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Information Technology as an Engine of Broad-Based Growth in India: A Case Study of Punjab*

Report to
The Rajiv Gandhi Institute for Contemporary Studies,
New Delhi, India

Principal Investigator : Nirvikar Singh

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1. Executive Summary

Punjab is a high-income state that has been relatively unsuccessful after India's economic liberalization, including in its efforts to develop an information technology (IT) industry within the state. Given its current push to succeed in IT enabled services, it is important to understand the Punjab experience, and the potential developmental benefits from successful efforts in this direction. This research identifies a lack of a strong enough policy environment, in terms of creating general conditions for doing business without government impediments, as a major factor in Punjab. The corollary of this conclusion is that across-the-board policy changes are more likely to be effective than narrowly targeted financial incentives.

This research also suggests that there is substantial potential for using IT to improve the working of industry in Punjab. In agriculture, there is scope to use IT in improving information for operational decisions, and also for marketing and distribution, provided that complementary reforms are implemented. In services, there is evidence that IT can be used to enhance local education delivery, improve financial services within the state, and be used for IT enabled services aimed at the global market. In all these cases, an overall government policy framework that emphasizes adequate infrastructure and enabling institutions, rather than specific policies for IT is what is required. At the same time, a more pervasive effort to incorporate IT in government functioning (back office as well as citizen interface) is required. The fieldwork undertaken as part of this research suggests that e-governance has high local value, but IT is also of value in rural areas for education delivery and some communication services.

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2. Introduction

Punjab is a high-income state with a very good infrastructure as measured by broad based indices (Table 1). It is best known as the center and vanguard of India's green revolution, the use of high yielding varieties of food grains, along with complementary modern inputs (tractors, fertilizers, irrigation, etc.) to substantially increase crop yields. In recent years, however, this growth engine has lost steam, and Punjab has also been beset by environmental concerns associated with its current pattern of cropping and resource use.

One alternative that has presented itself is the IT industry, which has been nil engine of growth for several of the states of southern India, and captured the imagination of policymakers, academics and entrepreneurs. The Punjab government, following this trend, has made seemingly substantial efforts to develop an IT industry in the stale. Despite these efforts, the state's success in IT has been very limited, (liven Punjab's apparently favorable pre-conditions, this relative failure deserves further investigation.

It is also of interest whether and how IT can be used to support broader economic development. Punjab has a range of manufacturing firms in sectors such as textiles, apparel and transportation equipment. What is the actual and potential role of IT in helping these firms to compete more effectively in a liberalized economy? Similarly, what kinds of roles can IT play in improving agricultural efficiency, through better production decisions or improved market access?

Table 1: Relative Infrastructure Development Indices, 14 Major States[1]

	1980-81	**1991-92**	**1996-97**
Bihar	83.5	81.7	77.8
Rajasthan	74.4	82.6	83.9
Uttar Pradesh	97.7	102.3	103.8
Orissa	81.5	95.0	98.9
Madhya Pradesh	62.1	71.5	74.1
Andhra Pradesh	98.1	96.8	93.1
Tamil Nadu	158.6	145.9	138.9
Kerala	158.1	158.0	155.4
Karnataka	94.8	96.5	94.3
West Bengal	110.6	92.1	90.8
Gujarat	123.0	122.9	121.8
Haryana	145.0	143.0	137.2
Maharashtra	120.1	109.6	111.3
Punjab	207.3	193.4	185.6
All India	**100**	**100**	**100**

*Source**:** CM1E index, taken from Ahluwalia (2002).*

Even more broadly, we are interested in the actual and potential impacts of IT on rural development. How can IT improve access to local government, delivery of services such as education and health, or general attitudes to social change? Are these benefits significant, and how can they be realized in a sustainable manner?

This report provides a summary of an investigation conducted over the course of almost a year, in 2001-02, and is mainly based on fieldwork in Punjab, including

[1] The 13 variables in the index are per capita electric power, percentage of villages electrified, railway route length per 1000 sq. km., surfaced road length per 1000 sq. km., unsurfaced road length per 1000 sq. km., handling capacity of major ports, gross irrigated area as a percentage of cropped area, and teledensity plus the following numbers measured per lakh of population: bank branches, post offices, primary schools, hospital beds, and primary health centers. Each indicator is computed for each state relative to an all-India average of 1(H). The composite index is then constructed as the weighted sum of individual indices.

interviews with government policy makers, industry members, rural entrepreneurs, IT users and others. The structure of the report is as follows. In Sections 3 and 4, we look at two key inputs for the IT sector, telecommunications infrastructure, and skilled workers. In Section 5, we briefly review the state of Punjab's core IT industry. In Section 6 we examine the possible and actual linkages from the IT industry to sectors that can use IT to improve efficiency or competitiveness. In Section 7, we look in particular at the role of IT in governance in the state. In Sections 8-10, we examine potential and actual development impacts in industry, agriculture and services, building on the discussion of forward linkages in Section 6. Section 11 examines the policy environment, and Section 12 concludes with a summary of key findings.

3. Telecommunications Infrastructure

As discussed in the introduction, Punjab is a relatively advanced state, with one of the highest per capita incomes, and also the highest infrastructure index among the states. Nevertheless, in practice, we found that the state of the telecommunications infrastructure was inadequate, especially for Internet use, and especially in rural areas. The problems were of the kinds that do not show up in official statistics. An immediate problem (based on our observations in Bathinda district) faced by semi-commercial efforts to provide rural Internet access and services was the poor quality of telephone connectivity. While phone lines might be available or installed specifically for a potential Internet kiosk, the quality of service turned out to be so poor in most cases that the ability to provide Internet-based services was undermined.[2] While IT-based services that do not rely on the Internet or telecommunications are valuable, their financial sustainability is much harder to achieve without good telecommunications links.

Many of the problems with telecommunications infrastructure have to do with central government regulatory policies, so a state government has limited room for maneuver. Thus, our primary discussion of telecoms is at the national level. Nevertheless, awareness of the constraints is important in order for the state government to be able to lobby the center to relax unnecessary constraints, or to formulate its own policies that work around the constraints.

India's telecoms infrastructure needs must be understood not just as providing high-quality, high-speed international data links for its premier software firms, and independently providing basic local voice calling capabilities for poor villagers. Although what is provided is closely linked to ability to pay, the value of being part of a well-functioning network must not be underestimated, even for the bottom rung. For example, the average annual revenue per line of village public telephones (VPTs) is estimated at $16 without long distance, and $760 with that capability.[3] The essence of a network is connectivity, and the domestic network and international gateways, fixed and wireless service, and voice and data must all be built out in a coordinated manner to maximize the value of the network to its users. The government's role should be to ensure this coordination, without

[2] This was also the case in Sirsa district, in the neighboring state of Haryana, where we observed a different organizational effort to provide rural Internet access and services.

