The Causes and Consequences of India's IT Boom

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This article examines the causes and consequences of India's success in IT (information technologies) and in particular in the software sector. From its genesis in simple coding and "body-shopping," India's IT exports have gradually climbed up the technological ladder even as they have diversified their geographical and market segments. More recently, opportunities in IT-enabled services and remote processing – from medical transcription to insurance claim processing, from payroll and human resource services to customer interaction services, data digitization and geographical information systems, call centers, digital content and legal databases and online education – have emerged as the most dynamic drivers of the technology-led services industry in India. Offshore back-office operations now encompass not only routine clerical tasks but also highly skilled professional activities drawing on India's large pool of skilled as well as semi-skilled professionals with relative cost advantage.

How did a country whose success in both exports and industrialization has been modest, suddenly achieve prominence and global competitiveness in a leading edge sector? Is India becoming the back-room office of the world?[1] More generally, is India becoming to global service trade what China has become to global manufacturing trade?[2] And if so, what explains this change, and what are its consequences?

In attempting to answer these questions this paper first examines the different dimensions of growth of India's IT sector. It then examines the causes of India's success in this sector, and the broader economic and political consequences of the IT sector's success for India. Finally, it lays out some broad implications for industrial policy in general and India in particular.

Dimensions of Growth

The IT sector is India's much-hyped success story, a globally competitive industry that for the first time has placed the country on

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India Review, vol. 1, no. 2, April 2002, pp.91–110.
PUBLISHED BY FRANK CASS, LONDON

the global map of a rapidly growing sector. The Indian IT industry was a ten billion dollar sector in 2000, two-thirds of which was software and one third hardware.[3] India's software sector is predominantly export-oriented, with about two-thirds of its turnover coming from foreign sales. Of the remaining one-third that is domestic, indications are that it is largely accounted for by the sales of imported packages. The industry exported software and services worth $25 million in 1985. By 2000/01, this figure had grown to $6.4 billion and is expected to reach $8.5 billion in 2001/02. Software exports grew at 41% annually in the 1980s and 47% in the 1990s (in current rupees) and 33% and 39.6% respectively (in current dollars). Overall growth rates over the last two decades have been 43.7% (in current rupees) and 34.4% (in current dollars, see Figure 1). The IT software and services industry registered a growth of 55 per cent in 2000/01, touching $8.26 billion in revenues against $6.2 billion in 1999/2000.[4] Although the recent global slowdown has affected this sector, growth rates are still likely to be about 30% in 2001/02. Given the much higher base, this slowdown will still result in quite respectable outcomes.

Indian firms now hold 1.5–2% of the global software services market. Although India's share of global merchandise exports barely grew in the 1990s (from 0.6 to 0.7%) its share in global services trade doubled (from 0.6 to 1.2%). About 16% of the global workforce in this sector, which employed about 340,000 professionals in 2000, is Indian.[5] Although IT only accounts for just under 2% of gross domestic product and 14% of exports, it is likely to grow to about 6–8% of GDP by the end of the decade. Moreover, even as the base has rapidly expanded, the growth of software sales, both exports and domestic, has been fairly stable over the last decade with a lower bound of at least 30%.

The rapid growth is based on a deep and broad industrial structure. While in 1994/95, only eight companies had exported software worth more than Rs. 50 crore, in 2000/01 75 companies had exports exceeding Rs. 50 crore ($11 million) worth of IT software and services, while 30 firms had exports exceeding Rs. 200 crore ($44 million). During 2000/01, India exported software and services to 102 countries around the world. Out of the total software exports, almost 62% went to the US and Canada, 24% to Europe, and 4% to Japan. There are, however, indications of increasing industry concentration. Sixty per cent of the revenues generated were from the top 25 firms and the recent industry slowdown is likely to result in a shake-out of the weaker firms.

Over this period, the software sector in particular has both climbed up the value chain and grown in technological sophistication, and now spans a broad array of emerging services and technologies. From the much derided "body-shopping" (wherein firms act as skilled labor contractors, with the labor doing simple coding jobs on mature and well-defined products), the sector has gradually upgraded its capabilities from adaptation to modification to project management.[6] Several develop-ments indicate ongoing technological upgrading. Onsite services - most of which consisted of "body-shopping" - which were more than 95% of all exports in 1990, had declined to 56% by the end of the decade. Research and development spending had increased from 2.5% in 1997/98 to over 4% per cent during 2000/01, and is expected to increase further as firms try to go up the value chain.

Explaining Growth

One of the puzzles about the explosive growth of India's IT sector is how and why India has emerged as a global leader in a leading edge industry when, despite strenuous (and, in retrospect, misguided) policies, it failed to achieve such leadership in any other technology-intensive sector (with the possible exception of pharmaceuticals). The issue is even more puzzling if one keeps in mind that India ranks poorly when measured by conventional indicators of IT penetration, such as personal computers (PCs) per thousand population, internet subscribers, telephone connections, scientists and engineers per million. The country's telecommunications infrastructure remains weak, and few Indians have access to a PC, let alone to the internet.[7] The Indian government only recently put into place policies that would encourage such investments.[8] India's ranking in the United Nations Development Program's (UNDP's) new Technology Achievement Index (TAI) is a modest 63 (below even Paraguay, Ecuador and El Salvador), not exactly indicative of a country that has achieved a buzz in the extremely competitive and sophisticated global IT markets.[9] The sector's performance has also contradicted critics who argued that Indian software firms appeared to be locked into a low level equilibrium, participating predominantly at the low end of global outsourcing arrangements, with the movement to more complex jobs constrained by the small domestic market.[10]

Conventional explanations for India's success in this sector emphasize comparative advantage and the absence of state intervention.

