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Multinational Firms and the Evolution of the Indian Software Industry

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Multinational firms and the evolution of the Indian software industry*

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Abstract :

The Indian software industry appears to provide a startling confirmation of the benefits of multinational investment in a fledgling industrial sector. The main question explored in this paper is how and why this happened. We find that multinational firms had an important catalysing effect on the industry's evolution, even though foreign firms established by expatriate Indians probably exerted more competitive pressure. We do not accept a popular view, which ascribes this benign influence to the development of human capital. We argue it was tight labour markets due to foreign competition, which induced domestic firms to both acquire unique organisational capabilities and to improve the value-adding strategies of multinational firms.

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Multinational firms and the evolution of the Indian software industry

The role of multinational firms in an industry's evolution is not well understood. We do know for certain that they enter into an industry as competitors with unequal abilities and empirical studies have shown that the usual barriers to entry in the form of advertising and R&D expenditures do not deter multinationals (Geroski and Schwalbach 1991). The accepted view of why firms become multinational at all suggest that it is the prospect of capitalising on firm-specific advantages that makes going global a profitable proposition. However, this should also mean that multinational firms would do their best to prevent such firm specific intangible assets from being imitated by domestic firms, as this would erode the profitability of those operations. Those who believe in the infant- industry argument argue that multinational firms will necessarily adopt monopolistic practices and not allow fledgling domestic firms to find profitable niches. So either multinational firms have to be kept out or governments should follow some kind of strategic trade polices to develop domestic industry.

In this context, the Indian software industry appears to provide a startling confirmation of the benefits of multinational investment in a fledgling industrial sector, with hardly any government intervention of either kind. When the first multinational firms entered India to set up software subsidiaries in 1984, the export of software services from Indian firms was thought of as little more than smart wage arbitrage. The Indian government still pursued the restrictive policies on multinational investment that had caused IBM to leave in 1977. The liberalisation of 1991 reversed all that, but India had already become an important destination for multinational firms by then. Multinational firms have steadily increased their share of software revenues: between 2001 and 2002 their share of software revenues grew from 15 % to 27%. Their employment shares are possibly higher: NASSCOM (2002) estimates that the largest 10 multinationals

employ more than a thousand technical people each on their rolls while 10 more multinationals employ at least 500 each.[1] Even so, multinational entry has not had a detrimental impact on the growth of Indian software. The export revenues of the sector still come largely from domestic firms, and both domestic revenues and the productivity of domestic firms continues to grow.[2]

What accounts for this success? In this paper we argue that the Indian software industry faced a somewhat unique experience of competing with multinationals, which produced benign effects on the industry's evolution. Two main factors were responsible for this. First, tight labour markets and unbridled competition (by domestic and foreign firms) in the product market squeezed the profitability of Indian software firms from both ends. Domestic firms responded to this squeeze in two ways. They actively invested in the development of organisational capability, such as in the management of project teams, standardisation of procedures where possible and using tools of participatory management. These investments in turn helped them to move to higher value-adding business models for their growth and for these multinational firms often provided the first prototypes. Here a second factor proved very beneficial. While multinational firms did compete for the same labour pool, they were not product market competitors to Indian firms since their operations fed the parent firm. This meant there were fewer barriers to the imitation and adaptation of their business models by domestic firms. As we show in section 3, leading domestic firms often adapted and improved the business models first pioneered by multinational firms.

A combination of both these circumstances created a virtuous cycle of competition and productivity improvements that has been beneficial to the evolution of the software industry. The remainder of the paper is organised in the following way: we start with an examination of the ways in which multinational firms can have an influence on the business activities of domestic firms. In section 2 we outline the growth

[1] As quoted in Economic Times, 20 August 2002.
[2] Figure 1 and Table 7 provide some evidence of growing revenues and productivity in the Indian software industry.

of the Indian software industry and the gradual increase in foreign participation in it, distinguishing between multinational firms and foreign firms established by expatriate Indians. In section 3 we study the contribution of both sorts of firms to the evolving of new business models in the industry. Multinationals pioneered the first successful offshore business models. These were adapted and improved by a handful of leading firms, and later imitated by many more newer firms in the industry. Section 4 examines the important contribution made by multinational firms to transforming the labour market for software programmers in India. We also outline briefly the nature of the domestic response to this situation, which was to develop firm specific organisational abilities. Section 5 looks at the relative roles of human capital and organisational capability in explaining the growth of the software industry. Section 6 concludes.

1. Multinational firms and their influence on domestic firms

It is well recognised that the entry of multinational firms has important positive and negative effects on domestic firms in the same market segment, though this literature normally does not pay attention to the evolutionary stage of the industry. In this brief review, we only outline the important channels of influence, in order to set the stage for the analysis of the Indian case study.

A well-recognised channel of influence is that when multinationals enter the domestic economy in order to export, they can help create an internationally recognisable national export brand for domestic firms. In recent years, multinationals have also developed international networks "to exploit the locationally differentiated potential of foreign centres of excellence" as Cantwell (1995) has argued. Multinationals are drawn to locate in areas that reveal a comparative advantage in the availability of particular resources or assets and this is seen to lie behind the growth of efficiency seeking FDI in the global economy. These areas then see an increase in their exporting activity.

