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Bangalore: The Silicon Valley of Asia?

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Abstract

This paper examines the growth and other dimensions of the performance of India's Information Technology (IT) industries, which have been remarkable during the 1990s. It pays particular attention to the role of policy in the development of these industries. Several policy changes were indispensable in inducing the rapid emergence and growth of the Indian IT industries over the past two decades. The 1984 Computer Policy and 1986 Computer Software Export, Development and Training Policy encouraged valued-added exports of IT products by allowing them easier access to the latest technologies abroad. The Software Technology Parks scheme introduced in the early 1990s facilitated a gradual shift away from on-site to offshore service provision during the 1990s. In 1998, the National Information Technology and Software Development Task Force was formed, which in 1999 made wide-ranging policy recommendations for the future growth of the IT industries. This paper concludes by suggesting that comparing India's Bangalore to California's Silicon Valley in the US is not only misleading but also distracts attention from the deeper challenges and opportunities that IT affords the Indian economy. In particular, the policy perspective needs to expand beyond a narrow focus on the software industry.

¹ I owe a special debt to Balaji Parthasarathy, now of the Indian Institute of Information Technology-Bangalore, and to the participants of the Workshop on Equity, Diversity, and Information Technology held at the National Institute of Advanced Study, Bangalore in December 1999. Their research and wisdom are reflected throughout this document. Any errors are, of course, mine alone. Special thanks as well to Sajjid Chinoy and Suraj Jacob who provided outstanding research assistance on very short notice.

Information technology (IT) has become the mantra of Indian politicians and policymakers. Soon after taking office in 1998, Prime Minister A. B. Vajpayee announced the goal of making India a "global information technology superpower" and a "forerunner in the age of the information revolution." India's software industry has grown so fast that it invokes frequent comparisons between Bangalore, one of India's leading software producing regions, and Silicon Valley. And the achievements of Indian professionals in leading edge technology industries abroad have contributed to a growing sense of confidence in India, confidence that did not exist before--largely because India and Indians have participated in the information technology revolution.

The performance of India's IT industry during the 1990s has been impressive, particularly in contrast to other sectors of the Indian economy. The sector's compound annual growth rate (CAGR) for 1994-1999 exceeded 40%, compared to only 6.6% for the economy as a whole.² This strong growth was led by the software industry, which in 1999 accounted for 65% of India's total IT revenues and employed more than 200,000 workers. Total software revenues of \$3.9 billion in 1999 were close to four times those of IT hardware manufacturing and grew more than 55% per year in the late 1990s. Moreover, the software industry's growth was driven primarily by exports. While the domestic market for software has grown in absolute terms, software exports account for a large and increasing share of total industry revenue (Table 1.) This export success is particularly striking for an industry that remained peripheral to world markets throughout most of the 1980s.

This paper examines the growth and performance of India's IT industries with particular attention to the role of policy in this process. It first reviews the evolution of the software industry, highlighting the policy departures that have contributed to its rapid emergence and growth over the past two decades. It then turns to the formation of the National Information Technology and Software Development Task Force in 1998 and its policy recommendations aimed making India the "number one provider of IT products" in the world. The concluding section steps back to address the role of the IT industry in India more broadly. It suggests that comparisons between regions like Bangalore and Silicon Valley are not only misleading but also distract attention from the deeper challenges and opportunities that IT offers for the Indian

² Data from NASSCOM (2000) and Ministry of Finance, Economic Survey 1999-2000 .

economy. In particular, the range of actors and the scope of policy debates need to be expanded significantly to realize the full potential of the IT revolution in India.

It is important to begin by putting the performance of Indian IT in a global perspective. India's \$4 billion in software revenues in 1998-99 represented a very small fraction of an estimated world software market of some \$300-\$500 billion (Arora et. al. 2000). In spite of the sector's rapid export expansion between 1985 and 1995, from \$28 million to \$481 million, India's share of total world IT exports remained stable at 0.5% (OECD 1997, 50.) Moreover, India's 0.5% share of world IT exports in 1995 was less the country's 0.6% share of world aggregate exports in the same year.³ These figures suggest the need for skepticism about the more inflated claims currently circulating concerning India's IT industries.

The weakest link in the IT sector, hardware development and manufacturing, remains small and barely viable. The industry suffered tremendously from the protection provided by the high import duties as well as from very limited access to foreign technology after IBM left the country in 1978. Personal computers, components, and other IT products manufactured in India in the 1980s were both costly and technically backwards, which limited demand and hence the volume of production. The inability to gain scale economies proved fatal in a highly capital intensive industry, and over time contributed to the industry's decline. By the 1990s, most of the India's IT hardware companies were transformed into direct or indirect dealerships for foreign brand computers and related products (Jhungjhunwala 1999.)

India's total hardware revenues amounted to \$1.03 billion in 1998-99 (Table 1). The sector has not grown in the past five years, and its exports are negligible. The reduction of import duties to zero by 2002, as recommended by the WTO, will put severe pressure on India's IT manufacturers, and it seems likely that only those that are able to develop higher value-added products are likely to survive. The remainder of this paper focuses on the software industry, as it is the sector in which an innovative policy regime has stimulated a different developmental dynamic.

The Evolution of the Indian Software Industry, 1984-1998

Prior to 1984, the Indian software industry operated within the framework of a highly regulated, autarkic model of import-substitution led industrialization (ISI) and the ideology of

³ Economic Survey 1999-2000, <http://www.nic.in/indiabudget/es99-2000/app7.5.pdf>

self-reliance that guided the Indian economy. This policy regime stifled entrepreneurs and isolated the India from the global economy. As a result, efforts to promote software exports during the period never took off. Policies that permitted the import of state-of-the-art computers in exchange for a guarantee to export a certain amount of software were not enthusiastically received (Subramanian 1992). Import procedures were cumbersome, duties were high and obtaining foreign exchange for business expenses was difficult.⁴

Policy Reform in Software

The election of Rajiv Gandhi as Prime Minister marked the turning point for policy reform in India's software and computer industries. Gandhi's administration was the first to emphasize new policies for electronics, software, telecommunications, and other emerging industries.⁵ A Computer Policy, announced in November 1984, recognized software as an 'industry', making it eligible for an investment allowance and other incentives. The policy also lowered import duties on software and personal computers (PCs) and permitted the import of computers in exchange for software exports at a special low duty.

The passage two years later of the 1986 Computer Software Export, Development and Training Policy marked an explicit rejection of Indian ISI and the idea of self-reliance in software. The policy was designed to promote the domestic software industry and facilitate a "quantum jump" in software exports by providing Indian firms with liberal access to the latest technologies and software tools to enhance their global competitiveness and to encourage higher value added exports. To that end, the import of software in any form was permitted and various procedures were simplified. The policy also invited foreign investment and promised to make venture capital available to encourage new firm formation and export growth.

