IJARSE

International Journal of Advance Research in Science and Engineering

ISSN(O) : 2319-8354, ISSN(P) : 2319-8346

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Recent Trends in Technology and its Impact on Economy of India: Information Technology

in

International Journal of Advance Research in Science and Engineering

Volume No.06, Issue No. 10, October 2017

This paper can be downloaded from the following link: www.ijarse.com

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International Journal of Advance Research in Science and Engineering
Volume No.06, Issue No. 10, October 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

Recent Trends in Technology and its Impact on Economy of India: Information Technology

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ABSTRACT

Information technology (IT) is an example of a general purpose technology that has the potential to play an important role in economic growth, as well as other dimensions of economic and social development. This paper reviews several interrelated aspects of the role of information technology in the evolution of India's economy. It considers the unexpected success of India's software export sector and the spillovers of this success into various IT enabled services, attempts to make IT and its benefits available to India's rural masses, e-commerce for the country's growing middle class, the use and impacts of IT in India's manufacturing sector, and various forms of e-governance, including internal systems as well as citizen interfaces. The paper concludes with an overall assessment of these different facets of IT in the context of the Indian economy.

I. INTRODUCTION

In his foreword to the NASSCOM-McKinsey Report (2002) over a decade ago, India's Minister for Communications and Information Technology called for a joint industry-government effort to "ensure that the Indian IT sector remains a dominant player in the global market, and that we emerge as one of the leading countries of the new millennium". The first of these goals pertains specifically to India's information technology (IT) industry, which has done quite well in the ensuing decade. The second stated goal is much broader, much deeper, and much harder to achieve, seeming to imply that IT can be the cornerstone of India's development. Does it make sense to pin so much hope on India's IT industry? What contribution can it make to India's overall economic development? Can it help change the country, reduce poverty, change people's lives for the better? Or will the benefits be restricted to an educated elite with access to jobs and power? This paper offers a conceptual overview of the possible roles of IT in development, and the different dimensions in which IT impacts, or might impact India's economy.

One can say a little more about how well IT fits the characteristics of GPTs. Pervasiveness seems to be potentially a natural property of IT. In the Indian context, doubts about achieving pervasiveness are centered on issues of cost and access. Table 1, however, illustrates the important positive trends that support pervasiveness. Technological dynamism refers to the potential for sustained innovation that come with new GPTs, and is again illustrated by the dramatic fall in costs shown in Table 1. The complementarities of GPTs are vertical complementarities, because GPTs spur innovation and lower manufacturing costs in downstream sectors, with positive feedback effects to the GPT itself. [4] There are

also horizontal complementarities, since the downstream sectors may face a coordination problem in expanding sufficiently to encourage the improvement of the GPT (thus creating positive feedback). Note that international trade with a more advanced country may be one way to overcome some of these externality problems.

Table 1: Falling Costs of Computing (US$)

Costs of computing	1970	1999	2012
1 Mhz of processing power	7,601	0.17	<0.01
1 megabit of storage	5,257	0.17	<0.01
1 trillion bits sent	150,000	0.12	<0.01

The growth model that best captures the special role of IT (including communications, and including non-digital methods of storing and communicating information) is an extension of the recombinant growth model of Weitzman (1998). The details of this model are presented in Singh (2008). The central idea of this approach is that new ideas are formed through combinations of old ideas. A key property of this formulation is that the increase in the number of ideas is faster than geometric growth (Weitzman, 1998, Lemma, p. 338). In Weitzman's model, all ideas are the same, and the rate at which potential ideas are converted into new ones depends on a "success function." The extension of Weitzman's model, to capture the special role of IT in the innovation process, allows the stock of IT knowledge to independently affect the success rate. In this case, IT gives the growth process an extra 'kick', even beyond that which comes from recombinant growth in general.