[3] See Telecom Regulatory Authority of India (2000). Yale Braunstein has pointed out to me that this wide spread partly reflects an inefficient tariff structure, with domestic long distance and international calling being priced significantly above cost. The spread is likely to have narrowed, with the introduction of competition in long-distance services.

stifling competition and innovation. We next discuss innovations that potentially provide cost-effective voice and data telecom access to rural and semi-rural populations. To the extent that such access can stimulate demand for IT products and services geared to the domestic market, there is a positive link between widespread telecom access and the domestic IT industry.[4]

Some of the key work on innovation for Indian telecoms has been done by teams led by Ashok Jhunjhunwala, of IIT Chennai.[5] He realistically frames innovation needs in the context of economics. Affordability is critical to making widespread provision of telecoms services economically viable. Jhunjhunwala gives the example of cable services in India, which are priced at $2 to $4 per month, and have 35-40 million subscribers. At this kind of price point, however, a telecom operator in India cannot recover set-up costs for access, which are about $800 using conventional technologies.

The economics of widely available telecom services in India is therefore very different from countries such as the United States (US), where revenue per connection will be several hundred dollars per year: innovation in the US focuses on increasing revenue through upgrading services, rather than reducing the cost of providing access. The goal of innovations by Jhunjhunwala's team, therefore, has been to bring the cost of access down below $300 per line, and as close to $200 as possible. The latter figure would make access affordable to 50% of Indian households at current income levels. On the other hand, without such innovations, targets of increasing India's teledensity fourfold (from 4 to 15 per hundred), or Internet access tenfold are empty rhetoric.

With the cost of fiber-based backbones falling rapidly, it is the access component of the network that accounts for as much as two thirds of the per line cost. The IIT Chennai group and spin-offs started by alumni have developed several key innovations that can dramatically bring down the cost of access. These innovations include developments in hardware as well as software, and address issues of network management and deployment as well as pure access issues.[6] They help bring both affordable voice and Internet access to rural areas of India.

The benefits of this suite of technologies are not restricted to rural users, but also extend to middle class and working class urban users. Current access costs using these new technologies are estimated at $400 per line, but are likely to fall with further innovation. Pilot projects in rural and urban areas appear to have been very successful, and adoption is finally gaining some traction, despite bureaucratic and policy hurdles.

An alternative technology, which bypasses the local network entirely, and is particularly

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[4]An example from field research in Bathinda district of Punjab in December 2001 can illustrate: a farmer told us he had taken computer lessons, bought a home computer, and signed an Internet service contract so that he could exchange email with his brother in Toronto, Canada. All three IT-related products and services depended on basic telecom availability. See also Prahalad and Hart (2002).

[5] See Jhunjhunwala (2000), as well as numerous presentations available on his web site, at www.tenet.res.in/ashok.html. The overall group is called the Telecommunications and Computer Network (TeNeT).

[6] The innovations are described in more detail in Jhunjhunwala (2000). They include some wireless components, combined access to voice and Internet connections, and low-cost access devices. One of the main implementations is called CorDECT**,** and is a wireless in local loop technology that provides joint voice and Internet access.

suited for rural Intranets connecting nearby villages, is that of high-powered Wi-Fi networks that travel long distances.[7] These versions of wireless networks using the Wi-Fi, or 802.1 lb, standard create a wireless zone of up to 12 miles long, far beyond the usual 300-foot-radius range that Wi-Fi typically achieves. The new products can achieve long distances by boosting the power inside access points—the radios that create the network, and by adding additional antennas to the access points so signals can be beamed directly to a user's location, rather than creating a cloud of access. While the technology is in its infancy, it is already being implemented in the U.S. and the main issue for use in India will again be cost and regulatory hurdles.

The bottom line is that bringing down the cost of access through innovation targeted at the domestic market is a critical component of any dramatic increase in telecoms connectivity in India. Economically combining Internet and voice access also has the benefit of increasing me value of connecting to the network. The benefits accrue not just to the poor, but also to the tens of millions of lower middle class households who are currently outside the affordability radius. Again, to the extent that a state government such as that of Punjab has room to widen robust telecoms access through policies that support implementation of such innovations, it can have an impact independently of national policies. To illustrate what is possible at the state level, the Sustainable Access in Rural India (SARI) project, which uses CorDECT (footnote 5), is being expanded by the Tamil Nadu government to cover 1,250 villages in 10 districts (see http://www.elcot.com/ netl70702.htm), after a successful pilot in 30 villages in Madurai district. Nothing close to this has even been contemplated in Punjab.

4. Education

The relationship of IT to education involves two aspects related to economic development. First, advanced technical and managerial education is an essential input for the development of an IT industry. From the perspective of an individual state, it might be argued that local educational facilities are not important, since labor, especially skilled labor, is mobile within the country. However, casual empiricism suggests that there are mobility barriers, in the form of language, culture, and substantial costs of moving.[8] Even in the United States, which is culturally and linguistically much more homogeneous than India, proximity to educational facilities (universities in particular) has been an important factor in developing IT industry in various local regions, with Silicon Valley, of course, being the most prominent of them.

[7] See, for example, the news article, "Wi-Fi stretches its boundaries", By Ben Charny, Staff Writer, CNET News.com, September 27, 2002, at http://news.com.com/2100-1033-959924.html

[8] Problems in signaling educational quality as well as in the levels of quality also restrict mobility. Thus an IIT graduate is employable anywhere in India, but a graduate of a recently set up engineering college in Punjab may be much less geographically mobile. Thus, In the name of creating job opportunities for the state youth, the Punjab government has opened a number of engineering colleges and polytechnics in the past few years. But most of the trained youth from these institutions are unable to find suitable jobs in the state despite paying hefty fees... The Confederation of Indian Industry (CII), Northern Region, in its recent report had also asked the state government to improve the quality of technical education and create job opportunities. It had lamented that the industrial units in other states were also reluctant to employ students from these institutes because of lack of required skills." Kumar (2003).

The case of Punjab is interesting since, while it has been a relatively prosperous state for some time, the extent of technical education it provided tended to lag behind its ostensible level of development, and behind several of the southern states in India. To some extent, this reflected educational policy decisions taken at the center, but also substantial periods of political turmoil, as well as a political focus on agriculture as the dominant sector of the state's economy.

In the late 1990s, some catching up began to take place, as part of a nationwide effort by the central and state governments to ride the wave of the IT boom. Punjab has increased the number of engineering colleges significantly, as well as non-degree granting technical institutes. A significant step was the establishment by the state government of the Punjab Technical University (PTU) in 1996-97 (http://www.ptujal.com/). The PTU acts as an independent provider of technical education, as well as an umbrella for technical education in pre-existing universities and colleges in the state. It states (on its main web site) that it has about 91 engineering and management colleges and 110 centers of IT/management under its Distance Education Program.[9] Its decentralized model, including the use of small entrepreneurs at the rural or small town level, is well suited to making a basic level of IT education available to a broad cross-section of the population. In particular, the costs of shifting to a city for education can often be a substantial barrier to less-well-off rural youth. Education closer to home is also particularly attractive for girls, where social norms might otherwise not permit them to go to a city for further education.

