Benign Neglect or Strategic Intent?

Contested Lineage of Indian Software Industry

The high and rising export intensity of India's software production reflects its global competitiveness. The progress of the industry is intrinsically related to the development of this competitiveness. The competitiveness has been developed in two stages. First, via long-term investment by the state in technical education and science and technology, with neither necessarily directed at the production of software. Subsequently, an incipient software industry with recognisably high export potential has been targeted via fiscal incentives and the provision of export-enabling infrastructure. The emergence of a globally competitive Indian software industry serves as an interesting example of successful state intervention at a time when the model is largely out of fashion.

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The nation's leaders shape an energy policy, they intervene in markets, they invade oil-rich nations. But when it comes to the global trading system, America today operates on an entirely different set of principles. No one dares whisper the words industrial policy.

– Barry Lynn, 'Globalisation Must be Saved from the Radical Global Utopians', *The Financial Times,* May 30, 2006.

I
Introduction

By the year 2000 India, along with Israel, was the largest exporter of software among the non-OECD countries. Within the OECD, Ireland was the largest exporter but with volumes not too far ahead of India. In that year India's exports of software services crossed the 4 billion dollar mark. In 1985, they were close to zero. While these export volumes are significant for India, the brief history of the short life of its software industry has an additional dimension. In this area India is something of a brand in that its IT industry also stands for excellence worldwide. Consider the following indicator. Of the 316 Indian software companies that had acquired international quality certification by 2002, 85 Indian companies were assessed at SEI-CMM Level 5, the highest attainable level, compared to 42 other companies elsewhere in the world.[1] Moreover, the Indian company Wipro is the first software services company in the world to be assessed at SEI-CMM Level 5, having attained it in June 1999. It is interesting to note how the company itself sees this achievement: "As part of the CMM Level 5 initiative, our process capabilities focus on defect analysis, cause identification and defect prevention plus technologies incorporation – tools, methods and processes – so as to facilitate continuous improvement in software quality and productivity."[2] This arrival at the top of the world tables, not to mention the self-avowed commitment to quality assurance, was certainly a first for any Indian industry.

Secondly, there is the aspect of sheer competitiveness. In 1992, a World Bank survey found that US and European vendors of IT services ranked India as the top choice for onsite and offshore software development. India had been ranked ahead of Ireland, Israel, Mexico, Singapore, China, Hungary and the Philippines. There is ofcourse evidence that some of India's competitive edge may be eroding, but it continues to be a major competitor in major segments of the world market for software services. Finally, software exports out of India have maintained a strong dynamic and are clearly on a growth path. In the financial year 2004-05 software exports grossed US $ 12 billion, up from US $ 9.2 billion in 2003-04. That represents a growth of over 30 per cent. Offshore adoption – industry jargon for outsourcing to India – by Fortune 500 companies has increased in the same period, from 300 companies in 2003 to 400 in 2004.[3]

In this strident progress of the Indian software industry there appears to be some sort of a paradox at first sighting. For, by almost every indicator of development India is a backward country. As Dreze and Sen (1995, Table 3.1) have pointed out, on some crucial social indicators it fares worse than sub-Saharan Africa. We would naturally be interested in how India's software success materialised. Such a query may also be seen to relate to a central issue in the economics of development, pursued most vigorously in the context of the development of east Asia.[4] This question is whether the economic success of a country is due to an industrial policy or, actually, due to its very absence. That is, is economic success the product of a non-interventionist state that merely secures property rights, ensures a liberal trade policy regime and pursues a stable macroeconomic environment – stability being defined as the absence of inflation, a view implicit in the definition of competitiveness proposed by the World Economic Forum? In the context, we might ask "What has been the role of economic policy in establishing the Indian IT industry as one among the leading software services exporters in the world today?" More to the point, we may seek the role of industrial policy defined as the use of "selective strategies to promote particular activities" [Lall 1994].

The story of the rise of the Indian IT industry, however, is not only one of the quantitative expansion of software exports but also of the emergence of the city of Bangalore as a leading global centre of software development. The city has been referred to as the Silicon Plateau in a flattering comparison to the original home of the chip and that crucible of innovation in the IT industry, the Silicon Valley in California. While this association has been queried by the cyberati, the lure of Bangalore as an IT destination in its own right is registered, among other developments, by the fact that on his first visit to India in 2005 China's prime minister Wen Jiabao did not fly into New Delhi as visiting leaders usually do. Instead he chose Bangalore, for an IT tour, as the first stop on his itinerary. Though Bangalore is not by far the largest site for software development, with Mumbai, Hyderabad and Chennai being only close behind, it has an iconic status as both the original site and the torchbearer of the Indian IT industry. It dominates the other locations if not by the number of software firms it hosts certainly so in terms of the best known – and largest – Indian software firms that have made their base there.