The 1984 and 1986 policies were championed by Dr. N. Seshagiri, Additional Secretary at the Department of Electronics (DoE) who had long argued that India's policies were too restrictive, its procedures too cumbersome and the idea of self-reliance was self-defeating (Sridharan 1996). He also argued that for India to become a major software exporter, it would

⁴ IBM's 1978 departure from India, after its refusal to comply with the requirements of the Foreign Exchange and Regulation Act, is indicative. For details, see Grieco (1984).

⁵ Rajiv Gandhi's administration also initiated the computerization of the railway reservation system and several government processes. One of his most innovative contributions was the creation of the Center for the Development of Telematics (C-DoT) that pioneered indigenous digital switching technology to facilitate India's shift from electromechanical to digital switching and transmission.

have to begin with high volume, low-value-added exports and move up the value chain. He believed that India's failure to follow such a strategy had left it far behind the East Asia NICs in hardware exports. Thus, the 1984 policy explicitly recognized bodyshopping, or the provision of labor-intensive, low value-added programming services, such as coding and testing, at client sites overseas, as valid exports. In spite of some ambivalence within the government about promoting bodyshopping, which a few technologically conversant policy makers regarded as “intellectual coolieism”⁶, Seshagiri was able to push through his policy only because of misconceptions that prevailed about software among most policy makers:

. . . if the administrators and some of the bureaucrats had too deep knowledge, they might have prevented bodyshopping or on site services. Software was seen as a glamorous high tech industry. So they said, alright, do it.⁷

If limited understanding of the software industry allowed Indian firms to begin body shopping, it also prevented policymakers from taking decisive steps to actively promote the software industry. The 1984 and 1986 policies merely removed barriers to its growth. Sen writes that: "until 1991-92, there was virtually no policy support at all for the software sector. Even the term ‘benign neglect’ would be too positive a phrase to use in this connection” (Sen 1994, 55).

The greatest challenge for Indian companies in the 1980s was the lack of the international telecommunication links that are the necessary infrastructure for software exports. While the export of data via satellite links was permitted, establishing an earth station was a long-winded procedure requiring permission from multiple government departments. When Texas Instruments set up the first earth station in Bangalore in 1986, for example, the process involved removing or breaking 25 different government rules.⁸ Without reliable telecommunications links, Indian firms had no alternative to providing contract programming on-site (at the customer's facilities), typically in the U.S.⁹

The Software Technology Parks (STP) scheme introduced by the Department of Electronics (DoE) in the early 1990s insured that the infrastructure and administrative support for exporting were available *in* India. An STP is like an export processing zone for software. It

⁶ Interview with N.Vittal, former Secretary, Department of Electronics, New Delhi, 25 June 1996 cited in Parthasarathy (2000).

⁷ Interview with N.Seshagiri, former Additional Secretary, Department of Electronics, New Delhi, 24 June 1996 cited in Parthasarathy (2000.)

⁸ *Ibid.*

gives export-oriented software firms in designated zones tax exemptions for five years and guaranteed access to high-speed satellite links and reliable electricity. The DoE also provides basic infrastructure including core computer facilities, reliable power, ready-to-use office space, and communications facilities including 64 Kbps data-lines and Internet access. As in the predecessor programs for Export-Oriented Units, firms in the STP are allowed to import all equipment without duty or import licenses, and 100 percent foreign ownership is permitted in exchange for a sizable export obligation.¹⁰

STP firms are also allowed to freely repatriate capital investment, royalties and dividends after paying the necessary taxes. Administratively, the STPs provide a decentralized, single window clearance mechanism for applications from potential investors. While STPs can be established by anybody, anywhere in the country, the DoE announced the first three in 1990 in Bangalore, Pune and Bhubaneswar, and another four the following year.

In June 1991, the Software Technology Parks of India (STPI) was registered as an autonomous agency, reflecting the desire of the DoE to avoid direct government involvement in the industry. The local directors of individual STPs have wide ranging powers and are intended to serve as “friend, philosopher and guide” to the industry while also functioning as the eyes and ears of the DoE.¹¹ Inclusion of industry representatives on the boards and councils of the STPs was also meant to emphasize the industry-friendly approach of the scheme. By 1998 there were 25 STPs under various stages of planning and development in different parts of the country (in addition to those sponsored by the DoE.) The Information Technology Park, Ltd. in Bangalore, for example, is a partnership between the Karnataka government, Tata Industries and a consortium of Singapore firms.

The introduction of the STPs coincided with the initiation in 1991 of the economic liberalization process in India.¹² Software producers benefited from general policy changes such as the devaluation of the rupee and the growing openness to foreign direct investment. They also benefited from the exemption from income tax of profits on software and other service exports

⁹ The terminology used in the Indian software industry can be confusing: onsite services are those in which programmers work at the customer's facilities, while offshore services are performed in a remote location, in this case in India.

¹⁰ Firms have to earn a net amount equal to 150% of the hardware imported within four years. They also have to earn a net amount equal to 150% of their wage bill on an annual basis. Though the STP scheme was meant for 100% export units, in January 1995 STP firms were allowed to sell 25% of their output to the domestic tariff area. The figure was revised to 50% in 1999 (Parthasarathy 2000.)

¹¹ Interview with S.K. Agarwal, Director, STPI, New Delhi, 20th June, 1996 cited in Parthasarathy (2000.)

and, most importantly, the 1992 removal of import licensing on equipment and industrial imports. This allowed Indian companies to import the computers that its clients used and produce or modify software for them directly.

To summarize, the policy reforms of the 1980s facilitated the emergence of an export-oriented software industry in India. However export growth in this period was based exclusively on body-shopping on-site (with Indian programmers working at the client site, typically in the US.) The shift to offshore production, allowing the programmers to work at facilities in India, was only possible following the reforms of the early 1990s, particularly the removal of licenses on imports of industrial equipment and the establishment of the STPs.

Even after the pace of liberalization slowed in the rest of the economy in the mid-1990s, the software industry continued to benefit from a series of sector-specific policy reforms. This was largely due to aggressive lobbying by the industry association, National Association of Software and Service Companies (NASSCOM.)¹³ In 1997, for example, all import duties on software were eliminated and software firms were allowed to invest in foreign joint ventures and wholly owned subsidiaries to a limited extent.¹⁴ And in 1998 software firms were permitted to offer ADR/GDR linked stock options to employees.¹⁵

The active role of the industry association, NASSCOM, in shaping policy distinguishes the software industry from the computer hardware and other older Indian industries. NASSCOM has been influential in shaping the Department of Electronics (DoE) strategy of working with software companies to provide critical infrastructure, while explicitly avoiding more detailed regulation or intervention. This is evident, for example, in the decision to organize the STPI program as an autonomous unit (and eventually to privatize it.) The DoE thus represents a very different model for India than an older generation of “strategic” ministries that sought to specify, develop, and directly regulate technology and industry structure.¹⁶

¹² For further details on policy changes in 1991 and since, see Krueger and Chinoy (this volume.)