However, while multinational firms may open up external markets for domestic producers, and they also compete for local factor resources with domestic firms. A key resource is skilled and managerial labour. Multinational firms usually offer higher wages than domestic firms and make every attempt to hire the best quality of labour available (Jenkins 1990). Overtime, domestic firms do reap the benefits of this as labour moves between multinational and domestic firms carrying skills learnt from the former to the latter employer. However, the first impact of multinational entry is almost always to increase labour demand and therefore wage rates in the domestic labour market.

Where industrial production depends upon several stages of production, the entry of multinationals may also build up the intermediate and ancillary goods supply in the economy. This is an obvious externality for other domestic manufacturers and a source of demand for the upstream producers. The extent to which multinationals will use local producers of input supply over imports of inputs from abroad depends however on factors such as cost and quality. An early empirical work addressing this question was that by Lecraw (1973) which found that multinationals tended to rely more on imported inputs for reasons of quality. Other studies on this subject for different countries and sectors are contained in Rasiah (1995) Hobday (1995) and Ernst and O'Connor (1992). This channel of influence is of limited application in the case of software as the different stages of software development are as yet not sufficiently standardised, though there are some signs now, that lower-level coding activities are often subcontracted to smaller software firms.

In recent years, it is the influence of multinational firms on the productivity of domestic firms, which has excited considerable enquiry. In a recent survey of this literature Blomstrom and Kokko (1998) point out that the empirical evidence on the influence of multinational firms upon domestic productivity is mixed. Drawing upon an earlier paper by Wang and Blomstrom (1992), they explain this variable influence of multinational firms as arising from two different channels of productivity spillover: the positive

demonstration effect and the more variable competitive effect of multinational firms. The latter effect has some implications for overall concentration in the industrial sector as well.

The demonstration effect of multinational firms refers to the imitation of technology, better managerial practices and quality control procedures, usually through the mobility of labour between domestic and multinational firms. To the extent that multinational firms do enter with superior technologies and managerial processes, their imitation by domestic firms is always a source of productivity gain for domestic firms. But in the model by Wang and Blomstrom, it is a one-off gain and the influence of this channel of productivity improvement wanes overtime. However, this result obtains because the model doesn't take account of the effects of learning. Research on OEM suppliers in Taiwan (Ernst 2000) or in Korea, Linsu Kim (1997) demonstrates the dynamic nature of inter-organisational learning.

The competitive effect of multinational firms refers to the outcome of competition for market shares between multinational and domestic firms. This process of competition can yield virtuous cycles of innovation, competition and productivity if domestic firms are able to compete with multinational firms. If however, multinational entrants are vastly superior to domestic firms it is also possible that multinational firms wipe out the domestic sector, and establish monopolistic positions on the domestic market. In this case, the effect of multinational competition on the productivity of domestic firms is largely negative.

This idea of a competitive process between domestic and multinational firms that is open-ended in terms of the eventual result also accords well with the mixed evidence of the influence of multinationals on industrial concentration. Differential productivity is closely related to the distribution of market shares and therefore to industrial concentration. In separate studies, Lall (1982, 1988) found that multinational presence could be de-concentrating in the short run (when it adds to the number of competitors) but can become concentrating over a longer time span as it steals market shares from other firms.

In general, it is useful to think about the influence of multinationals on domestic firms as outcomes arising out of the process of competition between the two firms in both the product and factor markets. Both types of firms carry different abilities and advantages. Multinational firms usually have superior managerial abilities and access to financial resources and R&D efforts of the parent firms. Domestic firms tend to be smaller, nimble and possessing a greater advantage in their knowledge and control of local resources. Furthermore, able rivals learn from each other's behaviours as the pursuit and success of strategies is revealed in the process of competing. In this competitive process there can also be cooperative elements as foreign firms seek out the complementary abilities of other domestic firms.

Is competition from multinationals in the product markets and factor markets of a host country equally desirable? Probably not. A somewhat different literature distinguishes between rent-seeking FDI and efficiency seeking FDI. The economic benefits to the host country of the latter are generally greater than that of the former. Rent-seeking FDI is usually marked by fierce product market competition and such foreign investment actively locates in countries where there are large markets to be tapped. Often this means displacing domestic firms operating in the sector, with negative consequences like predatory pricing, and anti-competitive conduct. Efficiency seeking FDI in contrast is associated with a global search for cheap resources and new bases of production. This kind of FDI competes more in the host country's factor market and secures for it the advantages of external markets and demand. The influences of this kind of FDI have been seen to be beneficial for the host economy. Furthermore Dunning (2002) points out that efficiency seeking FDI has been on the rise in the last few years and some of the relocation of software development in countries like India does in fact fall under this category.

To summarise, multinational firms enter host country markets as competitors with superior abilities. They might compete in the product or the factor market and often in both. This process of competition has uncertain outcomes for the domestic industry and much depends upon the responses and abilities of

domestic firms. In more aggregative terms it has also been observed that efficiency seeking FDI (which tends to compete more in factor markets) is associated with greater exports from the host economy and the other benefits of scale that go with greater exports.

2. Phases of software evolution and the role of foreign firms

Figure 1 plots the exponential growth of software revenues between 1984-2000, and the important role of exports in it. The most explosive phase of growth has been in the late 90s. However, the growth of revenues masks the long period of evolution that preceded the spectacular growth. This long period of evolution was marked by changes in government policy and changes in demand for software services, which in turn, influenced the gradual evolution of capabilities of firms in the industry. It is useful to think of software evolution as occurring in four phases as below: [3]

i. pre-1984, when the major thrust of Government policy was achieving self-reliance in hardware capability and the major event of significance for fledgling software firms was the dramatic exit of IBM, in protest against the Foreign Exchange Regulation Act which required the dilution of foreign equity.

ii. 1985-91, when the crash in hardware prices worldwide and de-regulation of licensing policy in India coincided with an acceleration of demand for software programmers worldwide as firms moved from mainframe to client server systems.

iii. 1992-1999, which saw full financial liberalization by the Indian government, large scale entry by multinational firms and a peaking of worldwide demand for software

iv. 2000 onwards, which saw a crash in software demands and forced consolidation in the industry.