The final aspect of IT's specialness explored here is that of efficiency gains and broader economic impacts. Static gains from the use of IT come from more efficient use of scarce resources, allowing higher consumption in the present: they are independent of any impact on growth. Benefits that are measurable as increased market-based economic activity, and hence show up in GNP statistics, are not the only component of development. Development can include improvements in the capabilities of the population, independently of any direct or indirect economic impact. Minimum levels of education, health and nutrition are perhaps the most important examples of such capabilities. The ability to participate in democratic decision-making can also fall into this category. Of course, broad-based improvements in the capabilities of a population can have positive impacts on long-run economic well being, but this is not a necessary condition for desiring such improvements. The role of IT in effecting improvements along non-economic dimensions must also be considered, though this role may be harder to quantify.

Digital IT involves the electronic processing, storage and communication of information, where anything that can be represented in digital form is included in the term 'information'. Information goods typically have the characteristic that one person's use does not reduce their availability for another person. Thus, a message or weather news can be viewed by many people, simultaneously or sequentially. Depending on the content of the

news or message, different people may place different valuations on the information. Only friends and relatives may be interested in a personal message, all farmers in a district may be interested in local weather news, and so on. The ability to share information among users can impact the feasibility of providing it on a commercial basis. IT dramatically increases shareability of information, and this affects the economics of private provision of information goods and services.

Information goods may also be provided by the government. The potential rationale for government provision exists for any goods that are shareable, and where users cannot be excluded. The classic example is national defense, but such goods may also be local in character,such as public parks or law and order. Of course many local shareable goods can be provided exclusively, in which case private provision is a feasible alternative (in a club-like arrangement). In such cases, government provision may be justified more on equity grounds than on the basis of failure of private provision. In some cases, government financing through taxes or statutory user charges can be combined with outsourcing of delivery to private providers to achieve both equity and efficiency goals.

Efficiency gains of IT can also come about through the enabling of new goods and services. In many cases, the new good is related to something available earlier, but is presented in a form that reduces costs and expands the size of the market. For example, recorded music is a mass-consumption item, whereas only a small minority of the population could afford or have access to live performances by the highest quality musicians. Educational material is another example where recording and duplication can replace more expensive, skilled-labor-intensive alternatives for delivery. The possibilities for interactivity with digital IT-based educational materials illustrate the advantages of digital IT over older technologies based only on recording and duplication. Interactivity also implies personalization, in that an individual can select the precise content that he or she wishes to see. This feature also distinguishes IT-based content from what was available through previous technologies. Finally, the sheer volume of information that is accessible through IT is much greater than before: this also allows new kinds of services to be provided at a cost that is affordable to larger segments of the population.

II. IT-BPO INDUSTRY

The numbers on India's IT industry tend to be well publicized by the industry association, NASSCOM (www.nasscom.org). NASSCOM has over 1200 members, over two-thirds of which have annual revenues exceeding US$ 40 million ("large" according to NASSCOM's own classification). [5] This association represents software (including services and products), as well as business process outsourcing (BPO), but excludes hardware manufacture. The latter term has mostly replaced an earlier term, IT-enabled services (ITES), in describing a whole range of activities driven by the use of IT in various forms. Estimates for 2012 on the IT-BPO sector project annual revenue reaching US$ 88 billion), or ten times the amount (in nominal terms) of a decade earlier. Growth rates have consistently been in double digits. Adding in hardware takes the total above US$ 100 billion. A decade ago, India's share of the world market, in terms of global expenditure on software and services, was about 2 percent, but the latest numbers represent about a 10 percent share of the global market. To compare the IT-BPO sector to GDP, one has to estimate the fraction of sales that constitutes value

added. Assuming this fraction to be two thirds would imply that IT-BPO directly contributed about 5 percent to GDP, well above the 1 to 2 percent estimated a decade earlier (Singh, 2002).