This paper investigates the factors accounting for the development of the Indian software industry, particularly its extraordinary success on the global market signalled by the growth of its exports at a rate unrivalled by any other sector of the economy. The explanation is couched in terms of a purposive role of the state. I develop the following argument. It is first shown that the export intensity of the Indian software industry is both very high and steadily increasing. This points to the competitiveness of India's software exports. Also, it leads us to the recognition that the rise of the software industry in India must be linked to the development of this competitiveness. As the principal input into the production of software is labour, the competitiveness of the product is directly related to the price-quality (of labour) configuration that Indian software firms are able to offer. Much of these internationally competitive levels of human capital available to Indian software firms have been developed over years of promotion of higher education by the Indian state. Part of it is the by-product of the drive to develop an autonomous scientific-industrial complex in India. This, I shall argue, accounts for the location of the software industry within the country. The policy was not targeted at software; also, it was largely driven by politics. Since the 1990s, however, the growth of software exports has been very directly targeted by policy, details of which are provided in the paper. Prior to this there was a policy-driven telecom revolution in India that having had an enabling effect, as software exports are communications-intensive, had prepared the industry to meet the surge in global demand that was to come later. The argument in this paper is aimed throughout at resolving the issue of whether the Indian software industry owes its global presence to, as has been suggested, a benign neglect or active intervention by the Indian state. Addressing this issue is important as it throws light on the debate on whether it is wise for governments to pursue an industrial policy that aims at picking winners.
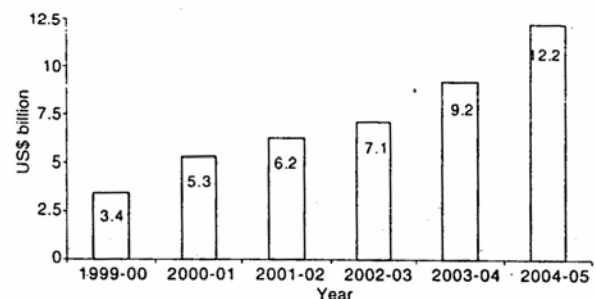
II
Some Facts and Figures

We may start with some information germane to an understanding of the success of Indian software exports. According to the National Association of Software Services Companies – the

Figure 1: Sales of IT Services and Software
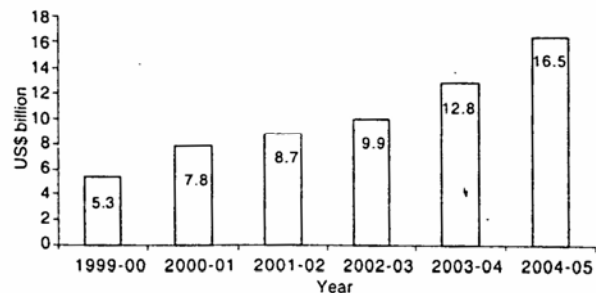
Source: www.nasscom.org

Figure 2: Exports of IT Services and Software

Source: www.nasscom.org

representative industry body in India – the IT industry is broadly classified into IT services and software, IT enabled services (ITES) and business process outsourcing (BPO), and hardware segments. IT services and software may be further broken down into core IT services – which include project-oriented services, IT outsourcing and R&D services and software products, including product development, design and development of embedded systems and sales of packaged/proprietary software (see www.nasscom.org). In this paper, I focus exclusively on IT services and software. Let us now consider some facts related to this segment of the IT industry in India. First its growth is shown in Figure 1. Total revenues of the IT services and software sector stood at 16.5 billion dollars in 2004-05, having expanded more than 200 per cent over five years. IT services and software are the mainstay of the Indian IT industry, accounting for close to 60 per cent of total revenues. The remainder is made up of revenues from the provision of ITES and BPO (www.nasscom.org). Next consider exports, figures for which may be read in Figure 2. Exports of IT services and software stood at US $ 12.2 bn in 2004-05, having grown 32.3 per cent over the year. During the five years for which data are presented, exports have grown at an annual average rate of 23.3 per cent. By comparison, such high rates of growth of output and exports have never been recorded by India's manufacturing sector, for instance. The Indian IT industry is able to grow so much faster because it is catering to a global market in which its share is as yet quite small. If we now move on to study the share of exports in output we find an extraordinary feature of India's IT industry, what has been described as a "super export-orientation" [Heeks 1996]. The data, presented in Table 1, point to a steadily rising export intensity of software production in India. Note by way of comparison that the export share for the economy as a whole would

be approximately 10 per cent. Finally, I present the list of the top 19 exporters and their export volumes during the most recent full financial year (Table 2). Note that the top three exporters have crossed the one-billion dollar mark. Also note the feature that the top five exporters are exclusively Indian[5] companies. The picture of the Indian software and services sector that emerges from these selected facts is that of an industry growing very rapidly over the past five years. Further, the industry is highly export-oriented and the exporters are predominantly Indian.

