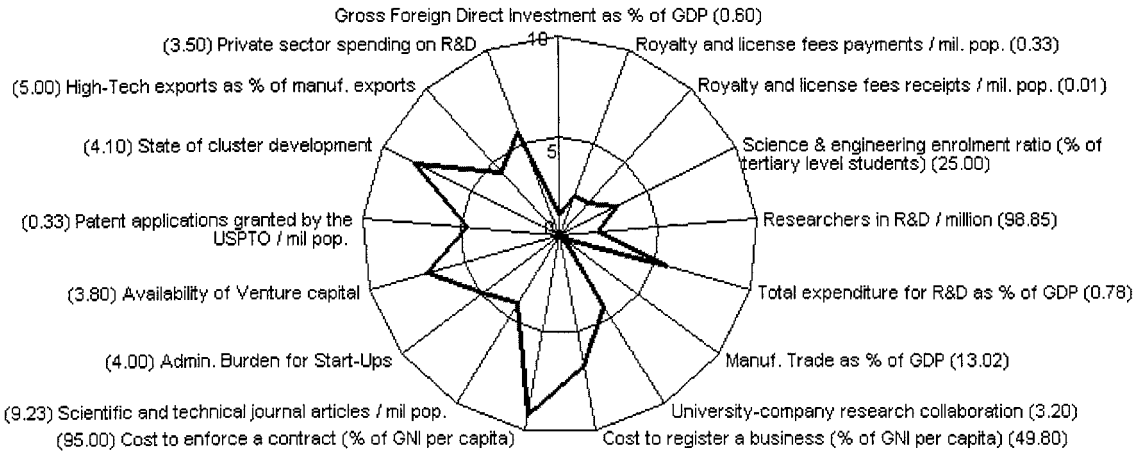



*Note:* Countries above the 45-degree line have improved their position in innovation for the most recent period for which data are available relative to their position in 1995 (or closest available date in the mid-1990s) and vice versa for countries below the line.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

In 2001 UNDP developed a *Technology Achievement Index* that focuses on three dimensions of innovation at the country level: creation of new products and processes through R&D; use of new technologies and old in production and consumption; and availability of skills for technological learning and innovation.[31] Countries are ranked in four categories in the index: leaders, potential leaders, dynamic adopters, and the marginalized. India is home to Bangalore, one of the most dynamic global innovation hubs (rated 11th among 46 hubs by *Wired Magazine).* Yet, *India ranks 63rd* on the Technology Achievement Index (of 72 countries) and is placed within the lower end of dynamic technology adopters, mainly because of huge variations in technological achievement among Indian states. Other reasons also exist. Even though the country has one of the world's largest pools of scientists and engineers, in 2001, as mentioned in chapter 3, its average years of schooling were just more than five years and the adult literacy rate was about 35 percent. These indicators matter, because they impact the ability of a country to harness technology and innovation for its development. To its credit, India has recently been making notable progress in terms of strengthening R&D infrastructure, developing technological innovations, and altering the mind set of its people toward better technology absorption.

Figure 4-2 presents the detailed innovation scorecard for India, and annex 10 presents the scorecards for the other comparator countries. It highlights that India has been weak in tapping into the rapidly growing stock of global knowledge. Notice the low FDI in India: a mere 0.6 percent of GDP in 1993–2002, as well as low payments for technology licensing as well low share of manufactured exports and imports in GDP. Availability of venture capital is also rather limited in India (Figure 4-2), but some signs of vibrancy are evident. A notable venture capital investment market is emerging; venture capital increased from $3 million in 1995 to $342 million in 2000 (UNDP 2001).

**Figure 4-2: India's Scorecard on Innovation, Selected Variables, Most Recent Period**




*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10 for 128 countries. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for India for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

[31] For the Technology Achievement Index, technology creation includes patents granted to residents and receipts of royalties and license fees; diffusion of recent innovations includes Internet hosts and high and medium technology exports; diffusion of old innovations includes telephones and electricity consumption; and human skills includes mean years of schooling and gross tertiary science enrollment ratio (UNDP 2001).

In addition, Table 4-1 presents data on the following five innovation variables in terms of absolute size (these same five variables are scaled by population in Figure 4-2): royalty and license fee payments, royalty and license fee receipts, researchers in R&D, scientific and technical journal articles, and patent applications granted by the USPTO, all for the most recent year for which data are available. Table 4-1 shows that India has notable strengths in its innovation capacity, particularly when viewed in terms of absolute size, as does China!

**Table 4-1: Selected Innovation Variables, India and Comparators, Various Years**
*(absolute size and scaled by population)*

| | Absolute size | | | | | | Scaled by Population (Per Million Persons) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | India | Brazil | China | Korea | Poland | Russia | India | Brazil | China | Korea | Poland | Russia |
| Royalties and License fees Payments ($ mil) (2002) | 350 | 1,229 | 3,114 | 2,979 | 557 | 338 | 0.33 | 7.04 | 2.43 | 62.58 | 14.58 | 2.35 |
| Royalties and License fees Receipts ($ mil) (2002) | 12 | 100 | 133 | 826 | 34 | 147 | 0.01 | 0.57 | 0.10 | 17.35 | 0.89 | 1.02 |
| Researchers in R&D (2001) | 95,428 | 55,103 | 742,700 | 136,337 | 56,919 | 505,778 | 98.85 | 323.94 | 583.88 | 2,882.39 | 1,474.59 | 3,492.94 |
| Scientific and technical journal articles (1999) | 9,217 | 5,144 | 11,675 | 6,675 | 4,523 | 15,654 | 9.23 | 30.61 | 9.31 | 143.19 | 117.00 | 106.99 |
| USPTO Patents Granted (2003) | 355 | 180 | 424 | 4,132 | 19 | 202 | 0.33 | 1.02 | 0.33 | 86.25 | 0.50 | 1.41 |

*Note:* Data for researchers in R&D in India are for the year 1997, whereas those for Brazil are for 2000.
*Source:* Knowledge Assessment Methodology (KAM) (http://www.worldbank.org/kam).

*Comparing India's performance in R&D.* In terms of inputs into the innovation system, India spends only a small fraction of its GDP on R&D: 0.78 percent of GDP in 2001 (Figure 4-2), which is more than Poland (0.67 percent of GDP), but less than Brazil (1.05 percent of GDP), China (1.09 percent of GDP), and Russia (1.16 percent of GDP) and much lower than Korea (2.96 percent of GDP) (annex 10), whose expenditures on R&D are on par with top OECD countries. India at 25 percent has the lowest science and engineering ratio in terms of percentage of tertiary-level students among all comparator countries. It also has the lowest number of researchers in R&D (per million) among all countries chosen. India does, however, have a critical mass of scientists and engineers and technicians in R&D in terms of absolute numbers (Table 4-1).

Qualitative surveys by WEF show that the country stands in the middle range relative to comparator countries on private sector spending on R&D. According to a UNESCO report (Westholm, Tchatchoua, and Tindemans 2003), spending on R&D in India by enterprises (both public and private) currently stands at about 27 percent of total R&D. In most OECD countries, the private sector finances 50–60 percent of R&D, as it increasingly has the finance, knowledge, and personnel needed for technological innovation. Firms play an even bigger role in R&D in Ireland, Japan, Korea, and Sweden. Universities also undertake research to a much larger extent in developed countries and have stronger linkages with the corporate world.

India's performance in R&D outputs relative to comparator countries is less than stellar. When scaled by population, India receives little in terms of worldwide royalty and license fees (Figure 4-2). Not surprisingly, it does much better in terms of absolute size (Table 4-1). For scientific and technical articles in mainstream journals (per million people), India matches the performance of China, but the contributions of both countries are very low compared with developed countries.[32] OECD countries

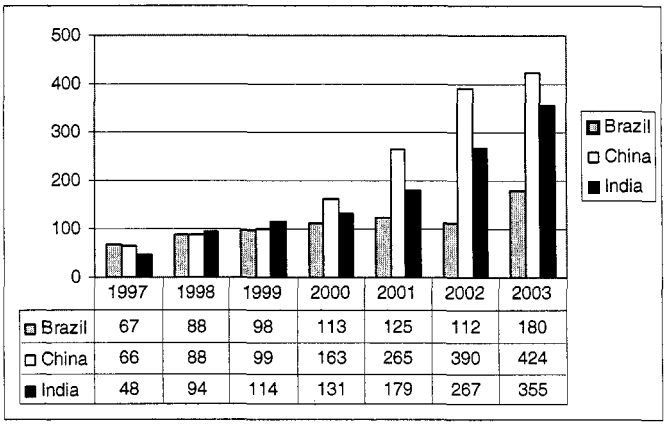
[32] It is not surprising that India does not score well in terms of the number of technical and scientific journal articles (per million people) appearing in mainstream journals. It could be argued that a per capita index may not be the right one to use. A more

accounted for 85 percent of 437,900 scientific and technical journal articles published worldwide in 1998 (UNDP 2001).

*Lagging performance on U.S. patents.* Figure 4-2 shows that India is on par with China in terms of patent applications granted by the USPTO (per million people), but still has a way to go in this regard. Although India (at 5 percent) surpasses Poland (at 3 percent) on high-tech exports as a percentage of manufactured exports, India again has some distance to cover to match the performance of China (23 percent) or Korea (32 percent) in this area.

Figure 4-3 shows that, even though the number of patents granted to India by the USPTO steadily increased in 1997–2003—India even surpassed Brazil and China in 1998 and 1999—China surged ahead of India after 2000. The figure shows that, during 1997–2003, the United States granted a total of only 1,188 patents to India (while China garnered 1,495), which accounts for only 1 percent of the total number of patents granted worldwide by the United States in this period! Japan, Taiwan, and Korea now account for more than a quarter of all American industrial patents (Broad and Glanz 2003).

**Figure 4-3: Patents Granted by the United States Patent and Trademark Office to Brazil, China, and India, 1997–2003**
*(number)*




| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| Brazil | 67 | 88 | 98 | 113 | 125 | 112 | 180 |
| China | 66 | 88 | 99 | 163 | 265 | 390 | 424 |
| India | 48 | 94 | 114 | 131 | 179 | 267 | 355 |

*Source:* U.S. Patent and Trademark Office (http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_all.pdf).

But India has recently made some progress in this area. For example, the number of U.S. patent grants to the Council of Scientific and Industrial Research (CSIR) increased from just six in 1990–91 to 196 in 2003–04.[33] Several new Indian firms have registered their innovations with the USPTO. This shows that the focus of research is shifting to patentable innovations, indicating better conceptualization of research.

*Emerging global trends in scientific R&D.* A recent study by UNESCO identifies some emerging global trends in scientific R&D (Westholm, Tchatchoua, and Tindemans 2003). The report finds that Asia today

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appropriate index (if data were available) would measure the number of articles as a percentage of graduates with research degrees (master's and Ph.D. degrees) in science and engineering.

[33] Presentation made by Dr. R. A. Mashelkar on "Seizing Opportunities to Leverage India's Potential in Education and Innovation" at a workshop on "India and the Knowledge Economy," New Delhi, November 9, 2004 (http://www.worldbank.org.in/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/INDIAEXTN/0,,contentMDK:20279055~menuPK:295602~pagePK:141137~piPK:141127~theSitePK:295584,00.html).

## Issues and Recent Developments in the Innovation System

In a world in which trade, investment, and production are becoming increasingly globalized, the capacity of countries to develop, acquire, diffuse, and commercialize knowledge is becoming a major source of competitiveness and growth. As a result of the 1991 liberalization of the Indian economy, several changes have taken place in India's innovation landscape. This section reviews important trends in innovation and R&D in India, highlighting issues related to strengthening India's overall innovation system.

*Increasing limited R&D expenditures.* India's R&D spending increased from $2.5 billion in 1994–95 to $3.15 billion in 1999–2000. The share of government expenditures increased from $1.92 billion to $2.5 billion during the same period. Some estimates suggest that the government now spends about $6 billion on research. But, even so, India's R&D budget is less than the amount spent by many individual multinationals.[34] The strategic sectors of defense, space, and atomic energy take up a significant chunk of government R&D expenditure (52 percent in 1999–2000) (Chandrashekhar and Basvarajappa 2001). But, the government has been increasing its allocation to various scientific agencies during the past decade. The CSIR, for example, has started a new initiative on emerging technologies through targeted consortia research. Box 4-2 presents trends in industrial R&D in India.

**Box 4-2: Industrial Research and Development in India: Recent Trends**

A recent study on innovation provides some interesting insights on industrial R&D trends in India, including the following highlights:

- Much of the investment in industrial R&D now comes from the Indian private sector. Only 15 percent of central government companies report R&D investments, and this figure is just 7 percent for state government commercial enterprises.
- To put this in perspective, in 2002, R&D spending was Rs. 4,426 million for central government enterprises and only Rs. 115.5 million for state government commercial enterprises. Indian private sector companies on the other hand increased their R&D spending from Rs. 198 million in 1991 to Rs. 14,503 million in 2002.
- Developing new products and exploiting new markets has become the focus of industrial R&D, especially for large firms. R&D expenditures of the top 20 firms in India included thirteen from the private sector. This is a major change, because before 1991, R&D was mostly a public sector activity.
- A majority of firms in the top 20 are from the high-growth sectors such as automobiles, electronics, and pharmaceuticals. R&D intensity by these firms also reflects this trend. Petrochemicals, electrical machinery and software companies make up the rest. Firms such as BHEL, BEL, Dr. Reddy's Laboratories, Ranbaxy, Tata Motors, Wockhardt, and IOC are focusing on commercializing innovations.
- R&D investments by the pharmaceutical, transport, and electronics industries were in the top three in 2002. Pharmaceuticals spent Rs. 5,770 million in R&D, and spending by transport and electronics was Rs. 3,942 million and Rs. 2,883 million, respectively, in 2002. This change is noticeably different from the priorities in 1991, when nonelectrical machinery, base metals, and transport equipment were in the top three.
- In terms of R&D intensity, in 2002, the major automobile players spent around 1 percent of their turnover on R&D. Tata Motors, and Mahindra and Mahindra are the leading firms in this segment.
- The pharmaceuticals sector also registered an overall increase in R&D intensity from 0.74 percent to 1.89 percent in this period. Top firms in this sector such as Ranbaxy, Dr. Reddy's Laboratories, and Wockhardt invested more than 5 percent of their turnover on R&D in 2002.
- Indian software firms are also increasing their R&D: Hughes software systems registered a high of 28.64 percent of R&D intensity in 2002.
- R&D spending on food and textiles, however, has registered a steady decline during the past decade. The Indian food processing industry is planning a major export thrust, but current levels of R&D spending in the industry are insufficient to make it globally competitive, because this is a highly competitive industry.
- Analysis of trends in R&D spending for the manufacturing and service sectors shows that firms in the service

[34] For example, in 2004, the actual R&D spending by a single company such as Pfizer was $7.7 billion. For more information, see http://www.pfizer.com/are/mn_about_company.html.

represents 30.5 percent of world R&D expenditures, making it the only region in the world to have increased its share between 1997 and 2000. Much of the credit for this progress goes to China, which is edging ahead of the newly industrialized economies in Asia in terms of R&D expenditures. It increased its world share of R&D expenditure from 3.9 percent to 6.7 percent between 1997 and 2000, thanks to a combination of strong economic growth and rising R&D expenditure. India, however, should ramp up its R&D investments if it is to take its place among countries that are rapidly harnessing science and technology for growth and development. Box 4-1 presents additional details from the UNESCO study.

**Box 4-1: India in the Context of Global Trends in Research and Development Investment**

In 1997 nearly 85 percent of all R&D performed around the world could be credited to OECD member countries. This share had dropped to about 80 percent by 2000, a decline explained by the retreating shares of North America, the European Union, and Japan. India's world share of gross expenditures on R&D (GERD) dropped between 1997 and 2000 from 2.0 percent to 1.6 percent. National investment in R&D failed to keep pace with healthy growth in GDP during this period. But, the government has since augmented research spending and plans further increases. India has set itself a target that would place it among the nations of the world that devote the greatest share of GDP to R&D: it plans to hoist research spending to 2 percent of GDP by 2007, according to its 2003 S&T policy (see section below on India's new innovation policy). Indicative of India's commitment, GERD had already climbed to 1.08 percent of GDP by 2002.

In 2000, about 1.7 percent of world GDP was devoted to R&D, compared with 1.6 percent in 1997. Even though the all-OECD GERD/GDP ratio for 2000 was approximately 2.4 percent and that of the European Union approximately 1.9 percent, the great majority of countries in the world still spend only a tiny fraction of GDP on R&D. For example, India's ratio was 0.5 percent and China's was 1 percent.

Although GERD as a percentage of GDP is the better indicator for reflecting the share of income invested in R&D, the GERD per capita indicator has the virtue of showing how far a country still has to go to rival the world's most prosperous states. For example, despite the fact that India has been making substantial investments in R&D, it will need to make a huge effort to narrow the gap with Brazil and China, not to mention advanced countries such as the United States. India spends just $PPP12 (purchasing power parity) on R&D per capita, compared with $PPP40 per capita in China, $PPP62 per capita in Brazil, and $PPP953 per capita in the United States.

In terms of scientists and engineers, statistics show that nearly 5.3 million full-time-equivalent research scientists and engineers were engaged in R&D around the world in 2000. North America and the European Union contribute a larger share of world expenditure than they do world personnel. This situation is reversed in the case of China, which contributes 13.2 percent of all researchers, but only 6.7 percent of world GERD. Similarly, India represents 2.7 percent of all researchers, but only 1.6 percent of world GERD.

Data on who performs and who finances R&D reflect the structure of the R&D system in a given country. Although differences exist among countries, almost all OECD countries, increasingly China, most of the Asian dragons, the Russian Federation, Brazil, and South Africa are moving toward a model in which the enterprise sector (private or public) both performs and finances more than 50 percent (and up to 75 percent) of R&D. In 2000, 70 percent of all OECD R&D was performed by the enterprise sector (although the median value for member countries was closer to 60 percent), 10 percent of R&D was performed by the government sector, and 17 percent in the higher education sector. The remaining 3 percent was carried out by private nonprofit institutes. In India, on the other hand, only 27 percent of R&D was done by enterprises.

*Source:* Westholm, Tchatchoua, and Tindemans (2003).

sector spend relatively less on R&D. More than 14 percent of firms in the manufacturing sector have R&D activities, compared with only 1.66 percent in services. If India is to become a service hub, this resolve needs to be reflected in R&D efforts.

*Source:* Bowonder, Kelkar, and Satish (2004).

*Finding innovative sources of R&D funding.* In many developing countries, the government and/or university sectors play a dominant role in performing R&D and the financing for R&D mainly comes out of the public purse. For example, about one-third of Chinese and one-quarter of Russian R&D is performed by the government sector. In India, some 70.5 percent of R&D is performed by the central and state governments, an additional 27 percent by enterprises (both public and private sector industries), and less than 3 percent by universities and other higher education institutions (Westholm, Tchatchoua, and Tindemans 2003 and India, Ministry of Science and Technology data).[35] In terms of promoting innovation, the government has had mixed experience, for example, in the manufacturing sector (Box 4-3).

**Box 4-3: How Well Does India Promote Innovation in the Manufacturing Sector?**
Mani and Kumar (2001) analyzed the role of the Indian government in promoting innovations in the manufacturing sector, which accounted for 16.8 percent of GDP in 2001–02. The study revealed that the country's manufacturing sector is dominated by the chemicals and pharmaceutical sector, which also accounts for the largest share in R&D investments and in the number of patents granted. The authors found that the broad external environment within which innovative activities of firms are encouraged consists of a series of policies that lack specificity in targets, time dimension, and budgets. Four dimensions of the innovation system are considered: *(a)* policies with respect to the supply of technically trained human resources for R&D, *(b)* physical technological infrastructure, *(c)* fiscal incentives for encouraging innovation, and *(d)* promotion of technology-based ventures through venture capital funds. The authors found that:

- India suffers from a chronic shortage of research scientists and engineers of the type required for R&D, caused basically by the quality of science and engineering education in the country and the ever-increasing brain drain.
- A network of government research institutes, some of which have been undergoing major restructuring since 1996, dominates the physical technological infrastructure. These institutes continue, however, to depend on government grants and projects for their sustenance, and their interaction with the domestic manufacturing sector is limited. India does not have any major research grant schemes; even the one it has is directed largely at public sector enterprises. Most of the schemes are research loan schemes. In other words, the extent of public subsidies for private sector R&D is quite low in the country.
- India has a variety of direct and indirect tax incentives for R&D; however, both a macro and micro exercise revealed that most enterprises do not perceive these incentives as important. In most cases, the level of R&D performed would be the same, even in the absence of direct tax incentives.
- Venture capital funds in operation conform to the ideal model of by and large providing equity support to technology-based ventures in their early stages.

India would do well by learning from other countries' experiences, such as Brazil and China in finding innovative sources of R&D financing. The Brazilian Agricultural Research Corporation's (EMBRAPA's) research system is a successful case of using public funding and a large network of partners to conduct

[35] Data from the Department of Science and Technology, Research and Development Statistics, 2000–2001, available at http://www.nstmis-dst.org/.

R&D activities.[36] China's "Jumping into the Sea" strategy is a unique management innovation to strengthen linkages between R&D and the market (Box 4-4).

**Box 4-4: China's "Jumping into the Sea" Strategy**

The major deficiency of the innovation system in China was once the separation of R&D from production. True to the Soviet model, most public research institutes (PRIs), including the research institutes of the Chinese Academy of Sciences, operated in isolation from production activities. Funded by an annual budget from the central or local governments, the PRIs conducted research projects guided by five-year national plans or other central or local plans. Industrial managers were rarely consulted about such plans. Scientific and technological knowledge was perceived as a free public good, leaving little incentive for researchers in PRIs and universities to transfer their research results to commercial applications. As a result, transfers from PRIs and universities to industry were left mostly to serendipity.

To respond to these problems and force research and development organizations to "jump into the sea," the government initiated major changes in funding and managing research organizations and in technology markets. For example, government appropriations as a share of PRI income decreased by an average of 5 percent each year from 1986 to 1993. After more than a decade, the country's innovation system has indeed changed. By 1993 only 28 percent of the income of PRIs came from direct government appropriations, compared with 64 percent in 1986. PRIs were able to generate close to 60 percent of their income from nongovernmental sources—half from technical services rendered to industrial enterprises. Similar changes took place in universities.

*Source:* Dahlman and Aubert (2001).

*Innovative India.* Despite the challenges, the overall Indian innovation system presents some remarkable and impressive features. India is home to several dynamic hubs of innovation: Bangalore, with its 150,000-strong army of software engineers, has developed a strong innovation "cluster" in IT, characterized by corporate offices, venture capitalists, business startups, and university and research labs (Box 4-5).

**Box 4-5: Evolution of Bangalore as an Innovative Cluster**

An innovative cluster emerges due to three elements, namely, labor market pooling, presence of specialist suppliers, and development of technological knowledge spillovers. One of the major clusters that has grown rapidly in India has been in Bangalore. Some authors have even named it the "Silicon Valley of the South." Bangalore started as a local cluster focused on aeronautics. It slowly expanded into IT and then into biotechnology. By the end of the 1990s, many multinational companies had established R&D centers in the city. Bangalore has acquired many of the necessary ingredients to gain such status: good educational institutions, critical mass of innovative companies, an entrepreneurial culture, and the presence of venture capital.

As they evolve, the focus of clusters moves from production to innovation. This transformation occurs when a threshold number of innovative entrepreneurs exists. The continuous entry of new players makes a cluster dynamic and fast growing. Availability of venture capital has been a catalyst for this change. The growth of software exports from Bangalore is positively correlated with the growth of venture capital activity. As global competition increases, local clusters are becoming crucial for enhancing competitiveness. Clustering and dense interfirm networks provide advantages for firms of all sizes. Two elements are becoming the drivers of cluster development: the presence of experienced entrepreneurs and specialized knowledge.

Clusters represent a new way of thinking about national, state, and local economies, and they necessitate new roles for companies, government, and other institutions in enhancing competitiveness. The evolution of Bangalore indicates that public policy must focus on designing a set of enabling instruments that must be implemented at the

[36] EMBRAPA's mission is to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer. For more information, see http://www.embrapa.br/.

regional and local levels. Focus on policy initiatives that fall outside the jurisdiction of traditional regulatory agencies has been increasing, which for clusters becomes important. In the early phases of a cluster, the policy focus has to be on supplying manpower and improving infrastructure. In the growth phase, the focus must be on supporting entrepreneurship, networking, and innovation. In later phases, availability of venture capital is crucial. Local institutions and government must play an increasing role in a cluster, if it is to become truly innovation based.

Bangalore is now at a crossroads. Many factors are pushing the city forward in terms of S&T development: a relatively mild climate, a proactive government, a large number of quality educational institutions in and around the city, the need for large companies to develop products on a global scale, and so on. But several factors are pulling the city backward as well: poor infrastructure, corruption, rapidly increasing pollution, and competition from hubs elsewhere in the world. In the long run, the first set of factors is likely to lead to positive outcomes, but in the short run, the negative factors could take the city through an unsteady period.

*Source:* Bowonder (2002) and ATIP (2003b).

India also has vast and diversified publicly funded R&D institutions: strategic, such as the Indian Space Research Organization, and others, such as CSIR, Indian Council of Medical Research, Indian Council of Agricultural Research, and world-class higher education institutions (IITs and RECs), which provide it with the critical human capital needed to forge ahead in the innovation area.

*Emerging global R&D platform.* India has recently been very successful in attracting R&D investments. About 100 MNCs have set up R&D centers in India, for example, GE, McDonald's, General Motors, Delphi, Eli Lilly, Hewlett-Packard, Heinz, Honeywell, and Daimler Chrysler (Basu 2003). GE's R&D center in Bangalore alone boasts a staff of 2,300 engineers, 60 percent of whom have master's or Ph.D. degrees! Since this center opened in 2000, engineers in Bangalore have filed for 95 patents in the United States (Kripalani and Engardio 2003). Large companies are coming to India not only to take advantage of India's human resource potential—its high-quality engineers, scientists, and designers—but also to reap cost advantages, because the cost of doing R&D in India is a fraction of that in the developed world. Not all MNC research labs in India, however, work at the cutting edge of technology. Most of them do developmental research, which develops or improves existing products.

The main motivation for India's emergence as a preferred destination is the low cost of its technical workforce and a large pool of technically qualified people (Basu 2003). Although some have expressed concern that the trend to MNC R&D investments in India is exploiting the country's most valuable human resources, it also has important benefits for Indian industry. Linkages in R&D between, on the one hand, local universities, research institutes, and firms and, on the other, the multinationals' worldwide R&D network help to integrate India further into global technology development activities. Such R&D activities are also useful to inculcate a "commercial culture" among scientists, helping them to apply knowledge for tangible and productive ends; many of them may leave their jobs with foreign companies to start their own technology-based firms or to work with Indian firms. People working in foreign firms also acquire new insights and skills that they would not otherwise be able to, and new scientific knowledge is a powerful engine for the economy and technical innovation. According to Dr. R. A. Mashelkar, director-general, CSIR, "just as globalization of trade is growing at a rapid pace, there is a globalization of research and technology too, which has brought a silent revolution in the country. The challenge is how to continue to tap the incredible dynamism of global R&D so that Indian institutions and companies can assume leadership in creating high-wage jobs and building new industries" (PTI 2004a). Box 4-6 provides more information on international corporate R&D in India.