Exports continue to be critical to India's IT-BPO sector, accounting for over 3/4 of its revenues (US$ 69 billion). Contrary to initial negative portrayals of Indian IT exports and being the work of "techno-coolies," narrowly focused on low-return routine tasks such as software testing, India's industry has broadened the scope of its exports, as well as steadily moving up the value-added ladder. Even in the case of BPO, Indian firms have been moving from call centers to services that require higher skilled labor or more complex outputs. While call centers and accounting services remain the largest segments, areas such as data management, data analytics and legal services have increased in importance. Table 2 provides a listing of types of BPO and related services. NASSCOM also provides lists of the leading IT -BPO companies (the major companies are all in both spaces) and of BPO firms specifically, in terms of exports and employment. These are presented in Table 3. NASSCOM estimates direct employment in the IT-BPO sector to be 2.8 million, with indirect employment generation of another 8 million.

Table 2: BPO and ITES Types

Customer Interaction Services
Business Process Management; Back Office Operations; Accounting Services
Insurance Claims Processing
Medical Transcription
Legal Databases and Services
Digital Content
Online Education
Data Management and Data Analytics
Data Digitization/GIS
Payroll/HR Services
Web Site Services

Despite India's emphasis on import-substituting industrialization, it has not developed a robust, world-class manufacturing industry, and this includes IT hardware. Much of India's hardware industry consists of assembly tasks, almost entirely for the domestic market, rather than for export. The largest hardware segments are notebooks and tablets, desktop PCs, and network equipment. Servers and storage are very small segments of the domestic hardware market. In June 2012, the Manufacturer's Association of IT (MAIT) complained about the challenges facing the domestic hardware industry, including supply chain disruptions, increasing prices of imported components due to the Indian Rupee's depreciation, and an unfavorable tariff structure on components, among other issues.

Table 3: Leading Indian IT Firms

Leading IT-BPO Exporters*	Leading BPO Firms*	Leading IT-BPO Employers
Tata Consultancy Services Ltd	Genpact India Pvt. Ltd.	Tata Consultancy Services Ltd
Infosys Ltd	Tata Consultancy Services BPO	Infosys Ltd
Wipro Ltd	Aegis Ltd	Cognizant Technology Solutions India Pvt Ltd.
HCL Technologies Ltd	Wipro BPO	Wipro Ltd.
Mahindra IT & Business Services	Firstsource Solutions Ltd.	HCL Technologies Ltd
MphasiS Ltd	Aditya Birla Minacs Worldwide Ltd.	Mahindra IT & Business Services
iGate	WNS Global Services (P) Ltd	Genpact Ltd.
Larsen & Toubro Infotech Ltd	Infosys BPO	Serco Global Services
Syntel Ltd	Serco Global Services Ltd	Capgemini India Pvt. Ltd.
CSC, India	EXL Services	Mphasis Ltd.
Polaris Software Lab Ltd	Hinduja Global Solutions Ltd	Aegis Ltd.
MindTree Ltd	HCL Technologies Ltd. - Business Services.	iGate
Zensar Technologies Ltd	Hero Management Service Ltd	Firstsource Solutions Ltd
Infotech Enterprises Ltd	Mphasis Ltd	WNS Global Services (P) Ltd
Hexaware Technologies Ltd	Syntel Ltd	CSC, India
KPIT Cummins Infosystems Ltd		Syntel Ltd
Honeywell Technology Solutions Lab Pvt Ltd		exl Services.com (India) Pvt. Ltd.
NIIT Technologies Ltd		Hinduja Global Solutions Ltd
3i Infotech Ltd		L&T Infotech
Infinite Computer Solutions (India) Ltd		Convergys India Services Pvt Ltd.

Despite India's past weakness in hardware manufacturing, hardware still provides opportunities. The design of hardware involves the development and use of appropriate software code, and value has tended to shift to design activities as production has become increasingly commoditized. India has already established some presence in areas such as circuit design. However, hardware assembly should not be dismissed. The example of firms like Dell and Cisco is useful here. Dell outsources most, if not all, of its component manufacturing. It is, in fact, an extremely sophisticated assembler. Its value creation is based on organizing this assembly as efficiently as possible, doing so on demand, and keeping its inventories absolutely minimal. Strong customer

service plus management of communications and logistics at both ends of the value chain are also keys to Dell's success. Dell's positioning to take advantage of strengths in infrastructure and closeness to a growing customer market is an important lesson for India.