III
A Typology of Software Exports

As a means to understanding the factors underlying the growth of India's software and services exports, I adopt the typology of these exports developed by Arora, et al (2001). These authors classify software exports from India into three types according to where they are developed and how the development is managed and organised. This section draws on their work quite substantially. Of course, as technology evolves and the IT industry grows, there might conceivably emerge additional types.

(i) *Onsite consultancy:* In this form of organisation of production, the Indian firm provides the client overseas with software professionals, mostly engineers, with the technical skills required to execute the project. The project is executed at the client's site. The project itself is entirely managed by the client. Crucially, the client controls the deliverables and the deadlines. This mode of supply is referred to as "body shopping", perhaps with a view to conveying that no more than directed labour services are sought by the buyer. It has the implication that the supplier is

Table 1: Export Intensity of Production

Year	Intensity
1999-2000	64.1
2000-01	68.0
2001-02	71.3
2002-03	71.7
2003-04	71.8
2004-05	74.0

Source: Author's calculation from www.nasscom.org

Table 2: The Top 19 IT Software and Service Exporters (Excluding ITES-BPO) from India, 2004-05

Rank	Company	Rs crore	US $ mn
1	Tata Consultancy Services	7449	1644
2	Infosys Technologies	6806	1502
3	Wipro Technologies	5426	1198
4	Satyam Computer Serices	3377	745
5	HCL Technologies	2664	588
6	Patni Computer Systems	1548	342
7	I-fllex Solutions	1110	245
8	Mahindra British Telecom	913	202
9	Polaris Software Lab	697	154
10	Perot Systems TSI (India)	657	145
11	Hexaware Technologies	583	129
12	Larsen & Toubro Infotech	557	123
13.	MASTEK	546	121
14	iGATE Global Solutions (Formerly Mascot Systems)	534	118
15	Siemens Information Systems	502	111
16	Mphasis BFL	465	103
17	Tata Infotech	463	102
18	NIIT Technologies	448	99
19	Flextronics Software Systems	424	94

Source: www.nasscom.org

able to internalise relatively little of the knowledge gained in the process of software development.

(ii) *Offshore development:* The second type of software services export involves a mix of locations where the work is done, the software being developed partially in India, "offshore" in our case, and partially "onsite" at the customer's location. The project is typically managed as follows. A few professionals are first sent to the client's site for requirement analysis or training in the system knowledge, which is essential for the project. Having studied the client's requirement the advance party returns to India with the specifications. The software is then developed offshore in India by a larger team within the company. In certain cases, say if the project is large or complex, a couple of the advance party of professionals remains at the client's site to liaise between the team offshore and the customer. Note that the organisation of software development is different in this case when compared to body shopping. In addition to the technical skills embodied in its personnel, the Indian supplier now also requires knowledge of the software development process and ability to manage the development. Ensuring quality and maintaining deadlines, both typically specified in the contract, are the main challenge for the supplier here.

(iii) *The offshore development centre:* The third type of software export is quite similar to offshore development but yet distinct. The offshore development centre is a form of organisation in which firms in Europe and the US refer projects to Indian companies which undertake the project at a site secured and physically separate from their own. An offshore development centre usually involves an umbrella contract with a long-term agreement on prices. This form of organisation allows multinational companies to maintain a base in India to which they may periodically refer projects, thereby taking advantage of the large pool of skilled labour available at a lower cost in India.

Offshore work in general is considered the most profitable form for the vendor. It is driven largely by cost factors. We are able to see this dimension when we consider some of the figures for the year 2000 reported by Arora et al (2001) and reproduced in Table 3. Then, one person-year onsite was billed at US $ 90,000-1,00,000 while the same work done offshore was billed at US $ 25,000-35,000. Given that cost-to-the-client is revenue for the exporter, that offshore work is more profitable yet must reflect the very high overheads of working out of the US and the higher cost of living there.

IV
Stages in the Emergence of Indian Software Exports[6]

Development of a Domestic Skill Base for the Industry

The almost exclusive input into software development and software services may be thought of as skill. Thus, the rise of Indian software exports is inextricably linked to the accumulation of the requisite skills. There were two parallel streams in the emergence of the skill base of the IT industry in India.

Software development in a closed economy: Academic economists view India's software export success in tandem with the relatively recent liberalisation of the economy, in 1991. Not so all industry leaders, however. For instance, Ashok Soota of MindTree Consulting – a blue-chip software firm of Bangalore