Foreign firms played an important role in all four phases, though their presence has been more marked in the last two periods. In our analysis we distinguish between two sorts of foreign firms: subsidiaries of multinational firms and the back end offices established by US individuals of Indian origin usually exploiting expatriate links. The latter have been noted to be an important factor behind the rising share of foreign investment for developing economies like China and India. There are two reasons why we distinguish between these two kinds of firms. First multinational firms are more likely to have the kind of superior managerial and business abilities than US back ends. Second, because the competitive pressures they exerted on domestic firms in the Indian software sector were different. Foreign subsidiaries established by expatriate Indians competed for both software projects and for software programmers along with domestic firms. Multinational subsidiaries were however, captive arms of the parent multinational and never competed with Indian firms for projects in the US or European markets. But they competed fiercely for software talent in the domestic labour market.

Both sorts of foreign firms were important to the growth of Indian software. This is clear from Tables 2 and 3 below. Table 2 charts foreign entry over the four phases of Industry growth. Our figures in these tables are based on the 2001 NASSCOM register of firms in the IT sector, and we added to the information provided in the register by classifying firms based upon their ownership. Appendix 1 details how this was done. Table 2 shows clearly the peaking of foreign involvement in the software sector in the 90s. As the numbers of foreign firms grew so did their share in employment and revenues, and some measure of this is available in Table 3. Table 3 also presents an interesting contrast in the revenue per man earned by the different categories of firms. Multinational firms show very high revenue per employee some of which may be due to the existence of transfer pricing/ high salaries paid by MNC firms. Foreign firms established with a US link on the other hand show poor revenue per man figures, compared to the average. Table 4 shows

[3] A detailed description of each of these four phases may be found in Athreye (2002).

the concentration of foreign investment (whether through joint ventures, as US- based Indian firms or multinational subsidiaries) in Bangalore by 1999.

{Table 2 -4 here}

The role of multinational firms was different in the four phases of growth. In the early period (pre-1984) the departure of IBM meant that other multinational hardware majors like Burroughs, Honeywell, DEC and Fujitsu rushed to fill the vacuum created by the departure of IBM. Their computers had to be sold to a population that was previously being serviced by IBM mainframes. Indian software firms responded to the demands made by non-IBM majors and indigenous IT firms for programming skills to access the vacuum for hardware created in the Indian market by IBM's departure. This involved writing migration programs from IBM mainframe computers to other computer platforms. All the early software firms had tie-ups with hardware firms. Examples include TCS with Borroughs, Tata Unisys Limited with Unisys, Hinditron with DEC, Datamatics with Wang and Patni Computer Systems with Data General. These collaborations were all with non-IBM manufacturers of hardware were an important factor in creating the build up of a variety of programming skills and knowledge of hardware platforms among Indian programmers, despite the small domestically installed base of computers.

By 1984 not only had the early Indian firms managed to acquire competence in handling migratory projects, they were also trusted by their multinational collaborators to undertake small bits of software work "onsite". The worldwide crash in hardware prices (which Indian firms could take advantage of due to the import liberalisation policies in this period) and the sharp increases in demand for software presented a valuable entrepreneurial opportunity for Indian firms. Many new firms (including the first MNC subsidiaries and the first foreign firms set up by Indian expatriates in the US) entered the market. In the main, the entry in this period was experimental. New domestic firms experimented with different business models such as

software products for the domestic market, educational software services, and the on-site service model. Many domestic firms even got their fingers burnt in this process of experimentation. By the end of the 80s, leading domestic firms had converged on the on-site service model pioneered by the industry leader TCS. The two big multinational firms Texas Instruments at Bangalore and COSL at Bombay tried out a different strategy, that of offshore software development. TI experimented with outsourced delivery of R&D services while COSL set up its India operations to computerise its global operations. Both of these strategies would be imitated in the next period by Indian firms.

The period 1992-99 saw large-scale imitative entry by domestic firms and foreign firms. The on-site model was reasonably well understood and demand for outsourced software was booming. This was also the period of peak entry by multinational firms. Most multinational firms that entered the software sector had captive operations in that they only met the needs of their parent firms. There was however, intense competition in the export market, in the main as Arora et al (2001) point out from other domestic firms and US firms (including those that were set up by expatriate Indians in the US with back ends in India). The result of this was intense competition for domestic software programmers, both because of the entry of foreign firms and because of the world-wide scarcity of software programmers. Attrition rates were high.

This heightened competition in the product and factor markets induced some firms to develop strategies to distinguish themselves from the competition: these included implementing quality certification procedures, transparent governance structures, building effective teams of workers that could be "ramped up" and were robust to labour attrition, the growing use of proprietary software tools, and the focus on specific domains of application. By the end of this period in 2000, Indian software was estimated to have 18% of the outsourced software export market, and a significant proportion of revenues started coming from new

value-adding business models: fixed price contracts and offshore contracts in the form of development centres for clients (usually Fortune 500 firms). [4]

Dedicated development centres were set up, usually for long-standing clients of particular firms, and they acted very much like the COSL and TI subsidiaries. In particular, programmers who worked in one development centre were not usually allowed to work on another development centre for a different firm, even if the employing domestic company was the same. In this period, several leading multinationals such as Adobe, HP and Microsoft, followed TI and set up India software operations for undertaking outsourced R&D services for the parent firms. Again this would be a strategy quickly imitated by some Indian firms such as Wipro and Satyam in the following period.