Finally, I discuss expectations, which can have a positive or negative role in determining the nature of equilibrium where complementarities matter. The argument of Kapur (2002), that India's success in software exports has increased the confidence of Indians, may also be couched in terms of a positive shift in expectations, helping to overcome a potential coordination failure. More broadly, Kapur gives the effect of IT's success on attitudes in India pride of place among the sector's impacts: "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." (p. 103). He goes on to discuss changes in attitudes to entrepreneurship, business culture, and reputational effects, which can include both horizontal and vertical impacts on expectations of entrepreneurs and customers in other knowledge-based sectors. Thus, in Kapur's view, these 'indirect' effects may be quite pervasive, more so than the technology itself.

III. RURAL DEVELOPMENT

It may seem paradoxical that modern IT, typically associated with developed country markets and capital-intensive methods of production, has any relevance for a country where hundreds of millions, particularly in rural areas, still lack basic needs of health, education and sanitation. Nevertheless, there are many efforts underway in India and other developing countries to demonstrate the concrete benefits of IT for rural populations, and to do so in a manner that

Even a simplified picture of rural households' economic activity drives home the point that they engage in a broad range of transactions and decisions with economic impacts. These include production and marketing decisions, saving, consumption, investment and risk management. What is noteworthy besides the complexity of this economic decision-making is that many decisions are made with very limited information, and that market interactions are often subject to high transaction costs, due to imperfections and asymmetries in information, as well as high transportation costs, inefficient intermediation and time delays. High transaction costs will always prevent marginal transactions from being undertaken; in extreme cases, the market may fail to function at all. Given this scenario, the role of IT can be understood in terms of reducing transaction costs, as well as improving the efficiency of decision making within rural households (both as producers and as consumers).

Reductions in communication and transaction costs are particularly beneficial where they can allow new markets to develop, in the sense that existing goods and services, otherwise restricted to urban areas, or to a very limited segment of rural populations, now can be offered to broader cross-sections of the rural population. [10] Examples include financial services, particular types of education, health services, long distance communications, and expertise on a range of production-related decisions. Whether this can be done in a sustainable manner depends on the supply conditions for IT-based rural services.

On the supply side, we can illustrate the various stages of decision-making and delivery of IT-based services in terms of a typical value chain, as shown in Figure 1. At each stage of the chain, the IT components include a

mix of hardware, software and services. For example, an Internet kiosk would have a computer, printer, web cam, modem, power back up, and software to enable standard Internet browsing, as well as handle specialized tasks such as education in the local language, agricultural information, e-governance and entertainment. At the other extreme, an alternative might be just a mobile phone, for basic voice and text communications. The creation of an organizational structure and value network is a critical first step, while managing human resources and customers is vital for successful final implementation.

For all types of organizations, building the right capabilities requires some effort. Creating what amounts to a brand new infrastructure for rural IT service delivery requires a broad mix of skills, and finding talented and trained people who can be effective in a role that mixes entrepreneurial tasks with corporate line responsibilities, all in an unfamiliar rural environment, can be a challenge. One significant aspect of this challenge is finding skilled people willing to work in rural areas. In many respects, the problems that emerge here are a symptom of the government's failure with respect to a broad range of practical education and training, especially in rural India. Kendall and Singh (2012) find, for example, in a sample of n-Logue kiosks, that an operator's having a college degree or even having completed high school did not significantly increase kiosk revenue: the minimum level of formal education needed to be a successful kiosk operator is not very high, provided adequate training is provided.