¹³ NASSCOM was founded in 1988 with 38 members. By 1999 it had 464 members and accounted for 95% of software industry revenues.

¹⁴ Firms were allowed to invest up to 50% of their foreign exchange earnings in the previous three years, subject to a maximum of \$25 million.

¹⁵ ADR/GDR- American/Global Depository Receipts. The ADR is a certificate issued by a US bank that trades like a share on NASDAQ, allowing the US investor to invest in a foreign market without having to deal with risk of currency transactions. ADRs represent a certain number of domestic shares of the firm deposited with the bank. GDRs are similar to ADRs, except that they are traded on international stock exchanges such as London. The Reserve Bank of India permits Indian employees to remit up to \$50000 in a block of 5 years to ADRs/GDRs.

¹⁶ See Parthasarathy (1999b) for a detailed analysis of the telecommunications case.

NASSCOM's leaders interact continually with politicians and policymakers, and the association is represented on many influential committees of the Government of India. It also sponsors high profile conferences and studies, consults for state governments, and promotes the Indian software industry around the world through a very effective web site as well as attendance at international trade shows and foreign visits.¹⁷ NASSCOM is also the sole source of IT industry data in India. Its annual Strategic Review provides the only detailed and up-to-date figures on employment, revenues, exports, and market share for the software and other IT industries. This provides leverage for the association, but is not an optimal situation for policymakers or scholars.¹⁸

Software Industry Growth and Transformation, 1984-1998

The post-1984 policy changes were crucial to the growth of the Indian software industry because they allowed domestic producers to exploit domestic resources in global markets. India's greatest asset is a large, educated, English-speaking workforce that is willing to work at relatively low wages. In spite of widespread illiteracy, India boasts thousands of educated engineers who have remained either under-employed or unemployed for decades. Few countries can match India's combination of low-wage, high-skill workers. In 1994, wages for software programmers and systems analysts in India were less than one-tenth of those for their US counterparts, and lower even than other developing countries like Mexico (Table 2.)

Indian programmers also had the unanticipated advantage of familiarity with the Unix operating system in the 1990s. The failure to develop a commercially viable computer following IBM's departure from the country meant that Indian users relied on imports of a wide range of models and vintages from different manufacturers. Indian programmers thus learned to work on a variety of platforms, which proved helpful in acquiring contracts for the maintenance of various legacy systems. More important, computer manufacturers in the 1980s had no alternative but to rely on Unix (the first portable, machine-independent, multi-user operating system) even though foreign companies were developing proprietary systems at the time. By the 1990s,

¹⁷ See <http://www.nasscom.org/>.

¹⁸ NASSCOM's data includes only the numbers provided by its members and thus overlooks large numbers of smaller software and IT companies that are not part of the Association. NASSCOM's goal of promoting software industry may tend to bias the data as well. Future policy reform would ideally include creation of a reliable, independent source of detailed industry data.

however, when Unix became the system of choice for PCs and workstations, India's Unix programmers had a skill that was extremely scarce elsewhere in the world.

Indian producers entered the world market in the 1980s by exploiting their cost advantage in the most routine, low-value added segments of software production such as coding, testing and maintenance. The vast majority of these exports derived from bodysourcing, which has been referred to as an "input-less" export because it requires only an overseas contract, a minimal amount of finance, and names of local programmers (Heeks 1996.) In these contracts, the amount of software code is specified in advance and revenue is earned per line of code. Indian engineers who work overseas are paid their salaries in rupees and provided with minimal allowances for housing and expenses. Some refer to this business as "resume selling" because it is, in essence, a lucrative form of labor cost arbitrage. And India boasts ample resumes. Indian educational institutions and polytechnics train more than 67,000 computer science professionals annually. Another 200,000 individuals enroll annually in the private software training institutes that have mushroomed in India in the 1990s (NASSCOM 1999).

The policy changes of the 1980s are typically credited with stimulating the accelerated growth of Indian software exports. However it is worth noting that this growth, at least initially, was more impressive in rupee terms than in dollar terms. Using quarterly data, Sen (1994) shows that between 1987 and 1993 a significant portion of export growth was accounted for by the falling value of the rupee (Table 3.) The devaluation meant that the growth due to a lower exchange rate was almost as great as the real growth rate in dollars.

The introduction of the STPs facilitated a gradual shift away from on-site to offshore (in India) service provision during the 1990s.¹⁹ While on-site production accounted for 90% of Indian software exports in 1990, the share had fallen to 58% by 1998 (Parthasarathy 2000a, 28). One advantage of offshore production soon became apparent. The 12 1/2 hour difference between Indian Standard Time and Pacific Standard Time allowed Indian firms to perform maintenance and reengineering tasks for U.S. customers by accessing their computers after regular users had finished for the day. This, combined with growing shortages of skilled labor in the West helps to explain why hundreds of U.S. and European corporations increasingly

¹⁹ By 1995, 435 companies were registered under the STP scheme, accounting for more than 16% of exports (STPI, 1995.)

outsourced routine, labor-intensive projects, such as coding, maintenance and Y2K solutions, to Indian software houses in the 1990s.

A growing number of foreign companies followed the earlier model of Texas Instruments and Hewlett-Packard and located offshore development centers (ODCs) in India in the 1990s. They were motivated by the labor cost difference, to be sure, but the availability of high quality skill was essential to these decisions as well. According to one U.S. employer in Bangalore, the low wages matter because they provide an attractive trade-off to working in an environment plagued by chronic infrastructure problems:

. . . we came here because of the skills. We expanded because of the skills. We were able to come to India because the risk of being 10,000 miles away, the risk of the satellite link and the telephones and the flights were offset by the costs.²⁰

There is anecdotal evidence that in the late 1990s the ODCs began to take on more sophisticated design and programming projects, either jointly or independently, and often as equal partners with their parent organizations.²¹ This underscores the potential for upgrading in India. The chief executive of one ODC explains why his company waited until the 1990s to move to Bangalore:

Now . . . the feeling is that high-tech, leading edge quality, timely, delivered, supported software will come out. That was not a risk you could have taken five years ago . . . if they had asked me then, I would have said no. I would have said, 'do anything, bodysourcing, subcontracting, modular work, but don't give full dependability here [in India] because nobody's ever done it. It's not proven.'²²

He compared the work done at his center with that at the headquarters in Silicon Valley:

New products come from here, new versions of old products come from here . . . products on a particular hardware platform come from here as opposed to an application for a customer . . . It's the same thing that they do over there. Technologically, there's zero difference.²³

The growth of offshore facilities also allowed some established Indian companies to begin building a base of in-house knowledge and to develop internal training programs, quality processes, and productivity tools. This has facilitated the upgrading of their capabilities. In December 1999, 137 Indian companies had obtained either ISO 9000 or SEI-CMM Level 2 certification, and ten companies were certified at Level 5 (the highest level, at which only six U.S. companies are certified.) Quality certification serves as an important marketing device for

²⁰ Interview with industry representative, Bangalore, July 30, 1996 as cited by Parthasarathy, 2000

²¹ The engineers at Texas Instruments development center, for example, developed a new (DSP) chip that has become a standard.