**Box 4-6: Highlights of International Corporate Research and Development in India**

Several transnational companies (TNCs) have established strategic R&D units in India. Survey results from 32 R&D units—16 from companies dealing with conventional technologies (chemicals, pesticides, fertilizers, pharmaceuticals, engineering, hygiene, healthcare products, and branded consumer goods) and 16 in new technologies (electronics, including ICT and software; biotechnology; and solar energy)—show that:

- A primary factor behind location of R&D in India is access to R&D personnel, especially in sciences and engineering. Other factors include a favorable climate for foreign investment and common use of English in education, government, and industry.
- Another primary factor has been the cost of carrying out R&D in India, which is a fraction of that in the industrialized world, mainly due to the lower wages of R&D personnel. For example, according to 1994 estimates, the annual net income of engineers and department managers in India (Mumbai) are $2,100 and $4,300 respectively, compared with $51,400 and $76,800 for Japan (Tokyo), $34,600 and $55,900 for the United States (Chicago), $20,100 and $23,600 for Korea (Seoul), and $11,600 and $16,000 for Brazil (São Paulo).
- By establishing linkages between local innovation systems (mainly local universities and research institutes) and TNCs' worldwide R&D network, such R&D helps to integrate India into global technology development activities.
- TNCs' R&D activities are inculcating a "commercial culture" among scientists in host countries. In India, one of the main reasons for not reaping the benefits of its scientific capacity has been the lack of application of its knowledge for tangible purposes. TNCs, through their R&D activities, are contributing to the diffusion of application skills to researchers and encouraging them to go beyond just proving principles.

In general, TNCs are able to recruit and retain the cream of available talent, due to higher salaries, advanced training, and other career growth opportunities. Domestic firms cannot match TNCs in these aspects, so they must make do with the talent available to them, which in turn, may affect the enhancement of technological capabilities in domestic firms. Other effects on innovation capability of the host country include diffusion of knowledge related to patents and other intellectual property rights. Indian firms and scientists are realizing the importance of patenting and acquiring knowledge related to it with the collaboration of TNCs. With TNC R&D investments in the country increasing, even academic institutions realize the importance of teaching the IPR aspect to students, for example, the Indian Institute of Science has started a course on IPR.

*Source:* Reddy (1997).

Despite India's advantages in attracting MNC R&D, however, some threats are looming: China, Russia, and Malaysia, which have at least one or both of India's strategic advantages—a cheaper workforce and talent pool—are making preemptive bids to grab a slice of the MNCs' global R&D investments. Others such as Canada and Singapore through government-initiated programs to invite foreign investment into R&D are also emerging as serious competitors to India (Basu 2003).

*Increasing outsourcing of high-end R&D to India.* This new trend is evident from the large number of established R&D outsourcing centers in India, from IT and telecom to automotive and pharmaceutical sectors (Box 4-7). According to a recent report by the Ireland-based leading market research resource, Research & Markets, the R&D outsourcing market for IT itself in India is expected to grow from $1.3 billion in 2003 to more than $8 billion by 2010 (PTI 2004c). Outsourcing in new areas by companies from developed countries is gradually leading to the development of many critical skills and technologies needed in the country, thus helping to raise India's technological capability with relatively modest investments. Box 4-8 highlights another example of India's potential in becoming the destination for outsourced R&D in such areas as chemistry and biology.

**Box 4-7: Globalization of Innovation: High-End Research and Development in India**
A great deal of high-end R&D is being outsourced to India. International firms are increasingly unwilling to keep expensive teams together between projects. Wipro provides such firms with an alternative to R&D by permanent in-house teams; this has become a big business for Wipro, accounting for one-third of its $1 billion in annual revenues and employing 6,500 people. Wipro is probably the world's biggest R&D services firm. Its smallest commitment to any of these clients is 300 people. On the one hand, elaborate procedures protect the customer's intellectual property, including mandatory "cooling-off" periods for engineers between clients, and sometimes a right of veto on their redeployment. On the other hand, the breadth of Wipro's industry knowledge is part of its sales pitch. The approach varies from micromanagement by the customer, who takes on Wipro engineers virtually as staff members, to "total product ownership," that is, handing a mature product and all its global development and maintenance requirements, such as adaptation for a particular market, to Wipro, allowing the customer to redeploy its own engineers to the next big project.

This is called "globalization of innovation," which continues the erosion of the old model of corporate R&D, which was dominated by big firms with big budgets able to erect big barriers to entry to their markets. This erosion is part of a broader trend, prompted partly by a rising number of entrepreneurial innovators and growing amounts of venture capital to finance them, toward a more "dispersed" model of R&D. The Internet has removed geographic barriers to using far-flung talent, and the popping of the "dotcom bubble" has spread innovation "offshore." This dispersal is becoming global, but it differs from the outsourcing of IT and other "back-office" processes; IT business comes from cost centers, driven by price and efficiency. R&D clients, however, are looking for innovation and a shorter time to market; they hope to be profit centers. Many firms still see untapped potential in using the wealth of Indian talent for R&D, not just in IT-related areas but in other industries such as drugs and biotech.

*Source:* Excerpted from *The Economist* (2004e).

**Box 4-8: Outsourcing Chemistry and Biology Research and Development in India**
Outsourced chemistry and biology R&D in India has not received as much attention in the United States as IT outsourcing. The chemistry and biology outsourcing market is small—pharmaceutical R&D outsourcing represents no more than $3–4 billion—but it is growing rapidly. India has a large number of contract research companies in chemistry, biology, and the new field of drug discovery services. These companies are becoming part of the global pharmaceutical and chemical R&D network. The increase in R&D outsourcing in the pharmaceutical and biotechnology sectors represents a significant development. Pharmaceutical and biotechnology companies are now convinced that networked R&D is the way to reduce costs and increase productivity. The trend is here to stay and is spreading to other related businesses, including the chemical industry, agriculture, and environmental engineering. Outsourcing in chemistry and biology is thus likely to grow rapidly.

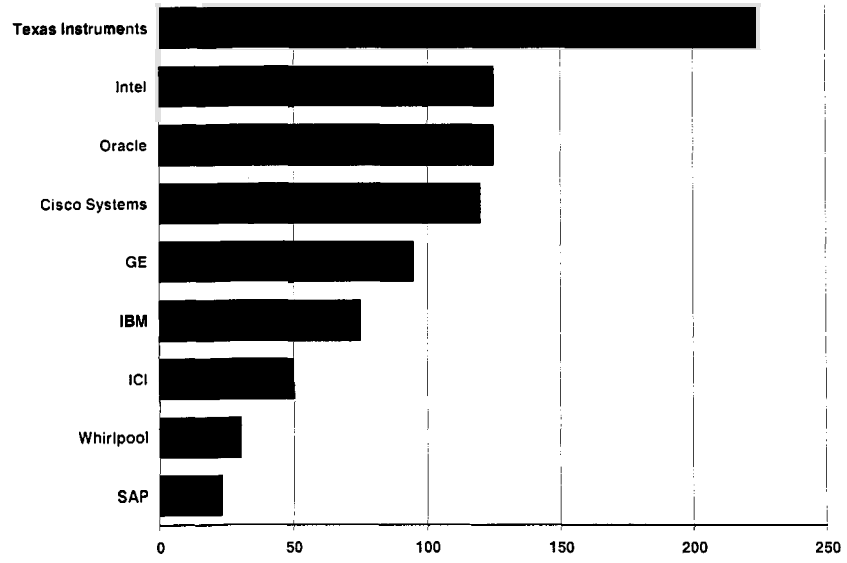
*Source:* ATIP (2003a).

*Protecting knowledge through patents.* Recent amendments to the Indian Patent Act adopted in a move toward adhering to the intellectual property norms under Trade-Related Aspects of Intellectual Property Rights (TRIPS) has also boosted confidence among international players. This has resulted in the clustering of R&D centers in new cities such as Hyderabad, Lucknow, and Pune. An increasing trend is also discernible in the number of patents granted to companies by the Indian Patent Office. Among Indian patents, it is the drugs and electronics industry that has shown a sharp increase in patenting in recent years (Bowonder, Kelkar, and Satish 2004).

The number of patents granted to residents and nonresidents in India has also been increasing over the years, although the patents granted to nonresidents have been about three to four times greater than those

granted to Indians.[37] Another interesting side to patenting exists in India: patents earned by Indian subsidiaries of multinational firms. Here, India is doing rather well; note the increasing number of patents by Indian entities of foreign firms (Figure 4-4).

**Figure 4-4: Patents Granted to Indian Subsidiaries**
*(number)*




*Source:* Based on a chart in *The Economist* (2004e).

Indians are acquiring a greater awareness of the importance of knowledge and the value of protecting it through patents. For example, in 1995 a U.S. patent on turmeric was awarded to the University of Mississippi Medical Center in the United States, specifically for the use of turmeric in wound healing, which has been used medicinally in India for thousands of years! India's CSIR filed a complaint in 1997, challenging the novelty of the university's "discovery," arguing that the patent "stole" India's traditional knowledge. The patent was subsequently cancelled in 1997. India has since also successfully challenged patents on neem and basmati rice.

*Unveiling a new innovation policy.* Keeping in mind these new developments, in 2003 India announced a new S&T policy. The policy recognizes that India has a sound innovation infrastructure including research laboratories, higher educational institutions, skilled human resources, and basic research strengths in agriculture, healthcare, chemicals and pharmaceuticals, nuclear energy, astronomy and astrophysics, space technology and applications, defense research, biotechnology, electronics, IT, and oceanography. The aim of the policy is to infuse the S&T system with new vitality so it can play a decisive and beneficial role in advancing the well-being of all sections of Indian society.

India's new innovation policy report outlines a number of policy objectives relating to S&T governance and investment, strengthening of infrastructure for science in academic institutions, finding new funding mechanisms for basic research, developing human resources, increasing industry and scientific R&D, encouraging indigenous resources and traditional knowledge, and strengthening generation and management of intellectual property (India, Department of Science and Technology 2003). The report does not, however, offer many specific details on implementation of these objectives. For example, even

[37] Patent data are available at WIPO at: http://www.wipo.int/ipstats/en/statistics/patents/index.html.

though the plan envisages, in partnership with industry, raising investments in S&T to at least 2 percent of GDP by the end of the Tenth Five-Year Plan, it does not provide any road map for doing so. Considering that more than 50 percent of the R&D allocation is accounted for by atomic energy, space, and defense research establishments, the actual sum available for civilian R&D is rather low and thinly spread across a wide spectrum of areas. The report also does not specify the types of fiscal policies that can enhance the contribution of the private sector to the overall R&D effort. In addition, it does not say much about the coupling of S&T with the market and industry.[38] The report also does not elaborate on how human resources for S&T can be strengthened in the country. Organizational and institutional mechanisms need to be developed to foster mobility of personnel among different segments of the national system of innovation. Little or no mobility currently exists, for example, between the CSIR and university system and between these two and industry.

**Measures to Strengthen the Innovation System**

India has been making steady progress in improving its overall innovation system. In moving forward, India should further energize its innovation system by increasing linkages with academia and industry; strengthening intellectual property rights and the patent regime; enhancing venture capital; promoting R&D by companies; encouraging new R&D niches, as for example in pharmaceuticals; increasing innovation in agriculture; conducting R&D to promote welfare and encourage grassroots innovations; and tapping the Indian Diaspora, which is so important in creating knowledge linkages critical for catalyzing India's future growth.

*Increase linkages between academia and industry.* Improving linkages between research and industry is an important aspect of good innovation practices worldwide and a goal of India's S&T policy. For educational institutions, effective labor market feedback mechanisms and regular consultations with employers and alumni are indispensable for adjusting curricula. In Denmark, for example, industry representatives, including presidents of large companies, regularly sit on the boards of academic departments at universities to advise them on training and research priorities. Industry representatives also sit on the boards of Mexico's new technological institutions.

Not much progress has been made to date, however, in this area in India, where a gulf exists between the academic world and industry. Lackluster partnership arrangements between industry and academia, even between high-caliber institutions such as IITs and industry, are a major cause for concern. No well-developed mechanisms exist for systematic feedback from the private sector to indicate the kind of knowledge and skills that are needed by the economy.

Because integrating the demands of the market into the education system will be important for India's transformation to a knowledge economy, special initiatives should be launched to increase the flow of information between the university and enterprise sectors. A notable example is the National S&T Entrepreneurial Development Board (NSTEDB) in India, which has recently developed an Entrepreneurship Development Cell to help inculcate an entrepreneurial culture and foster better linkages among academic institutions, industries, and R&D institutions. The goal is to develop 40 knowledge-based enterprises through such cells in college campuses in 2004–05.

*Strengthen intellectual property rights and the patent regime.* The protection of IPRs is becoming increasingly important in knowledge-based economies. This is being driven by the mounting costs of

[38] For a good discussion of how the interface among industry, R&D institutions, and academia can be strengthened, see India, Planning Commission (n.d.).

R&D for new products or processes, shortening of the product life cycle, rapid growth in international trade in high-tech products, and internationalization of the research process.

To move ahead in the global innovation race, India too needs to have progressive patent laws and a robust IPR regime. It passed a new patent regime on January 1, 2005, which made it compliant with the provisions of the WTO. It now needs to ensure rigorous enforcement of IPRs in the country, because this issue is becoming key to attracting new investments into the country. The Swiss pharmaceutical company, Novartis, for example, is looking closely at the issue of IPR enforcement in deciding the location of its third research center. It is looking at India and China; in addition to skilled people, government regulations and labor costs, patent protection is key to increased investment by them in India. Box 4-9 highlights some aspects of how the Indian pharmaceutical industry is gearing up to respond to the new patent regime in India.[39]

In terms of strengthening IPRs, the Indian Minister for Science and Technology also recently reiterated the need for manpower planning for IPR protection and making IPRs a compulsory subject in college law courses and in universities. This calls for setting up a number of patent training institutes. China has some 5,000 patent training institutes, whereas India has none. (*The Economic Times* 2004).

**Box 4-9: Indian Pharmaceuticals: Responding to Changes in the New Patent Regime**

Indian pharmaceutical companies are among the best in the world at producing generic drugs and exporting these drugs to about 200 countries. Their success is due in part because, in 1972, the Indian Parliament granted patent rights to manufacturing processes, rather than to end products. Indian pharmaceutical firms were able to take new drugs developed abroad, "reverse-engineer" the manufacturing process, and develop generic drugs. As a result, local firms control about 75 percent of the Indian market today, up from 30 percent in 1972.

On January 1, 2005, however, India introduced a new patent regime and developed the necessary legislation to amend its IPR laws, to be WTO compliant. In anticipation of these changes, some of the larger Indian pharmaceutical companies are now pursuing alliances with global firms: they bring to the table expertise in low-cost manufacturing, distribution networks, and low-wage labor and are looking for drug licenses and research partnerships. For example, Ranbaxy is working with GlaxoSmithKline to identify new drugs and perform clinical trials in India, and Glaxo will handle late-stage drug development. Dr. Reddy's Laboratories has developed partnerships with Denmark's Novo Nordisk and Novartis. Indian firms have also had some success in increasing R&D in anticipation of the patent changes. Wockhardt has developed two new potential antibacterial drugs, and Glenmark Pharma has licensed a potential asthma drug to Forest Labs in the United States for $190 million, the biggest licensing deal ever for an Indian company.

The prospect of better patent protection has attracted foreign drug firms in India, where they can take advantage of low research costs that are an estimated one-seventh of those in the United States. Hoffman-LaRoche, Bayer, Aventis, and Chiron have announced plans to make India a regional base for supplies. This new investment may also help stem the flight of top talent from India in biotechnology. The transition to the new patent regime will be difficult for many of the 20,000 small- and medium-sized Indian pharmaceutical companies, which do not have abundant drugs in the pipeline; this may result in consolidation and bankruptcies.

*Source:* Adapted from Seema (2004) and *The Economic Times* (2004).

*Enhance venture capital.* In a market economy, one of the most admired economic instruments for spurring innovation is venture capital. This form of support helps to reduce the "capital gap" faced by small entrepreneurs. The growth of Silicon Valley as well as Taiwan and Israel derives from the intensive use of venture funds.

[39] Fink and Maskus (2005) discuss the effects of patent protection on the behavior of pharmaceutical transnational companies and market structure in India.

In recent years, the venture capital industry has started creating innovative and entrepreneurial firms and inducing the growth of new and technology-based ventures in India. The IT industry has also helped to catalyze venture capital growth. After Japan, India has become one of the most preferred destinations of offshore venture funds. Venture capital is thus becoming a major mechanism for stimulating innovation and entrepreneurial growth in India. In the past five years alone many new entrepreneurial firms have ventured into new product development and contract research for global firms. Avesthagen, Strand Genomics, Bharat Biotech, Shantha Biotechnics, Ittiam, Tejas Networks, Ishoni Networks, Mitoken, Impulsesoft, to name a few, are some of the new venture-assisted firms that have innovated new products or services. Some firms such as Impulsesoft, Tejas Networks, Reva, and Ittiam have also become product developers for the global market. Mindtree and Kshema Technologies have grown rapidly by focusing on new high-technology business segments.

The government-supported quasi-venture fund, the Technology Development Board has also been effective in stimulating innovations in India (for more information, see http://www.tdbindia.org). The board's main aim is to accelerate development and commercialization of indigenous technology or adaptation of imported technology for wider domestic application. The board provides financial assistance in the form of equity capital, soft loans, or grants to industrial concerns and R&D institutions. With a proactive stance, the board thus helps to facilitate interaction among industry, scientists, technocrats and specialists; fosters an innovation culture through contract and cooperative research between industry and institutions; provides an interface with financial institutions and commercial banks for leveraging funds; facilitates creation of a new generation of entrepreneurs; assists partnerships with similar technology-financing bodies; provides opportunities for venturing into high-tech areas; and creates new job opportunities. In the past five years, Technology Development Board support for 103 entrepreneurial ventures has resulted in a variety of innovative products, including statins (by Biocon), electric cars (by Reva Electric Car), hepatitis-B vaccine (by Shantha Biotechnics), rotavirus vaccine (by Bharat Biotech), lithium ion batteries (by 21st Century Batteries), and high-strength alloys (by AV Alloys) (Bowonder, Kelkar, and Satish 2004).

*Encourage new R&D niches, such as in pharmaceuticals.* Indian pharmaceutical companies such as Ranbaxy and Dr. Reddy's Laboratories are also increasingly investing in R&D and are making their mark on the global stage (Box 4-10). For example, in 2004 Nicholas Piramal India inaugurated its research center in Mumbai, at which 250 scientists will research a wide range of areas, such as cancer, diabetes, inflammation, and infectious diseases. In a reverse brain drain, 30 scientists from the United Kingdom, United States, and Canada either from MNCs or academia have relocated to this center in India to work on novel drug development (Krishnan and Kamath 2004).

Indian pharmaceutical companies are working on a variety of new drugs with a variety of partners, sometimes in response to specific new demands. For example, the World Bank, in partnership with the Global Fund to Fight AIDS, Tuberculosis, and Malaria; UNICEF; and the Clinton Foundation, has announced agreements enabling developing countries to purchase high-quality AIDS medicines at the lowest available prices. In many cases the medicines and diagnostics would cost 50 percent less than their current prices. Cipla, Hetero Drugs Limited, Ranbaxy Laboratories, and Matrix Laboratories are four Indian pharmaceutical manufacturers tapped to provide the drugs in these agreements (Altman 2003 and an internal World Bank document).

**Box 4-10: Indian Pharmaceuticals Have Global Ambitions**

The success of Indian pharmaceuticals is already drawing comparisons with its IT prowess. Ranbaxy derives nearly half of its business from the United States and is looking for acquisitions in France, Germany, and Italy. Ranbaxy and Dr. Reddy's Laboratories both aspire to become "research-based" (Ranbaxy), "discovery-led" (Dr. Reddy's Laboratories) originators. Both firms plan to boost spending on R&D to 10 percent of revenues. But this needs to be put in context: Pfizer, for example, has an R&D budget for 2003 of $7.1 billion! So far, much of Indian firms' R&D has gone into the reverse engineering of existing drugs and the development of new tweaks on them: a new "delivery system," say, such as an inhaler. But both Ranbaxy and Dr. Reddy's Laboratories are also spending heavily on research into new drugs.

*Source:* Excerpted from *The Economist* (2003e).

*Promote R&D for new product development.* The above discussion points to the importance of promoting R&D in companies to generate new innovations and products and, in so doing, remain at the cutting edge of innovation worldwide. New products are considered the competitive lifeblood of companies, and the marketplace—in the developed and, more and more, in the developing world—is becoming increasingly unforgiving of delay and deficiencies in product development. Asked to identify the drivers of R&D activity, respondents in a recent global survey of senior executives rated the most significant forces as more demanding customers, market pressures to keep up with competitors, development of new technologies, and shorter product life cycles (EIU 2004b). With the stakes so high—traditional R&D budgets amount to 5–10 percent of companies' annual sales and market—organizations and companies throughout the world are working hard to get their choices of research directions right (see Box 4-11 for more details on this survey).

*Increase innovation in agriculture.* Given the importance of agriculture in India's economy, increased emphasis on innovations that can enhance productivity will be critical to raising agricultural growth. Such efforts include connecting India's farms to the world by diversifying into agricultural commodities in demand by consumers all around the world. For example, India produces about 14 percent of the world's fruits and vegetables, but only 1 percent is exported due to lack of processing facilities. The government is making concerted efforts to increase fruit and vegetable production in India and has set up a National Horticultural Board to promote production of these commodities. It has also identified horticultural crops as a way to diversify agriculture and make it more profitable and create skilled employment for rural people. These efforts have met with recent success. The grapes sector in India is now able to compete in the quality-conscious European Union market and is moving into value-added products, such as wine. The Indian telecoms company Bharti has recently moved into the global fruit and vegetable market in a joint venture with the United Kingdom's finance group Rothschild. A farm and research facility in the northern state of Punjab will source produce from all across the country, and cold storage, processing plants, and refrigerated transport facilities will be established. The plan is to sell apples, mangoes, grapes, cherries, tomatoes, baby corn, okra, and iceberg lettuce to the European Union, Southeast Asia, the Gulf states, and Central Asia (Ridding 2005 and WorldisGreen.Com 2004).

India's public agricultural research and extension system is one of the largest in the world, but its efficiency and effectiveness has been increasingly called into question. A more regionally differentiated R&D strategy is needed for agriculture. The top-down, narrow, crop-focused approach to agricultural extension has also become outmoded and ineffective in meeting the needs of farmers. In the future, the public extension system must become more demand driven, with stronger synergies between public and private extension efforts (World Bank 2003d).

**Box 4-11: The Evolving Innovation Landscape: Research and Development in the Corporate World**

A recent global survey of almost 200 senior executives on the topic of R&D strategies yielded some interesting insights on development of new products, services, and business models. According to these executives, almost 50 percent of current corporate sales represent sales of products that are less than three years old. The survey also shows that R&D models have shifted away from the supply-side approach of big firms that fund ambitious projects creating large barriers to entry, making irrelevant the previous system in which researchers developed a prototype and then threw it "over the wall" to production, sales, and marketing. Instead, R&D is moving toward a demand-driven approach that focuses on speed and need, which is driving closer collaboration among researchers, partners, and customers. Top R&D executives are still being asked to research innovations that create new markets several years out, but they are also being prodded to design round-the-clock global organizations that can innovate in swift and affordable response to current market pressures. The survey results suggest three forces that will shape the world of R&D in coming years:

- *Responsiveness to the market.* Market pressures to keep up with competitors' innovations and satisfy more demanding customers are the two top drivers of R&D activity. In this environment, anything companies can do to reduce the odds of failure as they embark on new research projects is critical. R&D planning and projects are increasingly being moved by companies closer to the market than has traditionally been the case. Although many companies retain a central R&D unit to take a long-term research perspective, R&D funds now tend to get distributed across a mix of business unit and basic research programs.
- *Globalization.* Competition for talent, new technologies, and easier market access has accelerated the process of R&D globalization; countries such as India and China host significant volumes of R&D activity for multinationals. Cost also drives globalization, but its significance can be overplayed as far as R&D goes. Once infrastructure and coordination costs for managing distributed R&D facilities are included, the total savings are not as huge as popular headlines suggest. Speed of development is a more important benefit of the global research economy.
- *Customer collaboration.* A more market-oriented approach to R&D is driving R&D leaders to work more closely with customers as they develop new products and services. Although collaboration is key for creating demand-driven innovations, maintaining customer involvement is one of the leading roadblocks to successful R&D projects.

This evolving innovation landscape promises a more effective R&D process, one that sharpens the decision-making process as firms choose where to allocate their R&D spending and increases the chances of launching commercially viable new products.

*Source:* EIU (2004b).

Agricultural higher education establishments in India have also accepted education, research, and extension activities as integral to their functioning. Although every effort has been made by these institutions to provide facilities for high-quality education, training, and research, rapid expansion of education and training facilities coupled with reduced financial allocations have resulted in a loss of quality in the educational and training process and an uneven standard of achievement by graduates and postgraduates of various institutions. It is, therefore, important to improve the quality and relevance of agricultural higher education and in-service training and strengthen the capacity of Indian states in developing and managing agricultural human resources.

*Conduct R&D to improve welfare.* According to Dr. R. A. Mashelkar, "India is part of the IDCs, innovative developing countries (as opposed to the LDCs that the world knows of) that include Brazil and China, and has demonstrated its potential in the area of not only high-end R&D, but is also using public-private partnerships to harness the potential of traditional knowledge to meet health and welfare needs and to reduce poverty."[40] More initiatives are needed in education (such as the CBFL program of the Tata

[40] Presentation by Dr. R. A. Mashelkar on "Seizing Opportunities to Leverage India's Potential in Education and Innovation," at the workshop "India and the Knowledge Economy," New Delhi, November 9, 2004.

Group described in chapter 3), healthcare, and connectivity to meet the needs of the poor. To move forward in these areas, it is important to use existing capacity in public institutions in IDCs in the discovery and development of new innovations and to move from "beaten paths" to alternative innovative paths for R&D.

One example is the triangulation of traditional medicine with modern science and modern medicine in the drug discovery and development process in India. To take a new drug to the market is an expensive and time-consuming venture with numerous bottlenecks. It now takes an estimated $1.7 billion for a pharmaceutical company to place a molecule in the market. Through "reverse pharmacology," however, India has shown how a drug can be taken to the market for a fraction of that cost (Box 4-12). For example, an Indian drug company took three years to develop a drug based on a traditional medicine for the treatment of psoriasis at a cost of only $4 million, with a resulting cost of treatment of $50, compared with a reported cost of treatment (Amgen) of $20,000 in the United States!

This example shows that alternative paths to R&D can make a difference, and this process requires rethinking the discovery and development process. New global public-private partnerships are needed to make this a reality, especially so the poor of the world can purchase medicines at affordable prices. India's New Millennium Indian Technology Leadership Initiative is one example in this vein. The initiative gives government funding to projects in which universities, government labs, and companies work together to make world-class products. The initiative has led to the development of two drugs in clinical trials, for psoriasis, as above, and tuberculosis, and a software package called Bio-Suite that can analyze DNA and manipulate molecules in three dimensions. Several institutions, including the Indian Institute of Science in Bangalore and the Institute of Genomics in Delhi developed Bio-Suite, which Tata Consultancy Services launched in June 2004 (Webb 2005).