Deciding the sequencing, scope and sophistication of various applications can be a major challenge, since many of the services are being offered for the first time, or are being delivered in novel ways that challenge existing institutional frameworks and relationships. However, one of the benefits of the numerous rural IT experiments that have been conducted throughout India is that the kinds of applications that are valuable to rural households have been identified and refined. As one would expect, computer games are popular with children, and some kinds of communication and information retrieval (e.g., forms, certificates, examination results) are highly valued. Word processing is often needed by children and adults, and digital photographs are also very much in demand. One can generalize somewhat, to say that basic digital applications, often taken for granted in developed countries, are the basis for any rural IT kiosk's financial sustainability.

Another kind of information that can be valuable is online listings of information about availability of care; furthermore, tools for making appointments and providing health histories in advance of travel to a medical facility can also be made available online. While these kinds of IT tools can substantially reduce uncertainty and transaction costs for individuals in rural areas, their adoption may require substantial investments and back-office reengineering by health care providers, whether public or private. The Health Inter Network (HIN) India, part of a global initiative sponsored by the World Health Organization, has experimented with giving consortia of medical colleges access to digital information on health care, as well as placing PCs in Primary Health Centers (PHCs) and Community Health Centers. Interestingly, while the appropriate content for rural local users was not much available, an immediate and beneficial use was for relaying basic information on local conditions (in particular, a daily heatstroke report) to district health centers (Kuruvilla et al, 2004).

IV. E-COMMERCE

E-commerce can be interpreted broadly to include business-to -business (B2B) transactions, or even internal processes. The latter are taken up in the next section, in a discussion of manufacturing. B2B transactions are part of the supply chain, and management of the supply chain is also a weak link in India. Again, this is an issue discussed further in the next section. In Section 2, I discussed the complementarities between the IT sector and the rest of the economy. These complementarities arise from transactions situated in the B2B arena. In fact, developing countries have the opportunity to leapfrog over older, more expensive approaches such as Electronic Data Interchange, which represent significant legacy investments in countries such as the US.

For example, Miller (2001) surveyed the potential for B2B e-commerce in India. He gives the example of Reliance Industries, which, though still quite diversified, is now heavily into production and distribution of chemicals. Of the company's 20,000- plus customers in India, about 3,000 are major buyers, accounting for over three quarters of total sales. These major customers are electronically linked to a Reliance- controlled Internet-based market exchange. Using leased lines, customers can process orders, and Reliance can communicate dispatching details, better manage inventory, carry out invoicing, and provide customer support. Using this system, Reliance reduced receivables from 310 days to 90 days. General cost improvements came from an overall tightening and acceleration of processing within the company, and between the firm and its customers. The speed of order delivery greatly improved, and inventories were reduced. A shift by customers from leased lines to the Internet will provide further cost savings.

Indian e-commerce sites have had to adapt to the Indian scenario, in terms of logistics, payment systems and legal mechanisms. Interestingly, they have been reasonably successful, despite the institutional weaknesses. The use of cash on delivery and private couriers and the importance of trust and reputation have allowed e-commerce transactions to gain a foothold in Indian retailing. Recent moves to allow FDI in multi-brand retail in India specifically exclude e-commerce, providing some "infant industry" protection to India firms. Flipkart, for example, has not had to compete with giants such as Amazon, and will continue to be sheltered in this respect. Of course, content and market intermediary services such as eBay are very much part of online offerings in India. Furthermore, the nature of e-commerce is that Indians are also able to make purchases from foreign e-commerce sites, and in many cases shipping costs are not prohibitive. There is also very little to prevent foreign sites from acting as intermediaries between Indian buyers and sellers.

V. MANUFACTURING

Compared to many other developing countries, India's manufacturing sector has played an unusual role in the national growth experience. In 1950-51, the first year for which comparable data is available, manufacturing was approximately 9% of GDP. By 1979-80, this ratio had risen close to 15%, but thereafter has hardly increased. The highest share of manufacturing in any year was in 1996-97, at16.6%: after then the figure has hovered on either side of 16%, even in the years when India's GDP grew at over 9% annually. [19] In this context, the new National Manufacturing Policy's (NMP, 2012) explicit goal of increasing manufacturing's share to 25% by 2022 is extremely ambitious.