²² *Ibid.*

²³ *Ibid.*

Indian companies while also improving their ability to manage time and resources involved in large projects (Arora 1999.)

Today, some of the largest Indian software houses, such as Wipro and Infosys, have track records that allow them to win bigger consulting contracts, often on a turnkey basis.²⁴ This allows them to take on a greater range of software development processes and managerial tasks (such as overall project scheduling, quality and productivity) than are required in bodyshopping and to begin charging higher rates for their work. Rather than competing on the basis of hourly productivity they aim to accumulate intellectual property by converting the knowledge gained during a series of consulting projects into broadly applicable software components that can in turn be customized for clients with similar needs. Industry observers have suggested that India's share of the world market for customized, as opposed to packaged, software is significantly higher than the aggregate data suggest (Arora et. al. 2000).

In spite of the evidence that a handful of Indian software companies are gradually moving up the value chain and gaining international recognition for their quality and performance, the industry as a whole remains significantly less productive than its global competitors. While the Indian software industry employed some 180,000 workers in 1998, the annual revenue per employee in India was \$15,000-20,000. This compared to \$100,000 per employee in other software producing countries such as Israel and Ireland (Arora et al. 2000).

Moreover, it appears that the software boom has exacerbated the brain drain. Programmers in India are increasingly aware of the global demand for their skills and the substantially higher compensation available in more developed economies. Many thus aspire to work for foreign companies not only for the relatively high wages but also for the opportunity be transferred overseas. The U.S. has been a major beneficiary. A recent study of the H-1B visa, which grants temporary work authorization to highly skilled foreign persons, reports that Indian H-1Bs grew steadily from 1989 clearly becoming the largest category in 1994, doubling in size by 1996, and quintupling by 1999. Indians accounted for nearly half of all visas issued in 1999 (47 percent.) This amounted to 55,047 Indian workers in 1999 alone, and a total of 195,083 between 1989 and 1999. The next largest groups of H-1 visa holders were from the UK and China, but each accounted for 6% or less of the total visas granted (Lowell 2000).

²⁴ Five companies account for close to 50% of software industry exports: Tata Consultancy Services (TCS), Infosys, Pentafour, Tata Infotech and Wipro.

There is growing recognition among Indian policy makers and software producers of the need to accelerate the industry's shift into higher value-added activities for two different reasons. On one hand, the developmental potential of the current trajectory is quite limited. The provision of routine software services for export may be highly profitable for individual companies, but it provides few opportunities for longer term technological learning and upgrading (Arora et. al. 1999).

Meanwhile, India's labor cost advantage is eroding, in spite of its sizeable labor pool. The software industry association estimates that wages in the software industry rose 21% per year in the late 1990s, albeit from a low base (NASSCOM 1998). Some analysts report that shortages of IT professionals are constraining the industry's growth.²⁵ As a result, India's producers face increasing competition from other low-wage, human capital rich countries like the Philippines and China. In the words of Ashank Desai (1999a), chairman and managing director of Mastek Ltd, a leading Indian software company:

Indian [software] corporations are at a crossroads, faced with growing globalization and competition . . . it is becoming difficult for them to compete only on one differential—the cost advantage; and this forces them to move to higher value addition in their offerings.

The IT Action Plan

While the central government initiated India's economic liberalization in the early 1990s, the state governments have pioneered some of the most far-reaching policy innovations in the IT sector. The Chief Minister of Andhra Pradesh, Chandrababu Naidu has drawn attention both in India and around the world for his entrepreneurial, high profile attempts to attract technology investment to the state and to promote the use of IT in his administration. Naidu has effectively promoted the concept of “e-governance” (the use of IT in delivering public services) as a way to insure greater accountability, transparency, and efficiency in the government of Andhra Pradesh. Many of the state's departments—such as Treasury, Employment, Commercial Taxes, Rural Development, Registration, Irrigation, Excise, and Police—are being computerized in order to both reduce corruption and improve service delivery.²⁶

²⁵ "India hit by shortage of IT professionals" *siliconindia.com*, May 21, 2000 <http://www.siliconindia.com/>

²⁶ One project will facilitate integrated delivery of 18 services (such as payments for water, electricity, property taxes, etc.) from six different departments. Another, the Multi Purpose Household Study, will develop records of all individuals in the state, and provide uniform data for all of the departments. See <http://www.andhrapradesh.com>

Naidu's efforts have triggered escalating competition from neighboring states. The recently elected government of Karnataka, for example, has laid out an ambitious plan for upgrading its overburdened roads and other infrastructure. The governments of Tamil Nadu and Kerala are also developing IT policies that include investing in infrastructure, computerization of government offices, single window clearance for IT ventures, and IT-related education. Today Andhra Pradesh and the other southern states where the software industry is concentrated are well ahead of the Government of India in their implementation of e-governance and other IT reforms.²⁷

Naidu has thus initiated a bottom-up process of policy reform in this historically centralized polity. He has been a vocal proponent of national policy reform as well. His recent book, *Plainly Speaking*, lays out his views on many issues related to governance and information technology in India. He calls, for example, for greater devolution of central tax revenues to state governments and greater flexibility in fiscal management. He also argues that there is an urgent need for administrative reform and for the removal of discretionary powers in a country where "bloated governments have bled their exchequers dry." And he claims that the IT-related initiatives undertaken by his government have helped to re-define the meaning and content of governance within the country. Naidu was also instrumental in raising the issue of IT at the national level.²⁸

The Prime Minister's office responded in 1998 with the formation of the National Task Force on Information Technology & Software Development. The Task Force was a high-powered group that included senior representatives from the private sector, government, and universities. It included Naidu and Sheshagiri (currently Director of the National Informatics Centre) as well as the Executive Director of NASSCOM, senior executives from Infosys and Wipro, and a range of other scientists, professionals, educators, and military officials. It also seconded the Secretaries of the Departments including Electronics, Finance, Commerce, and Telecommunications,

The Task Force moved extremely quickly--far more so than is the norm in India--and released its *Information Technology Action Plan* a year after the group was convened. The Task

²⁷ The IT industry is concentrated in Andhra Pradesh, Karnataka, and Tamil Nadu largely because of their concentration of engineering manpower. Sixty percent of India's computer science graduates come from these three states (Dossani 2000.)