**Box 4-12: Leveraging Traditional Knowledge with Modern Science and Exploiting Public-Private Partnerships for Drug Development in India**

In India, a new drug against a chronic and incurable skin disease called psoriasis is now under development through an industry-research laboratory partnership. The new drug, a purified extract from the leaves of a plant long used in traditional medicine, is now awaiting approval for clinical trials in patients with psoriasis after successful completion of toxicity trials in healthy volunteers. Lupin, a major drug company, and the CSIR are working to transform this herbal extract into a scientifically validated modern drug against psoriasis. It is estimated that the global market size for drugs against psoriasis is about $3 billion.

The candidate drug against psoriasis is part of an effort to develop new drugs from traditional knowledge through "reverse pharmacology." The conventional approach in seeking out new drugs involves identifying new molecules, testing their efficacy on laboratory animals, and then moving to humans. "Drug discovery around the world has focused on moving drugs from molecules to mice to men. In reverse pharmacology, we're going the other way—from men to mice to men," according to Dr. R. A. Mashelkar, director, CSIR. Traditional medicine has long used herbal extracts on patients. Reverse pharmacology is aimed at validating such extracts through rigorous science.

The psoriasis initiative took off three years ago when Lupin decided to investigate a herbal extract used by a practitioner of traditional medicine against psoriasis. The company first conducted a proof-of-concept study in a hospital in Mumbai where it evaluated the extract in a group of 21 patients. Twenty patients responded to the treatment—the severity of their psoriasis decreased and no serious side effects were observed in any of the patients. The encouraging results prompted Lupin to approach the CSIR for funding to carry the study forward. The first phase of the project received Rs. 60 million funding under the New Millennium Technology Leadership Initiative, a program managed by the CSIR aimed at nurturing industry-research partnerships to generate new technologies that are expected to have global impacts. Over the past two years, scientists at Lupin's R&D center and CSIR's Central

http://www.worldbank.org.in/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/INDIAEXTN/0,,contentMDK:20279055~menuPK:295602~pagePK:141137~piPK:141127~theSitePK:295584,00.html).

Drug Research Institute have studied the constituents of the herbal extract in detail, identified the "active molecule" that is believed to act on the psoriasis, and worked out standardized techniques to extract it from the plant. In September 2004, the drug went through phase I clinical trials in healthy volunteers designed to evaluate its side effects. The company has now sought phase II clinical trials to formally test its efficacy through a rigorous scientific trial. The CSIR will also fund a second phase of the project through the New Millennium Initiative. If all goes well, a new drug against psoriasis may be in the market in two years. If that happens, the time to develop a new drug would have shrunk from 10 years to less than 5 years.

*Source:* Excerpted from Mudur (2005).

*Encourage grassroots innovation.* The above underlines the importance of harnessing grassroots innovations for development. India has made some laudable efforts in this area. The Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), for example, supports the Honey Bee network of grassroots innovators engaged in developing sustainable alternatives for natural resource management (for more information, see http://www.sristi.org/honeybee.html). This society has documented innovations and traditional practices and collected outstanding examples of contemporary knowledge to form a 10,000-item database. Such initiatives should continue to be encouraged, because grassroots innovations can be a positive source of job creation, especially in rural areas. The National Innovation Foundation, established to help India become an inventive and creative society and a global leader in sustainable technologies, also supports grassroots innovations in India (for more information, see http://www.nifindia.org/). It is nonetheless important that intellectual property be protected in these cases so that people can increase their earnings from their own innovation, knowledge, and creative skills.[41]

*Tap the Indian Diaspora.* India has a large and well-educated Diaspora that it should tap to enhance growth and competitiveness.[42] According to Huang and Khanna (2003):

> . . . after decades of keeping the Indian Diaspora at arm's length, the country is now embracing it. . . . Until now, the Indian Diaspora has accounted for less than 10 percent of the foreign money flowing to India. With the welcome mat now laid out, direct investment from nonresident Indians is likely to increase. The Indian Diaspora has famously distinguished itself in knowledge-based industries, nowhere more so than in Silicon Valley. Now, India's brightening prospects, as well as the changing attitude vis-à-vis those who have gone abroad, are luring many nonresident Indian engineers and scientists home and are enticing many expatriate business people to open their wallets. With the help of its Diaspora, China has won the race to be the world's factory. With the help of its Diaspora, India could become the world's technology lab.

In a major initiative, the Indian government set up a high-level committee on the Indian Diaspora in September 2000 to prepare a comprehensive report highlighting ways to create a more conducive environment for leveraging these invaluable human resources. The report includes a detailed examination and recommendations on major Diaspora issues in the fields of consular and related matters, culture, economic development, investment, international trade, industry, tourism, education, health, media, science and technology, and philanthropy (India, Ministry of External Affairs 2000). Box 4-13 showcases the achievements of the Indian Diaspora in the United States.

[41] For more information, see Finger and Schuler (2004).

[42] In addition to specific citations, information in this section was also drawn from Panagariya (2001) and World Bank (2003f and 2004f).

**Box 4-13: A Snapshot of the Indian Diaspora in the United States**

The world is increasingly becoming one globally integrated market, and highly educated and trained people are key elements of competitiveness. Each year 2–3 million people emigrate due to higher salaries and complementary aspects: research centers, access to finance, and the ease of setting up businesses. Weaknesses in home countries include low salaries and weak complementary aspects: little funding for R&D; underequipped research centers; difficult access to capital, especially to start up new high-tech businesses; access to finance; and an overregulated business environment for starting and running new businesses. The majority of emigrants go to just four host countries: the United States, Germany, Canada, and Australia.

Although this migration has several positive effects on host countries by increasing the stock of high-level personnel and stimulating innovative activity, the negative effects on home countries include loss of highly trained personnel and fiscal costs, because many receive education that is publicly financed. Offsetting effects to home countries include remittances, return of migrants with greater international experience, and potential to use this Diaspora to access capital knowledge and markets. Remittances to developing countries have soared from $17.7 billion in 1980 to $30.6 billion in 1990 to nearly $80 billion in 2000 (Kapur and McHale 2003). In India, between 1990 and 2000, remittances from abroad grew sixfold from $2.1 billion to $12.3 billion. The destination of these remittances shifted significantly from Kerala and Gujarat to Karnataka and Andhra Pradesh, which are becoming centers of IT.

According to the U.S. Census of 2000, the Indian Diaspora in the United States is growing rapidly and very wealthy. The Indian-American community now boasts 1.68 million people compared with 0.81 million in 1990—a growth of 106 percent! Their average per capita income is $60,093 (compared with a U.S. average of $38,885 in the 2000 census). They have a high level of education: more than 87 percent of Indo-Americans have completed high school and 62 percent have some college education (compared with just more than 20 percent for the U.S. population). They are represented in virtually all professions, including agriculture, biotechnology, business, economics, finance, IT, journalism, management, medicine, and various sciences. In 1997–98, 4,092 Indian professors were teaching in U.S. universities. In the same year, 33,818 students born in India were registered in 2,579 U.S. universities. In 1997 Indian students obtained 3.2 percent of the total number of doctorates granted by U.S. universities. The Diaspora is also very entrepreneurial, and Indians have come to enjoy a dominant position in the U.S. IT industry: approximately 300,000 Indian-Americans work in Silicon Valley, account for more than 15 percent of startups in the United States, and have an average annual income of about $200,000.

The launch of economic reforms in India in 1991 opened up new business opportunities for the Indian community in the United States. They have had an important role to play in high-tech development in India, focused primarily on the software industry. Many IT professionals rely heavily on strengths back home—the huge pool of skilled computer experts and software professionals—to subcontract work to their country of origin, thus creating a "virtuous" cycle for the Indian IT sector and economy. As an example, in the software industry and IT-enabled services, investments of Diaspora members are quite limited (about 3 percent of FDI), but their contribution is mostly in the form of knowledge linkages, that is, with foreign markets, helping Indian firms to absorb technical and managerial knowledge. The initial impetus for outsourcing to India many times comes from employees of Indian origin. The success of the Indian Diaspora has also attracted the attention of major MNCs to India's potential in the IT sector. India has attracted investment in many R&D centers wholly funded and established by GE, Cisco, Sun Microsystems, Microsoft, IBM, and Hughes Software. Intel's R&D centers in Delhi, Bangalore, and Mumbai service its global operations. Oracle Corporation has two development centers in Bangalore and Hyderabad. Phoenix Technologies, ABB Group, IBM, America Online, and J.P. Morgan Chase are in the process of setting up new R&D centers, and Lucent Technologies is also making inroads into India.

*Source:* Author's research.

Indian professionals abroad have been able to create networks that are working for the benefit of the country, for example, Indians set up the Indus Entrepreneurs (TIE) (see http://www.tie.org/), a professional and social network in Silicon Valley, which now has 42 chapters in nine countries (Kripalani and Engardio 2003). These networks have mostly contributed knowledge linkages among countries and links with foreign markets. They are helping Indian firms to absorb technical and managerial knowledge

and have been providing the impetus for outsourcing to India (in IT and R&D). An increasing number of firms have their "front offices" in the United States and the "manufacturing facility" in India, generating more jobs. The deeper, more symbiotic relationship developing between Silicon Valley and India, thus, goes far beyond the "body shopping" of the 1990s when U.S. companies mainly wanted low-wage software-code writers. Now the brain drain from India is turning into a so-called "brain circulation," nourishing the technology scenes in both nations (Hof and Kripalani 2003).

As reforms progress in India and bureaucratic barriers come down, the Indian Diaspora will increasingly look for investment opportunities in their country of birth. The Indian government has also taken some positive steps to encourage the Diaspora:

- In December 2003 the government instituted the right to dual citizenship to people of Indian origin with the hope that the measure would enable the Diaspora to contribute more to the cause of national development.
- It launched an initiative (and Web site) to harness the talent of the globally mobile professional S&T Diaspora working in industries, research laboratories, universities, and scientific departments, as well as successful entrepreneurs in technology-intensive businesses and venture capitalists to encourage their collaboration on strengthening Indian education, research, and human resource capabilities in basic sciences and cutting-edge technologies.[43] Other aims include enhancing India's competencies in technology entrepreneurship, utilizing venture financing and mentoring the younger generation, connecting alumni abroad with their alma mater for purposeful and sustainable relationships, and catalyzing participation of Indian scientists as well as institutions in major international science projects and advanced research facilities abroad. It is hoped that these efforts will help to promote India as a global R&D platform and a preferred R&D outsourcing destination.

**Summary of Issues and Recommendations**

Moving forward, India should take steps to improve its overall innovation system further by taking advantage of new knowledge created at home and disseminating it for increased economic and social development. To gain maximum benefits, India needs to approach its innovation policy systematically by supporting innovators and entrepreneurs, removing regulatory and bureaucratic obstacles to innovation, and cooperating with the private sector and industry to engage in mutually beneficial activities; an illustration is the experience of the United States and Finland,[44] which have been remarkably successful in establishing an innovative climate. Strategies are needed to change the Indian mind set, that is, "the I in India, should not stand for imitation and inhibition, but for innovation." Strategies are also needed to develop innovative and "pro-risk" organizations that "learn to dare and dare to learn" and create channels of innovative financing and innovative management.[45]

As mentioned, an important part of India's innovation system relates to how modern and more efficient practices can be diffused to the greatest number of users. This chapter, however, has focused mostly on India's formal R&D efforts. In this context, some policies that can help to energize the Indian innovation system include the following:

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[43] See India, Ministry of External Affairs (n.d.). For a discussion of increasing S&T capacity throughout the world, see InterAcademy Council (2004).

[44] For example, Tekes—the National Innovation Agency of Finland—is the main public funding organization for R&D in Finland. Tekes funds industrial projects as well as projects in research institutes and especially promotes innovative, risk-intensive projects. More information is available at http://www.tekes.fi/eng/.

[45] J. R. D. Tata Corporate Leadership Award Lecture by Dr. R. A. Mashelkar, director general, Council of Scientific and Industrial Research in New Delhi at the 1999 All-India Management Association meeting, February 21, 1999, available at http://www.nifindia.org/jrd%20lecture.htm.

- Tap into the growing stock of global knowledge more effectively and provide incentives for international technology transfer through trade, FDI, licensing, and personnel movements, along with informal means through imitation, reverse engineering, and spillovers.
- Attract FDI more effectively, given the importance of FDI in the generation and dissemination of global knowledge and the role that they can have in domestic R&D. This should include removing regulations on foreign investment and encouraging FDI R&D into the country.
- Encourage members of the Diaspora and renowned expatriates to contribute further to innovative activities by appointing them to the management boards of national research institutes, universities, and so on to facilitate the design of university programs that better suit corporate requirements.
- Motivate scientists and engineers from India working in the United States and other developed countries to enter into alliances with multinational companies and establish firms or labs to undertake R&D on a contract basis in India.
- Audit and monitor S&T efforts and institutional performance to identify what works well and then redeploy resources to programs that have a proven track record of success.
- Use the savings to strengthen university-industry programs by means of matching grants and other initiatives, including encouraging academics to spend sabbaticals in relevant industries so that their research meets the needs of the productive sector.
- Find alternative sources of funding for R&D, especially as the government reduces its budgetary support for research programs. In some countries such as China, academic institutions are launching commercial ventures of their own or in collaboration with the corporate sector.
- Allow national research institutes to collaborate with domestic and foreign firms to forge closer links with industry. In recent years, strong criticism has been expressed on S&T institutions in India pursuing research of little relevance to the private sector and the needs of the economy. One way of encouraging scientists to work closely with industry and in so doing improving linkages between technology development and application would be to provide incentives such as bonuses and a share of royalties from products created through their research.
- Pay adequate salaries and create a proper working environment for scientists and engineers that provides them with access to capital equipment, instruments, and other infrastructure needed for R&D. Failure to compensate researchers adequately and lack of a supportive environment will only exacerbate the problem of brain drain.
- Restructure and modernize universities and publicly funded R&D institutions by giving them flexibility, freedom of operation, and financial autonomy.
- Increase the intake of students into science and engineering, given the competition for recruitment of trained personnel; this may require adding colleges and universities (such as IITs or others modeled after them).
- Develop entrepreneurial skills and management training for S&T professionals to encourage them to undertake business activities.
- Encourage the private sector to invest in R&D.
- Strengthen R&D by companies so that they can have a more demand-driven and market-oriented approach with closer collaboration among researchers, partners, and customers in developing new products and services that can be speedily brought to the market.
- Develop communication and other infrastructure for R&D, and create an attractive environment to motivate R&D investments, including favorable tax, and other incentives.
- Establish science and technology parks to encourage industry-university collaboration. Such parks might attract R&D work from both foreign and domestic firms if the parks are situated close to reputable academic institutions.
- Encourage venture capital, which can also be used as an incentive for commercialization of research.
- Effectively enforce and implement IPR to create confidence among domestic and foreign innovators on protection of their innovations in the country.

- Promote a national fund to support grassroots innovators, with the aim of building a national register of innovators, converting innovations into viable business plans, and disseminating knowledge of indigenous innovations, especially for job creation.
- Strengthen the emerging new model of reverse drug design to produce innovations in a more cost-effective way based on leveraging traditional knowledge with modern science and exploiting public-private partnerships.

# 5. INFORMATION INFRASTRUCTURE

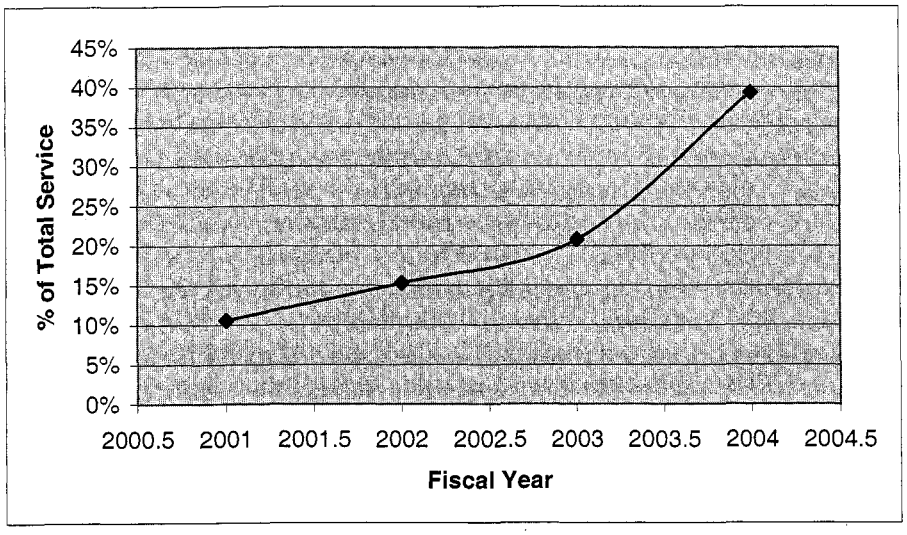
Rapid advances in ICTs are dramatically affecting the acquisition, creation, dissemination, and use of knowledge, which in turn affects economic and social activities, including how manufacturers, service providers, and governments are organized and how they perform their functions. Applications of ICT are improving the efficiency of existing services and creating new opportunities in trade, governance, education, business connectivity, health care delivery, and environmental and natural resource development. As knowledge becomes an increasingly important element of competitiveness, the use of ICTs is thus reducing transaction cost, time, and space barriers, allowing the mass production of customized goods and services and substituting for limited factors of production. With ICT use becoming all-pervasive and its impacts transformational, it has become an essential backbone of the knowledge economy. This means that countries need to harness the full potential of ICTs for all sectors of the economy: for education, innovation, and learning; public sector management; private sector competitiveness; and capacity building. They not only need to address the "digital divide," but must also take advantage of the emerging opportunities to leapfrog and participate in new knowledge industries.

The information infrastructure in a country consists of telecommunications networks, strategic information systems, policy and legal frameworks affecting their deployment, as well as skilled human resources needed to develop and use it. To develop a strong information infrastructure, it is necessary to mobilize the many stakeholders that are involved in its deployment and use: government, business, individual users, the telecommunication and information service providers, and so on.

Turning to India, although the country's IT industry and IT professionals have recently been on the cutting edge of technological evolution, it is also true that the vast majority of people have neither the access nor the awareness and education to derive benefits from advancing technology. Provision of basic telephone services, long distance telephony, and data communications services was, until recently, the monopoly of government agencies. Private players were not allowed to provide these services, and public sector enterprises had no incentive to extend the reach, enhance the quality, or reduce the cost of services delivered to customers. Regulation and centralization of communications development, restrictions on hardware imports until the mid-1980s, scant progress in meeting infrastructure needs, and the inability to scale up good quality higher education constrained India's overall information infrastructure.

The enabling conditions for increased ICT penetration and use, however, are slowly, but surely being created in the country. India's telecoms sector has registered rapid growth in recent years, spurred by reforms to open up the market and introduce greater competition to the sector. Many domestic and international private sector entrants are now providing consumers with high-quality services at low prices. Figure 5-1 shows the increasing percentage of total (fixed plus mobile) telephone service provided by private operators in India.

**Figure 5-1: Percentage of Total Telephone Service (Fixed and Mobile) Provided by Private Operators in India, 2000–04**




*Source:* World Bank (2004g).

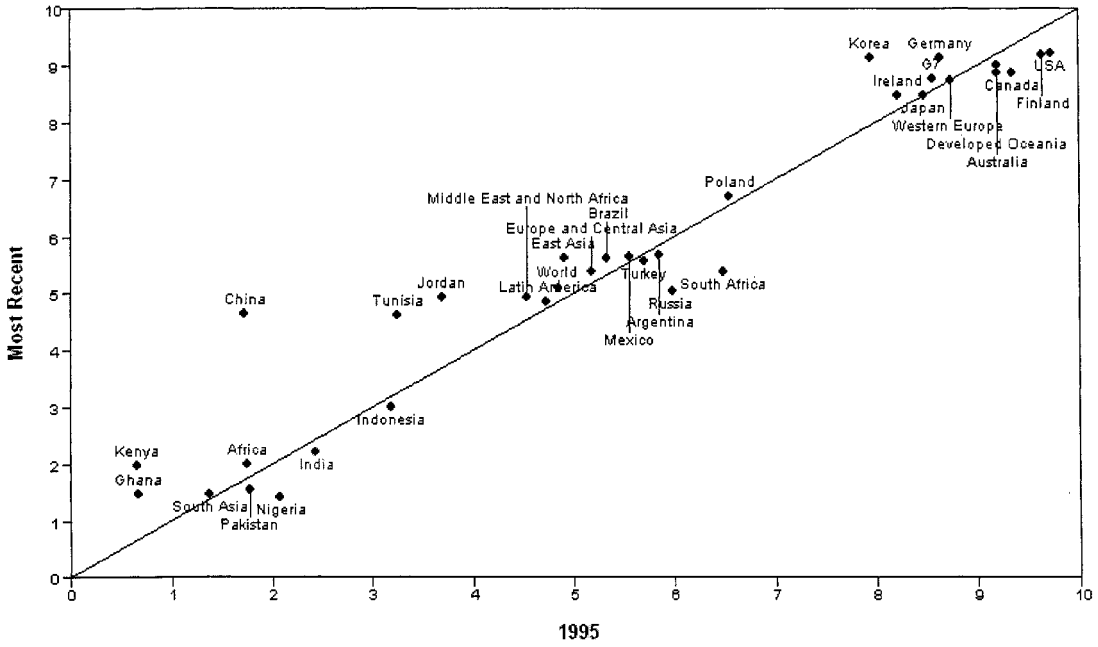
Some spectacular successes have resulted: more than 47 million people in India had mobile phones at the end of 2004! Fierce price competition has led to Indian mobile telephony becoming one of the cheapest in the world. This has been a boon, especially to people in India's 600,000 rural villages, which had no access to communication through traditional means, such as fixed lines. But now, from fishermen at sea and brokers ashore in Kerala to farmers in Punjab—people in industry and farming are embracing wireless technology for economic activity: to do business and increase their profit margins. The National Association of Software and Services Companies (NASSCOM)—the industry association representing the Indian IT industry nationally and internationally—also forecasts that by 2005 personal computer (PC) penetration will reach approximately 15 per 1,000 people (from 7.2 per 1,000 in 2003). (For more information, see http://www.nasscom.org.) India is also facing rapid growth in demand for satellite and cable television (EIU 2003a).

## Benchmarking Information Infrastructure

Despite these achievements, when viewed in a global perspective, the rates of teledensity and ICT penetration for India remain rather low. The global benchmarking presented in Figure 5-2 shows that, even though India does better than the South Asia and Africa Regions in terms of information infrastructure indicators, the country has slightly worsened its performance between 1995 and the most recent period for which data are available, whereas China has soared far ahead.

This seems surprising, given India's recent notable achievements in the IT domain. This is because, despite the several-fold increase in India's information infrastructure penetration ratios in absolute terms in the past half decade (in terms of fixed line telephones, mobile telephones, computers, and Internet users), in relative terms, the country has maintained its position in telephones (fixed plus mobile), made progress in computers, but fallen behind in Internet users, while the world as a whole has made a much more significant improvement in all these indicators in the same period.

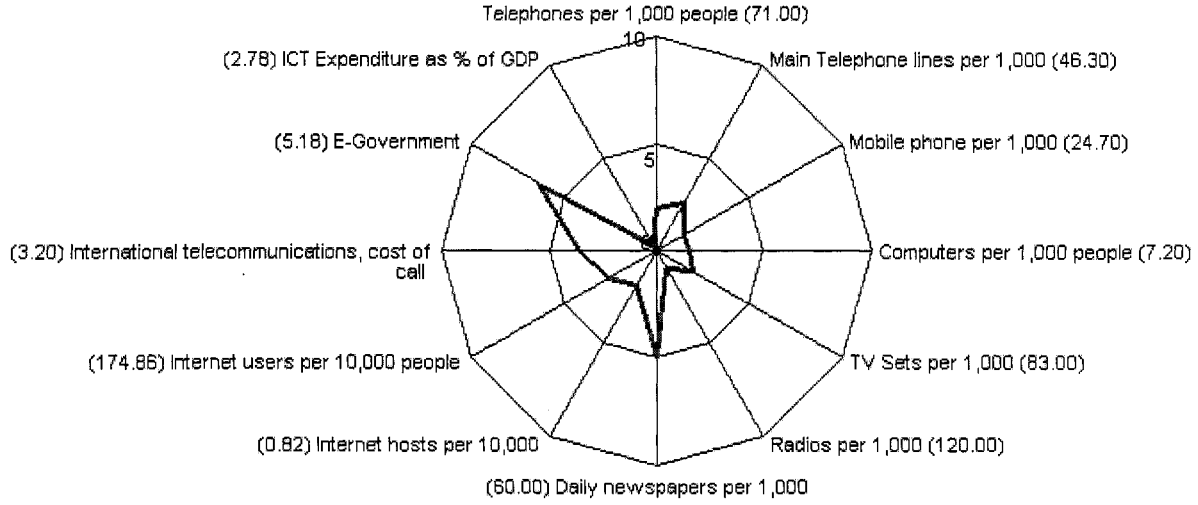
**Figure 5-2: Benchmarking Information and Communications Technologies, India and the World, 1995 and Most Recent Period**




*Note:* Countries above the 45-degree line have improved their position in the information infrastructure for the most recent period for which data are available relative to their position in 1995 (or closest available date in the mid-1990s) and vice versa for countries below the line.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

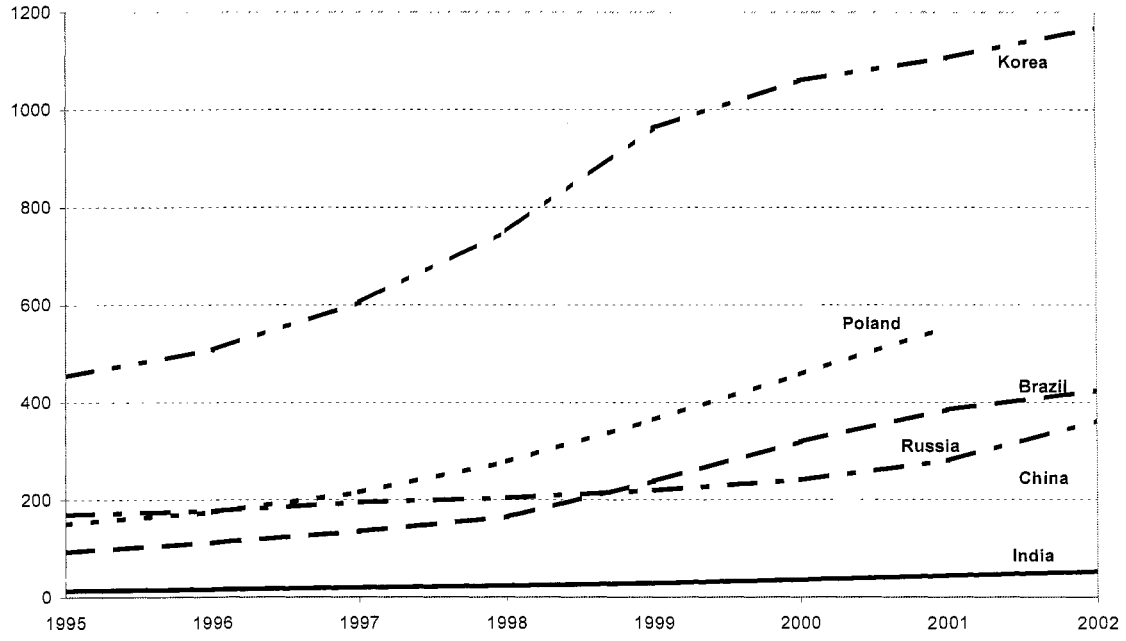
India's ICT scorecard in Figure 5-3 and the data presented in Figure 5-4 (a, b, and c) and annex 11 for India and comparator countries on telephones (both fixed lines and mobile), computers, and Internet hosts again highlight the fact that although some progress has been made, India's information infrastructure as a whole will need to be much further strengthened if India is truly to transform itself into a knowledge-based economy, especially as compared to China, which has made remarkable progress in enhancing its overall infrastructure (annex 12 presents the ICT indicators for India and China, based on the KAM). To take an example of just one indicator: total ICT expenditures in India in 2001 were 2.8 percent of GDP, compared with more than double at 5.8 percent in China and 8.3 percent in Brazil. The low level of spending in India has been due to a high-level of regulations, lack of local applications (most IT applications have been servicing the global market), and high tariffs on hardware, among others. More investment is clearly required so India can make greater strides in strengthening its information infrastructure.