– makes the point that the closed economy of India was actually "a plus" [Soota 2005] in the development of the software industry. How so? After the forced exit of IBM in 1977, domestic firms emerged as hardware producers for the Indian market. As the closed economy regime restricted imports, these firms had to develop the software themselves. Compilers, device drivers and operating systems were needed to operate Indian hardware. These were readily provided by the Indian industry and in the process there developed a substantial domestic skill base geared to the production of software. There was also some R&D in Indian hardware companies, primarily Hindustan Computers (HCL) and Wipro, originally a manufacturer of soaps and oils. With the liberalisation of the economy in 1991 the environment altered dramatically. Now software could be imported freely and so could hardware. Potentially this could have been devastating for the fledgling domestic software industry. But at least one company treated this as an opportunity. It recognised that with its software engineering skills – developed per force at a time when the economy was closed and foreign exchange for the import of software scarce – it could reinvent itself as into "a global laboratory for hire" [Soota 2005]. Wipro did this with astounding success and is now among the three largest software firms in India and its CEO Azim Premji is rated among the world's wealthiest men. Buoyed by its runaway success in software development, Wipro has by now more or less placed its computer hardware activity on the backburner. Its very successful foray into the production of software services would presumably merit the attention of management gurus ceaselessly exhorting firms to leverage and compete on their "core competence".

Learning from maintenance: Even as domestic hardware manufacturers were busy developing software to run their own-manufactured machines, a parallel development was taking place, one that contributed equally to the development of a software industry by building a skill base in India. This development even pre-dates the personal computer. Tata Consultancy Services (TCS), a member of India's oldest business group, offered to do mainframe maintenance first in India and subsequently abroad. Within a short time this service had progressed to include application maintenance. Such maintenance took the form of debugging client software, with both the identification and solution done during the day in India while the client slept in the western hemisphere. In this arrangement the time difference was also a factor in the emergence of India as a global source for software. TCS is now India's largest software services exporter. Industry leaders also speak of the Y2K "bug" as being a source of great learning for Indian software engineers and the IT industry, even though it was a one-off episode in the evolution of their skills.

This skill base forged in the maintenance of the mainframe and subsequently of application software, led naturally to the arrangement termed "business-process outsourcing" or BPO. Indian firms quickly saw the potential of the business proposition made to their overseas clients: "We developed your application (software), now let us run it for you" [Soota 2005]. For a knowledge-based customised product such as application software, this made eminently good sense to the client. Indian firms thus effectively achieved client lock-in, perhaps the supreme goal of a business strategy! BPOs represent the most recent stage in the development of the Indian IT industry. What had started out as the maintenance of "enterprise applications" in the age of mainframes, led to the development and sustenance of "customised applications" by Indian firms.

The export of skilled-labour services: While the imaginative transformation of a major hardware producer into a software exporter – the case of Wipro discussed earlier being perhaps the most prominent – had to wait till 1991, the provision of labour services to overseas clients on their premises – "onsite consultancy" in our typology – had started as early as the late 1970s. This is related to the second of the two parallel streams in the development of a domestic skill base that I have flagged. The provision of maintenance services for mainframes by TCS led almost naturally to the despatch of Indian engineers to sites in Europe and the US. As mentioned, this practice has been somewhat derisively termed "body shopping" and, in a language that we would all understand a little better, the protagonists themselves given the epithet "cyber coolie". Admittedly, onsite consultancy is a low-value-added activity with Indian engineers costed on an hourly basis undertaking programming services such as coding and testing. Moreover, it meant a severe under-utilisation of the skills of well-trained Indian engineers. It appears, however, that the government of India, ever mindful of having to manage the balance of payments, took a more pragmatic view, seeing the arrangement as an opportunity to increase India's export earnings.

But, there may actually have been more than an element of prescience involved in the encouragement of this body shopping. If brand building is vital to any product, there may be more than the usual bit of reputation to be earned first, before arriving as a supplier in the services, as opposed to the manufacturing sector. Especially, if the technological service is being delivered from an underdeveloped country whose exports hitherto had been mostly confined to textiles and agricultural produce, as was the case with India then. There is research [Banerjee and Duflo 2000] demonstrating that reputation does matter in software contracting even having controlled for other relevant factors such as cost. Therefore, it could be argued that there was no other route to the client's confidence other than the provision of onsite services that are demonstrably successful first. It may be seen as a case of starting at the base to move up the value chain. However, even this may be seeing the role of this mode of service provision a little too formulaically. Indian engineers abroad – when they did not jump ship for greener pastures – brought back to their parent firms much new knowledge in the form of business intelligence, management practices, an understanding of emerging technologies and, in a particularly imaginative formulation, "socially-specific communication protocols" [Parthasarathy 2005].[7]

There can be no doubt that the provision of onsite services enhanced the human capital stock of Indian software companies. In any case, in the precise evaluation of a debate on globalisation by Paul Krugman (1998), we might say that while high-value added

Table 3: Comparative Salaries of Software Professionals
(in 1997 US dollars)

Designation	India	US
Programmer	2200-2900	32500-39000
Help-desk support technician	5400-7000	25000-35500
Programmer analyst	5400-7000	39000-50000
System analyst	8200-10700	46000-57500
Network administrator	15700-19200	36000-55000
Database administrator	15700-19200	54000-67500
Software developer	15700-19200	49000-67500

Source: Arora et al (2001).

exports are certainly preferable to low-value-added exports, low-value-added exports are preferable to none. Armed with little more than a resume, some finance and embodied engineering degrees Indian software companies had managed to scramble on to the bandwagon coursing the information highway.