Force also developed an unusually open and transparent process for collecting information and formulating recommendations, a process that involved consultation with an unusually wide variety of public and private-sector actors.²⁹ All of the Task Force documents are available on the Internet, and, in the words of one of the background reports:

This is the first time in India that representatives of so many ministries, departments, industry associations, business houses, educational institutions and State Governments have interacted so intensively and in such a short period of time to cover so many bottleneck and promotional areas...³⁰

As a result, the *IT Action Plan* is the most ambitious IT-related policy proposal in India since the Computer Policy of 1984 and the Software Policy of 1986. The Plan lists 108 recommendations of "revisions and additions to the existing policy and procedures for removing bottlenecks and achieving a pre-eminent status for India." And it sets as targets for 2008, \$50 billion in software exports and "IT penetration for all."

The report is wide-ranging in coverage and sober in its assessments of the current constraints on IT development, in spite of often hyperbolic (if laudable) goals. It reflects a clear understanding of the needs of the industry and of the limitations of the Indian business environment—an understanding that could only have grown through consultation with the private sector and other industry specialists. This collaborative process in itself reflects an important step forward in policymaking in India. However the laundry list nature of the report raises concerns about the implementation process and what, if any, processes are in place to insure that the more politically difficult or longer term reforms are carried through.³¹

The *Action Plan* addresses the two concerns that are most frequently articulated by software and other IT producers in India: (1.) the inadequacy of the infrastructure: telecommunications in particular, but also roads, airports, and power supply; and (2.) the cumbersome bureaucracy and regulatory red tape involved in doing business.³² As we have seen, India's telecommunications, roads, and air transport infrastructure rank extremely poorly, in the

²⁸ This summary is drawn from a review of Naidu's book on the Official Website of Andhra Pradesh, <http://www.andhrapradesh.com>

²⁹ The Task Force set up four working groups, on IT Research, Design and Development, IT Human Resources Development, Citizen-IT Interface, and Content Creation and Content Industry. These each had 12-16 members and drew in a still wider range of perspectives. The Task Force Secretariat also reportedly received some 8,000 e-mail messages providing policy suggestions. See <http://it-taskforce.nic.in/>

³⁰ *IT Action Plan (Part I-Software)*, National Taskforce on Information Technology & Software Development, July 4, 1998, <http://it-taskforce.nic.in/>

³¹ Sheshagiri claims that 80% of the recommendations have been implemented already, but there is no way to confirm this figure (Prabhakar 2000b.)

³² See, for example, Desai (1999b); Saxenian (1999).

bottom 10% of ranked countries, on a global scale (Krueger and Chinoy, this volume). Take telecommunications: in 1997 there were only 18.6 telephone mainlines per 1000 people in India, compared to 55.7 in China, and the wait for a new connection was 12.17 months, compared to China's .68 months.³³ The state of the infrastructure imposes significant direct and indirect costs on producers and undoubtedly constitutes a barrier to foreign investment.³⁴

The processes of starting and running an IT business in India has been simplified and streamlined since 1984. However the complex rules and lengthy procedures for transacting business remain a source of tremendous cost and frustration. The costs are especially severe for companies in globally competitive industries like software, where success depends critically on speed, or “time to market.” In the recent words of Infosys chairman N. R. Narayana Murthy: “If you want to be the first mover in India, please expect a lot of delays and trying times . . . though in absolute terms the country may have made substantial progress, on a relative scale we have slowed down.”³⁵

The infrastructure section of the *IT Action Plan* calls for liberalization of the telecommunications market, particularly in the area of data communications, and expanded access to the Internet. It recognizes the bottleneck created by the power of the Department of Telecommunications, Mahanagar Telephone Nigam Ltd. (MTNL) and Videsh Sanchar Nigam Ltd. (VSNL) in this sector. The report’s recommends: (1.) elimination of the license fee for Internet Service Providers, (2.) termination of the VSNL monopoly as international gateway for the Internet, (3.) removal of the DoT monopoly on the long-distance backbone to allow railways, state electricity boards, and others to host fiber-optic backbones, (4.) provision of free permits for last mile access, and (5.) opening of a specified radio frequency band for public wireless usage.

The *Action Plan* also provides 39 recommendations calling for systematic rationalization of Indian duty structure and of the Companies Act. It proposes the exemption of public and private infrastructure providers from all import duties. It proposes phasing in the zero-duty regime earlier than was agreed to at the World Trade Organization's Information Technology

³³ World Telecommunication Indicators, International Telecommunications Union, 1998

³⁴ It is worth repeating the McKinsey-NASSCOM estimate that as much as \$23 billion in IT export revenues and 650,000 jobs fail to materialize over an 8-year period because of limitations of the telecommunications infrastructure, NASSCOM (1999).

³⁵ Cited in C. Chitti Pantulu “Entrepreneurs should be prepared for delays, says Narayana Murthy” *The Financial Express* February 6, 2000

Agreement in 1996. This section also recommends an overhaul of financial regulations to enable the accelerated expansion of IT. It designates IT as a priority sector in order to insure a greater flow of funds from banks into the industry, it calls on banks to establish VC funds and it recommends the removal of regulatory constraints limiting availability of venture capital. It also proposes expansion of the software industry definition to include IT-enabled service exports such as data-entry, call centers, and other back office operations, to insure that these businesses benefit from the tax exemptions currently granted to software exports.

The section on “IT for all by 2008” calls for development of e-commerce or cyber law, a campaign for universal computer literacy, schemes to insure provision of computers and the Internet in all schools, colleges, and public hospitals by 2003, and a variety of IT programs in universities. This section also calls for IT in rural India, the use of Indian languages for computers, and the development of indigenous technologies. The final section recommends bringing IT into government by allocating 1-3% of the budget of each ministry and department for IT applications.

This *IT Action Plan* has provided an impetus for change as well as an ambitious roadmap for India in the IT sphere. Prime Minister Vajpayee signaled his political support for the Plan in late 1999 by creating a new Ministry of Information Technology to oversee its implementation. The newly appointed IT Minister has in turn promised that all of the recommendations will be implemented by 2001. Many, such as the development of cyber law and regulations concerning overseas investment in venture capital, have been acted on already.³⁶ Other sections of the Plan will be significantly more difficult to implement for political or institutional reasons (e.g. because of resistance from bureaucrats who fear the loss of control) or because they are far too ambitious—at least in the short run.

A telling example of the challenges involved in achieving regulatory reform in India today is the recent efforts to facilitate the growth of the venture capital (VC) industry. The *IT Action Plan* recommends the promotion of VC, and most industry representatives and analysts agree that a dynamic venture capital industry will be critical to the long-term development of Indian IT. They argue that a healthy VC industry will stimulate new entrepreneurial entry,

³⁶ Task Force convener Sheshagiri claims that roughly 80% of the recommendations have been implemented, but it is very difficult to assess this claim.

broaden the range of activities in the field, and accelerate the country's move into higher value-added activities.