Thus, the past five years have seen a significant broadening of Punjab's local supply of technical education geared toward IT and related knowledge industries.[10] What is probably missing from Punjab is a top-notch institute at the level of the Indian Institutes of Technology (IITs). While the IITs are elitist in some respects, and a significant proportion of their graduates contribute to the brain drain, they also can act as a source of high-level technical skills that are important for innovation. The IIT Chennai group discussed in the previous section is an example of the possible positive role that more advanced institutes can serve. IITs are also important in enabling faculty of regional engineering colleges to upgrade their skills by acquiring doctorates. These aspects of technical education are part of the PTU's objectives (see Box 1), but appear not to have made much headway.

A similar quality gap lies in the field of management education, where Punjab, despite its long tradition of entrepreneurship, has no world-class management institute. Rankings differ, but the only management institute in the region that appears regularly in such lists is the University Business School, Chandigarh, which had ranks of 56, 18 and 28 in three different lists.[11] Of course Chandigarh, while the shared capital of the state, is not in Punjab. In some respects, this gap may be more serious than in the case of engineering education, where the best regional engineering colleges are fairly close in

[9] However, at http://www.ptuon1ine.com/aboutptu.htm. the figures given are as follows: "At present, Punjab Technical University has 18 Engineering Institutions, 49 Management and IT institutes & 11 Pharmacy Institutes."

[10] However, see footnote 8 for some qualifications to this statement.

[11] The Punjab School of management Studies, Punjabi University, Patiala, appeared at 49 in one list, at www.rbeindia.com/topbschools.htm.otherlists were available at www.geocities.com/shanmugavelbabu/50bschool.htm,and www.namasthenri.com/education/b_schools.htm.

terms of quality.

The second important connection between IT and education in development lies in the enabling role of technology in education delivery. Low-cost digital processing, storage, transmission and printing together lower the costs of developing and delivering educational materials. There is no reduction in the role of human capital, except to the extent that interactive materials can substitute partially for human teachers. On the contrary, there is a need for precisely the kind of human capital that can be produced by technical institutes, since the preparation of IT-based educational materials now requires IT skills as well as knowledge in the discipline in which the educational content lies. In the case of IT education, of course, the two overlap.

Box 1: Punjab Technical University Objectives

Academic objectives for quality manpower production

- To provide Academic Umbrella to all the Engineering Colleges in the State as well as Departments / Centers of Technical Education of the University.
- To conduct examinations and award degrees to candidates of affiliated Engineering colleges.
- To impart PG level quality education in emerging and front ranking areas of Engineering, Technology and Applied Sciences.
- To prescribe and maintain uniformity in the courses, curricula and syllabi for all the affiliated technical institutions of the State.
- To make Engineering education more practical, self-supporting and application oriented, in tune with the industrial culture and ethos, and Economic environment.
- To develop course material with the help of top academicians and leaders of Industry for keeping quality of the graduating manpower.

Technological developments and support for industrialisation

- To develop Technologies suited to the Indian environment particularly under globalisation and to ensure technology transfer to and upgradation of the industry.
- To provide the leadership role and act as facilitator in the adoption of lead as well as emerging technologies. This is to keep pace with the fast changing developments in the technology innovations, particularly in the emerging technological areas such as Information Technology, Material sciences, Manufacturing Technologies, Product design, Management Sciences, Energy sciences, Environment Sciences and Electronics product design
- To organise programmes of continuing education in the field of Engineering and Technology for skill up-gradation of working personnel in both Technical and Non-Technical sectors for Industry and other user organizations.
- To carry out Research and Development works with an integrated and multidisciplinary approach, in various fields of Engineering and Technology.
- To focus on the entrepreneurial development with special focus on rural area development. Thus fulfilling the needs of the State development.
- To develop and maintain active liaison with industry of the region, particularly in the small scale and medium sectors.
- To provide Total Consultancy services in technical problem solving and other allied areas.
- To provide testing facilities for materials / products and other such services which are beneficial to the small scale and medium scale industries of the region, particularly to help facilitate resource generation.

Source: http://puniabgovt.nic.in/Education/educate.htm *(Accessed May 5, 2003)*

There is evidence that broad-based delivery of nontraditional education can be enhanced by the use of IT. For example, our fieldwork in Bathinda in studying TARAhaat (see Box 2) suggests several general points. First, in all attempts to introduce IT to rural India in a manner that promotes development, sustainability is a key issue. The TARAhaat franchisee model offers important promise in this regard with respect to incentives and scalability, though there have been difficulties in implementation. Second, the experiment validates the idea that IT costs have come

down sufficiently to make rural IT services financially viable.

Box 2: TARAhaat

TARAhaat is a subsidiary of Development Alternatives (DA), which is a large NGO with two decades of experience of promoting sustainable development in rural India. TARAhaat itself is a commercial enterprise. The acronym TARA stands for Technology Action for Rural Advancement and by itself is the name of DA's marketing arm. TARA commercializes DA's product initiatives for rural markets, including cost-effective building materials and handmade recycled paper. TARAhaat itself was founded in 1999. In 2001, it was a joint winner in the Global Village category of the international Stockholm Challenge Awards.

TARAhaat has a mix of business and social objectives, which are operationalized by registration under India's Companies Act, but with 51 % ownership by a nonprofit foundation (Sustainable Livelihoods). It has a management team where each member has several decades of government, corporate and/or nonprofit experience. The organization's social mission is the creation of sustainable rural livelihoods through improved information flows and education that can be enabled by IT. Implementation of this vision is through a business model that involves franchising owners of TARAkendras (information/community centers). Currently, having begun in September 2000, TARAhaat has franchised about eight kiosks in Bathinda (Punjab), which were the focus of fieldwork. Four kiosks were earlier set up in the Bundelkhand region of Uttar Pradesh. TARAhaat's stated goal is to have 47,000 kiosks all over India by 2008, with an average of close to five computers and a little over 1,000 users per kiosk, implying 50 million users, or a little over 10% of India's rural 'middle class'.

Another component of TARAhaat's efforts is its educational content partner, called TARAgyan. In association with various partners, TARAgyan is developing content and software for use in TARAhaat's information kiosks. Tailoring educational material for rural markets, both in terms of content and language, is a formidable task given the linguistic diversity of India. Basic IT education is naturally an important part of TARAgyan's actual and potential offerings, but it is not the exclusive focus. However, in keeping with its identified market, TARAgyan is not aiming at developing basic literacy materials.