From body shopping to offshore development: To have radically transformed the business model to one that produced software offshore and sold IT services from India marked a certain coming of age of the IT industry. It was a significant evolution in that the output was now generated in India without the actual migration, with its connotations of servitude, of Indian labour to the customer's site in the US or Europe. Secondly, it reflected the confidence reposed in Indian companies by their overseas clients, who were happy to no longer micromanage the delivery of the service. Two separate factors have acted separately in the development of the supply side of offshoring. First, with the experience of over a decade of providing onsite services to clients overseas, Indian software firms grew in stature in their own eyes, and were endowed with a new confidence to offer services worldwide from a base in India.

One factor that enabled this was the advent of the software technology park (STP). STPs, which date back to the early 1990s, were to radically transform the environment for software production in India and thus the Indian IT industry. The STP, by providing an exclusive state-of-the-art physical site for software production, especially access to high-speed communication channels, enabled the Indian IT industry to sidestep the infrastructure constraint that is stoically faced by the rest of India's manufacturing sector. Now software production sites emerged in India, with the infrastructure, technology, training programmes, productivity tools and methodologies of the customer's workplace. Offshore projects in turn drove skill development, in that firms were now able to convert skills gained from specific projects in specific areas such as banking, retailing or telecommunications into a generic product for potential clients in the same area. Moreover, as implied by the numbers that we had looked at earlier, such services offered from India are more profitable than body shopping for the buyer. The rise of the offshore model reflected the rising confidence in the Indian software firm worldwide. In contrast with body shopping, successfully developing software for clients located overseas requires a firm to cover a wider span of tasks than just programming and to take responsibility for the overall project schedule and quality, in turn ramping up the firm's capability, and therefore credibility, in the eyes of the buyer.

An important route to acquiring contracts for the offshore development of software was the acquisition of quality certification. By mid-2002 over 300 Indian software companies had acquired quality certification with, as cited earlier, twice as many firms in India with SEI-CMM Level 5 certification than there were worldwide. Though the statistical relationship between certification and profitability has been found to be not robust, it is clear what the Indian software firms had intended when they pursued it. Certification is a signalling device to attract potential customers that the supplier follows an acceptable well-defined and clearly documented development process. And, once a process had been laid out it became a comparator or a device whereby the supplier could assess a project's profitability and manage its resources and time to maximise net revenues. The shift by Indian firms to providing software services offshore and the liberalisation of trade and industrial policy in 1991, which encouraged FDI, led to the development of the third category of software exports

that we had identified in our typology, the offshore development centre. Favourably struck by the quality of human capital available, reassured by vastly improved infrastructure – especially communication facilities, initially available only in the STPs but since 1998 provided in any location by private service providers – multinational IT majors flocked to the country to establish such centres. By now, India had come to be recognised not only as an exporter of software but as a top global site for IT excellence with Bangalore as its fountain head.

V
Source of Competitiveness and Role of Policy

There is little doubt as to where the competitiveness of India's software exports lies. It resides in the high-quality, low-cost skilled labour that India is able to offer. This cost aspect is evident from a comparison of the salaries paid to software professionals in India and the US, the destination of the larger part of India's exports. From Table 3, notice that for programmers the cost differential was as much as 10 times in 1997.

While the source of competitiveness of India's export is unquestionably the availability of world class programming skills in the economy, we might ask how this came to be. For instance, what has been the role of economic policy in the rise of the Indian IT industry. One way of making sense of the question is to understand whether the current competitiveness of India's IT exports is something intrinsic, only to have been leveraged at will by the industry, or whether the human capital stock was developed via policy intervention.

One view, recorded without subscription to it by Joseph and Harilal (2001), of the history of IT in India is that the industry has been the beneficiary of a "benign neglect". It is an allusion to the fact that unlike the larger units of the registered manufacturing sector the IT industry in India may have escaped the more obtrusive attentions of the lower bureaucracy. Economic units among the former are governed by the Factories Act, requiring them to comply with a plethora of laws ranging from health and safety to employment conditions (generally referred to as "labour laws" in India). The IT industry has been spared this compliance and in one stroke released from the clutches of factory inspectors and the legendary "inspector raj", perceived as a source of harassment for much of Indian manufacturing, especially in the small sector. However, while it is true that quite by default the IT industry has not had to deal with the debilitating bureaucratic hassles faced by most Indian entrepreneurs, it would hardly be correct to say that it attained its current international status, based on the fierce competitiveness of its product, through governmental neglect, whether "benign" or of any other kind. It is possible to record right away the policy interventions, some more general than specific, that gave a fillip to the IT industry in India.