However the supply of venture capital in India remains very small by international standards, largely because the industry is governed by a multiplicity of conflicting and often cumbersome regulations and discriminated against in a variety of ways. The industry is currently regulated by three different regulatory bodies: the Securities and Exchange Board of India (SEBI), the Ministry of Finance, and the Central Board of Direct Taxes (CBDT). In addition, foreign VC firms are also governed by the Foreign Investment Promotion Board (FIPB) and the Reserve Bank of India (RBI). As a result there are now three different, and inconsistent, sets of regulations governing the industry. For example, each prescribes different investment criteria for VC funds. These statutes in turn compete with existing corporation, tax, and currency laws--many of which are extremely anachronistic (including some that predate India's independence.)³⁷

This helps account for the modest size of the VC industry in a financial system that boasts substantial domestic and foreign investment. In 1998 there were only 21 companies registered with the Indian Venture Capital Industry Association with approximately \$700 million available for investment. This compares to Israel's 100 firms with \$4 billion investible funds (in 1999) and Taiwan's 110 funds with \$1.32 billion investments. Moreover, most of India's VC firms are funded either by the public sector or multilateral funding agencies.³⁸ These firms typically lack the expertise or contacts in the IT field or the willingness to take risk that would be essential to the sort of value-added financing that is associated with VC in places like Silicon Valley.

In an attempt to address these limitations, in 1999 SEBI convened a Committee on Venture Capital, led by a successful NRI entrepreneur from Silicon Valley, K.B. Chandrasekhar, with the task of recommending steps to promote VC in India. The committee's report develops a comprehensive vision for the growth of India's VC industry, based on a survey of the global experience, and it proposes a series of regulatory and institutional reforms to achieve this goal.³⁹ The SEBI board adopted the report in January 2000, signaling the seriousness of the government's intentions to pursue its recommendations.

³⁷ The discussion of India's venture capital industry draws from Dossani and Saez (2000.)

³⁸ *Ibid.*

³⁹ See the *Report of K.B. Chandrasekhar Committee on Venture Capital* to the Securities and Exchange Board of India at <http://www.sebi.gov.in/>

However many of the committees proposals require changes that go beyond SEBI's jurisdiction, so that the final outcome will depend on the report's acceptance by other parts of the government, particularly the CBDT, the FIPB, and the RBI. Thus the pace of change remains difficult to predict, in spite of the ongoing efforts at reform by the MOF (which, for example, recently proposed exempting venture capital funds from direct taxation) and SEBI, as well as the support of the IT Ministry for these reforms.

IT in Indian Development: The Need for a Larger Vision

Comparisons between Indian regions like Bangalore, where future IT growth depends either on continued supplies of low cost of skill or on shifting into higher value-added activities, and the world center of technological innovation, Silicon Valley, remain premature at best. This is not to discount either India's achievements or its potential. India's large skill base is an important competitive asset in the knowledge-based economy. And the successes of Indian engineers in the U.S. demonstrate their technical and entrepreneurial capabilities when working in a supportive environment.

However comparisons with Silicon Valley are misleading because they imply that India could, or should, seek to replicate the U.S. model in information technology. There are compelling reasons why India will need to define its own pathway in the IT era. Silicon Valley emerged in the post-war U.S. economy with the advantage of a large domestic market, a widely educated population, and well functioning infrastructure and regulatory institutions. The same factors have facilitated the swift diffusion of information technology into the U.S. economy and society--and supported a virtuous cycle of technological innovation to meet the needs of local producers and consumers.

In India, by contrast, a vast rural, as well as urban, population lives in poverty, lacking even minimal levels of education (Kochar, this volume.) The nation's transportation and communications infrastructure remain woefully inadequate (Krueger and Chinoy, this volume). And substantial bureaucratic and regulatory constraints continue to hinder the modernization of the private sector. In fact, a recent survey ranked India's bureaucracy as the worst in Asia in terms of efficiency and integrity (Mukherji, 2000.)

The current approach to IT policy in India addresses the immediate obstacles to growth identified by a small number of established, export-oriented software producers. This has proven

successful: IT policy reforms, business confidence, and investment have become mutually reinforcing. This is reflected in the escalating valuations of technology companies on the Indian stock exchanges over the past year.⁴⁰ It is also reflected in the growing number of multinationals locating Overseas Development Centers in the established IT regions. And this process of policy reform continues. The IT bill passed in mid-2000, for example, sets up a framework for electronic commerce in India. The growing political influence of the software industry means that much needed regulatory reform, particularly in the telecommunications sector, is being initiated by the Government of India. And competition between state governments for IT investments should insure improvements in transportation and communications infrastructure, at least in select urban areas.

However there is need for a substantially broader perspective on policy than that determined by the immediate needs of the software industry. The current policy approach risks accelerating the growth of IT as a small, modern enclave in a poor and backward economy. The export earnings from IT are important to India's GDP growth and foreign exchange reserves but they could be detrimental to the rest of the economy. Several observers have cautioned against the dangers of the "Dutch Disease" in which dollars earned from a narrow sector like IT (which remains under 1% of GDP) sustain an increasingly strong Indian rupee and hurt the competitiveness of other less productive sectors of the economy (Mukherjee 2000.)

The concentration of the software industry in a small number of cities in the South has the potential to exacerbate the already disparate rates of growth across states and regions in India (Ahluwalia, this volume.) Software employment and investments are overwhelmingly concentrated in urban areas in the southern states of Karnataka (Bangalore), Andhra Pradesh (Hyderabad), and Tamil Nadu (Chennai) along with the western state of Maharashtra (Mumbai) and areas surrounding Delhi. The evidence from the US suggests that such spatial agglomerations of IT production resist decentralization due to powerful supply-side externalities in the provision of skill, inputs, and technology.

Moreover, as incomes in the software sector increase, they will likely continue to diverge from those in other sectors. Professionals in IT enclaves could become better connected, both economically and socially, to distant regions than to the rest of the Indian economy. Already most IT development occurs in STPs that are insulated from the day-to-day challenges of doing

⁴⁰ Software and related IT services companies now comprise 20-25% of India's total stock market capitalization.

business in India by dedicated communications links, private power sources, and liberal rules for investment and taxation. And while the growing traffic of managers and policymakers between India and Silicon Valley has obvious benefits for India, it risks creating an international technical community with diminishing ties to (or beneficial impacts on) the rest of the country.⁴¹

The task for policymakers who aspire for IT to become more than an enclave in an otherwise backward economy is to develop a wider range of industries and institutions to support the economic and spatial diffusion of IT. This will require more far-reaching attention to development of the infrastructure and education in rural as well as urban India. It will also require a sustained attack on the political and bureaucratic obstacles to the adoption of IT in both public and private sectors. Indian workers today are contributing to the development of software to modernize foreign governments and corporations while their counterparts at home remain woefully backward.