The software sector uses those resources (low-cost, high-skill human resources) in which India enjoys international competitive advantage, while making less use of resources in which India is at a competitive disadvantage, namely physical infrastructure and financial capital.[11] The average annual wage of software professionals in India has been somewhat lower at Purchasing Power Parity wages (between 10 and 20% of comparable US wages).[12] Overall costs are also considerably lower – costs per line of code development are less than a third that of the US, and costs for systems support services are a quarter that of the US.[13] Unlike other sectors of the Indian economy, state intervention has been markedly different. India's IT minister, Pramod Mahajan, once quipped that India is a leader in "IT and beauty contests, the two areas that the government has stayed out of." Undoubtedly, there is much merit in this argument. The industry is driven by private sector firms that compete in global markets; while the state's regulatory role is relatively limited, its role as direct producer is even more sharply so.[14] The non-material nature of the sector's output constrains the myriad state agencies' grabbing hand – from octroi (a local tax) to customs to unionized public-sector ports. Two other explanations that are part of the conventional explanations of growth – exports and labor market flexibility – have characterized India's IT sector as well. As the data above show, India's IT sector is heavily dominated by exports and its labor market is almost as flexible as that of Silicon Valley. But these "explanations" themselves need to be explained. Why was the state's role facilitative? The lack of labor market flexibility in India has long been criticized – why was this never a problem in the IT sector?

Although the Indian state's role in the IT sector has certainly been different, it would be wrong to conclude that the state has played no role in the development of this sector. The historical roots of the industry lie in state intervention, while its later development owes some degree to the facilitative nature of state policies. A more nuanced perspective on the role of the state takes into account the change in the state's stance from a custodial (that is, protectionist) role to a promotional one, which, by some accounts,[15] began around 1984 when Rajiv Gandhi came to power. While this shift was certainly important for IT growth, its effectiveness was shaped by certain long term developments in which the state had played a central role.

Foremost was the historical compromise made by the Indian state in the late 1950s when language policy became a very divisive issue,

bringing the country to the brink of instability.[16] India's Southern states feared that accepting Hindi as the national language would ensure Northern political dominance. The compromise forged at Nehru's behest meant that, while Hindi would remain the national language, it would not be imposed on non-Hindi speaking states. Instead, English would henceforth enjoy the status of the official language. The compromise, while seemingly obvious in retrospect, demonstrated considerable statesmanship on the part of India's political leadership, since it enshrined the language of the just departed colonial power. This ensured that over the next few decades India developed a large pool of human capital that was versed in the English language, contributing to India's comparative advantage in software and IT-enabled services.

The Indian state's much maligned trade and industrial policies also had inadvertent positive effects for this sector. The departure of IBM in the late 1970s and the protection of India's hardware sector led to the development of software skills in a form of induced innovation. The very limitations, technological and cost, of hardware in India meant that developing software skills was the only way to overcome them. IBM's departure paved the way for the introduction of minicomputers and microcomputers. Most of these new systems used the UNIX operating language and as it gained popularity world-wide, Indian programmers had an early learning advantage.[17] The notorious MRTP (Monopolies and Restrictive Trade Practices Act) which limited the entry of existing large industrial houses in new sectors (as well as their expansion in existing sectors), meant that new firms began to enter the sector in the early 1980s. My analysis of the 100 largest firms in 2001 reveals that less than 10% were associated with a large industrial house. Although by 2001 a quarter were foreign, most of these had entered India only after 1990. Of the 11 fastest growing firms with revenues exceeding $50 million, not one was associated with an MRTP-designated industrial house in 1980 or 1990. The same is true of the medium-sized firms (revenues of $20–50 million). Of the 12 largest software firms (sales exceeding $100 million), only one is linked to a hitherto MRTP industrial house (TCS, part of the Tata group) and one is a multinational corporation (IBM Global Services India Ltd.). The rest are new firms, often started by individuals who broke away from other software firms and represent the new face of Indian capitalism.

The state's investments in R&D labs and tertiary education were also important in creating human capital and infrastructural clusters. The

India state's much maligned over-investment in tertiary education, especially in engineering, was critical in laying the human capital foundations of this sector. The six key IT clusters in India, Bangalore, Chennai (Madras), Hyderabad, Mumbai (Bombay), New Delhi, and Pune, had the highest concentration of public sector R&D establishments (especially defense) as well as publicly funded science and engineering educational institutions. This is similar to the pattern in the US where the role of DARPA (Defense Advanced Research Projects Agency) and defense-related IT expenditures did much to concentrate IT clusters in Boston, Austin, and, of course, Silicon Valley. The public investment clusters were important since, at least relative to the needs of manufacturing exports, the IT sector is not infrastructurally intensive. The ports, power plants, roads, and airports that are so essential for competitive success in global manufacturing markets are much less important for service sector exports. Moreover, the infrastructure for the IT industry can be easily clustered. Just as China concentrated its infrastructure for manufacturing exports in SEZs (special economic zones) the analog for the Indian software industry has been STPs (software technology parks), the "new temples of modern India," according to Indian Prime Minister Vajpayee.[18] Exports of software technology park units were estimated at Rs.18,000 crore in 2000/01, accounting for 63.15 per cent of overall software exports (in 1999/2000, the STP units had contributed about 60 per to Indian software exports).[19]