***Sources**: Kaushik and Singh (2002), Khanna (2001), Prakash (2001)*

Third, there is the issue of complementarities, both technological and pecuniary. To elucidate this point, note that one major roadblock for TARAhaat has been the poor quality of existing telecoms infrastructure (see Section 3). This has severely limited the scope of services that its franchisees could offer. On the other hand, the provision of complementary inputs such as financing and physical infrastructure, through subsidized loans from nationalized banks and the use of local government buildings, have been important in reducing startup as well as operating costs. The most important complementarity emerged when the Punjab Technical University (PTU) quickly piggybacked on TARAhaat's efforts, enhancing the franchisees' initial financial viability through its own offerings of college-level IT education.[12]

[12] Subsequently, TARAhaat has chosen to forbid its franchisees from offering PTU courses, in an attempt to solidify its brand and quality control. Whether this is the optimal strategy requires a separate analysis.

Fourth, the scope of potential educational services is quite broad. While ventures such as this are unlikely to be financially self-sustaining in providing basic education or adult literacy classes, they fill several gaps in the educational offerings available in rural and small town India. For example, TARAhaat offers classes in Tally accounting software, and some local small business owners have taken these. Going beyond IT education, it is also developing classes in rural retailing and in personality development. Again, these are not 'basic needs', but they raise the level of human capital outside the big cities, and without the costs of travel to those cities. While IT-based classes may provide the higher end of the educational product spectrum, rural entrepreneurs such as those franchised by TARAhaat and PTU have expanded to include classes in cooking, sewing and related topics for village girls. These can provide an entry point to attract girl students to the IT **c**lasses themselves, and the broader offerings represent a more efficient use of available entrepreneurial and physical resources.

The key inputs provided by TARAhaat are educational content and organizational capital. Our observations suggest that both these are scarce in rural areas, and any efforts to create and leverage such resources are likely to have a positive impact. TARAhaat is concerned about competition, and the protection of the content it has developed as intellectual property, but from a social perspective, competition in providing educational services that complement the existing government-sponsored education delivery.

Note that we have not emphasized distance education in our discussion of endeavors such as TARAhaat. Given the poor quality of the rural telecommunications infrastructure, and the low cost of manufacturing CD-ROMs that can hold large quantities of interactive educational materials, the benefit of distance education is unclear relative to the alternative of small-scale, dispersed educational establishments where the material is locally available.

There also appears to be a large enough supply of instructors for much of the kinds of education that is being implemented (basic English courses, basic IT skills, simple business software, and personality development, for example) and it does not make sense to substitute for such face-to-face interaction completely, which is what distance education would do. In other words, there appears to be an economic rationale for educational delivery that is geographically decentralized, with only content development having the appropriate economies of scale to justify some centralization. Having noted this, we recognize that there is a role for online distance education, and the PTU launched an online education program in 2001 (http:// www.ptuonline.com). Enrollment in 2001 was estimated to be in the order of 20,000 students, though this figure includes students using CD-ROMs offline.

Finally, we may relate the above discussion to the concept of linkages, used in development economics. In the case of technical education for employment in the IT industry, there is a backward linkage from IT to its inputs. A similar backward linkage exists in the case of telecommunications. These linkages are among the most obvious, and government policies all over India have been geared toward relaxing the constraints of telecoms infrastructure and IT skills. Punjab appears to have done a reasonable job in this respect. In the case of the use of IT for lower cost delivery of education, there is a forward linkage (with a feedback loop in the case of IT-education itself), since the availability of lower cost hardware and software has stimulated their use in offering

broader-based education. In Section 6, we look at forward linkages more generally.

5. Core IT Industry

The success of India's software exports, especially from places such as Bangalore, led other states to try to jumpstart local IT industry clusters. The main focus was on software development, but there were also niches in hardware design. However, despite substantial policy efforts in the late 1990s, Punjab's IT industry remains small. Chandigarh and Mohali appeared to be extremely attractive sites for an IT industry. They are close to the nation's capital, the area is pleasant to live in, and the people of the region have a reputation for being energetic and enterprising. The Punjab government allocated land, a software technology park (STP) was set up (see Boxes 3 and 4), and firms started to move in, from abroad and from other parts of India, including Quark, Infosys, and Tata Interactive. Others looked seriously at the region as a place for new investment.

However, in 2002, the total size of the IT industry in the region was still tiny,[13] and much of the activity came from struggling small firms. Some firms had even left, and the main development project for the Mohali STP had not got beyond laying the foundation stone. What went wrong? Our interviews with policy makers and people in industry suggest that, aside from the problems created by the global slowdown and Chandigarh's lack of an international airport and a few other amenities, the policy environment was just not right. The issues were not ones of financial incentives. In fact, given the parlous state of Punjab's government finances, such financial incentives can be too costly. Instead, the government could have done more to create a hassle-free environment for business, both in starting up and in continuing operations. Our field interviews yielded stories of government-as-usual, including delays, corruption, and policy inconsistencies. When there are other location options, such an environment can be fatal in getting momentum going. As a result, not a single firm made a big enough investment in the region to get the ball rolling, and there was never a critical mass in Punjab's IT industry. Employment directly associated with IT remains small. We also found that there was limited interest in IT at the northern region headquarters of the Confederation of Indian Industry (CII) in Chandigarh.

[13] This adjective is relative. The figure quoted for annual software exports from Mohali is Rs. 100 crore, but this was less than 1% of India's software exports in this period.

Box 3: Software Technology Parks of India

Software Technology Parks of India **(**STPI**)** is a society set up by the Ministry of Information Technology, Government of India in 1991, with the objective of encouraging, promoting and boosting the Software Exports from India.

STPI maintains internal engineering resources to provide consulting, training and implementation services. Services cover Network Design, System Integration, Installation, Operations and maintenance of application networks and facilities in varied areas ranging from VSATs to ATM based networks.

Role of STPI

- Promotional Role/Regulatory Role
- Facilitator/Catalyst
- Incubating Infrastructure Provider
- Dedicated Datacom Services
- To establish and provide Data Communication facilities, Computer Facilities and Infrastructure facilities like Office Space and General Amenities.
- Provides best interface between industry and Government
- Vital Role in attracting MNCs Front-end on behalf of MIT/Govt**.** of India
- To act as front-end to the Software Industry for the Govt. policies and approvals
- Effective projection of India through Road shows in **USA**, Europe & Japan
- To promote development and export of software & the services through technology assessments, market analysis, marketing segmentation, marketing support & related areas.
- To train professionals and to encourage design and development in the field of Software Technology and Software Engineering

There are over two dozen STPI centers, including Mohali (Punjab). The IT Park in the Kishangarh area of Chandigarh is associated with the Mohali STP, but benefits from being in a Union Territory, in terms of policy flexibility and speed. The Mohali park was set up several years ago, while the Chandigarh park was inaugurated in March 2002, but already appears to be overtaking Mohali. In November 2002, Infosys announced a Rs. 100 crore software development center in Chandigarh, which was expected to absorb its earlier office set up in Mohali.

http://www.stpi.soft.net/aboutstpi 1 .html

Having noted the negatives, we also note that several things seem to have changed since five years ago. First, there are some firms that are based in Mohali and doing reasonably well, so there is a base that did not exist earlier. Quark Media Services appears to be expanding its presence in Mohali, perhaps providing the needed critical mass. Furthermore, while the IT park in Chandigarh initially serves as a competitor for Mohali (see Box 3), the long run impact is likely to be positive, through agglomeration externalities, since Mohali is essentially a suburb of Chandigarh.