While investment in IT grew rapidly in India during the 1990s, the country's use of IT remains extremely low by international standards. In 1996, spending on IT was only 0.5% of GDP in India compared to 2.8% in the U.S. and 1.3% in Malaysia. In 1997, India had only 2.1 PC's per thousand people compared to 406.7 in the U.S. and 46.1 in Malaysia. Even China and the Philippines boasted higher rates of PC penetration, with 6.0 and 13.6 per thousand people, respectively. Finally, in January 1999, India had only 0.13 Internet hosts per 10,000 people, while Malaysia had 21.36 and the Philippines, 1.21 (Table 4.)

This is by no means to suggest that India pursue a policy of “computers at all costs.” Indeed we have seen that there are many other (often more pressing) needs in India, ranging from investments basic infrastructure to improvements in the quality and accessibility of education. And it is possible that a place like Malaysia has actually over-invested in IT given its level of development. The disappointing performance of the Multimedia Super Corridor, which has failed to attract private investments, suggests that the substantial resources devoted to its high-speed communications network and other 21st C infrastructure might have been more wisely invested.

However judicious investments in information technology offer the opportunity to improve the productivity of many other sectors of the Indian economy. Applications could be

⁴¹ Mukherji (2000) describes historic examples of Indian breakthroughs in mathematics and metallurgy that largely bypassed the general population and economy, often providing benefits outsiders.

developed to meet many of India's domestic needs: from revamping the education and health care systems to modernizing the retail and agricultural sectors. The state of Andhra Pradesh has been a leader and a model in public sector adoption of IT. Naidu's administration has pioneered the computerization of land records, for example, which improves the efficiency of public service while also reducing (formerly ample) opportunities for corruption. The challenge for India is to overcome the bureaucratic resistance motivated by fear of the loss of jobs--or of opportunities for graft.

IT also offers potential efficiencies in a wide range of private sector activities from distribution and marketing to banking to agriculture. Farmers, for example, can use IT for managing their timetables, crop scheduling, soil testing, insect and rodent control, as well as for marketing and water management. Similarly innovative applications of IT can help develop local language software and local content that will allow the entire population of India to access the benefits of the Internet. This too will require both the continuation of liberalization and regulatory reforms as well as incentives for investments in innovation to meet domestic needs.

Looking Ahead: Strategies for IT

The new communications technologies have generated important new opportunities for India that should not be overlooked, opportunities to expand remote services such as medical transcription or call centers. These IT-enabled services involve tasks that are too routine for western workers, but not so repetitive that they can be automated. Such remote services could ultimately provide more employment in India than the software services sector since they depend not on engineers but on large numbers of people with English language skills and willing to work for very low wages.⁴²

In addition, most scenarios for the IT sector envision Indian software companies starting to develop innovative products and applications as well as continuing to provide low-value added services for export (NASSCOM 1999.) Yet they typically overlook the opportunities in India for a localized process of innovation. IT producers typically must work closely with customers to develop expertise and to define and test new products. Yet as long as Indian software houses continue to rely primarily on exporting, they forgo the opportunity to test and perfect products through interaction with end-users.

⁴² See "Indian Business-Spice Up Your Services" *The Economist*, January 16, 1999.

India has the technical skill needed to experiment with developing new products and services for the domestic market. In this scenario, IT products would be developed as a means to enable creative solutions to local problems. The prerequisites for such a strategy include continued deregulation in telecommunications, support for entrepreneurship, and leveling the playing field so that IT products and services sold domestically enjoy the same tax benefits as those currently enjoyed by software export units. This should allow the private sector to find economically viable ways to serve the domestic market.

This strategy involves a commitment to experimentation with technology appropriate to the Indian environment. Products developed in the West are typically too costly and provide more features than are needed by the vast majority of the Indian population. If products and services were developed that were affordable and reliable, they could transform what is now a potential market into a very sizeable customer base. Take a product like an electronic pager. The pagers available in India today are produced in the West and sell for approximately Rs. 2,200, well beyond the means of most of the Indian population. However the technology is so simple that a pager could be developed and manufactured locally for only Rs. 100. At this price it would be affordable to 20% of the Indian population (which is a very large market, equal to the size of the West.) Such products would in turn be likely to have substantial export potential elsewhere Asia, in Latin America, and in the rest of the developing world.⁴³

The Simputer represents a model of innovation to meet domestic needs. The Simputer is a very low-cost mobile personal computer (priced at under Rs 9,000, or approximately US \$200) that was developed by a Bangalore-based team of engineers. The team--which is drawn from the Department of Computer Science and Automation at the Indian Institute of Science (IISc) and a local design company, Encore Software--designed the product explicitly for the Indian market. While the Simputer is extremely low cost, it applies leading edge technologies. It is based on free software (the Linux operating system), designed to be open and modular, and offers multiple connectivity options. It also includes a SmartCard reader/writer, which provides a delivery vehicle for financial transactions on the Internet and for E-commerce.

The Simputer project offers a model of collaboration for India, as well as an innovative product. The collaboration between the IISc and Encore, a public sector university and a private

⁴³ Remarks by Ashok Jhunjhunwala, Conference on Equity, Diversity, and Information Technology, National Institute of Advanced Study, Bangalore, December 1999.

sector company, is rare in India, but offers a way to efficiently leverage local capabilities. Similarly, a team at the Indian Institute of Management, Bangalore, is conducting a study of the likely applications for such a device in rural and semi-urban areas. Some of the potential applications include using the Simputer as a platform for microbanking, for data collection, for Internet access, for dissemination of agricultural information, and as a laboratory for experiments in rural schools.

India already has the design capabilities for developing such products. These capabilities are also evident in the growth of VLSI design in the ODCs, as well as in the activities of some small indigenous firms like Bangalore-based Silicon Automation Systems and Encore, currently develop the sophisticated intellectual property components for semiconductor design. However India lacks the environment needed to support experimentation with the application of these skills to new markets.

Policies to support innovation should facilitate new firm formation. While existing producers typically have resources and experience, as well as established reputations, entrepreneurial start-ups offer flexibility and focus without vested interests. This is why they are frequently the first-movers in defining innovative products and services. In India, however, the ten largest firms account for more than fifty percent of software exports at the same time that they represent a small proportion of the total firms in the sector.⁴⁴ A vibrant entrepreneurial sector could ideally generate innovative small firms that, over time, collaborate with established IT producers to take advantage of their respective strengths.