**Figure 5-3: India's Scorecard on Information and Communications Technologies, Selected Variables, Most Recent Period**



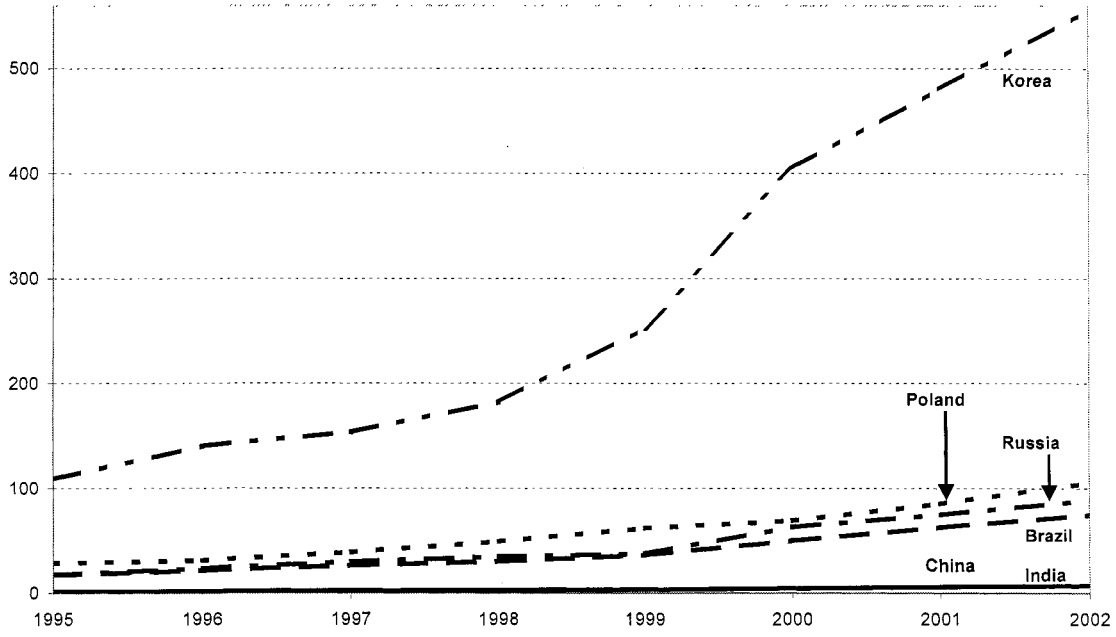

*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10 for 128 countries. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for India for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

**Figure 5-4: Telephones, Computers, and the Internet: India and Comparators, 1995–2002**
**a. Telephones (fixed and mobile per 1,000 people), 1995–2002**



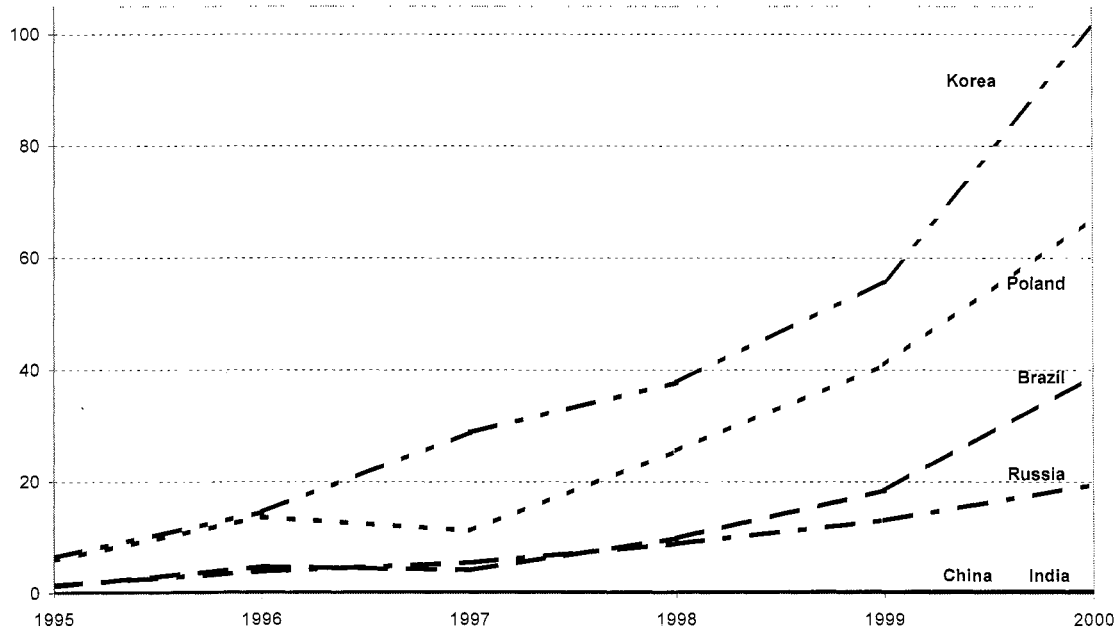

*Source:* World Bank internal database.

**b. Personal Computers per 1,000 people, 1995–2002**




*Source:* World Bank internal database.

**c. Internet Hosts per 10,000 people, 1995–2000**




*Source:* World Bank internal database.

## India's Global Standing on Information Communications Technology

A variety of indexes have been developed to rank countries' performance on ICTs. This section reviews some of these to see where India stands on ICTs on the global stage. The indexes provide a variety of rankings on where India stands in a global perspective and differ with regard to their context and specific informational functions. One possible explanation for the differences in India's rankings is the way the different indexes are calculated; all of them use different methodologies and differ in the scope in terms of the number of countries and indicators covered.

As a result, India seems to do better than some countries on some indexes and not much better on others. This is certainly true when comparing India with China. On average, China seems to do better as an economy than India on using ICTs for its overall development, whereas India has some noteworthy pockets of excellence and needs to do more to use and apply ICTs to meet domestic needs.

In this context, it is also worth noting that the global IT indexes presented here also provide a more somber picture of India's readiness than is perhaps apparent from looking at the progress made by some of the major Indian cities, such as Chennai, Bangalore, Delhi, Mumbai, Kolkata, Hyderabad, and so on. Several indexes have placed Denmark, Finland, Sweden, and Singapore in the top spots. These countries are rather small in size and population, compared with India. Given that India is such a large country with major metropolises the size of some European countries, an interesting exercise would be to compare the progress made by some major Indian cities with the performance of the top-ranking countries.

*Networked Readiness Index.* The World Economic Forum's *Global Information Technology Report of 2004–2005,* the fourth in the series, highlights its Networked Readiness Index (NRI) of 104 countries (WEF 2004d). The NRI measures the degree of preparation a nation or community has to participate in and benefit from ICT developments. The NRI is composed of three component indexes, which assess the following:

- *Environment* for ICT offered by a given country or community
- *Readiness* of the community's key stakeholders (individuals, businesses, and governments)
- *Usage* of ICT among these stakeholders.

The NRI for 2004–05 places Singapore as the best performer worldwide in a number of categories, including the quality of math and science education, affordability of telephone connection charges, and government prioritization and procurement of ICTs; it also gets extremely high scores in other areas, such as affordability of Internet access. Singapore is followed by Iceland, Finland, and Denmark, and the United States occupies fifth spot on the 2004–05 NRI. In terms of India and its comparators, Korea tops the list and holds 24th place, but India is next on the list at 39th, surpassing China at 41st, Brazil at 46th, and Russia at 62nd. India and China have both moved up the ranks in 2004–05 and have shown significant improvements on the rankings in 2003–04, when India ranked 45th and China ranked 51st.

*E-readiness rankings.* The Economic Intelligence Unit's 2004 "e-readiness" rankings (EIU 2004a) provide another interesting benchmark for countries in comparing and assessing their ICT-related environments, related to e-readiness. E-readiness or the extent to which a market is conducive to Internet-based opportunities takes into account a wide range of factors—from the quality of IT infrastructure to the ambition of government initiatives and the degree to which the Internet is creating real commercial efficiencies. The rankings cover the world's 64 largest economies. In the 2004 rankings, several countries have improved their scores since 2003, thanks to continued rollout of broadband services, uptake of mobile telephony, and a spate of Internet-related legislation and government programs. Four tiers of e-readiness have emerged in the 2004 ranking:

- Denmark holds the top spot, and Korea is ranked 14th. Korea has the densest broadband market in the world today.
- The countries in the second tier includes countries, for example, Brazil (35th) and Poland (36th), that do not yet have dense communications and Internet infrastructure or have less well-coordinated "e-government" policies, but do have significant and quickly growing "e-service" industries.
- The third tier includes large and increasingly "e-ready" economic powerhouses: *India (46th),* China (52nd), and Russia (55th). In 2003 India was also at 46th place, above Russia (48th) and China (50th). If it were not for the entry of four new countries in the 2004 rankings, India would have moved up four places!
- In the fourth tier (56th through 64th places) is a cluster of markets in which Internet services are struggling. The occasional bright star does arise, as is evidenced by the success of Vietnam's software development industry.

*Digital Access Index.* The International Telecommunication Union (ITU) unveiled the Digital Access Index (DAI) (ITU 2003), which ranks ICT access for 178 countries. The DAI distinguishes itself from other indexes by including a number of new variables, such as education and affordability. Countries are classified into four digital access categories in the DAI: high, upper, medium, and low.

Table 5-1 shows the following:

- Sweden leads the DAI, and Korea comes in fourth. Apart from Canada, which is ranked tenth, the top ten are all Asian and European countries. The United States holds eleventh place. All these countries are placed in the "high-access" category.
- Brazil, Poland, and Russia are classified in the "upper-access" category. Other countries in this category include those that have been using ICTs as development enablers. Positive government policies have helped them reach an impressive level of ICT access; this has been the case for Dubai Internet City in the United Arab Emirates (the highest-ranked Arab nation), the Multimedia Super Corridor in Malaysia (the highest-ranked developing Asian nation), and Cyber City in Mauritius (along with Seychelles, the highest-ranked African nation).

**Table 5-1: Digital Access Index, Various Countries, 2002**

| | |
|---|---|
| 1. Sweden | 0.85 |
| 2. Denmark | 0.83 |
| 3. Iceland | 0.82 |
| 4. Korea | 0.82 |
| 5. Norway | 0.79 |
| 6. Netherlands | 0.79 |
| 7. Hong Kong, China | 0.79 |
| 8. Finland | 0.79 |
| 9. Taiwan, China | 0.79 |
| 10. Canada | 0.78 |
| 11. United States | 0.78 |
| 12. United Kingdom | 0.77 |

*Note:* On a scale of 0 to 1, for which 1 = highest access.
*Source:* ITU (2003).

- *India is classified in the "middle access" category* and lags behind China, showing that it needs to do more to join the ranks of countries that have been using IT as a lever for enhancing overall development, not just in a few pockets of development.

*Information Society Index:* The Information Society Index (ISI) in 2004 measures the abilities of 53 nations to participate in the information revolution (see http://www.idc.com/groups/isi/main.html). The ISI combines 15 variables in four infrastructure "pillars" to calculate and rank each nation's ability to access and utilize information and IT. In much the same way that GDP measures a country's economic wealth, the ISI measures its information capacity and wealth. The four pillars are:

- *Computers.* This pillar looks at the basic building blocks of information society by measuring the number of PC households, IT spending as a percentage of GDP, software spending as a percentage of total IT spending, and IT services spending weighted against GDP.

- *Internet.* The Internet is a key factor in development of an advanced information society. This pillar factors in the number of Internet users within a country, percentage of users with Internet access at home, number of mobile Internet users, and e-commerce spending.
- *Telecoms.* To understand better how each society accesses information, this pillar measures variables related to broadband adoption, wireless services, and mobile handset shipments.
- *Social.* Social factors provide the glue that enables society to fix onto advantages offered by innovation. This pillar evaluates a society's ability to utilize information technology by measuring education, civil liberties, and government corruption.

In the 2004 rankings, Denmark was in first place, followed by Sweden. The United States, Switzerland, and Canada rounded out the top five. The top Asian country is Korea, in eighth place. Brazil took 38th place, Russia 41st, China 44th, and *India 51st.* In terms of the component rankings, India ranked 51st on computers, 53rd on telecoms, 43rd on the Internet, and 51st on social indicators. In contrast, the component rankings for China were 46th for computers, 39th for telecoms, 38th for the Internet, and 48th for social indicators.

*E-readiness assessment of Indian states.* The above indexes provide a glimpse of India's ranking on the global stage. The recently released report *India: E-Readiness Assessment Report 2004 for States/Union Territories*[46] differs from the others by looking at the level of e-readiness of various Indian states. The report classifies Indian states into the following categories:

- *Leaders.* Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, and Chandigarh.
- *Aspiring leaders.* Kerala, Gujarat, Goam Delhi, Punjab, and Haryana.
- *Expectants.* West Bengal, Pondicherry, and Madhya Pradesh.
- *Average achievers.* Uttar Pradesh, Chattisgarh, Orissa, Sikkim, Himachal Pradesh, and Rajasthan.
- *Below average achievers.* Mizoram, Jammu and Kashmir, Assam, Meghalaya, Uttaranchal, and Jharkhand.
- *Least Achievers.* Lakshadweep, Manipur, Tripura, Arunachal Pradesh, Andaman and Nicobar Islands, Bihar, Daman and Diu, Dadra and Nagar Haveli, and Nagaland.

ICT infrastructure and ability to use it is clearly strongly dispersed across Indian states. Some states in India, such as Andhra Pradesh, have made notable strides in using ICTs for their development. Among the leaders, Tamil Nadu has improved its e-readiness in the past year by consciously working on the environment, especially involving the private sector in development of ICT infrastructure and introducing ICTs in state-level policies. Among aspiring leaders, Kerala has used the competitive advantages of the state (high proportion of literacy, and awareness of citizens) to "pole vault" in the usage segment, and Gujarat has tried to replicate its success in industry segments, such as petrochemicals and chemicals in the ICT sector. Among the expectant category, Madhya Pradesh's ascent is notable and largely due to private sector involvement in developmental activities (for example, in e-Choupal). In all cases, these Indian states have made the progress due to leadership, connectivity, availability of skilled manpower, increased private sector development, and creation of institutional mechanisms with sustainable impact.

[46] For more information, including the methodology, refer to India, Ministry of Communications and Information Technology, and NCAER (2004b).

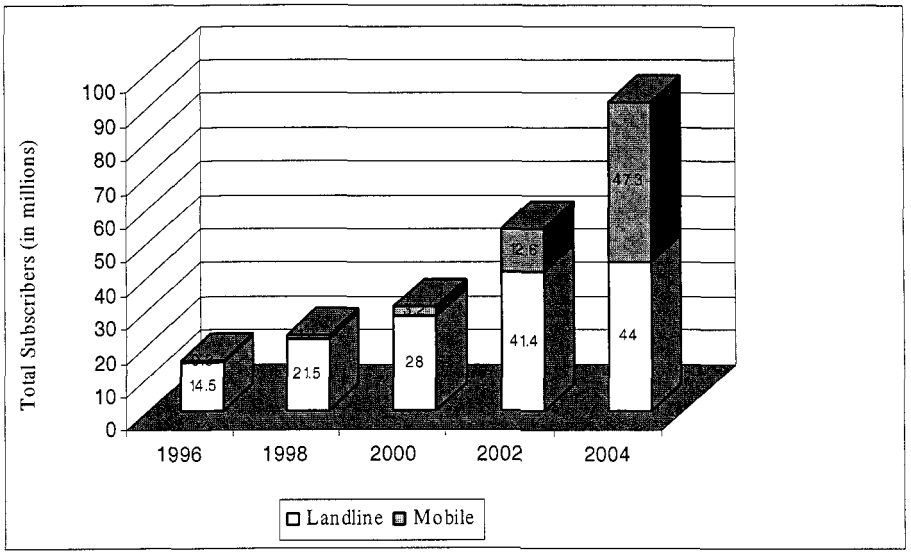
## Issues and Recent Developments in the Telecommunication and IT sectors

It is clear that developing countries must invest in building their information infrastructure. This includes not only developing the basic telephone and telecommunications services, but also ensuring that these services are provided at the lowest cost, as well as promoting the application of ICTs to facilitate improvements in the efficiency of the delivery of economic and social activities. Furthermore, as the application of ICTs becomes even more important for economic growth and increased social welfare, special attention must be given to new investments in upgrading the skills and competencies of workforces to use ICTs.

Even though this chapter has so far shown that India has a way to go in developing its information infrastructure to reach advanced country standards, the country nonetheless has recently had some impressive achievements. This section reviews recent developments in the India's telecommunications and IT sectors.

*Scaling up telecommunications.* The number of fixed and mobile subscribers in India has increased greatly, especially in the past four years (Figure 5-5). In fact, the number of mobile subscribers has now surpassed the number of fixed lines (or landlines). From 1998 to 2004, mobile subscribers increased from 1.2 million to 47.3 million, and fixed line (or landline) subscribers from 21.5 million to about 44 million.[47] This growth has resulted in a total teledensity in India from 10.7 per 1,000 people in 1995 to 71 per 1,000 people in 2003 and 87 per 1,000 people in 2004 (Figure 5-6). The growth in the mobile market is likely to be sustained in the next few years as the number of subscribers is expected to top 100 million, whereas the market for landlines continues to grow at a more conservative pace.

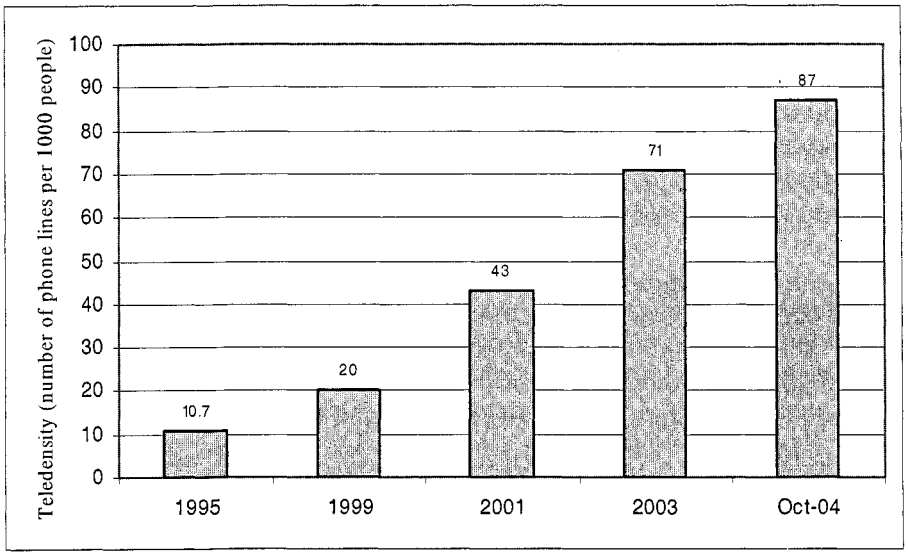
**Figure 5-5: Growth of Telephony in India: Numbers of Landline and Mobile Subscribers, 1996–2004**




*Source:* Abraham (2005).

[47] For more information, see http://sify.com/finance/fullstory.php?id=13645428; http://news.bbc.co.uk/2/hi/business/3994761.stm; and ITU at http://www.itu.int/ITU-D/ict/statistics/.

**Figure 5-6: Teledensity in India, 1995–2004**




*Source:* Abraham (2005).

*Developing a new broadband policy.* The Indian government, in keeping pace with up-to-date technological advancements, announced its Broadband Policy in 2004, to give impetus to broadband and Internet penetration in the country. Prime considerations guiding the policy include affordability and reliability of broadband services, incentives for creation of additional infrastructure and employment opportunities, introduction of the latest technologies, and encouragement of a competitive environment in order to reduce regulatory interventions. The policy sets a goal of three million broadband subscribers and six million Internet subscribers by December 2005 and 20 million broadband subscribers and 40 million Internet subscribers by the end of year 2010. The new policy encourages creation and growth of infrastructure through various coexisting access technologies, such as optical fiber technologies, digital subscriber lines on copper loop, cable TV network, satellite, and terrestrial wireless technologies.[48]

*Reforming telecommunications.* In spite of impressive progress in the telecommunications landscape in India, the reform agenda is still unfinished. Important areas that continue to need attention include the following:

- *Completion of full unified licensing.* This involves development and implementation of a second stage of the unified licensing regime, which would extend to all telecom services.
- *Tariffs and network interconnection.* Tariff rebalancing and terms of network interconnection need continued attention.
- *Rural connectivity digital divide.* As the telecommunications sector moves quickly to a more commercial and competitive environment, the government needs to review and develop policies regarding service needs of rural areas of India, including those groups who are not well served by the market. This issue will be discussed in some length later in this chapter.
- *Strategy to accelerate Internet and broadband use.* This strategy is in line with the government's broadband policy highlighted above to accelerate growth of the Internet and broadband penetration in the country (World Bank 2004g).

[48] For more information, see India, Ministry of Communications and Information Technology (2004a).

*Creating global niches in IT.* India's IT sector can boast of remarkable and impressive global achievements. The prediction that India will dominate IT work in the developed world, just as China and other East Asian countries commandeered manufacturing, is becoming a reality. Companies such as TCS, Wipro, Infosys, HCL Tech, and Satyam topped the list of India's IT services firms in 2004 in terms of total revenues *(The Economist* 2004b). In 2004 Infosys ranked as the ninth most respectable IT company in the world, behind Hewlett Packard, IBM, Dell, Microsoft, SAP, Cisco, Intel, and Oracle (Merchant 2004). As a result, Bangalore[49] and, more recently, Hyderabad, Chennai, Mumbai, and Pune are emerging as competitive IT hubs in the country.

According to NASSCOM, the Indian IT market overall has grown from $1.73 billion in 1994–95 to $19.9 billion in 2003–04, accounting for more than 3 percent of India's GDP in 2003–04. India's IT software and services exports recorded revenues of $12.5 billion in 2003–04. The domestic market, on the other hand, accounted only for $3.4 billion in 2003–04.

Several factors have contributed to India's success in the IT industry, including the existence of a highly skilled, English-speaking workforce graduating from India's engineering schools and earning lower wages than European and U.S. counterparts, low dependence of IT on physical infrastructure, the Indian Diaspora, and introduction of current account convertibility and easing of controls and regulations in the early 1990s. The IT industry in India has looser labor regulations and less corruption and bureaucracy, arguably, because it developed without government intervention!

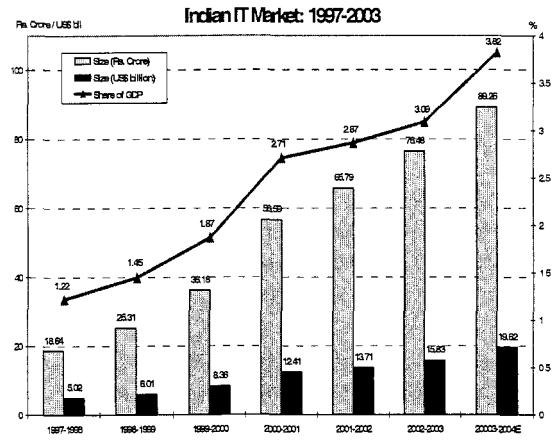
Box 5-1 provides information on the recent status of India's IT market and the software and services industry. Software and services exports continue to remain on top of the IT industry's revenue table. Major long-term projects in the export-driven software sector have come into India, and Indian companies have been taking on an increasingly larger share of the global outsourced business. In terms of software services delivery, in 2002–03, offshore project revenues grew by 49 percent compared with on-site revenues. In terms of geography, Indian ICT companies have begun tapping into regions outside the U.S. market, which remains the largest user of software solutions from India. Revenue contributions by the U.S. market continued to rise due to the large number of ITES/ BPO projects outsourced to India. Looking ahead, some of the key service lines for Indian companies continue to be custom application development and maintenance, applications outsourcing, ITES, and R&D services.

Although, on the one hand, India is reaping tremendous revenues from continuing to expand provision of distance services globally, on the other hand, the high fees garnered from providing foreign IT services preempts Indian companies from developing ICT applications to meet domestic needs. Domestic demand accounts for less than one-fifth of the IT turnover, which highlights the potential and urgent need for developing IT applications for the domestic market. This is a major issue for India, as it strives to transform itself into a knowledge-based economy.

[49] For more information, see the official Web site of the Department of IT and Biotechnology, Government of Karnataka at http://www.bangaloreit.com/.

**Box 5-1: Snapshot of the Indian Information Technology Market and Software and Service Industry**

**Figure a: Indian IT Market, 1997–2003** **Figure b: Indian Software and Service Industry, 2002–04**



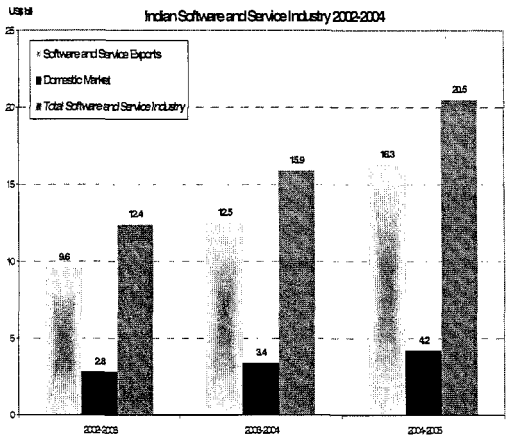




Figure a shows the evolution of the Indian IT market in 1997–2003. The market has been increasing by leaps and bounds, and the IT industry is estimated to contribute to 3.82 percent of India's GDP in 2003–04, compared with 1.22 percent in 1997–98. Thus, India's IT sector has defied predictions that it would never outgrow "body shopping"—simple, low-cost software fixes done at the client's site. Indian software companies have proven themselves and gone on to win bigger, longer-term, and more demanding contracts that they have fulfilled on time, on cost, and with high quality, thus reinforcing and cementing their dominant position in the world.