Second, the telecommunications infrastructure for the STP has improved considerably,

so that bandwidth is much less of a problem than it was a few years ago. Third, as discussed in the previous section, the local availability of technically trained manpower has improved, though we noted some of the remaining gaps. Finally, government policy appears to have progressed, at least in the conceptual stage. Whereas earlier efforts were somewhat ad hoc, there is now an effort to devise a comprehensive plan for the IT industry. As we discuss in Section 11, if new policies make it to the stage of effective implementation, Punjab may be able to do better in the future in developing a local software industry.

Box 4: Salient Features of STP Scheme

- Approvals are given under Single Window Clearance Mechanism
- Projects Costing up to US$ 10 Millions with Indian Investment & NRI funds on non-repatriable basis are cleared by local STP authorities at centre level itself
- 100% Foreign Equity is permitted
- All the imports in the STP units are completely duty free
- Import of Goods on loan, free of cost & lease basis is permitted
- Re-export of Capital Goods brought on loan/lease/free of cost is permitted
- Domestic purchases are completely excise duty free
- Domestic purchases are eligible for the benefit of deemed exports to the suppliers
- The sales in Domestic Tariff Area (DTA) are permissible up to 50% of the value of Exports
- STP units are exempted from corporate income tax up to Year 2010.
- The Export Obligation on the STP units is as follows

Export Performance for five years

US $ 0.25 million or 3 times the CIF value of imported capital goods whichever is higher.

Net Foreign Exchange Earnings as a Percentage

$$NFEP = \frac{A-B}{} \times 100 = 10\% \text{ (Minimum)}$$

Where 'A' is the FOB value of exports by the STP units; and 'B' is sum of total CIF value of imported inputs and Capital Goods and the value of Foreign Exchange outflow on commission, royalty, dividends, Internal and External borrowing etc.

Source: http://www.stpm.net/scheme.htm

6. Forward Linkages

The use of IT in agriculture, industry and services creates forward linkage from IT to those

sectors, To the extent that IT can have significant effects from IT to those of "forward linkages", since IT adoption has positive impacts on operations. This is, of course, the standard argument in developed countries such as the U.S. for the virtues of the "new economy" based on IT.[14] In a developing country such as India, the use of IT is still scattered, but falling costs and homegrown solutions may provide some promise.

The forward linkages from IT to agriculture are varied in nature. In the case of farming itself, good and cheap telecommunications access can enable farmers to access market information. Interestingly, in the case of Punjab, the role of the Internet appears to be currently limited by the fact that the existing institutional structures and physical infrastructure are relatively good. In other parts of India, where infrastructure is less well developed, information about market prices and conditions allows individual farmers to make more beneficial decisions on where to sell their crop. In Punjab, the good network of roads and market towns lowers the marginal benefits of using the Internet. Better-off farmers, for example, use cell phones to gather market information as needed. In other cases, the existence of dominant intermediaries, who, in addition to providing credit, have pre-purchased the farmer's crop, makes the Internet redundant.

One aspect of agriculture where there may be potential for use of IT is in providing information to farmers. The Punjab Agricultural University, Ludhiana, is well known for its research and extension services. These include training programs, farmers' fairs, and telephone help lines. However, the use of IT does not appear to go beyond the posting on the Web (www.pau.edu) of some basic information about agricultural practices, scheduled events, and locations and telephone contact information of district offices. All this information is in English. Email contact possibilities for farmers are restricted to a single, general address. Hence, the potential of the Internet and Web as a medium for farmers to pull in useful information about inputs and techniques has not been tested.

In the case of industry, the general picture that emerged from our discussions with policymakers, industry group representatives and IT managers was that the use of IT was not a front-burner issue. The general industrial investment climate in India appears to be poor, with the financial sector carrying a significant amount of non-performing assets, and unwilling to engage in much new lending. Equity markets in India remain in their infancy as well. Other hurdles are the difficulty of exit from any industrial activity, over-regulation in general, and corruption that accompanies such regulation. It was also suggested to us in interviews that the loss of guaranteed markets in the former Soviet Union continued to weigh negatively on Punjab's woolens and light manufacturing industries.

While these problems exist nationwide, they do so in varying extents. For example,

[14] Two recent, comprehensive analyses, by Jorgenson (2001) and Stiroh (2002), suggest that IT has been an important contributor to US productivity growth in the 1990s. Jorgenson directly traces this impact to the rapid fall in the prices of semiconductors and of IT products in general, especially after 1994. For 1995-99, Jorgenson estimates that two-thirds of the United States' productivity gains were the result of IT use. Stiroh goes even further, with a detailed, industry-level analysis of the US. He finds that the US productivity revival was indeed broad-based, that much of it took place in IT producing industries, and that industries that are IT-use-intensive also had higher productivity gains.

Dollar, Iarossi and Mengistae (2002) have examined the quantitative impact of state-level variations in policy on manufacturing productivity. Using a survey of 1000 manufacturing establishments across 10 Indian states, they find that states that are poor performers, and identified by survey respondents as having a 'poor investment climate', have total factor productivity (TFP) that is 26 percent lower than the high-performing states. About a tenth of this gap is found to be due to a higher regulatory burden (specifically, labor market regulations) in the worse states. Punjab is in the lower half of the states surveyed, and this should be a cause for concern.

In any case, we did find that there was limited use of IT in Punjab industry. Perhaps the best example was the case of accounting and inventory software. Two strong domestic competitors exist here. One is Bangalore-based Tally Solutions, a private company that makes Tally accounting software. Our fieldwork interviews in Punjab suggested that Tally is a market leader for small business accounting software, and that even small shopkeepers are interested in acquiring it and learning to use it. For larger businesses, Tally has recently introduced a server version, which fits the needs of businesses with multiple locations or offices. The second product is E.X. from Tata Consultancy Services (TCS), which is the oldest of India's IT services companies, currently the largest software services exporter, and a firm with a substantial presence in the domestic business software market. The two companies' products are priced similarly, and in each ease one can find all the features of distribution channels, after-sales support, marketing, and product versioning that exist in competitive US markets.

Another example of IT use was that of CAD software in manufacturing firms such as Hero and Punjab Tractor. Unlike the case of accounting software, the products here were not domestic, but made by the US and global market leader in design software, Autodesk. The software is distributed through local resellers, but demand is not very high. Companies tend to purchase limited amounts of software, upgrade infrequently, and demand little customization or maintenance support. Thus, the market for such software is not very strong as yet. The local reseller also identified piracy as somewhat of a problem. It may be noted that the small local market also means that the manufacturer appears uninterested in a pricing strategy that would build volume in small country markets, thus perpetuating limited adoption.