Venture capital is the first step toward encouraging entrepreneurship. If widely available, venture capital can support multiple experiments with new products, new services, and new applications. But venture capital alone is not sufficient. The greater challenge for India will be to create the social and institutional environments that support a decentralized process of experimentation and innovation. The lesson of Silicon Valley is clear: entrepreneurship is a collective, not an individual process. It depends upon a wider process of collective learning, typically within a localized community (Saxenian 1994.) Such a technical community is built through collaborations of the sort that are rarely practiced in India today: collaborations between firms of all sizes, ages, and specializations, between firms and universities or research institutes,

⁴⁴ NASSCOM (1999) reports that there are 826 companies in India engaged in the business of software exports.

and between firms and financial institutions (especially venture capital.) The Simputer project represents an important model that should be replicated across India.

Collaboration between IT start-ups and established producers with knowledge of particular domains could be especially important in the Indian context. A Bangalore company, Innomedia Technologies, for example, developed a low-cost technology for interactive television that uses existing cable-TV infrastructure to provide video on demand, interactive media and online shopping. Once the technology was defined, the firm built an alliance with the large, established manufacturer, Reliance Industries, to undertake volume production and distribution.

Such collaborations can, of course, involve partners from other regions in India and even elsewhere in the world. The large NRI community in Silicon Valley could become an invaluable resource in identifying and coordinating such long distance partnerships. However the precondition is the creation in India of the local networks that support the recombination of capital, skill and technology into new ventures. Such an environment is emerging from an R&D group led by the Telecommunications & Computer Networks Group (TeNeT) at the IIT Madras. This group includes university faculty, several small R&D companies formed by alumni, as well as distant collaborators. The group's mission is to make possible 25 million Internet connections in India in less than ten years. TeNeT has strategic alliances with IC manufacturers abroad to develop wireless access, fibre access, and Internet access systems specific to the needs of developing countries (Jhungjunwala et. al. 1998.)

Comparable networks can be created in other regions. Policymakers (state governments, ideally, since they are typically closer and more responsive to local needs) might provide incentives for collaborations between companies, or between companies and local universities or other research institutions. Or they might facilitate associational activities that bring together local producers, researchers, and service providers to seek solutions to shared problems such as the shortage of skilled labor or the need for better infrastructure. This process should facilitate the creation, cross cutting social and technical networks that, over time, support information sharing and collective learning.

The independent, outwardly oriented companies and institutions that currently characterize the Indian scene have the potential to become localized technical communities with differing specializations related to their institutional and resource endowments. India's secretive

public sector units, such as the aerospace and defense research outfits in Bangalore, for example, could provide a rich source of technological opportunities if their boundaries were opened up and skill and know-how were allowed to flow more freely within the region. Similarly, venture capitalists and other service providers could, with time, become more knowledgeable about local capabilities, opportunities, and resources in order to play a growing role in coordinating and facilitating local experiments across India.

Finally, while the Indian Institutes of Technology produce among the best engineers in the world, their graduates still leave the country in large numbers. This group (or even a subset of them) could play a technological leadership role in India in the coming decades if more were to return or stay in the country. As it stands now, however, too few remain or return to make an impact. By accelerating the deregulation of telecommunications and other key sectors, upgrading the physical infrastructure, and enhancing conditions for entrepreneurship, the government could create conditions under which more NRI's would be willing to invest in the Indian economy. It is even possible that young Indian engineers would return in far greater numbers than in earlier generations if they saw viable economic opportunities at home. This could make a substantial difference to India's future.

Concluding Comments

The IT industry has brought a wide range of important and tangible improvements to India. It has provided the confidence that India has a future in the new economy. And it has generated jobs, wealth and exports. Moreover, the pace of policy reform in the IT industry has been unprecedented. This reflects, at least in part, the opening up of the policy debates to include new actors. The industry association, NASSCOM, has accelerated the policy reform process through its aggressive lobbying while helping to define a minimally interventionist model of industrial promotion. Meanwhile entrepreneurial state governments, spurred by the example of Andhra Pradesh, have pioneered a potentially far-reaching, bottom-up, process of policy reform.

However there are also substantial dangers in the current fascination with IT in India. The challenge today is two fold. First, there is a need to be very realistic about the limits of software as a development strategy for India. Bangalore is not Silicon Valley and IT is not going to solve all of India's problems. IT is still a very small piece of the Indian output and exports,

and even if it grows rapidly it will remain only one among many sectors that contribute to Indian development in coming decades.

This suggests the second challenge, the need to widen the range of participants in the policy debates and to broaden their scope still further. The alliance between the large software industry and the government has restricted the debate over IT policy. The goal should not be to simply meet the needs of a handful of producers, but rather to use IT as a means to strengthen the fabric of the entire economy and to enhance opportunities and living conditions for the whole Indian population.

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Table 1. IT Industry in India, 1993-99 (US \$m)

	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
<i>Software</i>						
Domestic	230	350	490	670	950	1,250
Exports	330	485	734	1,083	1,750	2,650
Total	560	835	1,224	1,753	2,700	3,900
<i>Hardware</i>						
Domestic	490	590	1,037	1,050	1,205	1,026
Exports	93	177	35	286	201	4
Total	583	767	1,027	1,336	1,406	1,030
<i>Grand Total</i>	<i>1,143</i>	<i>1,602</i>	<i>2,296</i>	<i>3,089</i>	<i>4,106</i>	<i>4,930</i>

Source: NASSCOM, 1999,2000

Table 2. International Wage Rates, Software Industry, 1994

Country	Programmer U.S. \$	Programmer Index	Systems Analyst U.S. \$	Systems Analyst Index
India	4,002	100	5,444	100
U.S.	46,600	1,164	61,200	1,124
Japan	51,731	1,293	64,519	1,185
Germany	54,075	1,351	65,107	1,196
France	45,431	1,135	71,163	1,307
Britain	31,247	781	51,488	1,287
Hong Kong	34,615	865	63,462	1,166
Mexico	26,078	652	35,851	658

Source: Business India (1995: 199) as cited in Parthasarathy, 2000.

Table 3. Decomposing the Annual Growth of Indian Software Exports, 1987-1993

Period	Total Growth	Real Growth	Exchange Rate
1987-1993	46%	28%	18%
1987-1990	41	29	12
1990-1993	52	28	24

Source: Sen as cited in Parthasarathy (2000)

Table 4. International Reliance on Information Technology

Country	IT Spending/GDP, 1994	PCs per 1000 people, 1997	Internet Hosts/10,000 people, Jan 1999
U.S.A.	2.8%	406.7	1131.52
Singapore	1.9	399.5	210.02
South Korea	1.6	150.7	40.00
Ireland	1.3	241.3	148.70
Malaysia	1.3	46.1	21.36
Mexico	0.9	37.3	11.64
Brazil	0.9	26.3	12.88
Thailand	0.6	19.8	3.35
Philippines	0.5	13.6	1.21
China	0.5	6.0	0.14
India	0.5	2.1	0.13

Source: IT/GDP: OECD (1997), PCs: World Development Indicators, 1999-2000