(1) We are aware of the high export orientation of the software industry in India but are not always conscious of the fact that IT firms were actually required to export software in the early days of the industry. This arose in the context of a shortage of foreign exchange in India in the 1970s and 1980s. Software firms that needed imported inputs were required to earn the foreign exchange themselves through export of software. While compulsion can hardly be seen as "enabling", it introduced the very idea of a global market that Indian IT firms could possibly sell to, an idea entirely at odds with the general policy outlook of

that time, castigated as "export pessimism". It has long been recognised [Amsden 1989] that export quotas have been a significant policy intervention in the case(s) of South Korea and Taiwan, which eventually became major exporters. This policy of the government of India towards software is greatly at odds with its policy towards the rest of manufacturing, and may account for at least some of the egregious export orientation of the industry. (2) There was a concerted effort to build up a domestic IT capability during the premiership of Rajiv Gandhi, even though the electronic policy then was aimed almost exclusively at the development of computer hardware. (3) Exclusive STPs promoted by the central government provided the IT industry a physical site geared towards production and export of software. And, (4) For at least three decades before the emergence of IT exports from India the government invested in engineering colleges. So has the private sector, but a major difference is that government education was heavily subsidised and largely merit-based, thus different from private education in both respects. The Indian IT industry has received a significant subsidy on that most essential of its inputs, human capital. The policy interventions cited all suggest that the IT industry in India has been fostered, and has on balance faced a more enabling environment than manufacturing. The role of policy in the development of the Indian software industry has been made before. However, there is perhaps a tendency to focus [Patibandla et al 2000] a little too much on the public provision of human capital. In this paper I have argued that government has targeted the computer industry itself.

While the specific policies that I have cited clearly points more to a benign "attention", rather than "neglect", that the IT industry has received from the Indian government, the industry has benefited too from the policy environment in India more generally. Even when much of the policy was not in any way targeted towards it and also considering that the intention of the policy itself was to develop India in relative autonomy from the rest of the world, especially the west. I am referring to the vision of India's planners to develop a science and technology base in India geared largely to the autonomous economic development of the country. Though many would argue, legitimately, that much of this effort – such as space research – was removed from the real needs of the majority of Indians, the very project of developing such a science capability, the core of which was a knowledge base, contributed indirectly to the development of an Indian software industry. The one unquestionable indicator of this is the original location of the IT industry in India.

Bangalore the IT hub of India is, as mentioned, the base of two of the three largest Indian software exporters. It was also the most popular point of entry for international companies keen on tapping into India's human capital stock. Texas Instruments is the prime example, having entered Bangalore in 1985 armed with the latest satellite telecommunication infrastructure to transport software and services directly to the US from India. Almost all private entrants, whether Indian or foreign, had started out in Bangalore as this was seen as the locale most conducive, at least initially, to the success of an IT enterprise in India. Bangalore was India's science city, a deliberate construction of the policy of trying to establish an independent, world-class scientific foundation on Indian soil. By locating here, private entrepreneurs had access to scientists, engineers and management professionals who had honed their skills in the best technological environment in India, almost exclusively created by the government. A listing of the industrial and scientific research institutions in Bangalore

is provided by Parthasarathy (2005: 226), and I have reproduced it here as it is a unique compilation:

The public sector enterprises include Bharat Earth Movers Limited, Bharat Electronics Limited and Hindustan Aeronautics Limited under the Ministry of Defence, Bharat Heavy Electricals Limited and Hindustan Machine Tools under the Ministry of Heavy Industry and Public Enterprises, and the Indian Telephone Industries under the DoT [Department of Telecommunications]. Nine of the 49 Defence Research and Development Organisation's (DRDO) laboratories are in Bangalore. These include the Aeronautical Development Agency, the Centre for Air Borne Systems, the Centre for Artificial Intelligence and Robotics, the Centre for Aeronautical Systems Studies and Analysis, the Defence Avionics Research Establishment, Defence Bio-Engineering and Electro Medical Laboratory, the Gas Turbine Research Establishment, the Electronics and Radar Development Establishment, and the Microwave Tube R&D Centre. A laboratory of the Centre for Development of Advanced Computing and a location of the National Centre for Software Technology, both under the Department of Information Technology, and a laboratory of the Centre for Development of Telematics of the DoT is in the city. Bangalore is home to the Council of Scientific and Industrial Research's (CSIR) National Aerospace Laboratories, and the Centre for Mathematical Modelling and Computer Simulation. Finally, the Indian Space Research Organisation (ISRO) of the Department of Space is also located in Bangalore (italics mine).