Figure b shows total revenues of the Indian software and services industry in 2003–04 of $15.9 billion, including domestic revenues of $3.4 billion. The Indian software and service industry is likely to grow to $20.5 billion in 2004–05, with domestic market revenues of $4.2 billion. Indian software and services exports registered a growth of 30.5 percent in 2003/04, clocking revenues of $12.5 billion, and are likely to witness a 30–32 percent increase to reach revenues of $16.3 billion in 2004–05. North America, which accounts for more than 55 percent of global IT spending, represented approximately 70 percent of Indian software exports in 2003–04; Europe ranked second at 22.25 percent of total exports. North America remains the dominant market for ITES-BPO services, accounting for more than 80 percent of ITES-BPO business in India.

Some initiatives to make India a sustainable hub for ITES should include instituting single window clearances for the ITES industry, such as call centers, tele-education, telemedicine, and telemarketing; ensuring ease of operations and start-up assistance for ITES units through support from local authorities and state governments; setting up degree-level courses for ITES industry as well as ITES training infrastructure, and involving industrial training institutes and polytechnics for call center management; creating an "India Brand" marketing fund for promoting India as a preferred destination for the ITES sector; and establishing a suitable venture capital fund and developing special incentives to promote entrepreneurship and teleworking, especially for women in this sector.

*Sources:* NASSCOM (http://www.nasscom.org), NASSCOM's IT Industry Factsheet 2004 (http://www.nasscom.org/download/IndianITIndustryFactsheet.doc), and India, Planning Commission (2002c).

*Moving up the value chain.* India's IT services are moving up the value chain, and India is undertaking new and innovative work, such as management for clients of IT-related business processes. At present, call services and IT-enabled services (back-office operations, remote maintenance, accounting, public call centers, insurance claims processing, medical transcriptions, insurance claims, legal databases, digital content development, online education, data digitization/GIS, payroll/human resource services, and other bulk standards processing), which use cheap labor and do not require knowledge for software engineering, are expanding rapidly in India, and have substantial potential to generate wealth and create

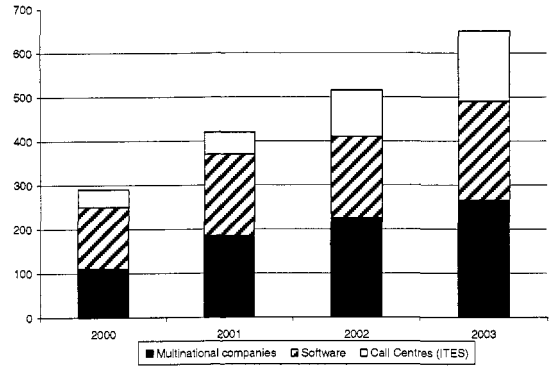
employment opportunities. As an example, Indian companies are offering back-office services to firms that do not want to set up their own Indian operations. Daksh.com near Delhi answers questions from customers of Amazon, the biggest online retailer, mainly by e-mail. One of the first big online travel agencies, e-bookers, uses a call center in Delhi to provide round-the-clock service for offices in Europe. Large global systems integration companies, such as IBM Global Services, are also relocating work and expanding their presence in India to take advantage of the country's cost and manpower strengths.

In addition, India is also increasingly making an impact in IT consulting: companies such as Wipro, Infosys, and Tata are managing U.S. IT networks and reengineering business processes. In chip design, Intel and Texas Instruments, for example, are using India as R&D hubs for microprocessors and multimedia chips (Kripalani and Engardio 2003). Indians themselves are also investing abroad. According to NASSCOM, the Indian software industry has recently made cumulative investments of $350 million abroad, most of it in the United States *(The Economist* 2003b). The success of the IT industry on the whole influenced competitiveness in other sectors as well by building confidence in Indian industry, enhancing the country's brand equity in the world and offering entrepreneurial opportunities on a global scale. In the future, it is expected that India will make inroads in financial analysis, industrial engineering, analytics, and drug research.

*Expanding employment in the IT industry.* The IT industry in 2000–03 created employment opportunities for almost 700,000 people in India (

Figure 5-7). NASSCOM more recently estimates that by the end of fiscal 2005, the number of people employed in India's outsourcing industry will have reached one million (Associated Press 2005). Some of the biggest U.S. employers in India in 2003 were GE Capital Services (conducts back-office work with 16,000 people), GE's John Welch Technology Center (conducts product R&D with 1,800 people), IBM Global Services (provides IT services and software with 10,000 people), Oracle (provides software and services with 6,000 people), Electronic Data Systems (provides IT services with 3,500 people), Texas Instruments (designs chips with 900 people), Intel (designs chips and software with 1,700 people), and J. P. Morgan Chase (conducts back-office work and analysis with 1,200 people) (Kripalani and Engardio 2003).

**Figure 5-7: Employment in the Indian Information Technology Sector, 2000–03**
*(thousands)*



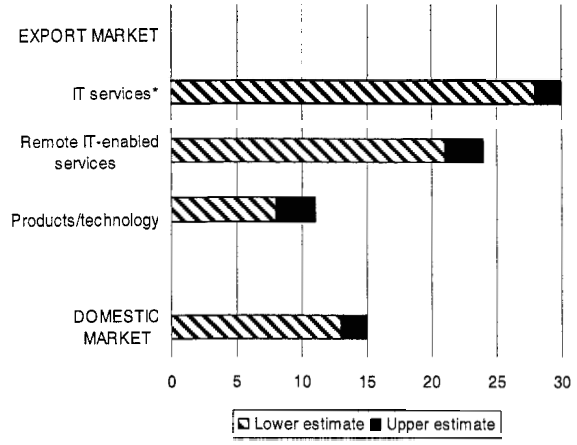

*Note:* Years shown end in March.
*Source:* Based on chart in *The Economist* (2003c).

*Contributing to economic growth.* Various forecasts have been given on where India's IT industry is heading. According to WEF's *Global Information Technology Report 2002–2003* (WEF 2003), India's IT industry is expected to grow at a compounded annual rate of 38 percent to reach $77 billion by 2008,

contributing to 20 percent of India's anticipated GDP growth in this period and 30 percent of its foreign exchange earnings. By that year, it is also expected to employ more than 2 million people and indirectly create another 2 million jobs (WEF 2003; "India's Shining Hopes" 2004). McKinsey forecasts that by 2008, IT services and back-office work in India will swell to a $57 billion annual export industry employing 4 million people and accounting for 7 percent of India's GDP.

Figure 5-8 shows the projected status of India's IT industry in 2008. The infrastructure needed for a growing knowledge economy must accompany this growth. One cannot have a successful IT industry when every company has to build its own infrastructure. In Bangalore, for example, many companies have created their own walled enclaves with their own electricity, bus service, telecommunications, and security (Friedman 2004)!

**Figure 5-8: India's Projected Information Technology Industry, Export and Domestic Markets, 2008**
*(billions of U.S. dollars)*



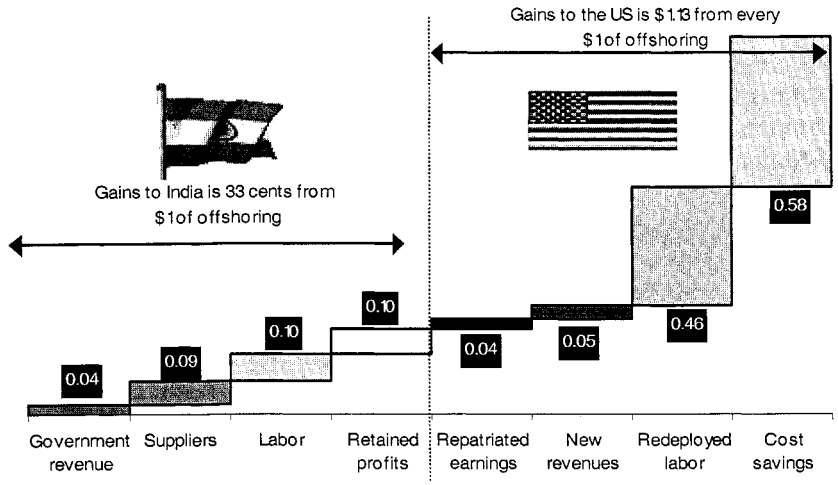

* Application maintenance, systems integration, support.
*Source:* Based on chart in *The Economist* (2004d).

*Growing trend towards offshoring to India.* India was in the news in 2004, especially in the United States, because in addition to being a leading supplier of IT services, its exports of BPO services have also been growing rapidly. Such services have arisen from the outsourcing (or out-location) of noncore business processes throughout the value chains of both manufacturing and services industries. The business practice of offshoring has been enabled worldwide by two main changes in the business environment. First, the improvement in international telecommunications capacity and the concomitant reduction in global telecommunications costs are fundamental to the economics of offshoring. Second and just as important, in the past two decades, personal computers have enabled the computerization and digitization of most businesses services. As a result, information can now be transmitted across long distances at low cost and with little loss of quality. These changes make organizational boundaries and national borders much less important in deciding the location of service functions.

The incentive for companies, especially from the United States, to outsource operations to India is based not only on labor cost savings (estimated to be between 30 percent and 60 percent), but also on reaping productivity gains (estimated as ranging from 15 to 25 percent). Destination countries such as India also see increased investment and job creation through offshoring. But it is important to note that this outsourcing benefits both India and the United States, as demonstrated by a 2003 study by McKinsey Global Institute (Figure 5-9). Of the $1.45–$1.47 of value McKinsey estimates is created globally for every dollar that a U.S. company chooses to divert abroad, the United States captures $1.12–$1.14,

whereas the receiving country, such as India, captures on average 33 cents. In other words, the United States captures 78 percent of the total value.

**Figure 5-9: Gains from Offshoring $1 of Services from the United States (Source) to India (Host)**




*Source:* Adapted from McKinsey Global Institute (2003) in World Bank (2004i).

Despite the current controversy surrounding this phenomenon, offshoring will allow the United States to capture economic value through multiple channels:

- *Reduced costs.* Savings from reduced costs means more savings, which can be passed to consumers or investors to reinvest.
- *New revenues.* Offshoring creates demand in destination countries for U.S. products, especially for high-tech items.
- *Repatriated earnings.* Several providers serving the U.S. market are incorporated in America, which means they repatriate their earnings back to the United States.
- *Redeployed labor.* U.S. workers who lose their jobs to offshoring will take up other jobs, which will in turn generate additional value for the economy.

*Emerging possibilities for e-commerce.* The "e-commerce" market in India has a long way to go, but is already helping to fuel competition and offering new opportunities to businesses and consumers. The Internet scenario in India has improved vastly in recent years, thanks to improving telecommunications infrastructure, better bandwidth availability, multiplicity of Internet service providers, and relatively cheaper computer hardware than previously. A major jump is still required, however, before India can achieve "anytime-anywhere" connectivity and the stage at which enhanced Internet penetration translates into high volumes of online transactions. E-commerce could flourish if India installed appropriate policies to ensure competitive pricing of Internet services and provided an appropriate regulatory environment and legal infrastructure to deal with online transactions.

Table 5-2 presents Internet usage patterns in India from a recent study by NASSCOM. The study showed that about 64 percent of users surf the Internet for 0.5–2 hours a day. On a work day, about 29 percent of users access the Internet from their workplace. At present, the Internet is used primarily for accessing e-mail and users are reluctant to make online purchases. Nonetheless, everyone from Yahoo, Microsoft, and IBM to local carpet vendors, hotels, and Indian ISPs are trying to claim a slice of the rapidly emerging Indian e-commerce market (NASSCOM 2003 and 2004b and The Asia Society 1999).

**Table 5-2: Internet Usage Pattern in India in 2002**
*(percent)*

| *Uses* | *Users* | *Time* |
|---|---|---|
| E-mail | 90 | 35 |
| Information | 50 | 9 |
| Chat | 43 | 9 |
| Education/academic information | 41 | 11 |
| Downloads | 38 | 6 |
| Music/movies/entertainment | 27 | 4 |
| Jobs | 23 | 4 |

*Source:* NASSCOM (2004b), chapter 8.

As borne out by NASSCOM's *Strategic Review 2004* (2004b), e-commerce activity in India is thus currently at a very nascent stage. The speed at which e-commerce can be adopted by various industries in India will depend on the current industry structure, supply chain characteristics of the industry, and current IT adoption within the industry. Among Indian industries, automotive and consumer goods are expected to lead e-commerce activity. India is expected to have an Internet user base of 52 million by 2005. Despite this, the Internet is unlikely to become a key sales channel in the near future due to cultural factors and current convenience in offline trading. According to NASSCOM's *Strategic Review 2003,* Indian business-to-consumer spending in 2002 is estimated at about Rs. 380 million. Travel is emerging as the fastest-growing category for business-to-consumer transactions and accounted for about 23 percent of transactions during 2002. Indian Railways and domestic airlines are launching the online sale of tickets; this segment is expected to account for a large proportion of business-to-consumer transactions in the near future. With a large base of mobile phone users, the potential for mobile applications—also called m-commerce—is huge.[50] Business-to-business transactions are increasingly expected to dominate total transaction volumes in the near future. This will, however, require greater investing in the telecommunications infrastructure as well as addressing issues related to intellectual property rights and legal protections for commerce via the Internet.

E-commerce faces a number of challenges in India. India is still in the main plagued by low PC penetration, high cost of Internet access, lack of hardware, and low telephone penetration. As far as e-commerce is concerned, a big problem relates to the use of credit cards and resulting security issues. The relatively small credit card population and lack of uniform credit agencies create a variety of payment challenges unknown in advanced countries such as the United States. Although the cyber-environment in India has improved thanks to the IT Act 2000, which regulates e-commerce on the Internet and makes e-commerce, online transactions, and digital signatures legally valid, more needs to be done to create a

[50] "M-commerce" includes application services that can be accessed by a user on a mobile phone (such as checking bank accounts, paying bills, and transferring funds). According to Merrill Lynch, short message service (SMS) could bring in as much as $75 million in revenues for Indian GSM (Global System for Mobile Communications) operators by 2005. An emerging trend in the Indian m-commerce market is integration of service providers with web portals. For instance, Hutch has a tie-up with Yahoo, which allows Hutch users to check their e-mail on Yahoo through their mobile phones; thus, WAP (wireless access protocol)–enabled applications are beginning to pick up their pace in the Indian market.

The m-commerce market in India is still in its infancy compared with the United States and Europe. High-value transactions, which involve credit and debit transfers, point-of-sale terminals, merchant terminals, and so on have not found widespread application in India. One of the major hurdles facing growth of m-commerce applications is the lack of steadiness in terms of technology and security. Two competing standards, namely WAP and SIM (subscriber identity module) are being used for mobile data applications. No commerce-capable cellular networks exist that can guarantee secure transactions in real time. This requires a considerable amount of coordination among the different parties involved in the entire m-commerce value chain, such as wireless infrastructure providers, service providers, certifying authorities, application or software providers, equipment manufacturers, credit card companies, and banks. Furthermore, m-commerce applications will not proliferate until high-bandwidth networks are deployed and wireless service providers cooperate with each other.

conducive environment for online business. Other factors that impede the growth of e-commerce in India include the following:

- Poor telecommunications infrastructure, including cost of hardware and unreliable Internet connection
- High telecom costs on dial-up charges as a barrier to growth
- Limited Internet access among customers and small businesses
- Lack of payment gateways for secure transactions on the Internet
- IT systems and processes unprepared for e-commerce activities
- Logistical difficulties, such as insufficient transport networks representing a serious hurdle to business-to-business development, because they make it difficult for companies to realize potential gains of increased efficiency in their supply chain
- Uncertainty of return on investments, for example, some Indian companies find returns on investments in e-commerce initiatives hard to justify, and many do not see any urgency to entering this area due to lack of competitive pressures.

**Measures to Strengthen the Information Infrastructure**

The above discussion has underlined the ways in which the Indian telecommunications sector has been quickly moving to a more commercial and competitive environment and the IT industry is moving on to greater heights. As this happens, the government also needs to establish and implement practical policies to develop IT skills in the workforce, reorient strategies in the IT industry to sustain growth, enhance the reach of IT to groups that are not well served by the market (i.e., bridging the "digital divide"), increase ICT applications throughout the economy, and usher in rural development through connectivity.

*Develop IT skills in the workforce.* One of the key inputs to achieving sustained growth and exports in the IT sector is the availability of adequate numbers of high-quality professionals. For continuous growth in this sector, India needs to maintain and enhance its competitive advantage of abundant, high-quality, and cost-effective human resources. The country needs to ensure the right mix of technical, business, and functional skills in the workforce to meet the needs of individual business segments and customer markets, which requires harmonization between the demand of the industry and the supply of trained manpower by Indian educational and training institutions.

India produces some 120,000 graduates in IT a year, from a variety of institutions, such as the newly launched Indian Institute of Information Technology in Bangalore, a new-generation graduate school focusing on all aspects of IT. Even though around one million people are employed in India's IT sector, the country could face an estimated shortage of anywhere between 65,000 to 530,000 IT professionals by 2005, depending on market conditions. Indian software companies are also increasingly concerned with the risk of brain drain, as worldwide competition for knowledge workers intensifies and India risks losing its best and brightest. For the first time, India is looking over its shoulder at China, which could become a competitor, initially at the low end of the market. India has an edge in English and experience, but the Chinese are learning quickly. Despite the slowdown, India may not produce enough good engineers and IT professionals to meet the expected growth in IT in coming years. The need exists, therefore, for rapid expansion of suitable training opportunities at home. Given the extent of demand for IT skills, many private IT training institutes offering IT-focused training have sprung up in India, such as NIIT and the Internet Training Centre Initiative for Developing Countries, developed by the ITU and Cisco systems (Box 5-2). Many large companies, such as Infosys, have also developed their own training infrastructure to ensure that they deliver good quality services to their clients.

**Box 5-2: Information Technology Training Initiatives in India**

NIIT offers the gamut of computer training for individuals and organizations from entry-level IT literacy programs to advanced courses on state-of-the-art technologies. According to its Web site, in the past 20 years, NIIT has trained 2 million students throughout the world in IT. NIIT provides on-site, "anytime-anywhere" training to customers across India through its extensive network of centers. Its training facilities are equipped with state-of-the-art infrastructure. NIIT provides on-the-job or project-based training, in which a mentor assists specific participants, while they use the technology on a sample NIIT project. NIIT thus customizes training programs to suit the requirements of different customers, enabling achievement of higher productivity in the workplace. NIIT has worked to date with major public and private sector organizations, such as the Indian Directorate of Income Tax, Indian Army, and Indian Navy. Private and IT companies include Hindustan Levers, Ranbaxy, Tata Steel, Pfizer, Maruti Udyog, Ericsson, and Coke India. Banks and insurance companies include the Reserve Bank of India, State Bank of India, and the Life Insurance Corporation.

ITU and Cisco Systems have developed an *Internet Training Centre Initiative for Developing Countries*. The initiative, a model for public-private partnership to bridge the "digital divide," now has more than 26 centers worldwide. The 800-plus students currently enrolled in this initiative are now armed with skills to face the challenge of the new economy. In Asia, eight centers exist in China, India, Indonesia, Malaysia, Maldives, Philippines, and Samoa. The centers provide affordable and relevant training and education to students in developing countries using both face-to-face and web-based curricula. Through the Cisco Networking Academy Program, Cisco Systems provides all ITU Internet Training Centers with hands-on coursework designed to teach students the skills needed to design, build, and maintain small- to medium-sized IP-based networks

*Source:* NIIT (http://www.niit.com) and Cisco Systems (2002).

India thus needs to put in place suitable human resource development initiatives, starting at the primary school and moving on to tertiary levels to meet the needs of the IT and other productive sectors of the economy. This includes the following:

- Continuously upgrading of basic standards of education at the secondary school level with enhanced emphasis on physics, mathematics, and English
- Updating syllabuses in computer engineering, electronics, and IT in various technical institutions to meet the demands of industry (curricula in other branches of engineering should also be broadly based to include IT subjects)
- Upgrading the skills of teaching faculties and introducing teaching aids, such as computers, videos, access to the Internet, videos, and so on
- Strengthening postgraduate education and innovative research in IT to maintain quality standards to face new challenges in this dynamic sector
- Augmenting RECs (now to become NITs) and other notable engineering colleges under deemed universities to the level of IITs, so the country has a critical mass of such institutions by the end of the Tenth Five-Year Plan to meet the requirements of quality manpower.

*Reorient strategies in the IT industry.* Although India has earned well-deserved recognition in the international sphere in the IT and software development area, to have sustained growth, strategies must be reoriented, especially as the industry is being threatened by emerging competitors, such as China, Philippines, Korea, and the Commonwealth of Independent States countries. A recent McKinsey study of China's software sector, however, shows that China needs to work on several fronts before it can truly compete with India (Box 5-3).

**Box 5-3: Can China Compete in Information Technology Services?**
Chinese revenues from IT services are barely half of India's $12.6 billion a year. A recent study by De Filippo, Hou and Ip (2005) notes that, to move forward in this domain and compete with India, China must first consolidate its highly fragmented industry to gain the size and expertise needed to capture large international projects. Growth is driven mainly by domestic demand, and most customers are small and mid-sized Chinese enterprises. China's nascent foreign software–outsourcing business accounts for just 10 percent of the industry's total revenue, compared with around 70 percent for India. In addition, despite lower costs, operating margins in Chinese software services companies average only 7 percent, compared with 11 percent at similar companies around the world, because many projects are below optimal scale, suppliers often compete on price and collecting payments can be problematic.

To compete effectively in global outsourcing, therefore, China's software industry must consolidate. The top ten IT-services companies have only about a 20 percent share of the market, compared with the 45 percent commanded by India's top ten. Furthermore, China has about 8,000 software services providers; almost three-quarters of them have fewer than 50 employees, and only five have more than 2,000 employees. India, on the other hand, has fewer than 3,000 software services companies. Of these, at least 15 have more than 2,000 workers, and some—including Infosys, Tata Consultancy Services, and Wipro—now have international recognition and global clientele. Fragmentation exacerbates the Chinese industry's other problems, including weak process controls and product management. Only six of China's 30 largest software companies are certified at levels five or four of the capability-maturity model; in contrast, all the top 30 Indian software companies have achieved these rankings. Chinese software services providers will also have to manage their talent much better. Most do little to develop their employees, and very few use stock options, training programs, or other incentives to build talent. Organizational and operational changes are also needed to protect the intellectual property of clients.

*Source:* De Filippo, Hou, and Ip (2005).

Nevertheless, India cannot afford to be complacent about its current position in the global IT market. Its domestic market in particular needs to be developed and catered to effectively to ensure sustained long-term growth and provide benefits to the masses. The experience of countries, such as China, which have very strong and vibrant domestic markets, should be considered. The Indian industry, however, needs to improve productivity continuously to hold its competitive edge in the global market. Some issues that require constant attention by India's IT industry include:

- Moving up the value chain by developing high-value products through R&D, improving the quality of products and services, and nurturing and generating the high-quality manpower needed for this.
- Focusing the industry to shift from "software solutions providers" to become manufacturers of "packaged products."
- Marketing its products and building brand equity to position further the "India" brand name abroad. This requires strengthening marketing channels with strategic global links, expanding the focus outside the United States to emerging markets in Asia, Pacific, Japan, and so on.
- Encouraging industry associations, such as NASSCOM and the Manufacturers' Association of Information Technology, to provide support to SMEs in their export efforts, because these enterprises do not have the requisite expertise and resources required for aggressive marketing.
- Promoting the development of software applications for the domestic market in different Indian languages to meet local requirements (India, Planning Commission 2002c).

*Enhance the reach of IT to the population at large.* As a result of the IT explosion and the impressive progress in the telecommunications and ICT sector showcased above, the usage of ICTs has, not surprisingly, been rising in the country. But this increase has mainly been concentrated in urban areas in the country, not so much rural. Village information kiosks, however, are gradually enhancing the reach of ICTs to a larger section of the population (Box 5-4).

**Box 5-4: Bridging the Digital Divide: Village Internet Kiosks in Tamil Nadu**
IIT-Madras is pioneering an approach in Tamil Nadu that is turning over the job of connecting rural India to the Internet to profit-minded entrepreneurs. This new approach seeks to bridge the "digital divide" with a national network of owner-operated computer centers with Internet access—part cybercafes, part digital town halls—that earn income from a broad range of small transactions. It takes advantage of low-cost wireless technology that eliminates the need for telephone lines. Central to the effort is the "wireless local loop" (WLL), which provides cheap, relatively fast Internet connections to fiber-optic cables as far as 18 miles away. Although many villages still lack phone service, India's fiber-optic network is sufficiently well developed to provide wireless coverage for up to 85 percent of the country. An independent company that spun off from this IIT, n-Logue Communications, identifies promising kiosk owners, trains them, and provides equipment—computer, printer, battery backup, and wireless Internet antenna—for about $1,000. N-Logue helps the owners arrange financing, which is then paid off with revenue from the kiosks. The company makes its money from hourly connection fees. So far, n-Logue has set up more than 500 kiosks in Tamil Nadu and other states and has plans for another 10,000 in the near future.

*Source:* Excerpted from Lancaster (2003).

Ensuring the sharing of ICT benefits among all will be critical to boost India's growth and poverty reduction efforts. This requires creation of an enabling environment for ICTs. Critical factors include increased *(a)* access to ICTs (through widespread availability of telephones, PCs, and mobile telephones and connectivity to the Internet), *(b)* enhancement of ICT literacy and skills in the population, and *(c)* development of ICT applications providing much-needed services to citizens:

- *Access.* Due to high tariff levels (30–40 percent of basis cost of an assembled PC), the cost of PCs and other hardware in India is significantly higher than in other countries. For example, a PC in India costs about 24 months of average per capita income, compared with 4 months in China and 12 days in the United States! But the rapid growth of software exports has attracted thousands of people into the IT industry and has stimulated demand for computers. Sales of computers rose by 9.6 percent to 1.76 million in 2001. Import liberalization and the entry of foreign manufacturers have transformed this industry, which, until five years ago, was tiny and dominated by a few Indian manufacturers. The ease of importing components has nurtured hundreds of unbranded assemblers, which command 62 percent of the market. Only three major Indian brands remain. HCL sold 151,000 computers in 2001, Wipro sold 65,000, and Zenith sold 64,000. Among foreign manufacturers, Compaq (147,000 units sold in 2001), Hewlett Packard (84,000 units), IBM (72,000 units), Dell (35,000 units), and Acer (18,000 units) have significant presence. After their recent merger, Compaq and Hewlett Packard have become the largest branded supplier (EIU 2003a). Although these developments are laudable, steps need to be taken to increase the reach of ICTs to the vast portion of the Indian population that is currently unserved through measures such as reducing tariffs and promoting the use of ICTs for domestic needs.
- *ICT literacy and skills.* These skills are critical to ensuring that people can derive benefits from the IT revolution. Although opportunities exist for acquiring the skills in urban areas (through government-sponsored programs to connect schools, private schools, and training institutes), the situation in rural areas is very different. Illiteracy; lack of access to ICT infrastructure and, where available, high cost of access; and lack of content prevent large rural populations from using ICTs. But some innovative technologies, such as Simputer (Simple Computer, a low-cost alternative to PCs) and corDECT (wireless access system integrating voice and Internet services),[51] can help to raise awareness of the potential of ICTs for rural areas.

[51] The key to bridging the digital divide is to have shared devices that permit simple and natural user interfaces based on sight, touch, and audio.