The slowdown in demand forced a consolidation of the domestic industry along certain lines. Domestic firms experimented with new business areas, where the outsourced model could be applied for providing higher value-added services, such as outsourced R&D services, the production of embedded software, bio-informatics based services, and voice based software to name a few areas. For multinational firms this phase marks a distinct break from earlier periods as some have begun competing with Indian firms in some of these newer services market. It is too early to say what the consequences of this will be.

Thus in the story of evolving domestic capabilities in software, multinational firms played an important catalysing role in two ways: multinational firms successfully pioneered business models that were imitated by other Indian firms, and multinational firms contributed to a tightening of the labour market and the emergence of a professional 'culture' which put the onus of retaining competitiveness upon organisational

[4] The reasons why multinational firms overseas suddenly switched to outsourcing, is also an extremely interesting and absorbing subject but lies beyond the scope of this paper. There is little doubt however, that this switch in MNE behaviour lay behind the spurt of demand for software in the 1990s, which in turn caused the scaling up of operations of Indian firms detailed in Section 4.1.

learning and the development of distinctive capabilities by domestic firms. The next two sections discuss these two processes in more detail.

3. The offshore business models pioneered by multinational subsidiaries

The first two multinationals that entered the industry were Citibank's subsidiary Citibank Overseas Software Limited (COSL) in Bombay in 1984 and Texas Instruments in Bangalore in 1985. In that period, TCS was the market leader for software services and had shown that on-site services were a profitable export and well within the reach of a team of talented programmers. The on-site model of software services delivery required the Indian software service firm to go on the site of the client firm to implement and write the software the client needed. In contrast, the first MNC subsidiaries, COSL and TI wrote software for the parent firm largely based in India and using satellite links to stay in touch with their parent firm. Thus, software writing was done "offshore" in India rather than on the clients' site as the most Indian firms of the 1980s had practised.

COSL was set-up by Citibank (who already had operations in India) to computerise the world-wide operations of the parent company (Citibank) and was no doubt attracted by the possibilities shown by TCS for internal cost-saving. The subsidiary was established in 1984 in the special export processing zone area of Bombay where exports were exempt from duties and taxes. COSL chose a local man Ravi Apte, who was a graduate from IIT, Bombay to set up a programming team to write software for the computerisation of their India operations, which could then be exported to other Citibank locations with customisation for those operations being done on-site.[5] These activities were almost completed by 1989, and COSL had a banking solution that was tried and tested in different legal and financial environments.

[5] This summarised account of COSL and the emergence of CITIL and I-flex is based upon my interview with Mr. Bhagawan, COSL, in Dec1999.

At around this time there was a divide in thinking within COSL: one faction within COSL felt that they now had the potential to develop a product which could be sold to other similar international banking firms in overseas markets and others who believed that doing so would mean helping Citibank competition. The product champions won the arguments on the grounds that software technology was changing so fast that Citibank's core software technology would have to change in any case to keep ahead. Little would be lost by selling a product based on an older technology to other similar firms in the export market. In anticipating the need for a similar product with upgrades in the market place COSL had demonstrated knowledge of the finance domain that was far superior to the number of years of its existence. Undoubtedly this superior domain knowledge came from Citibank itself, which was a reputed financial company.

Thus, a new company CITIL was born where the product aspects of the business hived off and kept separate from the Citibank's own software arm, COSL. CITIL produced Flex-cube that became the basis for the more successful product I-flex. It also earned considerable money from customisation services, interview estimates suggest over a period of nearly three years, which it used to finance further development of the new product. Eventually I-flex was spun-off as a separate company from CITIL and I-flex is perhaps the only successful international software product produced in India.

COSL-CITIL-I-flex story had demonstrated quite a few things to Indian firms that wanted to draw upon its experience:

(i) Firstly, it demonstrated the possibility of off-shore computerisation with the main software written in India and travelling to onsite locations only to implement the computerisation

(ii) Secondly, it showed a possible value-added transition into the product business by utilising customised services and the repeatability of certain aspects of computerisation that were likely to be common to all banks wanting to computerise.

(iii) In doing so, they had also shown the importance of the use of tools and of keeping control over the higher – level architecture of the computerised system while utilising domestic companies to do the lower-level tasks of coding and testing. COSL used other domestic companies such as Silverline and Nucleus software, which then offered similar services to the larger domestic and foreign firms.

(iv) Significant lessons could be learnt from the COSL story about the factors that eventually made for a successful product. Three important features of the I-flex success were the focus on international niche markets, the levels of investment and support that the product arm CITIL had got from COSL over a three year period till it developed a successful product, and the importance of complementary marketing strengths in being able to perceive market needs ahead of their time.

These were important lessons if we remember that Indian firms that had experimented with product models focussed on the domestic market but failed in the early 80s. Despite this the late 80s saw new firms into the software market (often business house subsidiaries) such as Wipro and Ramco attempt the product route again. They found limited success because of the lack of domain knowledge and also the complementary marketing strengths needed to push a product. Old firms also tried products as a value-adding route once again. Infosys for example developed a product BANCS2000 based on its computerisation projects with Indian banks, as did TCS with its banking product EX.