Finally, as discussed later, in the 1990s the Indian state, both at the center and the sub-national levels has, at least relative to other sectors of the economy, played a facilitative role in responding to the needs of this sector. Several government initiatives in the 1980s nurtured capabilities.[20] The establishment of Software Technology Parks in 1989 was again a state-driven initiative. The economic reforms of 1991, while helpful to all sectors of the economy, were particularly important for the software sector. Software firms, which had found it difficult to raise financing through debt because they lacked collateral, could now raise resources easily through equity. Although the 1991 reforms signaled that India had become receptive to foreign investment, low fixed costs, export-orientation and India's comparative advantage, led many MNCs (multinational corporations) to open facilities in India. Of the 95 MNCs in India in 1999, 70 entered India after 1990.[21] However, during this decade the MNCs had a greater role in spurring competition in factor

markets (for instance, innovative corporate strategies for attracting talent) than in product markets.[22] With domestic firms now easily able to import hardware and uplink easily, they were in a better position to compete off-site and reduce their on-site work abroad.[23] And critically the government granted the sector preferentially low tax policies. These tax breaks (along with foreign exchange gains) became an important non-operating income factor resulting in high average net margins (around 30%) for Indian IT services companies. The state has also helped build domestic demand: in 1999/2000, government spending constituted more than a third of all domestic IT spending in India (compared to 23% in the US in the same year).

A different interpretation of India's success is a *supply* side story. India is one of the largest producers of the human capital required by the software industry. Although this reputation was built on graduates of the Indian Institutes of Technology (many of whom migrated to the United States for higher education and jobs), these institutions account for barely 3% of the annual output of engineers. By the late 1990s India was producing about 65,000 engineers and 95,000 diploma-holders annually in engineering and technology,[24] through a large network of public and private colleges. The system was producing nearly 100,000 IT professionals annually, many through private institutes (the figure is projected to increase to half a million by 2006). The increasing wage premium for technically skilled human capital has on the one hand raised the demand for higher education, while on the other it has become an attractive business opportunity for the private sector. Private schools are augmenting the government's efforts to expand the supply of students to meet the anticipated needs of the software industry, exemplified by Karnataka and Andhra Pradesh. Karnataka has 132 engineering colleges with 25,000 seats, in addition to 200 diploma institutes. A further 78 colleges in engineering and science are to be permitted, with a possible addition of another 10,000 students. In Andhra Pradesh, the number of engineering colleges has gone up from 32 to 107 in the last five years and a further 30 will be added shortly. In addition, there are over 600 colleges offering courses in computer applications.[25]

Although much of this human capital is modestly trained, it is one of the few available pools of talent when global demand–supply imbalances increase. Thanks in large part to the H-1B program, thousands of Indian specialists (about 200,000 by the end of 2000),[26] were drawn into the US, and although this created cost pressures for Indian

firms, the industry benefited considerably. As John Miano, founder of the Programmer's Guild, argued, "There would be no better way for another country to develop a software industry than to be able to send workers to the United States to have them trained in software development and the ways of U.S. business."[27]

Another argument that has been advanced is that the technological underpinnings of software – its mathematical abstraction – is especially compatible with Indian society and culture. The cultural disdain amongst Indian elites to "get their hands dirty" has often been remarked upon as a reason for India's poor success in manufacturing. In contrast, Indian elites' high regard for abstraction and "clean work" find perfect resonance in software.

It has also been argued that India's open polity has been conducive to the free-wheeling atmosphere required to nurture internet-related services. Thus, although China has many more internet users than India, Beijing has imposed tough legal controls over political content on websites. These include regulations passed last year prohibiting subjects as wide-ranging as rumors, slander, and "harmful information." However, there is little evidence to support this argument and for all practical purposes internet users appear to enjoy a large degree of freedom in China.

Unlike other sectors of the economy, collective action on behalf of the private sector has been much stronger. The role of NASSCOM (National Association of Software and Service Companies) is particularly noteworthy. Industry associations in India have either been distant from the state or, in the case of peak industry associations, have had conflicting interests between upstream and downstream members. The lobbying, advocacy, and public relations role of NASSCOM has been unique in the annals of Indian industry associations. Not only does it represent almost all firms in the sector, both domestic and foreign (850 firms representing more than 95% of the industry's revenues) – thus giving the industry a unified voice – but it has also managed to work in tandem with the Indian state to jointly promote the sector's interests.