Panagariya goes on to argue that, "India must walk on two legs as it transitions to a modern economy:

traditional industry, especially unskilled-labor-intensive manufacturing, and modern services such as software and telecommunications. Each leg needs to be strengthened through a set of policy initiatives." (Panagariya, 2008, p. 287) His own policy recommendations include somewhat separate discussions for each of his two "legs" of the Indian economy. For labor-intensive industry, he emphasizes labor law reform, bankruptcy reform and privatization, while software and telecommunications require attention to education and urban infrastructure. However, an important potential linkage exists between these two parts or "legs" of the economy, namely, the use of IT in domestic manufacturing as a potential avenue to spur productivity and employment growth in that sector.

The next NMS, in 2007, was analyzed in Chandra (2009). Supply chain management remained a key weakness in the later survey, and investments in R&D remained low, despite perceptible benefits to innovation. Investment and usage of IT on the shop floor also remained low, at about 45% for this later sample, which is not much higher than the 2002 figure. Chandra concluded, "Once basic IT investment is done, only then will Indian firms be able to implement and take advantage of automation on shop floors. IT firms in India have failed to develop a viable and low cost IT solution for Indian Manufacturing. Firms other than the large ones are struggling on this count."

Chandra (2009) also summarized regional differences in IT use among the NMS sample firms. IT use was highest in the South, and lowest in the East, but also in Uttar Pradesh (in the North). Interestingly, IT use tended to be concentrated among managers, and to some extent supervisors, with less IT use by operators on the shop floor. To some extent, the pattern of IT use (or non-use) was symptomatic of under- investment in both physical and human capital, reflecting high financial costs as well as an unfriendly policy environment. At the same time, Indian manufacturing firms were able to make strong profits in this period, despite their inefficiencies.

The NMCC-NASSCOM report emphasizes the potential role that can be played by national and local industry associations in developing best-practice business process re-engineering guidelines to manage the organizational changes that are often needed to realize benefits from IT investments. Human capital development to overcome lack of appropriate skills can be addressed through improving the quality of government-provided training programs, and through tax incentives for firms to spend on this training. Anomalies in the tax code, broader deficiencies in the legal framework, poor telecoms infrastructure and lack of access to finance all emerge in the report as barriers to IT adoption that can be overcome through new policies. The report also discusses possibilities for adding requirements for electronic communications in certain contexts, and the possibility of creating a more efficient national market for IT products and services, through information dissemination, creation of electronic market platforms, and award programs. Many of the issues raised in the report illustrate the status of IT as a novelty for Indian manufacturing firms, especially the smallest ones.

In addition to the case study and qualitative evidence, several econometric studies have reinforced the conclusion that IT has a positive effect on manufacturing productivity. Gangopadhyay, Singh and Singh (GSS, 2008), used Annual Survey of Industries (ASI) data for 1998-2002 to examine the determinants and impacts of IT investment in India's manufacturing plants. The GSS study found that IT use was possibly constrained by factors such as the availability of electricity and of short-term finance. At the same time, there was evidence that

plants that used IT were more profitable and more productive than those that did not. This finding has recently been confirmed and extended in Sharma and Singh (2013). The latter use newer data, which also allows them to construct a panel of manufacturing plants, and therefore to control for plant-level fixed effects. Including these fixed effects, which may plausibly be attributed, at least partially, to differences in managerial ability or availability, reduces the estimated impact of IT investment on productivity, but does not eliminate it.

Kite (2012) finds very similar results using the PROWESS database from the Centre for Monitoring the Indian Economy (CMIE). This data covers large and medium sized firms listed on India's stock exchanges, as well as public sector enterprises. Services firms (including financial services) are included, along with manufacturing firms. The analysis covers four years, 2005-08, with most firms in the sample reporting data for more than one of the years. She focuses on expenditure on IT outsourcing, proxied by a reported measure of "expenditure on software and other professional services," but also uses measures of in-house software and hardware. Her basic result is that all the three IT variables have positive and significant impacts on output, and the results are robust to a variety of changes in the sample, the specification and the estimation method.