TI, in contrast, was a new multinational with no previous experience of Indian operations and whose main impressions about Indian workforce were possibly shaped by the experience of Indian employees in America. The Indian Diaspora in the US has a disproportionately high share of post-graduates and

professionals (Kapur and Mchale, 2002). Not surprisingly then, TI's aim in its Indian operations was to shift some of its strategic R&D work to utilise the talented workforce in India, as scientific talent was becoming very expensive in the US.

There are two views on why the location of Bangalore was chosen for its set up. Lateef (1997) argues that in contrast with other locations Bangalore had better communication links because of the location of many defence and space research establishments in the city. Its relatively dust-free environment, and the distance from India's borders had attracted the setting up of several public sector undertakings such as Bharat Electronics Limited, Hindustan Aeronautics Limited, and the Indian Space Research Organisation. Thus, TI chose to locate in India 'because of its strong educational system in theoretical sciences and engineering' and in Bangalore because it was perceived to be the location which best suited the lifestyles of TI's international staff, by virtue of its openness as a city. Patibandla and Petersen (2002) suggest that TI is an example of the influence of the Indian Diaspora, as one of the senior Vice-Presidents of TI, Mr. Mohan Rao was himself an Indian, and also an example of a major departure from earlier rules governing FDI. The Rajeev Gandhi government approved the setting up of the TI subsidiary with a dedicated satellite link and TI managers brought in the most modern communication equipment at that time.

TI pursued a fully off-shore model, with no subcontracting to local firms but starting with low level software requirements and graduating to more complex R&D tasks, such as the design of the DSP chip.[6] They demonstrated the usefulness of good satellite links and allowed many leading firms like Wipro and Infosys to use leased satellite capacity from them.[7] This allowed other local firms to scope out the possibilities of outsourcing and also encouraged them to ask for permission to make such investment themselves or with their partners. Indeed in the later establishment of offshore development centres, the

[6] It is only relatively recently (in 2002) that TI has announced a collaborative R&D program with Wipro, Infosys and Sasken to work on the GSM standard.

investment in a dedicated satellite link became the most important aspect of the business model for offshore work among local firms. The good experience with TI probably made public administration less distrustful of such private investments as well.[8] Additionally, TI made a concentrated effort to reach out to educational institutions in the Bangalore area, in an effort to tap into the local scientific talent directly. It was involved in curriculum development activities, funded laboratories especially with the Indian Institute of Science.

Thus, both COSL and TI presented the first prototypes of an offshore model of software development: COSL was based around applications software development in a specific domain with local outsourcing and TI was based around complete outsourcing (and no local subcontracting for strategic reasons) with value addition built in the eventual outsourcing of higher R&D functions. The managerial aspects of these newer business models leaked out to Indian firms in a variety of ways. COSL hired Indian subcontractors among the second tier Bombay firms at that time to do the low level coding tasks while the COSL team focussed on the architectural aspects of application development. But the turnover of labour was also important as new skills and learning was brought to domestic firms from those that had worked with multinational firms.[9]

Through the late 80s and 90s, many more multinational firms followed the example set by COSL and TI. Later multinationals such as Microsoft, HP and Motorola conducted these activities on a much larger scale. Most notable among these are Adobe and Microsoft, who have also filed for patents based upon R&D work done in India. These product firms transferred some of their R&D functions to India but also use

[7] This cooperation would probably have been impossible if TI had not been serving a captive parent market.
[8] In our interviews, firms such as Satyam reported that they had faced huge resistance to such private investment in satellite links in the mid 80s.
[9] Consider for example the following recent statement from N Lakshmi Narayanan, President and COO of Cognizant , a foreign firm in our definition: "MNCs will be helpful in growing the consulting culture among Indian professionals. For software product development, the staff needs a different capability and discipline, which Indian software professionals could learn from the MNCs". (ET, 20 August 2002)

local sub-contractors to write the code for certain stages of product development. Like TI, Microsoft has been active in the educational sector and funded its first non-US chair of Computing Science at the Indian Institute of technology in Delhi.

A different kind of offshore R&D services model was also introduced into India by the entry of Nortel in the mid 90s. Like TI before it, Nortel sought to use the talented workforce in India for R&D activities. But unlike its rivals Motorola and TI, it sought to do this through joint ventures rather than the establishment of a new subsidiary in India. To this end it entered into IP protected contacts with four local firms in slightly different areas. By doing so, Nortel introduced a new business model for R&D services from India based on shared risks and rewards. More than subcontracting, the joint venture model proved to be an important and valuable learning opportunity for domestic firms in the telecom domain.[10] It was not without its costs to Nortel however, who found they had created competitors in the form of Sasken, who eventually competed for the same product market as Nortel. In 1996, Nortel has finally set up its own subsidiary in Bangalore. The Nortel strategy of sharing risks and rewards in R&D outsourcing was also imitated by Cisco, and ironically now by the original pioneer in outsourced R&D, TI itself. Both Cisco and TI have involved the same four firms that were originally chosen by Nortel to be its partners. This suggests that the four domestic firms now have an additional capability and knowledge that makes them valuable to other multinational firms in the telecom area.