Finally the role of *serendipity* should not be underestimated. As in many other cases,[28] luck – not just successful policymaking – has been an important factor. By the late 1980s, India had become a clear laggard in manufacturing, even as East Asia had emerged as the golden boy amongst LDCs. At this juncture, two simultaneous and independent

events occurred: the IT industry boom accelerated, and India began to liberalize its economy. With East Asia locked into manufacturing, India's underutilized human capital assets suddenly found a booming demand for which alternative suppliers were not easily available. Another exogenous factor stemmed from technological developments in ICTs which led to a shift in the locus of value addition from hardware to software – away from India's weaknesses and into its strengths. Added to this was the fortuitous coincidence that the locus of the IT boom was the US. For one, the country's time zone complemented India's working hours – thereby allowing for round-the-clock project work between the two countries. And second, as we shall examine next, the presence of a large and successful Indian diasporic community in Silicon Valley also played a critical role.

The Role of Reputation

LDC firms face reputational barriers to entry in export markets, resulting from limited information that buyers may have about the quality of their products and service reliability. Because buyers in major export markets will have had little prior experience in dealing with these firms, they may be reluctant to do business with them. This places newcomers at a disadvantage relative to established firms, effectively creating a reputational barrier to entry. The importance of reputational barriers varies across industries and across segments within industries. Reputational barriers are likely to be greater in service sectors, such as software, for several reasons.[29] First, quality is more tacit, and *ex ante* determination of quality of the product or service is consequently more difficult. Second, the risk of extremely adverse outcomes associated with poor quality is high. Third, designing contractual mechanisms to mitigate information asymmetries is difficult. Fourth, timely, reliable supply is extremely important.

To mitigate these reputational handicaps, Indian software firms have adopted several strategies. The first is to structure contracts to take into account this weakness.[30] A second option is to form inter-firm linkages, through joint ventures ranging from joint projects to share cross-holdings.[31] Third, firms have tried either to open up branches in the US or buy US companies, which then serve as the "front office" providing a "reputational exterior" to the parent firm.[32] A fourth option, but one limited only to the largest companies, is to list on the New York Stock Exchange or NASDAQ, precisely because US securities laws are the

most stringent. The listing is a signal of quality and helps build the firm's reputation. A fifth option, much in favor with Indian software firms, is to get independent reputational certification. Indian IT firms have aggressively sought out this option. Half (24 of 49 as of end-March 2001) of the software development centers in the world with Carnegie Mellon University's CMM Level-5 (its highest) rating are located in India.[33] According to a survey of the top 400 firms by NASSCOM in January 2001, nearly half (196 firms) had already acquired ISO 9000 or SEI or other certification; another 80 were set to acquire such certification by the end of 2001 and another 90 by end-2002.[34]

This paper explores another mechanism – the role of the Indian diaspora (especially in the IT sector in the US) as a reputational enhancement mechanism. Its importance is underlined by the growing importance of global production networks and the role of diasporas as networks facilitating economic exchange.[35] Networks embedded in social institutions mimic market structures through signaling and informational exchange among participants and affect the flow of information in fundamental ways, shaping content, access, and credibility of information. The Chinese diaspora has played that role in labor-intensive manufacturing exports from China by providing market information and matching referral services. The network effects are greater for differentiated rather than homogenous products, which means that with the increasing informational intensity of international trade, network effects are likely to continue to be important.[36] The effects are probably even greater in the growing segment of trade ignored by these studies: services. Recent work on "ICs" (Indians and Chinese) in Silicon Valley has provided interesting insights on the economic effects of diasporic networks on the IT industry in China, India, and Taiwan.[37]

India's experience demonstrates the long-term consequences of cognitive externalities arising from the brain-drain. First, it has played an important role in boosting the confidence of overseas investors about India's potential despite its innumerable problems. Companies like Yahoo, Hewlett Packard, and General Electric opened operations in India largely because of the confidence engendered by the presence of many Indians working in their US operations. According to one estimate, 71 of the 75 multinationals in Bangalore's software technology park were headed by Indians who had lived and worked overseas, especially in the US.[38] Diasporic networks act as reputational

intermediaries and as credibility enhancing mechanisms which may be particularly important in economic sectors where knowledge, especially *ex ante* knowledge of quality, is tacit. For instance the Indian diaspora's success in Silicon Valley appears to be influencing how the world views India, reflecting the reputational spillover effects of success in a leading sector in a leading country. It has created a "brand-name," wherein an "Indian" software programmer sends an *ex ante* signal of quality just as a "made in Japan" label sends an *ex ante* signal of quality in consumer electronics. India's IT talent is being courted not just in the US, but in other countries where Indian emigration had slowed to a trickle (the UK) or had been very small to begin with (Germany, Finland, Japan, and South Korea).

Second, the overseas Indian presence has helped in the diffusion of knowledge through a variety of mechanisms. Given the technological frontier in the US, there is substantial skill upgradation when Indian technology professionals work in the US, through learning by doing. To the extent that some return while others circulate between the two countries, technological diffusion occurs through imitation, mimicry being an effective way to reduce search costs. Just as Korea climbed up the technological ladder by importing capital equipment of recent vintage (which embodies frontier technologies), diasporic networks embody technologies in human (rather than physical) capital. India's success in software exports can at least in part be explained by the strategic, informational, and reputational roles played by its diaspora, stemming from the position of the diaspora in global production networks.