It cannot escape one's attention that few locations worldwide can boast of such a concentration of varied knowledge using and knowledge producing institutions. It can no longer remain a puzzle why the Indian IT industry got located here. The fact of these institutions having been developed exclusively by the state is vital information in the context, as it helps us see the contribution of policy to the development of the industry. Of course, it must be acknowledged that the leaders of the Indian IT industry put the advantages offered to them, through proximity to the publicly provided scientific infrastructure of India, to more than excellent use. Their technical ingenuity and business intelligence combined to transform irreversibly the image of India in the global marketplace. But going back to the list of public scientific organisations in Bangalore, one cannot but be struck by both the scale of the Indian government's intervention in this sphere and the density of the institutional network in a compact geographical area. A succinct summary of its impact may be found in the work of Heitzman (1999) based on case studies of diverse companies – one large-scale public sector enterprise, three Indian companies and two companies started by leading multinationals – active in the field of information technology and services: "The public sector was ... a stage in the assembly of capital and human resources that established a critical mass of market opportunities and people, allowing the emergence of an internationally competitive high technology" [Heitzman 1999: PE 9].

Finally, observers have cited an additional reason for the concentration of the Indian IT industry in Bangalore, Pune, Hyderabad and Chennai. It is that this is the region with the highest concentration of engineering colleges, mostly private, in the country. Fresh engineers are the most important input into software development. But there is a certain role of policy to be discerned in this factor too. While engineering colleges have mushroomed in the private sector since the rise of an Indian IT industry that provides a seemingly endless employment potential, the original thrust to engineering education in India had come from the government as early as the 1950s. A subsidy, that almost waived

fees, had enabled many in the country with low incomes to avail of a technical education. By the 1990s when the stage was set for accelerated globalisation, the Indian IT industry had at its command a stock of skilled workers, many of them turned out from the government sector. Once again, "benign neglect" appears to characterise poorly this publicly endowed legacy.

Having argued that a long-drawn strategic intervention by the Indian state is significant in the context, it would be interesting to consider the industry's own view on the role of government in its development. For this I turn to NASSCOM, by far the most representative software industry body and find it declaring that "The government has played a major role in the development of India's IT sector" [NASSCOM 1999: 14.2]. In particular:

> The software and services industry has received immense support from the government both at the central and state level. This support, in the form of tax incentives and other benefits has been instrumental in the growth of software and services exports from India. In addition to this, the government has established several task forces that have made far reaching proposals for the development of this sector. Many of our recommendations for the government are in line with the overall thrust of these task forces [NASSCOM 1999: 14.2].

It is rare to find such congruence between the aspirations of an industry body and the broad policy interventions of a government.

I must consider an alternative view, however. N R Narayana Murthy, the doyen of India's software industry, has taken the software industry as a case in point to demonstrate the favourable impact of the economic reforms since 1991 on Indian industry. In particular, he speaks of the "unprecedented growth" of the software sector as an example of "how liberalisation of the economy reduced friction to business and accelerated growth" [Narayana Murthy 2005]. While it would be unwise to ignore the account of the rise of the industry by so prominent an insider, at least two comments may be made in response. First, there is no inconsistency between the faster growth of software (exports) since the liberalisation of 1991 and the fact of the foundations for the success of the industry – notably competitiveness – having been laid earlier by an interventionist state. Secondly, some of the factors enabling faster growth of software exports since 1991 may have had very little to do with the reforms. On the supply side the 1990s had witnessed both the dramatic decline in tele-communication costs[8] and the commercialisation of the internet. On the demand side there was the Y2K "problem" that had turned out to be a windfall for the Indian industry in that the (time-bound) demand for software service providers exploded globally.[9]

Finally what of the role of multinationals, if any? Some authors [Patibandla and Petersen 2002, Athreye 2004] see their role as competitors who induced productivity increases within Indian firms. Though apparently respectable in terms of their allegiance to the reasoning of mainstream economics, these studies focus on a phase in the evolution of the industry – the middle of the 1990s – pretty much after it had established a global presence, the topic of my concern. I believe that industry insiders [Soota 2005] have a more nuanced understanding of the role of MNCs in the emergence of the Indian industry. It is that multinationals were essentially partners in the enterprise. In particular, that MNCs played a dual role of providing invaluable "domain knowledge" to Indian firms that wrote customised software for them and served as impressario when these firms sought to launch themselves on the international market.

I now draw together my main argument. The growth of the Indian software industry is intrinsically tied up with its, very likely growing, global competitiveness. I have here attempted to explain the foundations of the last. Of the lineages of this quite spectacular rise, widely known and documented here, state intervention forms a varied but major stream. The extraordinary technical talent and business acumen of Indian entrepreneurs forms the other. The extent to which the rise (and rise) of the software industry can be treated as a successful case of industrial policy is, however, arguable. A fruitful line of contestation would be that though state policy was important in creating the software boom in India, it is quite different from the strategy of "picking winners", for instance in east Asia where the state pushed certain sectors.