- *ICT applications.* ICTs can help to improve the delivery of social, economic, and government services to rural populations in a variety of ways in areas with the highest potential. ICTs are already enhancing transparency and efficiency of government operations, and progressive states such as Karnataka and Andhra Pradesh have made significant strides in using e-government applications to create an environment conducive to enhanced productivity.[52] Box 5-5 presents some examples of e-government applications in the country. ICTs are also being used for community development: the M. S. Swaminathan Foundation, for example, helped establish ICT-networked village knowledge centers based on the principle of ownership by local communities (for more information, see http://www.mssrf.org/).

**Box 5-5: Three E-Government Initiatives Hold Promise in India**
The following examples illustrate the kind of promising e-governance initiatives underway in India:

*Bhoomi: online delivery of land titles in Karnataka.* The Department of Revenue in Karnataka has computerized 20 million records of land ownership for 6.7 million farmers in 176 *taluks* (administrative unit under a district) in the state. Farmers previously had to seek out the village accountant to get a copy of the record of rights, tenancy, and crops, a document needed for many tasks such as obtaining bank loans, with accompanying delays, harassment, and bribes to be paid. Today, for a modest fee of Rs.15, a printed copy of this document can be obtained online at computerized land-record kiosks (Bhoomi centers) in 140 *taluk* offices. In the next phase, all the *taluk* databases will be uploaded to a web-enabled central database. The record of rights, tenancy, and crops would then be available online at Internet kiosks, even in rural areas. (See http://www1.worldbank.org/publicsector/egov/bhoomi_cs.htm and http://www.revdept-01.kar.nic.in/Bhoomi/Home.htm.)

*Land and property registration in Andhra Pradesh.* Land registration offices throughout Andhra Pradesh now operate computerized counters to help citizens complete registration requirements within an hour instead of several days, as was necessary under the earlier system. The lack of transparency in property valuation under the old system resulted in a flourishing business of brokers and middlemen leading to corruption. Antiquated procedures, such as manual copying and indexing of documents and their storage in paper form in ill-maintained backrooms, have all been replaced, showing the benefits of IT in improving citizen-government interface. (See http://www1.worldbank.org/publicsector/egov/cardcs.htm.)

*Empowering dairy farmers through a dairy information and services kiosk.* In recent years, the milk cooperative movement initiated by India's National Dairy Development Board has led to a substantial increase in milk production in India. Two main reasons for this increase are more efficient collection of milk and higher profits for producers, both of which have been influenced by IT. The milk buying process has been automated at 2,500 rural milk collection societies. The Dairy Information Services Kiosk makes it possible for cooperatives and farmers to manage a database of all milk cattle and access a dairy portal with information about valued services. This demonstrates the willingness of rural farmers to invest in technology, provided it can deliver real value (see http://www1.worldbank.org/publicsector/egov/diskcs.htm.)

*Source:* Author's research.

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- The Simputer meets these demands through a browser for the Information Markup Language (IML). IML has been created to provide a uniform experience to users and to allow rapid development of solutions on any platform. For more information, go to http://www.simputer.org.
- Jointly developed by Analog Devices, Midas Communication Technologies, and the TeNeT group of IIT Madras, corDECT is India's very own wireless local loop technology. Based on the Digital Enhanced Cordless Telecommunications standard specified by the European Telecommunications Standards Institute (ETSI), corDECT provides cost-effective, simultaneous high-quality voice and data connectivity in both urban and rural areas. This revolutionary new technology provides voice communication using 32 Kbps ADPCM, and Internet connectivity at 35/70 Kbps. For more information, see http://www.tenet.res.in/cordect/cordect.html.

[52] For more information, see Andhra Pradesh's portal at http://www.ap.gov.in, its Centre for Good Governance at http://www.cgg.gov.in, and its Department of IT and Communications at http://www.ap-it.com.

*Increase ICT applications.* Other noteworthy examples of ICT applications in India include the following:

- *Agricultural value chains and extension services that link farmers with end-market suppliers to increase value by better anticipating consumer demands and also raise upstream earnings.* The "E-chaupal movement," for example, is a program initiated by ITC, a private company that uses electronic kiosks to source agrocommodities across 18,000 villages in the country, reaching 1.8 million farmers. The electronic kiosks installed in villages enable a virtual aggregation of poor farmers' demand and supply needs by linking them to neighboring village agromarkets and providing them real-time information on prices. It thus connects rural farmers in order to procure produce such as soya, coffee, and prawns, allowing farmers to obtain information on market prices and good farming practices, place orders for inputs such as seeds and fertilizers, and negotiate the sale of their produce directly with ITC (for more information, see http://www.echoupal.com/default.asp).
- *Land titling systems that link rural landholders to a transparent system for verifying and updating tamper-proof land records.* These are then used by banks, courts, private organizations, ISPs, and development program formulation. An example is Bhoomi (Box 5-5).
- *Education and health management facilities that link rural students and patients with relevant information and techniques.* An example is allowing village health workers to interact online with expert systems to improve primary care. Drishtee, a private initiative to scale up Gyandoot-type rural information kiosks, is an effort in this direction, connecting rural citizens with government and private service providers, which allows citizens to send complaints to government regarding services such as health and water and provides computer education and e-health services (for more information, see http://www.drishtee.com/). In less than two years, Drishtee has successfully demonstrated its concept in more than 300 kiosks across six Indian states.
- *Other types of information systems that empower the poor,* for instance, systems that allow demand-driven learning from rural communities regarding what types of information and ICT initiatives are most needed to increase standards of living to ensure that initiatives are not supply centered. Another example is a system allowing local information retrieval to improve benchmarking and thereby to spur upgrading in the level and quality of infrastructure services, such as water supply and sanitation, local transport, and electricity.

Box 5-6 presents some additional notable ICT initiatives in India.

**Box 5-6: Information Communications Technology Efforts Expand in India**

A number of notable ICT initiatives are now underway in India:

- In an endeavor to bridge the digital divide, Kerala embarked on the Akshaya project in November 2002, which addresses three key issues in IT dissemination to the masses: access, content, and skills. The aim of the project is to generate and distribute locally relevant content, improve public delivery of services, and catalyze the IT industry in the state. The plan is to develop 6,000 information centers, provide 30,000 employment opportunities, and create investment opportunities.
- Sustainable Access in Rural India is a demonstration project set up with help from Harvard and the Massachusetts Institute of Technology and financed in part by India's ICICI Bank. Situated in the Madurai district of Tamil Nadu, the project has so far set up 40 kiosks in rural villages.
- The "Hole in the Wall" experiment conducted by the NIIT has shown that semiliterate poor children can quickly teach themselves the rudiments of computers and Internet. By installing an unmanned PC in a local slum, it was proven that children can learn the basics of ICT literacy without the help of instructors. This shows the potential for enhancing literacy by installing Internet-enabled PCs in such areas with occasional guidance from instructors. The development of Simputer, as mentioned earlier, is yet another example of such research.
- In the "Rural Reach Program," being conducted by Infosys, ICT professionals and educators visit rural schools and help students from grades 5 to 10 to become familiar with technology. Another program is "Catch Them Young," which provides basic knowledge of software development and the ICT industry to young students. Infosys' "Train the Trainer" workshops are conducted in association with eminent universities in various cities with Infosys development centers. The primary objective is to have active industry-academy interaction and

keep academia updated on the latest trends in IT. The company is conducting these programs in most of its development centers across India: in Bangalore, Chennai, Mysore, Bhubaneshwar, Hyderabad, Mohali, Mangalore, and Pune.

In addition, the number of ICT pilot projects is growing. Examples include the following:

- Franchise model computer projects or kiosks (Gyandoot) in the state of Madhya Pradesh, which generates revenue and is expected to become independent of state funding.
- Swayam Krishi Sangam smart card project, which uses ICTs to reduce the cost of credit.
- Computerization of the Mandal Revenue Offices in the State of Andhra Pradesh.
- India Health Care Project initiated by CMC Limited, which is intended to improve the effectiveness of health prevention programs by using computers, communication technologies, and personal digital assistants for data collection in rural healthcare delivery systems in Andhra Pradesh.
- Seelampur project of Datamation, which entails putting ICTs into the hands of Muslim women in a slum area in Delhi and directly linking the use of ICTs to alleviation of their poverty.
- A number of schemes to use ICTs in education (Indira Soochna Shakti, empowering a quarter million schoolgirls through ICTs), bicycle-based connectivity in rural West Bengal, mobile classrooms through IT buses in rural Pune, and the Project Shiksha–Computer Literacy, which are intended to accelerate computer literacy by providing instruction in software solutions, comprehensive training for teachers and students, IT curriculum development, and scholarships for teachers and students across India.
- Use of ICT for education and e-commerce, as in "Empowering the Poor: A Pilot ICT Program for the Rural Areas of Pune District," whose objectives are to promote e-literacy and IT education and develop e-commerce opportunities.
- Handheld computers that enable auxiliary nurse-midwives in Andhra Pradesh to eliminate redundant paperwork and data entry, freeing time to deliver health care to poor people. Nurse-midwives provide most health services in the state's vast rural areas; each serves about 5,000 people, typically across multiple villages and hamlets. They administer immunizations, offer advice on family planning, educate people on mother-child health programs, and collect data on birth and immunization rates. They usually spend 15–20 days a month collecting and registering data. But with handheld computers, they can cut that time by up to 40 percent, increasing the impact and reach of limited resources.

*Sources:* World Bank 2002e; Lancaster 2003; IIT n.d.; Hole in the Wall Education Ltd. 2003; author's e-mail correspondence with Infosys (October 2003); Akshaya (http://www.akshaya.net); http://Gyandoot.nic.in; and internal Bank documents.

*Enhance rural connectivity for development.* India's economic development is predicated on India's rural development, because around 700 million Indians live in rural India in 600,000 villages. The essential needs of the villages today are many and include water, power, road, sanitation, healthcare, education, and sustainable employment generation opportunities. Lack of these services has resulted in lack of economic opportunities in rural India, which has burdened the population with low incomes and significant illiteracy. The private sector has neglected rural markets, because of a market failure in coordinating the investments required for basic infrastructure and provision of services.

Two promising models, however, have been proposed, but not yet implemented, for rural economic development: President A. P. J. Kalam's initiative Providing Urban Amenities in Rural Areas (PURA) and the Rural Infrastructure and Services Commons model (RISC) (Box 5-7). Their goal is to raise awareness and get buy-in from policy makers to begin pilots allowing market-based solutions to issues of rural connectivity and rural development. These initiatives show what is possible; it is hoped that successful pilots will lead to rapid scale-up.

**Box 5-7: Ushering in Rural Development through Connectivity: The PURA and RISC Models**

*Providing Urban Amenities in Rural Areas (PURA).* President A. P. J. Kalam's vision for development of rural India consists of empowering rural people by providing them with four forms of connectivity:

- *Physical connectivity*, by providing good quality roads in rural areas for movement of people and goods as well as for access to schools, health centers, farming areas, markets, and so on. With 600,000 villages, the means to physical connectivity is to organize villages in clusters of 10 or more. A ring road would provide physical connectivity to these clusters, which would become loci of economic activity by reducing transactions costs.
- *Electronic connectivity,* through telecommunications by providing reliable and high-quality telecom, Internet and IT services. Electronic connectivity will be useful in providing services such as tele-education for farmers and villagers, village Internet kiosks, public call offices, telemedicine, e-market, e-governance, e-commerce, and so on.
- *Knowledge connectivity*, through education by developing educational and training institutions at these clusters to provide vocational training for farmers, artisans, and craftsmen as well as entrepreneurship programs.
- *Economic connectivity,* in which integration of the three preceding forms of connectivity would lead to economic activity that would help villagers maximize their economic potential by starting enterprises with the help of banks, microcredits, and marketing their products.

In his vision, PURA is an economically sustainable business proposition managed by local entrepreneurs and consumers. The government's role is largely supportive in providing initial economic support and finding the right structure to manage and maintain the village clusters.

*Rural Infrastructure and Services Commons model (RISC).* The RISC model recognizes an "ecological" approach, that is, if one creates a sufficiently rich environment in a location, sustainable economic activity will evolve. It also recognizes that India's 600,000 villages have very poor infrastructure, very low rural per capita incomes, and severely limited resources to provide infrastructure to every village. RISC is a strategy to initiate rural economic development through a modular, scalable, low-risk solution that recognizes that investable resources are severely limited. RISC is based on triage: it concentrates infrastructure investments (private and public) in specific locations that are within "bicycle commute" of about 100,000 people (or 100 villages) to create a standardized infrastructure platform. A wide range of services provided by public and private sector firms can be colocated on this platform. Market forces will determine the services provided by commercial firms and will be largely supported by user fees, which in turn will support the cost of infrastructure. The participation of the government will be critical, but not primary.

RISC conceptually and operationally has two levels: the lower infrastructure level (I-level) consists of power, broadband telecommunications, and physical plant (building, water, air conditioning, sanitation, and security). The user services level (S-level) consists of services that are relevant to rural economic activity, such as market making, financial intermediation, education and library, health, social services, governmental services, and so on. The I-level provides a reliable, standardized, competitively priced infrastructure platform achieved by coordinated and cooperative actions of firms specializing in the component activities. A variety of firms providing user services are colocated on the S-level. The presence of the I-level reduces S-level costs and, therefore, the prices for users. The presence of the variety of different service providers obtains economies of scope and agglomeration.

RISC is a way to bootstrap limited resources to initiate rural economic development by inviting the private sector to invest in profitable ventures in rural areas. As prosperity increases, the rural areas themselves will have a surplus to plowed back in. In a few years, the transportation network as envisioned by PURA will evolve organically and make President Kalam's Vision 2020 a reality. In other words, implementation of RISC is only the first step in the task of implementing PURA.

*Sources:* Details of PURA are included in President Kalam's Address at the CEO's Summit on September 26, 2003 (http://presidentofindia.nic.in/scripts/sllatest1.jsp?id=163) as well as in his Convocation Address at Jamia Millia Islamia, New Delhi, August 30, 2004 (http://jmi.nic.in/Notices/Notices04/convocation_address.htm). The RISC model has been jointly developed by Vinod Khosla at Kleiner, Perkins, Caufield, and Byers, and by Atanu Dey at Deeshaa Ventures and Netcore Solutions. For more information, see http://www.deeshaa.com. Reuben Abraham, Columbia University, and Atanu Dey undertook the RISC/PURA comparison.

## Summary of Issues and Recommendations

As is amply demonstrated in this chapter, India has made impressive progress in the IT domain, and its IT industries, and IT-enabled services have become one of the most globalized and dynamic industries and services in the world. At the same time, India also needs to boost the use of ICTs throughout its economy. To reap full benefits of ICTs (new and traditional) and equitably extend reach, India needs to address national and local dimensions of ICT infrastructure and connectivity (access, content, and language). Some critical policy measures include the following:

- Enhance regulatory certainty and efficiency to facilitate new services that will enable India to reap the benefits of the convergence of existing and new technologies and enable the sector to contribute more to economic growth.
- Boost ICT penetration by resolving regulatory issues in communications and reducing and rationalizing tariff structures on hardware and software.
- Increase the use of ICTs as a competitive tool to improve the efficiency of production and marketing in areas such as supply chain management, logistics, information sharing on what goods are selling in the markets, responding to rapidly changing market needs, and so on.
- Move up the value chain in IT by developing high-value products through R&D, improving the quality of products and services, marketing products and building brand equity to position the "India" brand name further, including by strengthening marketing channels with strategic global links, expanding the focus outside the United States to emerging markets in Asia, Pacific, Japan, and so on.
- Provide suitable incentives to promote IT applications for the domestic economy, as the focus currently seems to be mainly on IT services exports. This includes developing local language content and applications.
- Put in place suitable human resource development and training initiatives, starting at the primary school and moving on the tertiary levels to meet the expected growth of IT and other productive sectors of the economy.
- Update syllabuses in computer engineering, electronics, and IT in various technical institutions to meet the demands of industry (curriculum in other branches of engineering should also be broadly based to include IT subjects)
- Massively enhance ICT literacy and skills among the population at large through conventional and nonconventional means, so that people can begin to use ICTs to derive benefits, both economically and socially.
- Create opportunities for local communities to benefit from ICTs by providing support (seed money for local innovation on low-cost and appropriate technologies), enhance private investment in ICT infrastructure, and promote national and international support for rural community-based access.
- Strengthen partnerships among government agencies, research and academic institutions, private companies, and nongovernmental organizations (NGOs) to ramp up the ICT infrastructure and achieve faster penetration of ICTs.
- Further develop and scale up (in joint public-private initiatives where feasible) ICT applications, such as community radio, fixed/mobile phones, smart cards, Internet, and satellite television, to bring the benefits of connectivity to rural communities all across the country and improve the delivery of services to rural populations.
- Share successful applications of ICT, for example, in e-government among different Indian states. This also requires scaling up successful ICT initiatives to bring the benefits of connectivity to rural communities all across the country.
- Create a suitable environment for the effective use of ICTs to permeate the entire economy and lead to flourishing competition and business growth. This calls for the government to continue with the economic reform agenda put in place in the past decade.

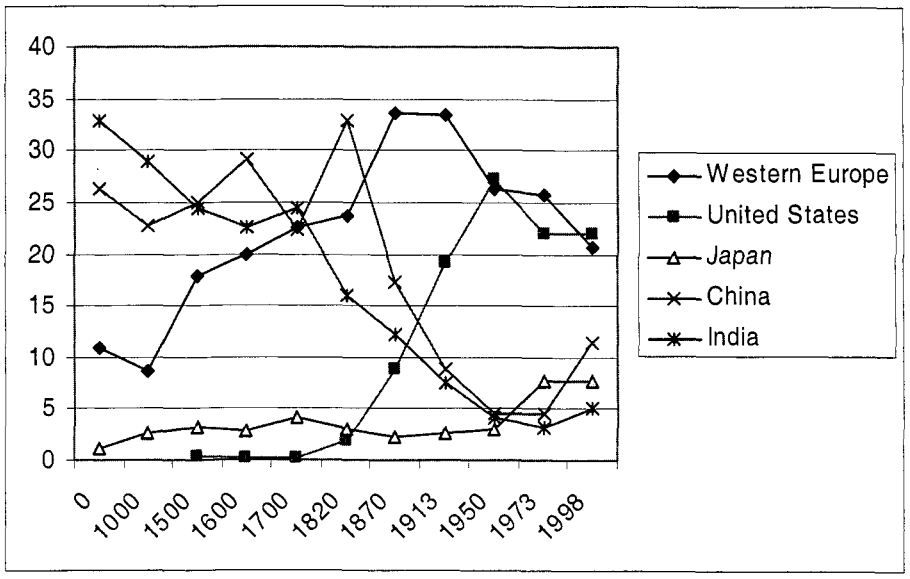
# 6. MOVING AHEAD WITH THE KNOWLEDGE ECONOMY IN INDIA

This report, particularly in chapters 2–5, has looked at developments in India regarding the four pillars of the knowledge economy, highlighted some reforms that have already been accomplished, and outlined some of the issues on which further reforms should be focused. It underlines the unarguable fact that India has tremendous assets as it moves to transform itself to a knowledge-based economy. This chapter looks at how India can build on various initiatives that have been put in place in recent years to springboard into the knowledge economy of the twenty-first century.

### Indian Initiatives on the Knowledge Economy

The notion of a knowledge economy is not new or foreign to India. India's past achievements in science, philosophy, mathematics, and astronomy reinforce the notion that the country has for millennia been a leading "knowledge society." In economic terms, India was the world's largest economy in the first millennium, producing a third of global GDP (Figure 6-1). By 1500 its share had declined to 25 percent, as China overtook it and Western Europe's share began to expand rapidly. India's share continued to fall after 1700 due to the collapse of the Moghul Empire, the costs of adjusting to British governance, and the rapid increase in the share of Western Europe, followed by the spectacular rise of the United States. India was a latecomer to the industrial revolution. It cannot afford to miss the knowledge revolution!

**Figure 6-1: India: Percentage Share of Global Gross Domestic Product, Years 0-1998**
*(percent)*




*Source:* Maddison (2001).

In the current knowledge-driven era, India has already developed a profile for the Indian knowledge society (Box 6-1). Broader than a knowledge economy, a knowledge society includes spiritual, social, intellectual, and philosophical knowledge.

**Box 6-1: Indian Knowledge Society**
As noted by a high-level Indian team, the main aim of an Indian knowledge society is to use knowledge to drive societal and economic transformation to enrich all. It has three elements:

- A learning society that is committed to innovation
- A society with the capacity to create, absorb, protect, disseminate, and use knowledge to create economic wealth and societal good
- A society that uses knowledge through all its constituents and endeavors to empower, enrich, and enlighten its people to take an integrated view of life as a fusion of mind, body, and spirit.

*Source:* As presented by a group of senior Indian policy makers and leaders at the "K4D Policy Forum for Brazil, China, and India," March 22, 2001, Wilton Park, United Kingdom.

In 2000 the Indian Prime Minister laid down a vision for developing India as a knowledge society. Stating that "a knowledge-based society will enable us to leapfrog in finding new and innovative ways to meet the challenges of building a just and equitable social order and seek urgent solutions," he unveiled a five-point agenda that includes strengthening education for developing a learning society; broadening global networking; encouraging vibrant government-industry-academia interaction in policy making and implementation; leveraging existing competencies in IT, telecom, biotechnology, drug design, financial services, and enterprise-wide management; and building economic and business strategic alliances on capabilities and opportunities.

Taking these on board, India's Planning Commission developed the report *India as Knowledge Superpower: Strategy for Transformation* (2001a), which identified three key drivers for the Indian knowledge society for the twenty-first century (Box 6-2).

**Box 6-2: Key Drivers for the Indian Knowledge Society**
Per the Indian Planning Commission report, *India as Knowledge Superpower: Strategy for Transformation* (2001a), three key drivers exist for the emerging Indian knowledge society: societal transformation for a just and equitable society, wealth generation, and protection of knowledge, not only generated in research labs, but by communities as traditional knowledge. The report focuses on education as the foundation for the knowledge-driven economy and examines issues related to connectivity, governance, and use of IT to reduce the "digital divide." As part of a strategy to become a knowledge-driven economy, it recommends a four-tiered approach for increasing employment in the new economy that includes:

- Creating structures for biotechnology promotion and application
- Promoting knowledge-based service industries in which India has competitive strengths (such as software and IT)
- Packaging and marketing traditional knowledge, especially in medicine
- Improving capacity building in three mutually supportive areas: human resource development, R&D capabilities, and the application of technologies flowing from innovations.

*Source:* India, Planning Commission (2001a).

In 2002 India's President, Dr. A. P. J. Abdul Kalam unveiled *India 2020: A Vision for the New Millennium* (Kalam and Rajan 2002), which calls for developing an India that is free from poverty and strong in trade, commerce, and science and technology and that provides health and education to all. For India to join the ranks of developed nations, it must invest in its people, grow the economy, and create critical infrastructure. India should leverage its strengths in the agro-food, engineering, and chemical industries; further globalize its service sector; capitalize on its vast mineral wealth; and strengthen its infrastructure. Tackling issues related to food, agriculture, health care, and service sector development

will require an interdisciplinary approach because, as he noted, "for a nation to progress, the golden triangle of R&D laboratories–academia-industry must emerge."

Building on these premises, the Indian Planning Commission's *India Vision 2020* (2002a) envisages that "by 2020 the people of India will be better educated, healthier, and more prosperous than at any time in its long history. India in 2020 would be a nation bustling with energy, entrepreneurship, and innovation." The report conceives of India evolving into an information society and knowledge economy built on the foundation of ICTs. The vision is predicated on the belief that human resources are the most important determinant of overall development. The vision document highlights several areas critical to India's transition to the knowledge economy: *(a)* creating employment opportunities and raising the level and quality of education, all the way from abolishing illiteracy to achieving 100 percent enrollment at primary and secondary levels, *(b)* broadening access to higher education and vocational training through traditional and nontraditional delivery systems, *(c)* encouraging high-tech science and technology, *(d)* enhancing India's expenditures on R&D, *(e)* improving linkages between technology development and application by fostering close ties between research and business, *(f)* spurring growth of Indian IT and biotechnology sectors, and *(g)* stimulating growth of manufactured and service exports.

In light of these initiatives, in 2003, a High-Level Strategic Group (HLSG) was set up comprising leaders from industry, academia, and government to discuss policies that would enable India to optimize the emerging opportunities and see how all stakeholders can work together to advance the country's effective transition to the knowledge economy and promote knowledge-based industries. The HLSG developed a report, *India's New Opportunity, 2020* (AIMA 2003), that identifies the acceleration of economic growth and employment of skilled youth in the next two decades as the key concerns for what it calls "India Inc." The HLSG estimates a net workforce shortfall of 32–39 million by 2020 in the developed countries of today. This challenge presents a great opportunity for India in the provision of remote services. It is estimated that by 2020, the contribution of remote services alone will be in the range of $133–$315 billion of additional revenue flowing into the country and the addition of 10–24 million jobs (direct and indirect). Furthermore, bringing customers into India (medical tourism,[53] educational services, and leisure tourism)[54] could add another $6–$50 billion in revenues and create an additional 10–48 million jobs (direct and indirect) by 2020. The HLSG estimates that through the provision of remote services and the importation of customers, India could enhance its annual GDP growth by up to 1.5 percent above current growth rates, most of which (approximately 80–85 percent) would be through remote services. Box 6-3 provides additional information on the recommendations of this HLSG.

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[53] According to Dr. Naresh Trehan, executive director and chief cardiovascular surgeon, Escorts Heart Institute and Research Centre, India, the country has great potential as a healthcare center for the world, because healthcare costs are one-tenth to one-seventh the cost in developed countries. India could also become a source of human capital for nurses and therapists. What is needed in this domain is a uniform accreditation system for hospitals, simplification of procedures for setting up medical schools, provision of infrastructure for tertiary health care, and enabling of policy frameworks for research and clinical trials (WEF 2004e).

[54] The India Economic Summit 2004 also noted that India is consistently cited as one of the top five tourism destinations worldwide. Yet, it has failed to leverage this strong interest as a means to rebuilding its infrastructure, encouraging FDI, and producing nonagricultural employment. More flights, paved roads, clean water, and reliable power would lead to the levels of tourism spending that developed countries rely on to grow their service sectors. India should look at how it can make tourism a catalyst for greater infrastructure investment and a source of future job growth (http://www.weforum.org/site/homepublic.nsf/Content/India+Economic+Summit+2004).

**Box 6-3: India's New Opportunity: 2020**

HLSG's report, *India's New Opportunity, 2020* (2003), states that India is positioned well to take advantage of the new opportunities given its large pool of qualified manpower, track record in service delivery in sectors such as IT, and lower costs (specifically in areas such as medical treatment and education services). To convert these opportunities into actual revenues, however, "India Inc." will have to take several initiatives. To boost demand for India's services, India must strengthen the "India Inc." image/brand, focus marketing on select countries with select services, build customer credibility, promote acceptability of the "offshore" concept, improve service experience for customers, and invest in promoting trials. Actions to boost the supply of India's services include developing expertise in specific areas, reforming its education and training sector to increase the base of skilled professionals, strengthening its connectivity infrastructure (telecom, IT, airports, and the like), promoting public-private partnerships, forming interest groups around emerging opportunities, and aligning its legal and regulatory structure.