GSS (2008) also estimated a full set of demand equations for unskilled and skilled labor (proxied by wage and salaried workers, respectively, as is standard in working with ASI data), and found that IT use increased the demand for both types of workers. This result can be interpreted in the following manner. Even if IT leads to the substitution of capital and skilled workers for unskilled workers (as is theoretically plausible), the positive output effects of increased efficiency on the demand for unskilled workers outweigh any negative substitution effect. This result strongly reinforces the case made in the NMCC-NASSCOM report for focused policy attention on promoting the use of IT in Indian industry. While broad systemic reform is needed if India's manufacturing sector is to have any hope of meeting the NMP goals, attention to IT investment and diffusion of knowledge of possibilities in this area may be a relatively low-hanging fruit for policy-makers.

VI. E-GOVERNANCE

Poor public service delivery is a major symptom of poor governmental performance in India at all levels. The problem is probably more acute at the subnational level because day-to-day and basic services – such as health care, education, water and sanitation – are more the responsibility of subnational tiers, while, at the same time, these tiers of government have been disadvantaged with respect to fiscal and administrative capacity. Increases in patronage politics and rent-seeking over time have also resulted in a decline in the quality of public expenditure. Seeing this situation in terms of the functioning of accountability mechanisms, whether of elected officials to citizens or of other government employees to elected officials, a major problem is lack of good information flows both within government and across government boundaries to citizens.

IT has a dual role to play in the case of governance and administrative reforms aimed at increasing efficiency and effectiveness. First, the use of IT for improving internal government processes is important, through its potential to increase the efficiency of these processes. For example, the costs can be lowered, and accuracy improved, of data entry for tasks such as the preparation of electoral rolls and lists of welfare eligibility. Second, and perhaps more importantly (because it can hasten the first change), transparency, accountability and responsiveness can all be enhanced by using IT to alter the citizen-government interface. This second

avenue is particularly relevant in rural areas, where government is both extremely important and also stretched very thin: effective access to government services can be difficult and costly for the average rural citizen.

VII. CONCLUSION

This paper has provided a review and overview of various facets of IT in India's economy. The most obvious of these is the IT sector itself, including IT enabled services such as business process outsourcing. This sector has proved to be resilient and innovative, continuing to expand and upgrade its offerings. The export orientation of the sector has contributed to its competitive discipline and success, though that success has never been a forgone conclusion.

At the other end of the development spectrum, this paper discussed several aspects of rural IT in India. A decade ago, there were many ambitious attempts to harness the potential of IT for providing rural communications and other IT-based services. The story of these attempts illustrates many of the general problems of development. Often, the binding constraint was a lack of certain types of human and social capital. Low levels of income also were an obvious challenge in creating sustainable business models for rural Internet delivery. Nevertheless, various experiments and more ambitious ventures have provided lessons about how to go about such efforts in the future, and they have suggested that IT access for India's rural masses is not a pipe dream.

This problem is most acute in the case of manufacturing, and here the paper marshaled qualitative and quantitative evidence for the benefits of the use of IT in manufacturing, and throughout the supply chain, as well as the fact of its under-adoption. While it has been suggested that the Indian IT industry is itself to blame, in not providing suitable products for domestic firms, the overall inefficiency and backwardness of much of Indian manufacturing must shoulder the most responsibility for this state of affairs. Again, one might argue that the government's failure to provide a policy environment in which business can function effectively is a major roadblock to development.

If the major theme of a review of IT in India's economy is that the government must do better, the natural question is what role IT can play in that effort. This paper's penultimate section provided some thoughts on how IT can improve the functioning of government itself. Of course, technologies that enhance information flows and improve transparency and accountability are not guarantors of major positive change. Ultimately, what determines

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