Domestic firms tried to implement the offshore model in its different variants, learning from the relative success and failure of multinational firms. An important problem in implementing the offshore model for domestic firms was to ensure a constant stream of work that was progressively more complex and value-added. This was the one way to avoid the pressure on billing rates due to growing competition in the 90s, in the main from domestic firms, and also to learn the more complex tasks. While MNC subsidiaries

gradually got more complex tasks other firms had to bid for it and show that they could be trusted with such tasks. This was more difficult than it seemed and it was not until the late 90s that large firms and older firms like TCS, Wipro, Satyam, Infosys and HCL could utilise their long-standing relationships with old clients to bring in new work that was more complex.

However, before this time, during the mid to late nineties, many large Indian firms had adopted organisational improvements that made their offshore development centres much cheaper than setting up off-shore subsidiaries. As a result many Fortune 500 firms sought Indian partners for their firm specific software needs. A similar process is also underway in the outsourcing of R&D services, as the success of Wipro indicates. Indeed Wipro is a good example of a leading domestic firm that actively learnt from the activities of the TI.

Wipro was remarkably quick to imitate the TI strategy in offering its R&D services to firms with whom they had long standing outsourcing relations. In the late 90s they adopted a conscious strategy of focussing half their software work on telecom R&D.[11] Wipro invested heavily in acquiring the requisite certification for standardised quality and software process control. This strategy has now clearly paid off with Wipro getting the first fully outsourced R&D deal with Ericsson in 2002. In obtaining this deal Wipro has demonstrated that a domestic firm with the right focus on domain and investments in process capability is cheaper than a strategic subsidiary. Other domestic firms with similar investments will now enter the market as during these recessionary times the opportunity of cost-cutting this represents to multinationals worldwide is far too large to be ignored.

[10] For the learning effects of the Nortel alliances for domestic firms see Basant et al (2001).
[11] Interview with Mr. Ghose, VP Marketing, WIPRO, December 1999.

4. The development of organisational capabilities complementary to the offshore model among domestic firms

As remarked in the previous section, Indian software firms did more than imitate the offshore model first demonstrated as viable by multinational firms. They were able to improve the basic offshore services model pioneered by multinationals and offer these services much more cheaply and efficiently in their dedicated development centres. As a result development centres became more popular than fully owned subsidiaries and many Fortune 500 companies sought out Indian firms to meet their software needs. They were able achieve this success by developing organisational capabilities that were complementary to the off-shore model and by signalling this ability to prospective clients.

4.1: Increasing scale and complexity of work in offshore development centres

Initially, the tasks undertaken in the off-shore development centres were simple and the survey reported by Arora et al (2001) suggest that this was the case till as late as 1997. However, overtime a handful of firms were able to undertake larger and more complex tasks. These big projects like the Boeing contract for Satyam starting coming in towards the late nineties and the two years of this millennium. This increase in size of projects is reflected in the growing revenue and manhours per project. Here is some comparative evidence that will help place the issues in perspective.

Recent NASSCOM estimates suggest top Indian companies have been routinely bagging multi-year offshore contracts valued at about $75 million or 300 man-hours, which is higher than the $10-15 million contracts of a couple of years ago which were however spread out over many more firms[12] Contrast these figures to those reported by Arora et.al (2001) based on their interviews in 1997:

[12] NASSCOM vice president Sunil Mehta as reported in "Indian software sector sees recovery", The Washington Times, 15 October 2002.

"The typical export project is to the US, small (10 manyears) worth about $1million and involves maintenance, porting an existing application from a legacy platform to a client server platform or Y2K work. Between 33% and 66% of the work is executed offshore (in India)."

All three developments- the spread of off shore development work among Indian firms, the increasingly complex nature of projects and the larger size of some of the offshore work is reflected in the steadily increasing proportions of offshore revenues in total revenues. NASSCOM estimates suggest that the revenues from off-shore work are in 2002 about equal to what now comes in from on-site work. The frequency of this work in more recent years also suggests that either the organisational capabilities to handle more complex projects among leading Indian firms were in place only by 1999, or that they were able to show credibly to prospective clients their skills only relatively recently.

A key factor linking the emergence of organisational ability to undertake large-scale, complex work and signalling this ability to prospective clients, was the acquisition of quality certification by several Indian firms. The ISO standards but more importantly the CMM levels tested the software processes employed by firms using the so-called waterfall model. An important requirement of good procedures and process control was the standardisation of low level coding to make software error free, adequate documentation and in-built checks for consistency at all the five stages of the waterfall model, and good human resources management. Arora and Asundi (1998) point out that the ISO 9000 certification was closer to CMM level 2 and ISO9001 to CMM level 3. The importance of such process control for the efficiency of outsourced work is apparent from the fact that many captive multinational subsidiaries in India such as TI and Motorola, have acquired CMM certification at levels 4 and 5, and as Table 5 shows in India, MNC subsidiaries show a higher incidence of certification. 70% of firms certified with CMM level 3 and above are in India.

{Table 5 here}

What induced Indian firms to acquire certification on such a large scale? It seems very likely that the high rate of labour attrition faced by Indian software firms through the 90s (18% was the industry average reported by NASSCOM sources) was the most important inducement for both. Arora and Athreye (2002) have argued that early software firms often utilised engineers for fairly simple tasks that did not require any engineering talent or principles. To a large extent the employment of engineers was a strategy employed by Indian firms to distinguish themselves from the rest of the competition. They were able to point to the better quality of their human resources to convince prospective clients of the better quality of their (skilled labour-intensive) work.