In addition to identifying areas in which action needs to be taken, the HLSG report also provides a structured framework for key stakeholders to participate in the assimilation of ideas and development of their implementation plans. The report, however, is just the first in a series of steps; the next step will include appropriate agencies developing implementation plans for the critical areas that have been identified. These agencies may be interdepartmental task forces to look at key areas, joint industry government task forces, or business organizations that will pilot and then implement projects to realize the benefits of the opportunities analyzed in this report.

*Source:* AIMA (2003).

India, thus, has already developed a vision and strategies to address its transition to the knowledge economy. In the main, its initiatives have, however, largely been developed around the three functional pillars of the knowledge economy (education, innovation, and ICTs). But to get the maximum benefits from investments in these areas, these initiatives must be part of a broader reform agenda, because some elements of India's current economic and institutional regime are constraining full realization of India's potential. India will, for example, not reap the full benefits of its investments in increasing education, ramping up ICTs, or even doing more R&D, unless its broader institutional and incentive regime stimulates the most effective use of resources in these areas, permits their deployment to the most productive uses, and allows entrepreneurial activity to flourish to contribute better to India's growth and overall development.

India's current Tenth Five-Year Plan (India, Planning Commission 2002e) is already beginning to address some of the broad issues related to the economic and institutional regime (India, Planning Commission 2002b). Its core strategy includes improving governance, targeting poverty, managing the economy for growth, and strengthening the productive base by addressing deficiencies in infrastructure, invigorating agricultural and rural development, and removing controls to encourage industry and services both at the central and state levels. The emphasis is on inclusive development—in which all sections of society would benefit from the opportunities engendered by the knowledge revolution, not just the elites. Four critical dimensions of this transformation include:

- Improving governance by bringing about dramatic improvements in the functioning of administrative and judicial systems to foster a dynamic and vibrant market economy
- Dismantling of barriers to inter-state and intra-state trade and commerce
- Reversing a wide range of controls and restrictions on entrepreneurial initiatives that have retarded the emergence of an investor-friendly climate, and creating an environment that welcomes entrepreneurship with open arms
- Strengthening effective delivery of basic social services by empowering local institutions *(Panchayati Raj)* so that they can become the focal point of democratic decentralization.

## Looking Ahead

It is hoped that this report will help stimulate, through a consultative process, a greater sense of the importance of the emerging policy agenda on the knowledge economy in India. India's effective transformation to a knowledge economy calls for it to act in many different policy domains, deepening, complementing, or reorienting ongoing reforms to use knowledge efficiently and sustaining development in the long term to achieve inclusive growth. India needs to recognize that many policy reforms leading to a knowledge-based economy will not yield results overnight. It will thus need to make some tough choices in the short term; yet, other reforms will be of a medium- to long-term nature.

It is clear, however, that going ahead with such an ambitious agenda in India first and foremost requires raising massive awareness and consultation among all interested stakeholders in government, the private sector, and civil society on the need and plans for such a transformation. Creating a shared vision among all parties on ways to accelerate India's progress toward the knowledge economy is thus important, as well as commitment on the part of all stakeholders to stay the course in order to manage such a transition effectively. Effective leadership will be key to articulating this vision, through the involvement of all stakeholders. It also requires that the country develop a "virtuous" cycle between growth and the reform process.

Moving to a knowledge economy, however, is not only about stimulating such a reform agenda from the top. What will be needed is trial-and-error experimentation on what works in a bottom-up fashion and what does not work in the Indian context as well as scaling up successful bottom-up initiatives. The process requires that India constantly monitor its achievements and adjust its strategy in light of changing conditions.

The challenge of developing such new governance structures is not unique to India, but to all countries, including OECD economies. Countries such as Korea, Ireland, or Mexico and emerging economies such as China have become examples of so-called pragmatic agendas, which have placed innovations in governance at the center of policy making and implementation. In all these cases, national economic crises compelled diverse actors to define and implement a new agenda through explicit or implicit national agreements on goals and mechanisms for moving forward. The crises have also prompted policy makers and private sector leaders to lengthen the time horizon of the policies adopted. These countries are continuing to work with concerned groups and are balancing the interest of varied stakeholders to shape their transition to the knowledge economy. For example:

- In Korea, the main impetus for this transformation and for the development of a shared national vision came from the private sector. The government is steadfastly monitoring progress made to date and making rapid and continuous adjustments to its overall knowledge strategy in light of its experiences and changing circumstances (Box 6-4).
- Ireland also exemplifies a successful combination of top-down and bottom-up policies. It invested in education and R&D infrastructure in the 1980s, followed by drastic policy changes beginning in 1987. To complement its top-down policies, Ireland instituted pragmatic bottom-up programs: regional partnerships to mitigate high unemployment and a program to expand national-supplier linkages from FDI (for more information, see http://www.ida.ie/news/endofyear_2003.pdf).
- China has adopted more of a top-down approach, but some exemplary initiatives do exist. The most impressive is in Shanghai, which has developed a coherent strategy that covers all the key policy planks of the knowledge economy, including 20 well-focused, mutually reinforcing programs. Another is Shenzhen, which had the first special economic zone open to foreign investments (for more information, see Dahlman and Aubert 2001).

- Mexico is following a two-pronged strategy, which includes undertaking major reforms to create contestable factor markets as well as making major advances in education, innovation, enterprise upgrading, and ICT systems (for more information, see World Bank 2005a).

**Box 6-4: Implementing the Republic of Korea's Knowledge Strategy**

The Republic of Korea, at the initiative of its president launched a national strategy to move to a knowledge-based economy in the wake of the financial and foreign exchange crisis of 1998. The impetus for this came from the private sector—the Maeil Business Newspaper—which concluded in 1996 that an urgent need existed for a more coherent vision of the future of the Korean economy. The newspaper launched the "Vision Korea Project" as a national campaign in February 1997 and developed the first "Vision Korea Report." The president's initiative was led by the Ministry of Finance and Economy, with intellectual support by the Korean Development Institute, which coordinated the work of a dozen think tanks. A joint World Bank–OECD report provided a framework, outlining concrete steps for reforms in various policy domains. Close monitoring of progress has been important in keeping up with the reform process and identifying areas of inertia or resistance, for example, in the area of education.

Korea's knowledge strategy of April 2000 evolved into a three-year action plan for five main areas: information infrastructure, human resources, knowledge-based industry, science and technology, and elimination of the "digital divide." To implement the action plan, five working groups involve 19 ministries and 17 research institutes; the Ministry of Finance and Economy is coordinating implementation. Every quarter, each ministry submits a self-monitoring report to the Ministry of Finance and Economy, which publishes an integrated quarterly report detailing progress. The mid-term results and adjustments to the plan are sent to the executive director of the National Economic Advisory Council, which reports on implementation progress and appraises the three-year action plan to its advisory members.

*Source:* Dahlman and Aubert (2001).

## Taking Action

The knowledge economy is no doubt a critical element of India's reform agenda. As has been highlighted:

- India has already developed a strategic vision of how knowledge and expertise can be harnessed for the benefit of all. It also has examples of states that are making rapid strides in putting in place pragmatic agendas to further growth and competitiveness and reduce poverty. Such successful state-led initiatives should be shared across the country to engage other states in the process of preparing the bases for the more effective use of knowledge for development.
- The Indian government has publicly acknowledged that its role in the twenty-first century is to remove bottlenecks, both legal and bureaucratic, that are impeding India's successful transition to the knowledge economy. It is focusing on ways to accelerate India's transition to the knowledge economy by carrying out economic legislation that will enable the country to have better infrastructure, strengthening property rights and institutions, enhancing social infrastructure in terms of education and health, protecting knowledge through patent legislation to reap innovation dividends, and using ICTs to meet the needs of the population at large.
- The government is trying to communicate better to the citizens on the need for economic reforms in the various domains, and to be an effective facilitator of the dialogue on the knowledge economy in India.
- In addition, some recent noteworthy initiatives in India are trying to bring together concerned stakeholders to promote India's transition to the knowledge economy. The HLSG has most recently discussed ways in which different agencies can work together to help India accelerate economic growth and mitigate the unemployment problem that is forecast for the coming decades; this includes seizing a huge opportunity provided by a combination of global developments in industry, trade, and demographics (Box 6-5).

Taking these initiatives to fruition and moving forward with energy and determination, India too can take its rightful place among nations that are embracing knowledge, innovation, and technology to spur inclusive growth and achieve sustainable development.

**Box 6-5: "India Inc.": Moving to Action**

The report developed by the HLSG is different in that it first analyzed why India, despite having sufficient knowledge of what needs to be done, often fails to "make it happen." The collective experience of HLSG members suggested that the inability to make things happen faster, with alignment, is the main reason why India misses opportunities. On further study, it was felt that the lack of speed was generally a result of an implementation model that enforces compliance rather than obtaining commitment. As a result, the energy in the process peters out.

To obtain commitment from all stakeholders, the HLSG embarked on a path that designs and guides the process of involvement and action using the report as a stimulus. The report thus takes an innovative approach to developing what it calls "India Inc." and is based on two principles, which have been found to be highly effective in situations involving disparate interest groups: first, creating an appreciation of the opportunities that exist and prioritizing areas for action, and second, aligning processes and participants (implementation partners) toward a common goal.

With this in mind, the HLSG identifies changes required at the macro level and recommends solutions in three broad areas: marketing India, educating and training the Indian workforce, and connecting India (through telecoms, IT, airports, and so on). For each of these areas, HLSG then identifies concrete actions steps the central government, state governments, and the corporate sector can take. The HLSG concludes that in each of these domains, the concerned agencies must now be vigorously engaged in many sectors, and the private sector and government agencies must continue to work together or begin to work together more effectively to ensure that India Inc. wins.

*Source:* AIMA (2003).

## Launching a Process

To make this agenda even more action oriented, an important signal needs to be given, as is amply demonstrated by the experience of other countries highlighted above. A concrete way to begin this process would be to designate a national "knowledge" champion to advance the knowledge economy agenda in India by integrating the economic reform agenda with initiatives already taking place in more functional areas.

A very appropriate national champion to coordinate and orchestrate the necessary knowledge-related actions across the various domains would be the Prime Minister's office. In fact, recently, the Prime Minister has proposed the setting up of a Knowledge Commission to leverage various knowledge networks to make India a knowledge engine of the world. This function could, for example, organize a Knowledge Economy Task Force, headed by the Prime Minister and comprising stakeholders from government, the private sector, academia, think tanks, research organizations, and NGOs. The main objective of the task force would be to determine ways of coordinating action involving diverse stakeholders to tackle key reforms in the four pillars of the knowledge economy and sequence the investments necessary to move India successfully into the knowledge economy of the twenty-first century. Some examples of cross-cutting knowledge economy issues that the task force could address include:

- In the past decade, India has undertaken major economic reforms; as a result, its growth rate has increased from 3.5 percent in the 1950s to 1970s to approximately 6 percent between the 1980s and 2002. During much of this period, however, China has been growing at about 10 percent. What are the fundamental reforms needed to unleash India's tremendous entrepreneurial potential and benefit from more active participation in the global knowledge economy to achieve this higher rate of growth sustainably?

- India has the advantage of a highly skilled human resource base, which has gained world renown. It also has world-class institutions that train this world-class manpower, but on a limited scale. What would it take to ramp up such institutions even further so that India can become a leader in education and training, not only in IT and software, but also more generally in high-skill areas that can provide greater outsourcing services to the world?
- An increasing number of multinational corporations are currently working with Indian firms to contract and subcontract high-end R&D. How can India become a global leader in innovation in its own right, not only in IT-related areas in which it has carved out a global niche, but also in other knowledge-intensive industries, such as pharmaceuticals and biotechnology?
- India is a leading exporter of IT services and software, but has not yet fully harnessed the potential of ICTs at home to reduce transaction costs and improve efficiency. As it has a large local market and many needs, what will it take for India to exploit this capability on a larger scale domestically and help the country leapfrog even more rapidly into the knowledge economy of the twenty-first century?

Dealing with the kinds of illustrative issues highlighted above requires prioritization and working with many different interest groups, which is not an easy task; thus, some guiding principles for the Knowledge Economy Task Force would include the following:

- Defining priorities and establishing budgets
- Adopting systemic, integrated approaches for the different policy planks at all levels of government
- Mobilizing state governments, which are key to the Indian economy and its modernization
- Multiplying experiments and publicizing concrete initiatives that clearly exemplify the move to a knowledge-based economy.

The role of the Prime Minister's office would be to put in place a robust mechanism to facilitate, monitor, and scale up successful initiatives.

In sum, India is well positioned to take advantage of the knowledge revolution to accelerate growth and competitiveness and improve the welfare of its citizens and should continue to leverage its strengths to become a leader in knowledge creation and use. In the twenty-first century, India will be judged by the extent to which it lays down the appropriate "rules of the game" that will enable it to marshal its human resources, strengths in innovation, and global niches in IT to improve overall economic and social development and transform itself into a knowledge-driven economy. Sustained and integrated implementation of the various policy measures in these domains would help to reposition India as a significant global economic power, so that it can rightfully take its place among the ranks of countries that are harnessing knowledge and technology for their overall economic development and social well-being.

**A Final Note**

This report presents an outside view of India's position on the global scale, recognizes India's achievements, but sees a tremendous potential that is yet to be unleashed. What is needed is an India-led process of coordination and integration of the different reforms, combining those in the economic and institutional regime with the many initiatives that are actually being undertaken in more functional areas, as covered in many Indian strategy reports. Consolidating and launching these can only be done through a domestic process of consultation, stakeholder awareness, and buy-in to get backing for the necessary reforms to implement the various actions needed to leverage India's potential. It is hoped that this perspective serves as an additional vote of confidence to help catalyze such an integrated and well-grounded process.

## Annex 1: India's Total Factor Productivity Construction: Theoretical Framework

In this total factor productivity decomposition exercise, a neoclassical aggregate production function that accounts for the quality of labor is considered. For simplicity, a human-capital augmented version of the Cobb-Douglas production function along with perfect competition and constant returns to scale is assumed:

$$Y = A K^{\alpha} (HL)^{1-\alpha}$$

where:

$Y$ is the level of aggregate output
$K$ is the level of the capital stock
$H$ is the level of the human capital stock
$L$ is the size of the labor force
$A$ is total factor productivity
$\alpha$ is the share of capital in national income

Taking logs and time derivatives and rearranging leads to the estimate of growth rate of total factor productivity with human-capital augmentation:

$$\hat{A} = \hat{Y} - \alpha \hat{K} - (1 - \alpha)(\hat{H} + \hat{L})$$

Where:

$\hat{X}$ represents the growth rate of variable $X$.

Following Woessmann (2000), human capital stock is specified to have the Mincer specification:

$$H = e^{rs}$$

where:

$r$ is the market returns to education
$s$ is the average years of schooling.

### Data Sources

Real GDP (in constant 1995 U.S. dollars) and labor force figures are taken from the World Bank's internal database. The capital stock is constructed using gross capital formation (in constant 1995 U.S. dollars) obtained from the World Bank internal database. The perpetual inventory method is used with an assumed depreciation rate of 5 percent. To calculate the initial value of the capital stock, the average growth rate of gross capital formation for the first five years is used, and the formula is applied for the sum of an infinite geometric progressive series.

Estimates for the returns to education are taken from Bils and Klenow (2000). For the average years of schooling, the simple average of the estimates obtained from Barro and Lee (2001) and Cohen and Soto (2001) are used. Note that, given that data for the average years of schooling are available only on a decade basis, interpolation by growth rates is used to obtain annual estimates of the average years of schooling in order to construct the human capital stock on an annual basis. The estimate for the labor share in national income for India is taken from Gollin (2001), whereas that for Ireland is taken from Bernanke and Gürkaynak (2001). The estimate for labor share for India and Ireland are 0.828 and 0.750, respectively. The capital shares were obtained by taking 1 and subtracting the respective labor shares.

## Annex 2: Knowledge Assessment Methodology

The Knowledge Assessment Methodology (see www.worldbank.org/kam) is a user-friendly tool designed by the World Bank Institute to assist client countries in understanding their strengths and weaknesses in terms of their ability to compete in the global knowledge economy. The KAM is designed to proxy a country's preparedness to compete in the knowledge economy through a series of relevant and widely available measures: 80 structural and qualitative variables—available for 128 countries—that benchmark how an economy compares with other countries. The KAM helps to identify the problems and opportunities that a country faces and where it may need to focus policy attention or future investments. The unique strength of the knowledge for development methodology is its cross-sector approach, allowing the user to take a holistic view of a wide range of relevant factors, rather than just focusing on one area.

The 80 variables used serve as proxies for the four areas (pillars) that are critical to the development of a knowledge-based economy (economic and institutional regime, education, innovation, and ICTs). Also included in the 80 variables are several measures that track the overall performance of the economy.

### *Normalization Procedure for the KAM*

The raw data (u) are collected from World Bank datasets and international literature for 80 variables and 128 countries.

Ranks are allocated to countries based on the absolute values (raw data) that describe each and every one of the 80 variables (rank u). Countries with the same performance are allocated the same rank; therefore, the rank equals 1 for a country that performs the best among the 128 countries in the sample on a particular variable (that is, it has the highest score), the rank equals 2 for a country that performs second best, and so on.

The number of countries with a worse rank (Nw) is calculated for each country.

The following formula is used to normalize the scores for every country on every variable according to their ranking and in relation to the total number of countries in the sample (Nc) with available data: Normalized (u) = 10*(Nw/Nc).

The above formula allocates a normalized score from 0 to 10 for each of the 128 countries with available data on the 80 variables. Ten is the top score for the top performers and 0 the worst for the laggards. The top 10 percent of performers get a normalized score between 9 and 10, the second best 10 percent get normalized scores between 8 and 9, and so on. As mentioned above, more than one country may be allocated either at the top or bottom of the normalized scores. The 0–10 scale describes the performance of each country on each variable, relative to the performance of the rest of the country sample.

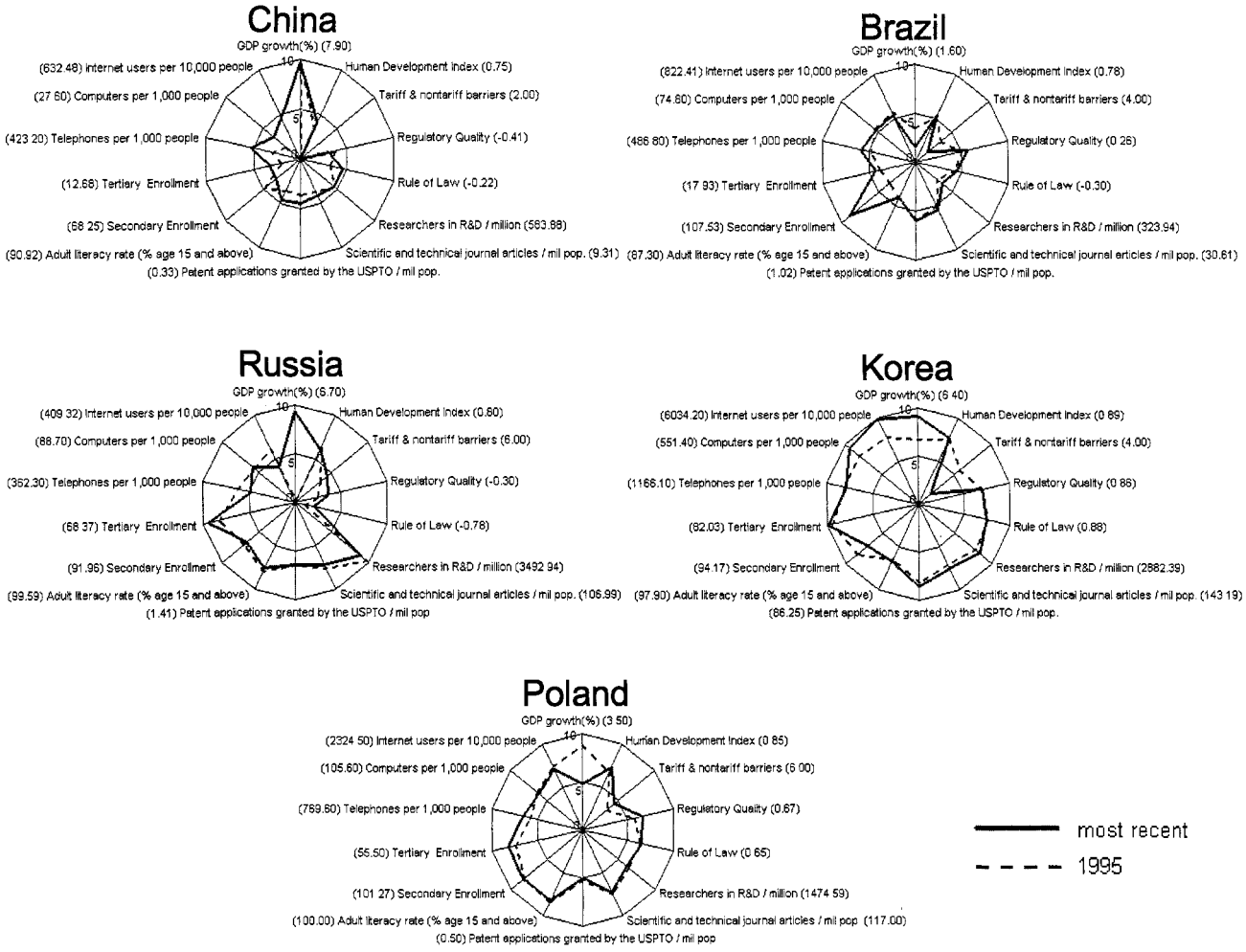
The KAM is updated about once a year. More information on the most recent version of the KAM, its functionalities, technical notes, data sources, and a user guide are available on the Web site: www.worldbank.org/kam.

**Annex 3: Knowledge Economy Index for India and Comparator Countries, 1995 and Most Recent Period**

| | Knowledge Economy Index (KEI) | | Economic Incentive Regime | | Innovation | | Education | | Information Infrastructure | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Most recent* | *1995* | *Most recent* | *1995* | *Most recent* | *1995* | *Most recent* | *1995* | *Most recent* | *1995* |
| **Korea** | 7.59 | 7.60 | 5.39 | 6.74 | 8.11 | 7.61 | 7.86 | 8.11 | 9.00 | 7.95 |
| **Poland** | 6.70 | 6.49 | 5.84 | 5.15 | 6.15 | 6.30 | 8.22 | 7.96 | 6.59 | 6.54 |
| **Russia** | 5.91 | 5.99 | 3.34 | 2.33 | 7.50 | 7.89 | 7.88 | 7.78 | 4.91 | 5.98 |
| **Brazil** | 5.05 | 4.49 | 3.94 | 4.18 | 5.02 | 4.59 | 5.75 | 3.85 | 5.50 | 5.32 |
| **China** | 3.80 | 2.86 | 2.55 | 2.29 | 4.42 | 3.95 | 3.74 | 3.48 | 4.50 | 1.71 |
| **India** | 2.72 | 2.75 | 2.91 | 2.85 | 3.58 | 3.34 | 2.33 | 2.38 | 2.06 | 2.42 |

*Note:* The Knowledge Economy Index (KEI) is the average of the performance scores of a country or region in all four knowledge economy pillars: economic incentive regime, education, innovation, and information infrastructure.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

## Annex 4: Overall Knowledge Economy Scorecards for Brazil, China, Korea, Poland, and Russia, Selected Variables, 1995 and Most Recent Period



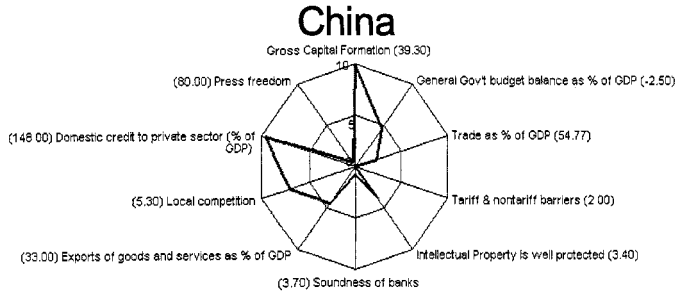

*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for the particular country for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

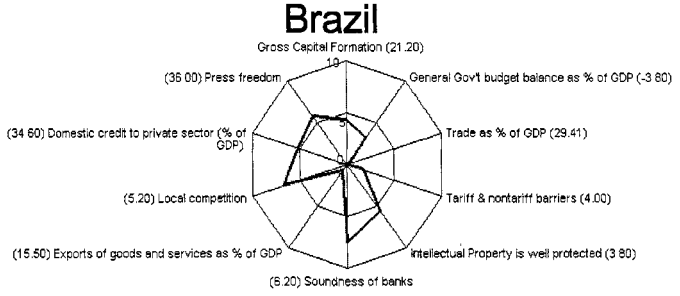
## Annex 5: Data for the Scorecards for India, Brazil, and China, 1995 and Most Recent Period

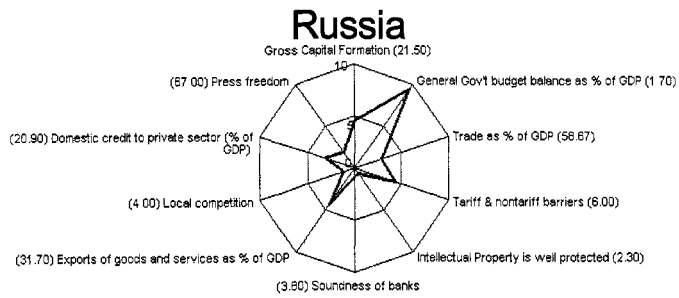
| | India | | Brazil | | China | |
|---|---|---|---|---|---|---|
| | *(actual/normalized)** | | *(actual/normalized)** | | *(actual/normalized)** | |
| **Variable** | most recent | 1995 | most recent | 1995 | most recent | (1995) |
| Average annual GDP growth (percent) | 5.40/8.66 | 6.60/8.98 | 1.60/1.57 | 3.20/3.54 | 7.90/9.69 | 9.90/9.84 |
| Human Development Index | 0.60/2.30 | 0.55/2.11 | 0.78/5.40 | 0.74/5.12 | 0.75/4.21 | 0.68/3.41 |
| Tariff & nontariff barriers | 2.00/0.00 | 2.00/0.00 | 4.00/1.75 | 4.00/3.44 | 2.00/0.00 | 2.00/0.00 |
| Regulatory quality | –0.34/3.54 | –0.13/3.39 | 0.26/5.67 | 0.13/4.96 | –0.41/3.07 | –0.10/3.70 |
| Rule of law | 0.07/5.20 | –0.01/5.16 | –0.30/4.41 | –0.24/4.13 | –0.22/4.57 | –0.43/3.17 |
| Researchers in R&D per million people | 98.85/2.00 | 146.00/2.45 | 323.94/3.56 | 168.00/2.87 | 583.88/4.56 | 464.00/4.47 |
| Scientific and technical journal articles per million people | 9.23/4.09 | 9.36/4.17 | 30.61/5.51 | 19.65/5.04 | 9.31/4.17 | 5.81/3.70 |
| Patent applications granted by USPTO per million people | 0.33/4.64 | 0.04/3.39 | 1.02/6.00 | 0.44/5.87 | 0.33/4.55 | 0.05/3.67 |
| Adult literacy rate (percent age 15 and above) | 61.03/1.42 | 53.30/1.43 | 87.30/4.09 | 83.20/4.13 | 90.92/4.65 | 80.80/3.57 |
| Secondary enrollment | 48.47/2.50 | 48.80/3.05 | 107.53/8.83 | 55.60/3.59 | 68.25/3.28 | 65.80/4.77 |
| Tertiary enrollment | 10.58/3.07 | 6.58/2.66 | 17.93/4.33 | 12.90/3.83 | 12.68/3.31 | 5.30/2.11 |
| Telephones per 1,000 people (mainlines and mobiles) | 71.00/2.03 | 13.00/2.03 | 486.80/5.86 | 93.00/4.77 | 423.20/5.31 | 36.00/3.05 |
| Computers per 1,000 people | 7.20/1.58 | 1.29/1.33 | 74.80/5.25 | 17.33/5.50 | 27.60/3.58 | 2.27/2.08 |
| Internet users per 10,000 people | 174.86/2.58 | 3.00/3.91 | 822.41/5.39 | 11.00/5.70 | 632.48/4.61 | 0.00/0.00 |