Another network effect – increasing collective action – is evident in the role of TIE (The IndUS Entrepreneur), a group of Indian IT entrepreneurs and network professionals founded in 1992. In less than a decade the group emerged as a successful – and politically powerful – networking organization. From its core North American and Indian markets TIE expanded and grew to 25 chapters (including five in India) extending to the UK, Singapore, and Switzerland, where South Asian communities sought to become part of the TIE phenomenon. The core of this network has been a group of angel investors who got rich by starting companies and who then began recycling both their wealth as venture capitalists, and also their knowledge and expertise. While most of their wealth was directed at funding US companies, they also funneled funds into a new generation of start-ups in India, as well as

hybrid companies and investment funds that operate in both India and the US. Equally, if not more importantly, members of the group have played an important role in advising (and pressuring) the Indian government to change the regulatory framework for venture capital in India. As a result, the Indian Venture Capital industry has grown rapidly in the last few years. In 1998 there were fewer than half a dozen venture capital firms in India. By 2001, India had 36 domestic venture capital firms and 75 foreign funds. The investable amount held by these funds amounted to $5 billion of which $2 billion had been committed by end 2001.[39]

The complex effects of human capital flows from LDCs to richer countries are evident from the attitude of Indian IT firms to the increases in the caps for temporary high-skilled workers in the US – the so-called H1-B visa program. Indian IT professionals dominate these visas: Desai *et al.*[40] estimate the stock of H-1B visa holders in the US (by the end of 2000) at about 400,000, of whom about half are from India. Interestingly, as these visa caps were being raised over the past few years, the Indian IT industry – rather than opposing them on the grounds that they would exacerbate the brain drain – has supported them enthusiastically.[41] The reason lies in changes in the market structure of the global IT industry, itself a lagged effect of previous brain-drain. Ten of the largest 25 companies hiring foreign nationals with H1-B visas are IT firms based in India or US-based IT firms run by Indian nationals.[42] The availability of this labor pool has played a vital role in the expansion of Indian-owned and Indian-run firms operating in the United States who have "private" information ("deep knowledge") on IT workers from their country of origin. The brain drain has become a vital mechanism for India's booming IT sector to have workers trained in software development and the ways of US business.

It should be emphasized that India's success in software is principally the result of domestic entrepreneurs and domestic capabilities. The role of the Indian diaspora and international human capital flows from India simply highlights additional mechanisms that are important in understanding sectoral growth processes.

Consequences for India

While the IT sector has been the most rapidly growing sector of the Indian economy, its share of GDP or the labor force is still quite modest. Although the IT sector offers some promise that it could allow India to

"leapfrog" vintage technologies, thereby accelerating its economic growth,[43] my claim is that the critical effects of India's success in the IT sector have been – and will continue to be in the immediate future – indirect. For one, the success of IT, more than any other change, has helped legitimize capitalism in a country whose intellectuals have long harbored suspicion of markets and the private sector. As Indian Prime Minister Atal Bihari Vajpayee recently argued, "the shining success of Indian IT professionals, both in India and those working in the U.S. and elsewhere in the world, have unleashed a tremendous energy among our people. Most of the success stories are scripted by first generation entrepreneurs, who were not born in the families of *lakhpatis* and *crorepatis* (millionaires)." As a result, there has been a marked shift in the preferences of India's younger generation. Entrepreneurship, long derided, is now celebrated. For the first time a generation of young Indians does not face a choice between making money and making it "cleanly." For younger Indians this is a revolutionary idea, and one that is having a broader effect on India's capitalism. The sector is also having an important impact on corporate governance practices, serving as an exemplar for the corporate sector more broadly.[44] There appears to be a virtuous cycle with the most dynamic firms, the ones with the best corporate governance practices, being most easily able to attract financial and human capital. And unlike other models for success, because this one is indigenous, it has greater legitimacy.

A second effect – and a double-edged one – is that, criticisms of hype notwithstanding, IT has become the contemporary Indian *zeitgeist*. Despite the recent slowdown there is a strong confidence in India that the sector will grow rapidly, and that its growth can contribute to a break with India's lackluster record of overall growth and human development. Even state governments that disdained capitalism are wooing the IT sector, to the extent of bearing the criticisms of capital in a manner that they would have found unacceptable a few years ago. Recently, at the launch of the Kolkata Chapter of the IndUS Entrepreneurs, Kanwal Rekhi, the organization's founder, excoriated the Marxist state government in the presence of the Chief Minister Buddhadeb Bhattacharjee: "West Bengal has a serious image problem and the state government will need to rebrand itself if it is to attract global investments ... no amount of foreign aid can help unless the state is perceived as genuinely productive. ... Only entrepreneurs can generate wealth, governments can only destroy ... the good ones destroy

wealth slowly while the bad ones do so more rapidly. ... [I]t is high time governments turn facilitator rather than be an inhibitor of economic activity."[45] If this had been said by the World Bank or the representative of a foreign company or government, the state government would have been apoplectic. In this case, however, it kept its counsel.

Indeed, this injunction by industry is one that is increasingly shared by the Indian state itself. Thus Law Minister Arun Jaitley, while opposing calls for his Ministry to rapidly formulate cyberlaws, argued that "The country did not traditionally have any laws on IT and as a result, the IT sector was able to flourish in a largely unregulated environment. The IT sector is a success story in India due to private initiative."[46] This correlation has put pressure on political elites to let Indians do as well within India as they do when they go abroad. The sense is that India missed the industrial revolution, and it should not let the IT revolution pass it by.