I believe that my argumentation anticipates this when earlier in the section I speak of the industry having benefited from the policy environment more generally, even when much of the policy was not in any way targeted towards it. Unlike in the cases of the South Korean industries that rose of global prominence, the role of the state vis-a-vis the software industry in India was perhaps merely catalytic in the early stages, and got directed only as the government of India recognised that this goose laid golden eggs and when the industry got more organised and vocal in its demands for favourable treatment. Then came the fiscal incentives, the publicly-funded training institutes and the enabling infrastructure in the form of software parks. Nevertheless, to insist as some do explicitly, and many more by implication, that "benign neglect" fully accounts for the searing competitiveness of Indian software globally would be to miss the big picture. Indeed, the history of this industry helps us sort out the ideology from sound economics in the ongoing debate on the appropriate role of economic policy worldwide.

VI
Future of Indian Software Exports

The success of Indian IT exports thus far has been based very largely on a competitiveness derived from low wage cost. It is apparent in the nature of the exports, mainly software services. Observers speak of "... an industry that is based primarily on providing relatively simple software programming and coding services, exploiting its superior access to a supply of cheap software programmers, and with only limited degree of technical and managerial contribution" [Arora et al 2001]. While not taking away from the high levels of skill embodied in India's software engineers, the industry-business model clearly is one of arbitraging on labour cost.

There are two reasons why Indian IT must move on from this model. First, the source of the advantage is unlikely to last forever. China and east Europe, both repositories of engineering skills at least comparable to that of India, are said to be catching up in the area of software services. Secondly, if the goal of any industry is to move up the value chain, it is particularly relevant for the Indian industry to provide more value-added services, such as consultancy, and also move beyond IT services to IT products. Specifically, the challenge is to provide services beyond simple programming jobs, to provide "solutions" to business problems rather than the programming solutions provided to

either the customer directly or to IT consulting firms such as Accenture or Oracle. This would require much greater "domain expertise", or knowledge of industry specific requirements and of business practices generally.

Documenting the career of Indian firms in the area of software products and solutions is not easy. However, on balance it would be appropriate to say that there is progress but it is slow. One type of more advanced service is the provision of device drivers – the software for specific hardware components such as cellular phones and modems. Some Indian firms have begun to provide this relatively specialised and moderately value-added service. Where products are concerned, Indian software companies have tended to specialise in banking products, a notable one being 'Flexcube' by I-Flex. This product has met with some export success. The company Ramco has for some time now offered an enterprise resource planning software package, but its progress in the global marketplace is slow. Thus, the challenge for Indian software firms is to wean themselves away from the market for basic software services to the market for software products and the even higher value-added software services represented by IT consulting. This requires more than just the eschewing of short-term profits so well assured by offering programming services, but also developing the credibility to compete with the large organisations currently dominant in the world market for IT consultancy services, such as the Big Six. This indeed is a challenge for the Indian industry.

There is, however, another view. This has two aspects. First, practitioners state, it is also important to acknowledge that the services provided by Indian companies have already moved into significantly higher value-added segments such as mission-critical applications, development and support, product design and large complex projects. Secondly, they argue, while the advice to move from services into products is unexceptionable per se, the real challenge for Indian companies is to move up the value chain while yet remaining competitive enough to occupy the entire spectrum. A country as large as India, it is pointed out, cannot afford to vacate the low-end services market, as the base of the pyramid provides the largest employment opportunity and currently the largest market. This brings back the importance of recognising that an economy is not the same as a firm, and therefore the impact of a strategic move is to be appropriately judged by a wider criteria. We may conclude with two observations. First, if the history of the Indian software industry is any indication, neither of the two challenges identified here are insurmountable. Secondly, while it remains to be seen in which direction the Indian software industry will move, currently its prospects seem reasonably well assured. [EPW]

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Notes

1 According to the Carnegie-Mellon University's Software Engineering Institute, CMM – or the Capability Maturity Model – is a common sense application of software or business process management and quality improvement concepts to software development and maintenance. It's a community developed guide for evolving towards a culture of engineering excellence and a model for organisational improvement. It has emerged as the standard indicator of product quality in the international IT industry.

2 http://www.wipro.com/aboutus/quality/seicmm.htm.

3 Data mostly from www.nasscom.org

4 But also elsewhere. See the analysis of the role of policy in the dramatic recent rise of Ireland, currently one of the fastest growing countries globally, in Hardiman (2005). For the discussion in the case of east Asia see Lall (1994).

5 However, the simplistic reading that foreign firms have had absolutely no role whatsoever in the rise of the Indian IT industy is to be avoided at all cost.

6 This section draws on Parthasarathy (2005) and Soota (2005).

7 Perhaps the author means that while in the early 20th century it was de riguer to say "sling" as one docked in Singapore, one had better reveal a mastery of the intricacies of American football while in the Silicon Valley in the early 21st!

8 Documented in Narayana Murthy (2005).

9 As a digression, Soota (2005) sees this as constituting a "disruptive change" in that it effectively challenged the then global monopoly of leading multinationals such as IBM and Price Waterhouse Coopers.

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