The global scarcity of programmers, particularly middle level software programmer-managers, the large wage gap between what Indian firms paid and what foreign competition was prepared to pay in the global competition for Indian software talent meant that Indian firms were particularly vulnerable to both wage increases and labour attrition. Attrition particularly affected completion of projects and made the earlier signalling strategy somewhat suspect as the same labour could be easily bid away. A new signalling strategy was required which would point to the capability of the firm itself and its ability to organise teams and employ processes that were error proof. Certification uniquely fulfilled this need and also alerted firms to what they needed to do in order to make software ability reside in teams rather than people. Firms thus began to invest in developing organisational ability.

4.2 Labour scarcity, attrition and investments organisational capability

Through the 1990s, there was also an upward pressure on software salaries, which created its own inducement for different software developing strategies. NASSCOM estimates suggest that salaries rose at the rate of 30% per annum. Multinational presence contributed to this rise, as they paid roughly 20% more

than domestic firms. But growing competition from all types of firms and new entrants put pressure on software salaries. Time series data on salaries are hard to come by. Heeks (1996) reports average salaries in the range of $8000 per annum for a software developer[13] in 1995. Reporting figures from another source Arora (2000) reports average annual salaries $15700-19200 for the same group. A Dataquest survey for the year 2001-2002 (which was the recession year) reveal that these figures had come down slightly in the recession year: the annual industry average for an employee with two to four years of experience was $10,417.

The impact of the increase in salaries in the mid 90s was to prompt firms to look for a more rational labour using strategy to keep costs down in a market where other domestic firms were competing on costs alone. This strategy had two main components. The first one was the use of proprietary software tools for automating some parts of the writing of software code. This helped firms reduce the production cycle time and build upon software already written. The second prong was to substitute non-engineers for engineers wherever possible, thus reversing the wasteful use of engineering talent in the very early period.

The off-shore model that gained popularity in the mid and late 90s was uniquely suited to such a labour using strategy. The popularity of the off-shore model also resided in it being a cheaper way for a western firm to meet its software needs than either a fully owned subsidiary or on-site servicing. NASSCOM claims that costs in the off-shore model were roughly 1/3 those of the on-site model due largely to the higher expense of living costs in the US. Interestingly however, Arora and Asundi (1998) also note that vendors preferred the offshore model as it was more profitable than the on-site work. This suggests that there was considerable cheapening of the cost of software development in the Indian variant of the

[13] The classifications used in the three data sources are a bit different. We have considered a software developer with 2-4 years experience.

offshore model. However, the higher profitability of off-shore operations was also due to a different organisation of work in the case of off-shore development.

Two kinds of factors were relevant. First, if there was increasing substitution of cheaper (non-engineering labour) for the more expensive engineering labour. Second, if the spread of salaries for engineering and non-engineering labour was lower in the domestic market than in the international market. It was very difficult to obtain data on both. Comparing figures in Heeks (1996) with those in the Asia Week survey for 2000, suggests that the spread between different salaries has probably increased slightly. This is what we should expect with the attrition of developers and project leaders with some experience- those grades would begin to enjoy a premium even as the lower level salaries are kept down as labour supply increases. Indirect evidence of such use of non-engineering labour alongside the engineers is the large-scale expenditures on training incurred by domestic firms and reported in Kumar (2000). Kumar (2001) also estimates that the number of professionals engaged in purely software development has come down over time from 70% of total employment in 1996 to about 63% in 2000. Correspondingly the proportion of people involved in managerial and marketing functions has also gone up.[14]

It is also important to realise that such a rationalisation of labour use was a strategy permitted by the growing scale of software operations as demand for software outsourcing grew in the late 90s. Certainly no other industry in India had faced a growing market for its production for over a decade. Consequently, as Babbage had predicted in the mid nineteenth century, growing scale allowed productivity increases due to a fine specialisation of tasks where each worker could be assigned to tasks, which he or she was best suited to. The organisational strengths built up were in response to recurring labour shortages, but they were also acquired in the process of scaling-up of software service operations in individual firms: as Table 7 below

[14] See table 14: page 4285.

indicates the median size of the Indian software firm measured in terms of revenue increased between 1995-2000.

It is scarcely disputed that the leading Indian software firms possess some unique organisational capabilities that allow them to deliver an internationally competitive combination of low cost-high quality software services. These organisational measures and practices seem to have developed in the main between 1995-2000, and their presence is indicated by the rising trend in labour productivity. Table 6 below reproduces labour productivity per unit of wage bill, for 66 companies, computed by Kumar (2001). In a climate of increasing wages there is a pressure on this index to fall. It can rise only on account a reduced labour input usage or a more than proportionate increase in overall revenues. What is interesting in Table 6 is that the industry as a whole started registering an increase in labour productivity in the period after 1996-97. Subdividing the sample by size groups we find it is only the largest firms that have been able to increase labour productivity, the smaller and medium sized firms have not be able to reverse their falling productivity. The table thus also suggests some advantages to scaling up in terms of labour productivity.

{Table 6 here}

In sum, the purpose of this section has been three-fold. Firstly, to show that this development of organisational capability had different components some of which were closely related to certification (such as standardisation and quality control) and others to a more rational use of scarce software talent, which over time possibly reflected in the higher productivity of the sector. Secondly to argue that these organisational capabilities were strongly related to a process of 'scaling up' of software operations, permitted by the huge demand created by the Y2K work. Lastly, to argue that these investments were induced by tight labour markets which forced firms to keep costs down but when twinned with expanding scale,

created a virtuous cycle. A firms kept costs down the market itself expanded making more cost saving possible.