With India's software industry migrating upwards to higher value-adding activities, its target markets have broadened beyond the United States and its success has spilled over into other knowledge-based services. The geographic spillover occurred because of positive brand-name externalities. Indian IT experts are in global demand from the EU to East Asia, the result of a virtuous cycle, with success in the US leading to a global expansion of demand for Indian IT experts and a corresponding expansion of the social and economic network of overseas Indians. At the same time, India's success in software is spilling over into success in other knowledge-based services for several reasons. First, software success has enhanced India's reputation and credibility as a provider of skilled services, given that software is seen as a "sunrise," high technology sector rather than a mature, low technology sector. It is no longer improbable for MNCs to consider India a location for such services. Second, other knowledge-based services leverage many of the same strengths India enjoys in software – namely, access to a large pool of skilled, inexpensive, English-speaking talent – by employing, for example, doctors, scientists, chartered accountants, consultants, or mathematicians. As in the case of software, public educational and research institutes nurture talent in these fields too, and, increasingly, they will be supplemented by private institutions as demand grows. Third, software and IT are "general purpose technologies" with large spill-over effects in other economic sectors. Capabilities built up in software can be leveraged in other high-technology fields such as bio-informatics, pharmaceuticals, and media and entertainment.[47]

At the same time, there are many concerns. Linear projections of future growth extrapolating from the past should be treated with skepticism. And if perchance these high growth projections were to turn out to be true, it would create a new set of macroeconomic problems from India. IT-related exports alone could well exceed all current account payments by the end of the decade, completely dominating all other parts of the economy.[48] This could well put strong upward pressure on the Indian currency with inimical consequences on other sectors of the economy, especially manufacturing. Thus, even as more and more global firms are drawing upon India's engineering talent to set up engineering design centers (especially in Pune), there is little move to do so in manufacturing. It is possible that these developments reflect global production networks where India is emerging in the upstream design and engineering base and as a large consumer, but not as a manufacturer. A more troubling effect has been the distortionary consequences of the rapid growth of the IT sector on the allocation of talent. The dual combination of booming domestic demand and international mobility led a wide range of talent – from civil engineers to doctors – to repackage their skills to work in the IT sector (for instance doctors serving as medical records transcribers). As a result, other important sectors of the economy, especially non-tradable sectors, be it public administration, construction, or medical services, are being starved of talent. Additionally, these labor market developments are affecting India's educational institutions with better students (and prospective faculty) de facto exiting the vast majority of ill-equipped state universities and opting for private courses. Whether this form of "exit" will result in greater pressure to reform India's moribund universities remains an open question.

Critics argue that the inordinate focus on the IT sector will only amplify India's inequalities. More than half of India's villages lack telephone connectivity, let alone internet access, and rural internet and telephony have yet to take off. Chandrashekhar reflects the skeptical view of the effects of the IT industry, arguing that any benefits have been confined to an urban elite, and that its growth has been based on cost advantages rather than deeper technological capabilities, making the continuation of growth doubtful.[49] In addition, the fiscal costs have been large since the export segment enjoys tax-free status. The rapid expansion of India's call centers, building on India's large low-cost labor pool (with low rupee costs and high dollar revenues, Indian call centers

are about 40% cheaper to run than US ones), is an example of the sort of activity that worries some observers who see in it evidence of a proliferation in India of a new proletariat – "cyber coolies." But the operations of running such a center require a degree of technological and organizational competence that is anything but "low tech." In any case, the high demand for call center jobs indicates that this is a sought-after career (unlike in the advanced industrial countries). And at least in one case – gender empowerment – the IT sector is mitigating inequalities, since participation rates of women in this sector are relatively higher than other sectors in the organized economy.

More pertinent are concerns that India cannot truly benefit from its growing strength in the field of information technologies without servicing its own domestic needs first, particularly rural India where nearly 70% of Indians reside. There are some indications that state governments are developing initiatives in e-governance, e-commerce, and e-education for the rural sector. The Gyandoot intranet system, which commenced operations in January 2000 in Dhar district in Madhya Pradesh (one of India's poorest states) using the state's *zilla panchayats*, illustrates the possibilities. The panchayats bore the expense for Gyandoot (about Rs.25 lakh or $0.5 million). Local rural youths were drafted as entrepreneurs to run *Soochanalayas* (information centers) on commercial lines (based on user charges). The Soochanalayas are housed either in the gram panchayat buildings in block headquarters or at prominent market bazaars and villages which are on the main road. The system, which reaches over half a million people living in about 800 villages in MP, appears to be eroding the monopoly of a few people over information and records which were once a source of exploitation and corruption. Papers would get lost, files misplaced – either through negligence or by design. Now, if a citizen has a complaint, it is recorded in Gyandoot and supervisory staff at any level can log in and find out why related files have not been put up, allowing complaints to be easily monitored. Farmers use the Soochanalaya to avail of government services from caste certificates to variety-wise rates of crops twice a day. Documents relating to their land are now immediately available and can be used as extracts for the purposes of banking transactions in local cooperative banks. If India's masses are to benefit from theIT revolution, initiatives such as Gyandoot and other innovations are essential.[50]