In the case of design software and other higher-end products, it appears that the structure of Punjab industry may also act as a barrier to IT adoption. Smaller firms are less likely to be able to afford the fixed costs of IT adoption, and this problem is compounded by the lack of competition (partly due to over-regulation), which reduces incentives to modernize production.

One area where higher-end software may be more likely to be adopted is in the financial sector, where the inherent possibilities for digitizing financial information are stronger. This takes us over to the services sector, however, in exploring forward linkages. Large financial institutions, such as ICICI, State Bank of India and Bank of Punjab appear to be adopting IT for internal business processes as well as customer interfaces, but this is a nationwide phenomenon, and Punjab is neither a leader nor a laggard in this respect.

Interestingly, in the case of finance, there is also an important opportunity at the other end of the spectrum. The use of IT in rural banking and micro finance can impact a much broader cross-section of the population. The evidence of pilot schemes such as the

SKS InfoTech Smart Card project is encouraging. Handheld computers and smart cards can substantially reduce the costs of making loans, as well as monitoring them. Reducing these transactions costs may turn out to be critical for the scalability and sustainability of micro finance schemes. On the other hand, as in the case of market information for farmers, the relative benefits for Punjab may be lower, since it has entrenched credit institutions that serve the majority of farmers, and the scope for micro finance may be more limited.

Table 2: IT-Enabled Services Types

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

***Source**: http://www. nasscom. org/it__industry/spectrum. asp*

The best hope for Punjab in terms of the use of IT in the services sector is the opportunity that is currently exciting many Indian firms. IT-enabled services (ITES) have shown the strongest growth among IT-related sectors in the last two years. They include a variety of types of service, ranging from customer call centers, to accounting services and other business process outsourcing, to GIS and engineering services. Thus the required degree of technical sophistication of the workforce and the level of use of IT can vary widely. In fact, the three categories mentioned make up most of India's ITES exports, with the first two showing high growth and representing over 60% of the 2001-02 total of Rs. 7100 crores. The list of ITES segments constructed by NASSCOM displays ample scope for specialization within the category (Table 2), and it is clear that individual firms are already trying to capture niches. For example, Daksh has a 90% concentration on customer service, whereas HCL Frontline (a division of HCL) is 100% focused on technical support *(Dataquest*, 2002, p. 134).

Table 3: ITES penetration and ranking of cities

City/Region	Number of Companies	Survey Rank
National Capital Region	53	8
Mumbai	45	7
Bangalore	35	6
Chennai	35	3
Kolkata	29	4
Hyderabad	24	1
Kochi	10	2
Ahmedabad	9	5
Pune	6	9
Others	32	
Total	**278**	

Source: NASSCOM (2002)

In the case of Punjab, the draft government IT policy makes ITES a priority, and lists the strengths of the state in this respect. These are said to include a large and technically competent English-speaking workforce and high quality infrastructure. We have already discussed some of these issues in Section 5. We will also return to a discussion of the policy environment in Section 11. However, here we note that a concerted effort will be required if Punjab is not to miss the boat again. For example, the data on the location of ITES companies from NASSCOM shows that Punjab (and Chandigarh) is nowhere in the current ITES picture (Table 3, column 2). More worrying is the fact that the region did not even make the survey of promising ITES cities, in which the cities were assessed on factors such as manpower availability, real estate, telecom infrastructure, policy initiatives, power infrastructure, city perception and entrepreneurial history (Table 3, column 3).

7. Governance

Governance is well established as an area where IT can lead to substantial improvements in functioning. There are two broad uses of IT for improved government functioning. First, back-office procedures can be made more efficient, so that internal record keeping, flows of information, and tracking of decisions and performance can be improved. Second, when some basic information is stored in digital form, it provides the opportunity for easier access to that information by citizens. The simplest examples are e-mailing requests or complaints, checking regulations on a web page, or printing out forms from the web so that a trip to pick up the forms from a physical office can be avoided. More complicated possibilities are checking actual records, such as land ownership or transactions. Still more complicated are cases where information is submitted electronically by the citizen, for government action or response.

As in the broader case of using the Internet for communications and transactions, sustainability of e-governance initiatives is a significant issue. Since governments at all levels are financially strapped (with Punjab being one of the worst placed), the initial investments and ongoing expenditures for IT-based service delivery may act as a barrier to adoption as well as to long-run sustainability. However, our initial investigations suggest that the franchise model can be successful here. Low-cost rural Internet kiosks, a tiered franchising model, and a suite of basic government access services for which users are willing to pay, are key components of what Drishtee, an outgrowth of the Gyandoot project in Madhya Pradesh, is implementing in several parts of India.[15] Cooperation of local governments and access to subsidized financing for kiosk operators have been important elements for Drishtee, as in the case of TARAhaat, with the role of government being obviously critical in the case of Drishtee, given its initial focus on e-governance. It is important to note that once Internet access is available, its benefits are not restricted to e-governance. Individuals can obtain market information, training, job information, advice on farming techniques, and so on, as discussed earlier in this section.

The Punjab government's implementation of e-governance at the rural level appears to have been very slow, both for reasons of funding and prioritization. For example, TARAhaat explicitly promised e-governance services when it began operations in Bathinda district, but has since abandoned this direction, partly because it perceived a lack of anything to offer. That, in turn, was apparently the result of a lack of progress on the front of computerizing land records. On the other hand, the state government's own sponsored e-governance initiative in Sangrur district appears to have had some success, based on our conversations with state officials in charge of IT policy. Another pilot project that has received attention is at Fatehgarh Sahib, with a Web based Citizen-IT Interface for or services offered by district administration (for example, see http://informatics.nic.in/archive/inf2002apr/ e_governance.htm).

IT policymakers in Punjab have developed an elaborate analysis and plan for e-governance, and in some ways have been conceptual leaders among the states, but implementation, as noted, has lagged. In some ways, the elaborateness of the plan, including a statewide identity scheme to manage digital access and exchange of information between citizens and government, has also contributed to delay by substantially raising the setup costs.[16]

[15] Further details of Drishtee's efforts are in Kaushik and Singh (2002). Drishtee has a pilot effort in Jalandhar, but we did not get much sense of it going forward with any speed. The district hub has been set up, but only two kiosks are operational, with just two more in the pipeline, (http://www.drishtee.com/drishtee_districts/present_status.asp)

[16] The 'citizens' database scheme' is described in detail by Nirmaljeet Kalsi as follows: "Almost all transactions with the government require a citizen to prove his identity, the ownership of property as well as his professional credentials. The documents that verify these are typically pre-defined transactions with agencies like the state electricity board, municipal corporation and transport department. If the process of acquiring these documents is automated, the delays in getting such work done will be cut down by 80%. Key services include dissemination of information, billing, handling complaints and grievances, licenses and approvals, certificates, financial transactions or procurements. Therefore the citizens' database, property database and business database along with the departmental databases like Punjab State Electricity Board, old age pensions, food and civil supplies or transport would cover almost all services being provided by the government to the citizens and businesses. The creation of these three authenticated databases will be at the core of our e-governance strategy.