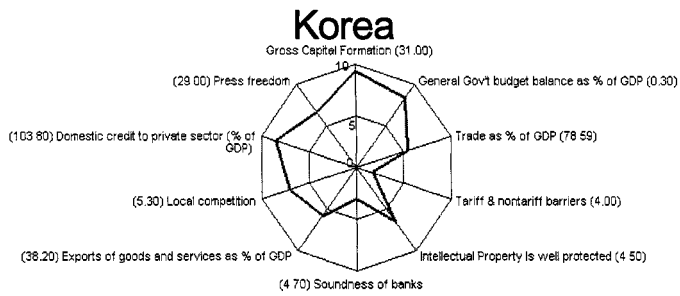
* Actual value/normalized values are for the group comprising all 128 countries in the database.
*Notes:* Average annual GDP growth (most recent) is the average annual GDP growth for the period 1998–2002. Average annual GDP growth (1995) is the average annual GDP growth for the period 1993–97.
*Source:* World Bank. "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

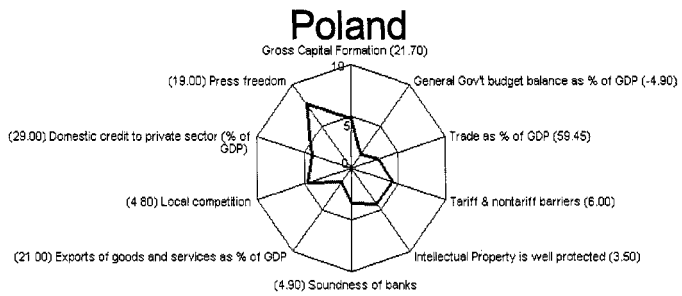
## Annex 6: Economic and Institutional Regime: Scorecards for Comparator Countries, Selected Variables, Most Recent Period




*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for the particular country for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

## Annex 7: Governance Data for India

### a. Governance Indicators for India: 1998 and 2002

| *Governance Indicator* | *Year* | *Percentile Rank (0–100)* | *Estimate (–2.5 to + 2.5)* | *Standard Deviation* | *No. surveys and polls* |
|---|---|---|---|---|---|
| Voice and accountability | 2002 | 60.6 | +0.38 | 0.17 | 10 |
| | 1998 | 59.2 | +0.26 | 0.23 | 6 |
| Political stability | 2002 | 22.2 | –0.84 | 0.20 | 9 |
| | 1998 | 35.2 | –0.34 | 0.24 | 7 |
| Government effectiveness | 2002 | 54.1 | –0.13 | 0.15 | 9 |
| | 1998 | 52.5 | –0.13 | 0.20 | 8 |
| Regulatory quality | 2002 | 43.8 | –0.34 | 0.17 | 8 |
| | 1998 | 41.8 | –0.08 | 0.21 | 7 |
| Rule of law | 2002 | 57.2 | +0.07 | 0.13 | 13 |
| | 1998 | 67.0 | +0.21 | 0.17 | 11 |
| Control of corruption | 2002 | 49.5 | –0.25 | 0.15 | 10 |
| | 1998 | 60.1 | –0.17 | 0.16 | 10 |

### b. Governance Indicators for India and Regional Average, 2002

| *Governance Indicator* | *Year* | *Percentile Rank (0–100)* | *Estimate (–2.5 to + 2.5)* | *Standard Deviation* | *No. surveys and polls* | *Regional Average (percent)* |
|---|---|---|---|---|---|---|
| Voice and accountability | 2002 | 60.6 | +0.38 | 0.17 | 10 | 29.6 |
| Political stability | 2002 | 22.2 | –0.84 | 0.20 | 9 | 32.4 |
| Government effectiveness | 2002 | 54.1 | –0.13 | 0.15 | 9 | 48.1 |
| Regulatory quality | 2002 | 43.8 | –0.34 | 0.17 | 8 | 35.3 |
| Rule of law | 2002 | 57.2 | +0.07 | 0.13 | 13 | 42.1 |
| Control of corruption | 2002 | 49.5 | –0.25 | 0.15 | 10 | 41.5 |

### c. Governance Indicators for India and Income Category Average, 2002

| *Governance Indicator* | *Year* | *Percentile Rank (0–100)* | *Estimate (–2.5 to + 2.5)* | *Standard Deviation* | *No. surveys and polls* | *Income Category Avg. (percent)* |
|---|---|---|---|---|---|---|
| Voice and accountability | 2002 | 60.6 | +0.38 | 0.17 | 10 | 27.9 |
| Political stability | 2002 | 22.2 | –0.84 | 0.20 | 9 | 28.6 |
| Government effectiveness | 2002 | 54.1 | –0.13 | 0.15 | 9 | 24.6 |
| Regulatory quality | 2002 | 43.8 | –0.34 | 0.17 | 8 | 25.1 |
| Rule of law | 2002 | 57.2 | +0.07 | 0.13 | 13 | 24.9 |
| Control of corruption | 2002 | 49.5 | –0.25 | 0.15 | 10 | 25.5 |

*Source:* Kaufmann, Kraay, and Mastruzzi (2003).

## Annex 8: Various Costs of Doing Business in India, 2004

### a. Starting a Business (2004)

The challenges of launching a business in India are shown below through four measures: procedures required to establish a business, the associated time and cost, and the minimum capital requirement.

| *Indicator* | *India* | *Regional Average* | *OECD Average* |
|---|---|---|---|
| Procedures *(number)* | 11 | 9 | 6 |
| Time *(days)* | 89 | 46 | 25 |
| Cost *(percent gross national income [GNI] per capita)* | 49.5 | 45.4 | 8 |
| Minimum capital *(percent of income per capita)* | 0.0 | 0.0 | 44.1 |

### b. Hiring and Firing Workers (2004)

The difficulties that employers in India face in hiring and firing workers are shown below. Three indexes measure how difficult it is to hire a new worker, how rigid the regulations are on working hours, and how difficult it is to dismiss a redundant worker. Conditions covered by the indexes include availability of part-time and fixed-term contracts, working time requirements, minimum wage laws, and minimum conditions of employment. Each index assigns values between 0 and 100, with higher values representing more rigid regulations. The overall Rigidity of Employment Index is an average of the three indexes. Firing costs are calculated on the basis of *(a)* the number of weeks' worth of salary in severance, *(b)* notification, and *(c)* penalties that must be paid to dismiss a worker.

| *Indicator* | *India* | *Regional Average* | *OECD Average* |
|---|---|---|---|
| Difficulty of Hiring Index | 33 | 37 | 26.2 |
| Rigidity of Hours Index | 20 | 36.7 | 50 |
| Difficulty of Firing Index | 90 | 53.3 | 26.8 |
| Rigidity of Employment Index | 48 | 42.3 | 34.4 |
| Firing Costs *(weeks of wages)* | 79 | 84.7 | 40.4 |

### c. Registering Property (2004)

The ease with which businesses can secure rights to property is measured below using the following indicators: the number of procedures necessary to transfer a property title from the seller to the buyer, and the time and the costs as a percentage of the property value.

| *Indicator* | *India* | *Regional Average* | *OECD Average* |
|---|---|---|---|
| Procedures *(number)* | 6 | 5 | 4 |
| Time *(days)* | 67 | 55 | 34 |
| Cost *(percent of property per capita)* | 13.9 | 6.0 | 4.9 |

### d. Getting Credit (2004)

Measures on credit information sharing and the legal rights of borrowers and lenders in India are shown below. One set of indicators measures the coverage, scope, quality, and accessibility of credit information available through public and private registries. A second set measures how well collateral and bankruptcy laws facilitate lending; the scores range from 0–10; higher scores indicate that those laws are better designed to expand access to credit. The Credit Information Index measures the scope, access, and quality of credit information available through public registries or private bureaus; the index ranges from 0–6, and higher values indicate that more credit information is available from a public registry or private bureau. The Legal Rights Index measures the coverage, scope, quality, and accessibility of credit information available through public and private registries; the scores range from 0–10, and higher scores indicate that those laws are better designed to expand access to credit.

| *Indicator* | *India* | *Regional Average* | *OECD Average* |
|---|---|---|---|
| Cost to create collateral *(percent of income per capita)* | 11.3 | 8.0 | 5.2 |
| Legal Rights Index | 4 | 3.8 | 6.3 |
| Credit Information Index | 0 | 1.7 | 5 |
| Public Credit Registry coverage *(borrowers per 1,000 capita)* | 0 | 1.4 | 76.2 |
| Private bureau coverage *(borrowers per 1,000 capita)* | 0 | 3.1 | 577.2 |

**e. Protecting Investors (2004)**

The degree to which investors are protected through disclosure of ownership and financial information is measured below. The Disclosure Index captures seven ways of enhancing disclosure: information on family, indirect ownership, beneficial ownership, voting agreements among shareholders, audit committees reporting to the board of directors, use of external auditors, and public availability of ownership and financial information to current and potential investors. The index varies between 0 and 7; higher values indicate more disclosure.

| *Indicator* | *India* | *Regional Average* | *OECD Average* |
|---|---|---|---|
| Disclosure Index | 4 | 3.2 | 5.6 |

**f. Enforcing Contracts (2004)**

The ease or difficulty of enforcing commercial contracts in India is measured below, using three indicators: the number of procedures counted from the moment the plaintiff files a lawsuit until actual payment; the associated time; and the cost (in court and attorney fees), expressed as a percentage of debt value.

| *Indicator* | *India* | *Regional Average* | *OECD Average* |
|---|---|---|---|
| Procedures *(number)* | 40 | 29 | 19 |
| Time *(days)* | 425 | 375 | 229 |
| Cost *(percent of debt)* | 43.1 | 39.6 | 10.8 |

**g. Closing a Business (2004)**

The time and cost required to resolve bankruptcies are shown below. Costs include court costs as well as fees of insolvency practitioners, lawyers, accountants, and so on. The recovery rate measures the efficiency of foreclosure or bankruptcy procedures, expressed in the number of cents on the dollar claimants recover from the insolvent firm.

| *Indicator* | *India* | *Regional Average* | *OECD Average* |
|---|---|---|---|
| Time *(years)* | 10.0 | 5.2 | 1.7 |
| Cost *(percent of estate)* | 8 | 8.3 | 6.8 |
| Recovery Rate *(cents on the dollar)* | 12.5 | 21.4 | 72.1 |

*Note:* Data are available at http://rru.worldbank.org/DoingBusiness/.
*Source:* World Bank (2004b).

Even though India has a relatively vibrant private sector and has made some improvements, the data in Annex 8 show that India needs to do more to spur greater entrepreneurial activity. One important reason for less competitive markets in India is excessive regulation of entry and exit of firms. India has higher requirements for obtaining permits and a significantly longer median number of days to start a firm than many other countries.

Annex 8a shows the challenges of launching a business in India through four measures: procedures required to establish a business, associated time and cost, and minimum capital requirement. Entrepreneurs can expect to go through 11 steps to launch a business within 89 days, on average, at a cost equal to 49.5 percent of gross national income (GNI) per capita. There is, however, no minimum deposit

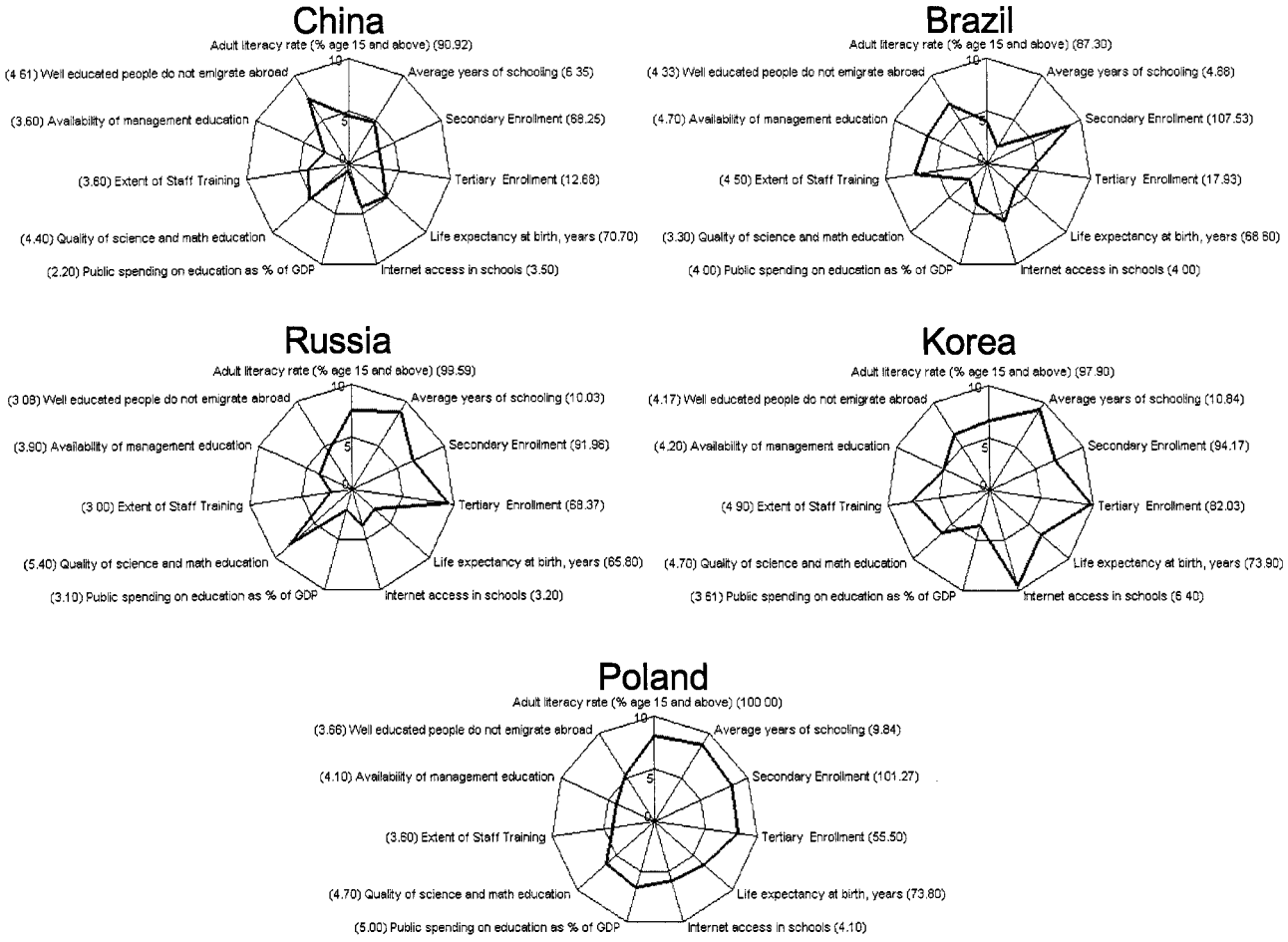
requirement to obtain a business registration number, compared with the OECD average of 44.1 percent of GNI. Starting a business in India requires about the same number of permits as in China (12), but in China it takes less than half the time (41 days), on average, to take care of all procedures and at a much lower cost (14.5 percent of GNI per capita). They must, however, deposit at least 1,104.2 percent of GNI per capita in a bank to obtain a business registration number.

India also has one of the more regulated labor markets in the world, and restrictions on the hiring and firing of workers are a great obstacle to doing business (see annex 8b). India's overall Rigidity of Employment Index is 48, higher than in China (30), but lower than in Brazil (72). In a World Bank–CII survey (World Bank 2002c), the typical firm reported it had 17 percent more workers than desired and that labor laws and regulations were the main reasons why it could not adjust its workforce to the preferred level. These regulations are a key reason why firms are reluctant to take on new employees.

In India, it takes 67 days to register property, higher than it takes in both Brazil (42 days) and in China (32 days). This is important in terms of the ease with which businesses can secure rights to property (see annex 8c). In terms of getting credit, annex 8d provides data on credit information sharing and the legal rights of borrowers and lenders in a particular country. India does better than Brazil and China on the Legal Rights Index. India has a score of 4 on this index, and Brazil and China both have a score of 2.

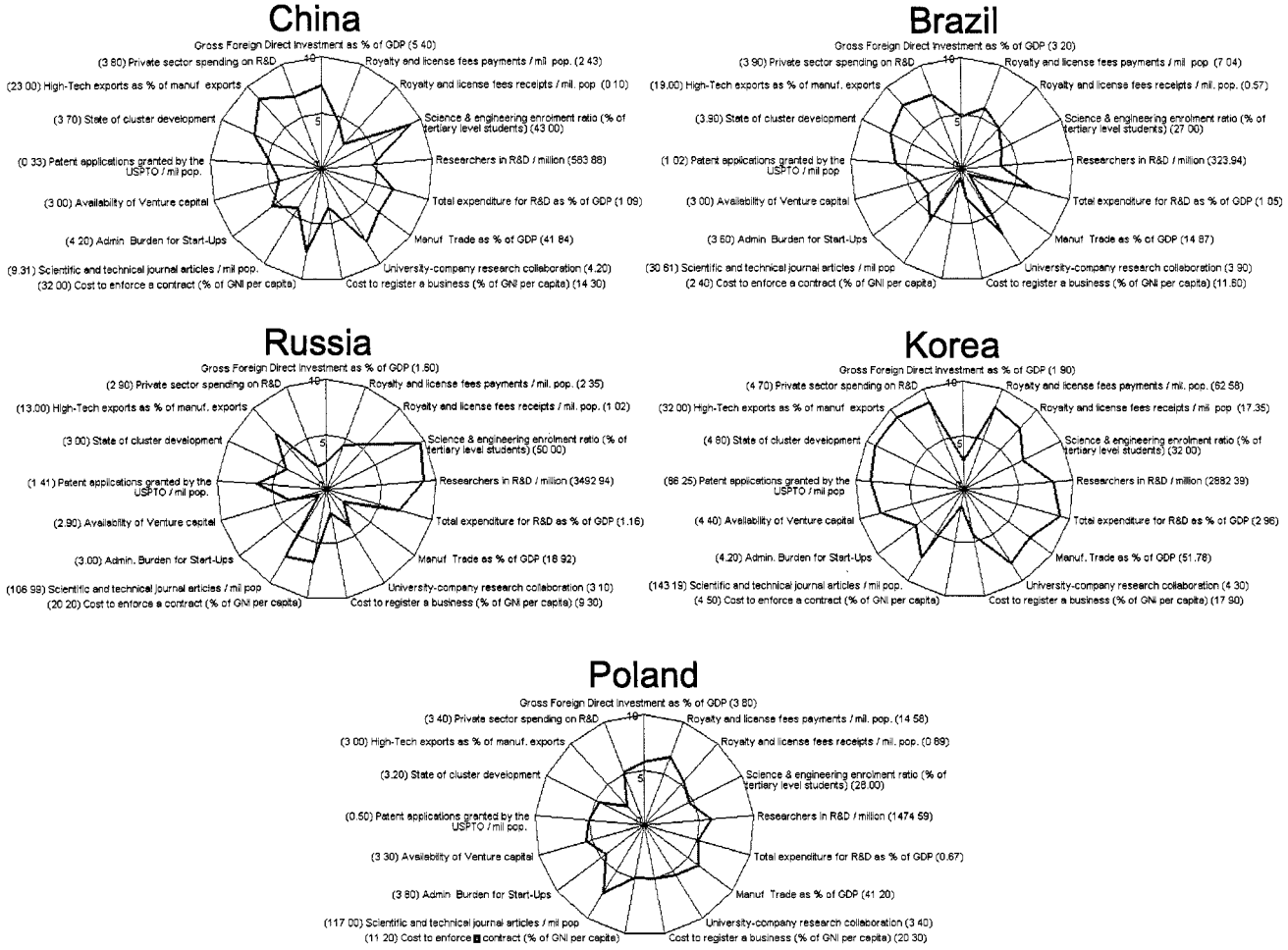
The Disclosure Index measures the degree to which investors are protected through disclosure of ownership and financial information (annex 8e). This index shows that India and China both have a score of 4, but Brazil does better with a score of 5. Enforcing a contract is also a major problem in India, as it takes more than a year (425 days) to resolve a payment dispute in India, compared with 566 days in Brazil and 241 days in China (annex 8f). In addition, although it takes less than six months to go through bankruptcy proceedings in Ireland and Japan and 2.4 years in China, in both India and Brazil, it takes more than 10 years (annex 8g). These indicators, thus, reveal some strengths and weaknesses of India's national business environment that need to be tackled to improve its competitiveness in an increasingly integrated and knowledge-based global economy.

## Annex 9: Education: Scorecards for Comparator Countries, Selected Variables, Most Recent Period




*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for the particular country for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

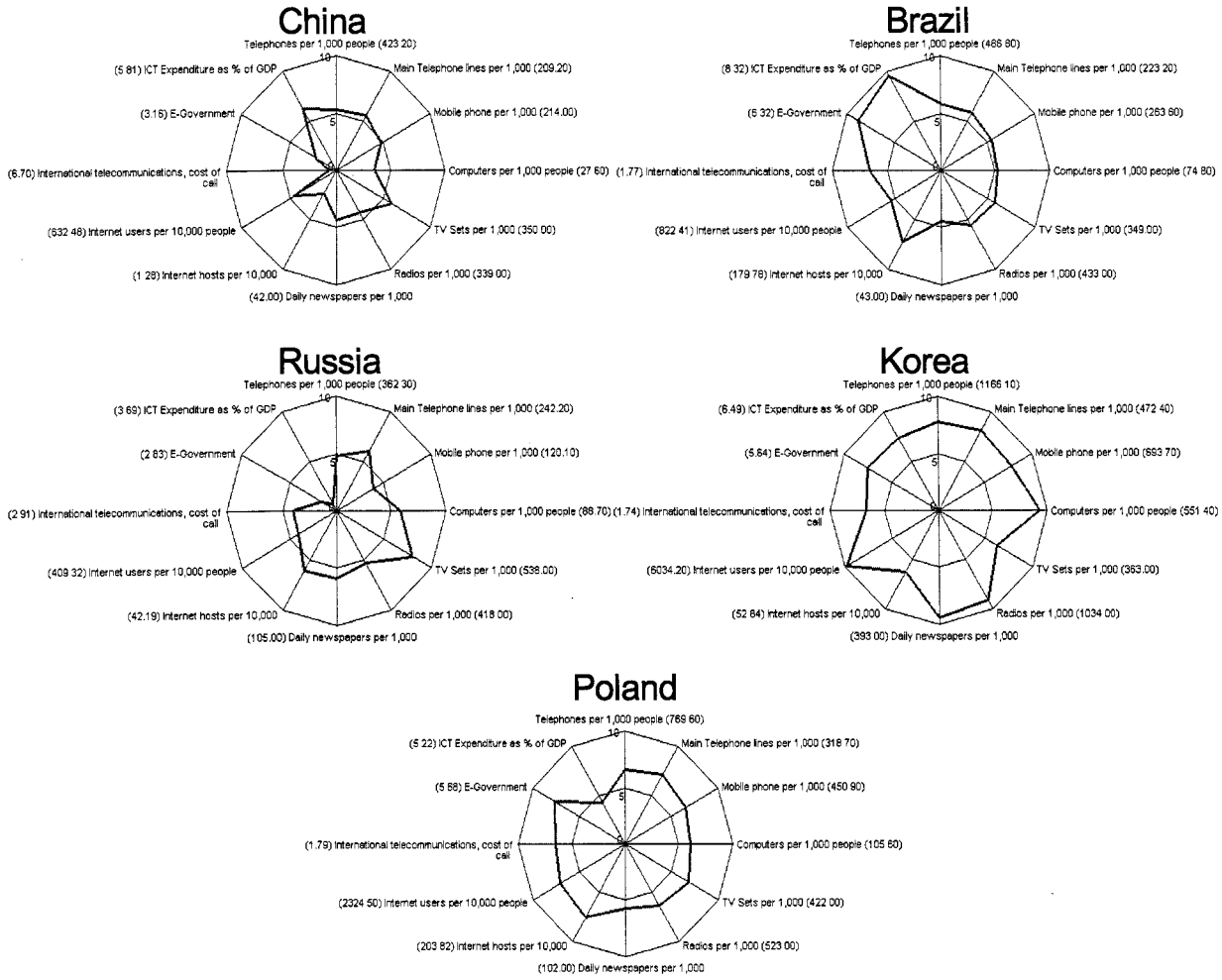
## Annex 10: Innovation: Scorecards for Comparator Countries, Selected Variables, Scaled by Population, Most Recent Period




*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for the particular country for the most recent period for which data are available.

*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

## Annex 11: Information Infrastructure: Scorecards for Comparator Countries, Selected Variables, Most Recent Period




*Note:* Each of the 80 variables in the KAM is normalized on a scale of 0 to 10. The fuller the scorecard, the better poised a country is to embrace the knowledge economy. But an economy should not necessarily aim for a perfect score of 10 on all variables. This is because the scorecards may be shaped by the particular structural characteristics of an economy or by trade-offs that characterize different development strategies. Values in parentheses denote actual values for the particular country for the most recent period for which data are available.
*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.

## Annex 12: ICT Indicators for India and China, Various Years

| Variable | India | China |
|---|---|---|
| Telephones per 1,000 people (mainlines + mobiles), 2003 | 71.00 | 423.20 |
| Telephone main lines per 1,000 people, 2003 | 46.30 | 209.20 |
| Mobile phones per 1,000 people, 2003 | 24.70 | 214.00 |
| Computers per 1,000 people, 2002 | 7.20 | 27.60 |
| TV sets per 1,000 people, 2002 | 83.00 | 350.00 |
| Radios per 1,000 people, 2001 | 120.00 | 339.00 |
| Daily newspapers per 1,000 people, 2000 | 60.00 | 42.00 |
| Internet hosts per 10,000 people, 2003 | 0.82 | 1.28 |
| Internet users per 10,000 people, 2003 | 174.86 | 632.48 |
| International telecommunications, cost of call to the United States ($ per 3 minutes), 2002 | 3.20 | 6.70 |
| E-Government, 2003* | 5.18 | 3.16 |
| ICT Expenditures as percent of GDP, 2002 | 2.78 | 5.81 |

*Source:* World Bank, "Knowledge Assessment Methodology," http://www.worldbank.org/kam.
* Represents the percentage of companies in a country that use the Internet for online government services.

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