Conclusion

India's success in the IT sector raises many questions. Is the "model" replicable, both in other sectors in India and in other countries? If so, what are the policy and other initiatives required to accomplish this? Is the state's role more conducive to the growth of newly emerging sectors, where there are fewer established interest groups? At another level, the question can be turned around to ask: is a dynamic, globally competitive software sector necessary to internalize the benefits from the IT revolution? These are difficult questions, but India's IT success does appear to hold one lesson for economic development. While "picking" winners may not be possible, having at least one winner is important. In India's case perhaps the most important consequence has been on the country's confidence. While investors and markets always emphasize the importance of confidence, the sources are unclear, other than positive outcomes. Despite this circular causality, the issue's importance is central. By the late 1980s, India had lost faith in itself, as its elites grappled with the reality of the country's growing relative backwardness, particularly in comparison to other Asian countries. The success of the IT sector served to legitimize capitalism to Indian political and intellectual elites who had only grudgingly accepted the reforms of the 1990s, much as China's successes with market-oriented reforms were the ultimate legitimizer of the reforms in that country. The important ingredients underlying the IT sector's success – export-led and private sector-driven growth with flexible labor markets and a limited role for the state – were not ones that India had embraced in the past.

At a different end, the rapid growth of wages in this sector raised the wage premium to human capital and in turn the demand for education. The demand for – and supply of – education sharply increased in the 1990s, accelerating growth in the country's human capital, despite stagnating public expenditure. Entrepreneurs, rather than bureaucrats, became the new role models, spreading the message that one could make substantial wealth, but without the manifest corruption associated with business. For India, whose public and private sectors have both been less than a paragon of virtue, this realization has been revolutionary.

State governments, where much of the reforms had been stalled, have begun competing with each other to the extent that IT is emerging as the wedge, driving reforms in a country whose political economy would otherwise make change even less likely. Finally, IT has reconnected India with its diaspora. The erstwhile envy and resentment of the Indian population, coupled with the disdain of the diaspora, have

given way to a substantially less negative view. If a country is to succeed, it needs to have the confidence that it can succeed. The IT industry may just possibly have served that purpose for India. And increasing India's confidence in itself may be IT's largest contribution to India's economic development.

NOTES

1. *Economist*, "Back Office to the World," May 5, 2001.
2. Devesh Kapur and Ravi Ramamurti, "India's Emerging Competitive Advantage in Services," *The Academy of Management Executive*, Vol.15, No.2 (2001), pp.20–31.
3. *Computers Today*, July 1–15, 2001.
4. National Association of Software and Service Companies (NASSCOM), www.nasscom.org/it-industry/indic_statistics
5. Nagesh Kumar, "Indian Software Industry Development. International and National Perspective," *Economic and Political Weekly*, Nov. 10, 2001, pp.4278–90, Table 14.
6. Ted Tschang, "The Basic Characteristics of Skills and Organizational Capabilities in the Indian Software Industry," Asian Development Bank Institute Working Paper 13, Feb. 2001.
7. It should be noted, however, that despite low levels of penetration the growth rates of PCs, internet connections, ISPs, optic fiber cables, cellular mobile phone connections are all extremely rapid.
8. For an analysis of the infrastructural – especially telecommunications – bottlenecks facing this sector, see Nirvikar Singh, "Information Technology as an Engine of Broad-Based Growth in India," University of California, Santa Cruz, April 2001.
9. United Nations Development Program, *Making New Technologies Work for Human Development* (New York: Oxford University Press, 2001).
10. Richard Heeks, *India's Software industry: State Policy, Liberalization and Industrial Development* (New Delhi: Sage Publications, 1996).
11. Kapur and Ramamurti, "India's Emerging Competitive Advantage in Services," pp.20–31; Ashish Arora and Suma Athreye, "The Software Industry and India's Economic Development," WIDER Discussion Paper No. 2001/20, http://www.wider.unu.edu/
12. Mihir Desai, Devesh Kapur, and John McHale. "Fiscal Impact of the Brain Drain: Indian Emigration to the United States," paper presented at NBER-NCAER Conference, Neemrana, India, Dec. 2001, Table 10.
13. World Bank, *Global Economic Prospects and the Developing Countries* (Washington DC: World Bank, 2002), Figure 3.4.
14. Of the 100 largest Indian IT firms, only one, CMC Limited, was a PSU (public sector enterprise). It was privatized in 2001.
15. Peter Evans, *Embedded Autonomy. States and Industrial Transformation* (Princeton, NJ: Princeton University Press, 1995).
16. Robert D. King, *Nehru and the Language Politics of India* (New Delhi: Oxford University Press, 1999).
17. Narayana Murthy, "Making India a Significant IT Player," in Romila Thapar, ed., *India. Another Millennium* (New Delhi: Penguin Books, 2000).
18. http://www.rediff.com/money/2001/jan/19pm.htm.
19. On the importance of innovation clusters, see Organisation for Economic Cooperation and Development, *Innovative Clusters: Drivers of National Innovation Systems* (Paris: OECD Publications, 2001).
20. Noteworthy examples include the National Informatics Center and complex computerization projects in state entities, especially the railways.
21. Kumar, "Indian Software Industry Development," Table 5.