Areas where some implementation has occurred are in tax collection and information availability. According to Nirmaljeet Singh Kalsi, who has directed much of the effort in this direction: "The results have been very encouraging so far with the improvement in revenue collection by the excise and taxation department. Also, the punjabsewa.govt.in portal offers almost 300 services to citizens." (http://www.dqindia.com/content/special/102062403.asp). Our own examination of this "citizen services portal" suggested limited functionality and available information, although the framework and interface are both attractive and comprehensive. One obvious positive feature of the While Punjab already has the business database in the form of master dealer files (MDF) with the department of excise and taxation, the citizens' database would take some time. We first need to complete the pilot project at Fatehgarh Sahib, the *pro forma* for which has already been finalized. Funds for the door-to-door survey has also been allocated to the deputy commissioner (DC)." (http://www.dqindia.com/content/special/102062403.asp) portal is that its offerings include complete options in the Punjabi language: this contrasted, for example, with the lack of such options on the PAU web based information for farmers, as discussed in Section 6.

8. Development Impacts: Agriculture

We discussed some of the potential linkages from IT to agriculture in Section 6. Briefly, the benefits that would flow from these linkages include improvements in the working of input and output markets, and improvements in the quality of decision-making in productive activities. One of our surprising findings was that immediate and obvious benefits from improved market information via the Internet did not appear to be available in Punjab. In general, this could be understandable as a consequence of the relatively good infrastructure of markets and roads (and to some extent voice telecommunications) in Punjab, in contrast to more backward areas such as Dhar (Madhya Pradesh) and Bundelkhand (Uttar Pradesh), where Internet access seemed to make a dramatic improvement relative to the status quo.[17]

However, further analysis suggests that existing market institutions may have a lock-in effect, preventing the benefits of improved information from being realized. Thus the problem may not be one of efficient existing institutions, but simply entrenched institutions.[18] At least in Bathinda district, we were made aware of the importance of "commission agents", intermediaries who provided credit as well as pre-purchasing farmers' crops. In such circumstances, information of spot market opportunities that the Internet could provide is made irrelevant.

On the input market side, our interviews with government officials suggested that input traders constitute a strong political lobby. Hence, direct purchases of inputs from manufacturers, which might be aided by the Internet, in a straightforward example of disintermediation through improved information, were precluded by lobbying-influenced

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While Punjab already has the business database in the form of master dealer files (MDF) with the department of excise and taxation, the citizen's database would take some time.We first need tyo complete the pilot project at Fatehgarh Sahib, the *Pro Forma* for which has already been finalized.Funds for the door-to-door survey has also been allocated to the deputy commissioner (DC)."

[17] These two districts are, of course, where Drishtee and TARAhaat, respectively, begin operations.

[18] For an example of reported problem with the current system, see http://www.flonnet.com/fll523/15230940.htm.

policies.

Box 5: Punjab Food and Supplies and Consumer Affairs Department

The functions of this Department are:

- Procurement of foodgrains.
- Storage of foodgrains.
- Supply and distribution of essential commodities.

The main objective of the Department is procurement of foodgrains i.e. wheat and rice for the Central Pool. The Government of Punjab contributes approximately 50 to 60% in wheat and 40 to 50% in rice to the Central Pool. The Department makes arrangements to procure/purchase various kinds of foodgrains during the Rabi and Kharif seasons. These purchases are made at prices fixed by the Government of India (M.S.P.). The procured rice and wheat are handed over to the Central Pool through FCI. The entire operation of procurement is carried out by the Department along with other Procurement Agencies like FCI, Markfed, Punsup, PAIC and PSWC. The coordination work is carried out solely by the Department.

***Source**: http://punjabgovt.nic.in/government/gnvt75m.htm*

In terms of using the Internet to reach new markets, especially abroad, we did not find any strong evidence for this taking place, though it was being discussed in policy-making circles. To some extent, the problem was again lock-in to an existing institutional structure, which determines with some rigidity the cropping patterns, market channels, and prices paid. This existing structure is built around the public procurement system of the state government (see Box 5). It is also true that the complementary physical infrastructure is available for the existing institutions, but not for newer efforts that might require a more pivotal role for IT. Possible areas where IT could play a role in marketing and contracting are the production of fruits and vegetables for non-controlled domestic markets, and processed foods for export markets.

We would argue that the lack of any noticeable efforts or impacts with respect to IT and Punjab agriculture is, to some extent, the consequence of needing to change a set of complementary institutions and policies in tandem. However, large players, such as the state government or corporations with agricultural interests (e.g., agro-processing), can make a difference through coordinated implementation, as illustrated by the ITC effort in several southern states. Their annual report (ITC 2002) states:

> Project 'e-Choupal'.. .links the Indian farmer with domestic and international markets .. .It already reaches out to more than half a million farmers to provide web-enabled realtime information on the weather, best farming practices and commodity prices. Through virtual clustering, these 'e-Choupals' are conferring the power of scale on even the smallest of individual farmers. This...e-infrastructure will dramatically enhance efficiency in the purchase and sale of agri-inputs and farm produce, with direct benefits to the farmer. 770 'e-Choupals' are already operational, covering 4,500 villages across four states in India.

Of course the Punjab case requires some major changes in the thrust of future agricultural development in the state, and it is an evaluation of these changes that is required. This presents a much larger challenge than the ITC example. The point to be made here is that the incorporation of potential IT use into designing any such policy shifts may allow the benefits to be realized to a greater extent, and in ways that otherwise might not be possible.

9. Development Impacts: Industry

As discussed in Section 6, there currently appears to be limited use of software to enhance productive efficiency. Accounting software and CAD software were two examples that we came across, and these are natural ones in the context of Punjab's industrial structure, which is largely made up of many smaller manufacturing firms (Table 4). More complex uses of software, including networked applications, or more sophisticated logistics or production management, seem to be far away. The thinness of IT use suggests that its development impacts in practice have been limited. The situation reflects the weakness of Punjab's manufacturing industry, as discussed earlier.

Table 4: Punjab Industrial Structure

Size	**Number of Companies**	**Employment**	**Fixed Investment (Rs. Crore)**	**Production (Rs. Crore)**
Large/Medium	629	229,626	16,435 07	26, 577.08
Small	201, 736	909,266	4,373.79	20,338.55

Source: http://punjabgovt.nic.in//Industry.htm, data as of March 31, 2002.

It should be emphasized, however, that even at India's level of development, there is tremendous scope for the use of IT. For example, Miller (2001), who surveys the potential for B2B e-commerce in India, gives the example of Reliance Industries, which, though still quite diversified, is now heavily into production and distribution of chemicals. In this area, 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 has reduced receivables from 310 days to 90 days. General cost improvements have come from an overall tightening and acceleration of processing within the company, and between the firm and its customers. The speed of order delivery has greatly improved, and inventories reduced. A shift from leased lines to the Internet will provide further cost savings.

Reliance is one of the largest firms in India, as well as being one of the most dynamic. The absence of firms like this from Punjab (or their scarcity) may be partly responsible for the lack of any discernible impact of IT on the functioning of firms in Punjab. Specifically, both the size distribution of Punjab firms (skewed toward smaller firms), and their focus in more traditional industries may reduce the adoption of IT in Punjab industry. One emerging exception may be in pharmaceuticals, where a more

knowledge-based industry cluster might be developed. Otherwise, in general, the sophistication and scope of Punjab's industry does not seem to provide an attractive place for IT use to make an impact, despite Punjab's relatively high per capita income levels and good traditional infrastructure.

10. Development Impacts: Services

In financial services, the opportunity for IT to improve the efficiency of the sector is tied somewhat to national forces. The financial sector in India in general is not in good shape, with the banking sector in particular being overstaffed and subject to political compulsions in making loans. New private banks are somewhat free of these problems, but their role in the sector is still limited, and is overshadowed by the continued dominance of public sector banks and other lending institutions. Government-controlled lending institutions, because of their own financial problems, are unlikely to be leaders in IT adoption, though some progress is being made.

In tourism, there is some minimal use of the World Wide Web for marketing, with the emphasis on historical sites of religious significance.[19] While Punjab lacks other forms of tourist attractions, religious tourism by the large Punjabi emigrant community appears to be robust in its traditional forms. It is unlikely that IT use can have any major impact, beyond making online bookings possible.

The most prominent opportunity for IT to have an impact in services is, of course, in ITES. As we have noted in Section 6, there is a strong government push for Punjab to capture some of the projected all-India growth in ITES, but this will mean starting from a base that is relatively low, with no existing location currently in the top ten ITES destinations. Even if Punjab is successful in establishing a niche in ITES, the overall employment impacts may be relatively small, in the order of tens of thousands additional people employed (the official target is 50,000 jobs over the next two years: see Kumar, 2002). Nevertheless, given the severity of youth employment problems in the state, even marginal impacts will be useful.

11. Policy Environment

Punjab has been a successful agricultural state, and evolved an infrastructure and a set of institutions that provided excellent support for its agricultural economy. At the same time, Punjab's development was very much in line with India's economic policies that emphasized heavy government involvement in all aspects of the economy. In some respects, Punjab's success with agriculture, and its relative success with government intervention in the state economy, have together made it harder to develop the potential of IT in the state. In particular, policymaking remains geared toward traditional crops and the interest groups that benefit from them, including farmers, distributors, input suppliers and other middlemen.

In the late 1990s, as we have discussed in Section 5, there were policy efforts toward developing an IT industry in Punjab. From our conversations with people in government and in industry, it appears that implementation lagged substantially behind intentions.

[19] For example, see the Punjab government's own site, and its links: http://punjabgovl.nic.in/tourism/Tour.htm.

Much of the implementation activity within government appears to have been limited entrepreneurial efforts on the part of a few individuals, with the bulk of the government machinery unchanged in its orientation and approach, and therefore failing to provide an environment for business that was attractive enough to bring in firms with several locational alternatives to choose from within India. The closeness of the Delhi-Gurgaon-NOIDA IT cluster, with better international access since firms interested in regional diversification within India may prefer Delhi and its satellites. While a few firms did enter Chandigarh and Mohali, major impediments in the allocation of land and provision of other infrastructure deterred any substantial build out of a local IT industry.

In 2002-03, the policy environment appears to have improved in several respects. The government has accumulated substantial experience (its own and that of other states) to help it understand what initiatives are crucial to success. The current policy documents - including the policy on IT and ITES, as well as on industrial policy - are more comprehensive and detailed than earlier ones with respect to the different dimensions of government policy.[20] In particular, there is more of an emphasis on creating a hassle-free business environment, without the roadblocks to startup (e.g., clearances for goring started) and continuing operations (e.g., various kinds of health, safety and environmental inspections) that have continued to exist. There is also considerable attention being paid to issues of complementary infrastructure, such as housing, social amenities and transportation. Progress in making the Union Territory of Chandigarh an IT destination will also have a long run positive impact for Punjab, by creating a critical mass.

Of course it remains true that policy implementation will be the test. Two constraining factors have not changed since the 1990s. The first is what we alluded to earlier in this section, namely, the strength of the societal groups that have a stake in the traditional agricultural economy of Punjab. The second is the continued poor condition of the state government's finances. These two factors are closely connected, of course, through the provision of lavish subsidies for agricultural inputs such as water and electric power.

The state government will have to make several changes in its policy approach in order to overcome its resource constraints. The first is to reallocate its resources toward developing infrastructure for a "new economy" in Punjab. The second is to rely more on the private sector in developing infrastructure. The third is to avoid narrowly targeted financial incentives in an attempt to build up a local IT and ITES sector.' Such incentives are typically a strain on the budget, without necessarily overcoming key roadblocks to industry growth.

12. Conclusions

We offer three conclusions in this report. First, we offer some understanding of the paradox of Punjab's lagging in the development of IT capabilities, despite its being one of the richest states in India in terms of per capita income levels. We have argued that the policy environment was not sufficiently supportive of what was, in fact, a substantially new form of economic activity in the state. In turn, this policy environment has been a function of the state economy's dominance by particular

[20] Draft documents are available at http://www.ecpindia.com/dpolicy.pdf (IT and ITES policy) and http://www.ecpindia.com/new%20IP.pdf (industrial policy).

interest groups tied to traditional agriculture.

Second, we have suggested that some policy shifts are both feasible and can support the development of IT and ITES. In particular, policies that are broadly more favorable toward industry, and that reduce the costs of starting up and doing business are likely to be more beneficial than narrowly targeted financial incentives. Furthermore, while the direct employment benefits, even with ITES added to IT proper, are likely to be small, the spillover effects can be substantial. We were struck by how little impact the use of IT was having on industry in Punjab. To some extent, this reflects policies that do not allow successful small firms to expand easily - this is something that has been a problem throughout Indian industry, we believe, since it is the result of policies determined at the center.

Third, at the micro level, we were struck by how easily small collaborative entrepreneurial efforts in IT could have an impact on local development. This was most clearly illustrated by our fieldwork in Bathinda district. While TARAhaat's efforts in Bathinda district have been fraught with missteps and problems, they have at least partially validated a model of local entrepreneurship that uses IT as an input for a variety of educational purposes.[21] The impacts included new employment created, new services generated, lower cost and broader education delivery, and most importantly, the economic testing of the use of IT in rural areas. Thus, despite the failure of local e-governance to take off (as has been true throughout the state), and mistakes by TARAhaat in strategy and execution, the Bathinda example is indicative of what is possible in terms of developmental impacts

[21] Further, more robust validation comes from the efforts of Drishtee in the neighboring states of Haryana and Rajasthan .

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