22. The share of MNCs in total revenues and exports of India's software industry was 13.7 and 18.7% in 1998/99. Kumar, "Indian Software Industry Development," Table 4.
23. I am grateful to an anonymous referee for pointing this out.
24. World Bank, "India: Scientific and Technical Manpower Development in India," Education Sector Unit, South Asia Region, Aug. 2000. Report No. 20416-IN.
25. *Business Standard*, May 24, 2001.
26. Desai *et al.*, "The Fiscal Impact of the Brain Drain."
27. Testimony, Congressional Committee, 1999.
28. William Easterly *et al.*, "Good Policy or Good Luck: Country Growth Performance and Temporary Shocks," *Journal of Monetary Economics*, Vol.32, No.3 (1993), pp.459–83.
29. Devesh Kapur, "Diasporas and Technology Transfer," *Journal of Human Development*, Vol.2, No.2 (2001), pp.265–86.
30. Abhijit Banerjee and Esther Duflo, "Reputation Effects and The Limits of Contracting: A Study of the Indian Software Industry," http://web.mit.edu/eduflo/www/sofpap102-1.pdf, 2000.
31. Rakesh Basant and Pankaj Chandra, "Inter-firm Linkages in the IT Industry in India: A Case Study of Telecom Technologies," Indian Institute of Management – Ahmedabad Working Paper No. 2001-03-06, 2001.
32. An example of this is HCL Perot's purchase of a 1% stake in US-based $400-million software concern IXL for $3 million; in turn IXL guaranteed HCL Perot business worth $65 million for the next three years.
33. There are different quality ratings in software including SEI CMM Maturity Level 1 to 5, PCMM (People-CMM), SPICE, Boostrap, and ISO 9000. The Software Engineering Institute (SEI) at Carnegie Mellon University is the source of the Capability Maturity Model (CMM), a structured process for software development consisting of five "maturity" levels, with level 5 being the highest.
34. http://www.nasscom.org/business_in_india/nasscom_survey.asp.
35. James Rauch, "Business and Social Networks in International Trade," University of California, San Diego, 2000. Networks are groups of agents that pursue repeated, enduring exchange relations with one another. Broadly networks serve two purposes: a reputational role regarding past opportunistic behavior in business transactions; and an informational role regarding business opportunities in both trade and investment that matches agents characteristics to market opportunities.
36. James Rauch and Vitor Trindade, "Ethnic Chinese Networks in International Trade," *Review of Economics and Statistics*, forthcoming.
37. AnnaLee Saxenian, *Silicon Valley's Immigrant Entrepreneurs* (Public Policy Institute of California, 1999).
38. Pankaj Ghemawat, "The Indian Software Industry at the Millennium," Harvard Business School, Cambridge, MA. Paper no. N9-700-036, 2000.
39. *Economic Times*, Dec. 6, 2001.
40. Desai *et al.*, "The Fiscal Impact of the Brain Drain."
41. According to GAO estimates cited in Desai *et al.*, "The Fiscal Impact of the Brain Drain," 48% of H-1B visas granted in fiscal year 1999 were to individuals born in India, and nearly three-fourths of those workers approved for the IT sector were born in India.
42. The India-based firms are: Wipro, TCS, Infosys, and Tata Infotech. US-based firms founded and run by Indian nationals with major offshore operations in India are Mastech, Xoriant, Syntel, Intelligroup, Hi Tech Consultants, and Ipex.
43. Robert R Miller, "Leapfrogging? India's Information Technology Industry and the Internet," International Finance Corporation, The World Bank, Washington, DC Discussion Paper No. 42, 2001.
44. Arora and Athreye, "The Software Industry and India's Economic Development"; Tarun Khanna and Krishna Palepu, "Does Globalization of Markets Cause Convergence in Corporate Governance," Draft, Harvard Business School, 2001.
45. *Economic Times*, Feb. 15, 2001.
46. *Economic Times*, May 8, 2001.
47. Kapur and Ramamurti, "India's Emerging Competitive Advantage in Services," pp.20–31.

On the role of General Purposes Technologies in economic development see E. Helpman, *General Purpose Technologies and Economic Growth* (Cambridge, MA: MIT Press, 1998).

48. If software exports continue to rise at 50.9 per cent per annum, they will reach $158 billion in 2008/09. If payments for visible and invisible imports continue to rise at 7.6 per cent – the average rate between 1990/91 and 1999/2000 – they will reach $138 billion. In other words, India could very well finance all its imports of goods and services from exports of software alone by that year. If nothing else changed, it would not need any other exports – or foreign investment. And if other exports continued and foreign investment kept coming in, India would have to increase its import intensity. Ashok Desai, unpublished manuscript, 2001.
49. C.P. Chandrasekhar, "ICT in a Developing Country Context: An Indian Case Study," HDR 2000 Background Paper, Centre for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi, 2000.
50. Another notable example is the "minimally invasive education" experiments conducted by the Center for Research in Cognitive Systems at NIIT, one of India's biggest information technology companies. Kiosks containing PCs with internet connections were set up on streets. Street children immediately started playing with them, and although they had never seen a computer in their lives, they started surfing the internet in a matter of minutes, underlining the role of natural curiosity in learning. The social experience for children further enhances learning. Children learn much faster in groups because they mimic one another, spur one another on, and pool their learning. As soon as one child has discovered something new, that knowledge spreads to the rest, increasing the value of play and education.