Foreign competition (by multinational firms, foreign firms and global competition) was crucial to creating the tight labour markets in software in a way that they haven't done in any other industrial sector in India so far. The investment in organisational capability was principally a response by domestic firms to survive this competition in the factor market, but as they survived the factor market competition by building organisational capability, new opportunities for value addition also opened up. As we showed in the earlier section many of these new value-adding opportunities were first scoped by multinational firms, but were adapted and improved by leading Indian firms with almost no competition from the multinationals themselves. It is highly unlikely that this scope for experimentation and adaptation would have been as large if multinationals were competing in the same product market segment. They would have tried to capture most of the market shares in it capitalising on different advantages specific to their parent firms.

4. Human capital or capability building by firms?

In a recent paper Patibandla and Petersen(2002) have argued that multinational firms and MNCs in particular were drawn to India because of the wage advantage of India, and their operations afforded spillovers of many kinds, which were absorbed by capable domestic firms. In particular they argue that the higher wages afforded by multinationals also drew attention to the private rewards to human capital formation by individuals. Investment in human capital raised the returns on physical investment by domestic firms and increased productivity in the industry.

The argument made by Patibandla and Petersen is general enough to be true about a variety of different sectors where multinational firms have entered the domestic economy, e.g. pharmaceuticals, and a

range of manufacturing. Indeed, the entry of multinationals in any sector raises wages[15] in the sector, as it expands demand for labor in the short term, and by the Patibandla Petersen argument should therefore induce human capital formation by individuals. In turn this should result in productivity improvements of domestic firms as human capital-intensive labor worked to increase the efficiency of production of the physical capital already invested.

This is not the case for a variety of sectors. The most obvious counter-example is domestic pharmaceuticals, which share the derived demand for scientific talent with software. Domestic pharmaceutical firms are finding competing with multinationals very hard going despite drawing on a similar talent pool, and in addition investing significantly in R&D in order to try and improve their productivity. This is primarily because of the market power and the brand reputation enjoyed by large pharma multinationals who compete aggressively in the product market with domestic firms often displacing them in some areas. Consequently, the role of multinationals in this sector has been less benign. Leading domestic pharma firms are either pushed to niche markets like bulk drugs or to being R&D arms for the bigger multinational pharma companies.

One does not observe this pattern in software. Leading domestic software firms have grown to challenge some large MNCs (like EDS, Andersen consulting, Accenture) in key areas of software development and in this they have been aided by the presence of other MNC software development subsidiaries in India. So what makes the experience of software different? We have argued that software was unique in its experience of foreign competition because the effects of foreign competition induced domestic firms to become more efficient in resource use without closing the door on the product space. Further, the story we have told about software evolution suggests that the locus of productivity increases resided in the growing

[15] See Jenkins (1990) for evidence of this general pattern.

organisational capabilities of firms rather than from a greater use of engineers- as we would expect if there was greater use of human capital.

While it is certainly true that Indian software firms were fortunate in the initial abundance of human capital that enabled them to exploit an important market opportunity, the initial use of human capital by domestic software firms was quite wasteful in the use of scarce engineering talent. It is also the case that multinational firms were drawn to India because of the abundance of human capital. But as foreign competition bid up the prices of software programmers and managers, domestic firms responded by developing organisational capabilities that helped them reduce costs and explore different value-adding strategies.

As we see it, the crucial role played by foreign firms and multinationals was in creating competition in the factor market, which induced firms to switch from human capital intensive strategies to more capital intensive strategies and building organisational capabilities in managing teams of workers to produce error proof software. Furthermore, this increase in production happened along with an increase in the capital requirements per output. The difference between our story and the human capital story can be illustrated diagrammatically as in Figure 2.

{Figure 2 here}

The Patibandla Petersen argument suggests that the Indian software industry moved along ray OL' from A to A' as more and more employees realised the rewards to investing in human capital which in turn raised productivity in the industry. This paper has argued that Indian software industry moved from A on ray OL' to E on the more capital intensive ray OK'. This shift happened as the industry responded to the increase in software salaries by adopting different methodologies for producing software (e.g. use of tools) and to

attrition by investing in organisational capability. Both of these in turn increased productivity at the firm level.[16]

Table 7 below offers some figures that support this broad story. It details several characteristics of the median firm in three NASSCOM registers. Note in particular the sharp increase in the authorised capital requirements overtime and the contraction in total labour employment and the proportion of software professionals after 1996-97. These happen along with growing size and productivity. These data are exactly what we would expect if the average firm in the software sector was moving from a point such as A to E in figure 2.

{Table 7 here}

The organisational capabilities that leading firms invested in were those complementary to the offshore model. Multinational subsidiaries had first pioneered the use of offshore software development. However, the absence of multinational competition in the product market also meant that domestic firms were free to experiment and substantially improve business models first introduced by multinational firms. Indeed in bringing down the cost of offshore outsourcing, domestic firms may have raised the opportunity cost (for multinationals) of establishing such subsidiaries in India!

5. Summary and implications

The Indian software industry is an interesting example of the role that foreign firms and multinationals can play in an industry's evolution. Many of the other influences of multinationals noted in the literature are evident: the opening of international markets to Indian software exports, the establishment of

[16] Strictly, the Patibandla- Petersen argument implies labour augmenting technological change, which should shift the isoquant X , downwards but biased towards saving more labour than capital. In Figure 2, we have depicted a parallel shift representing neutral technical change. Perhaps this is a minor point as in the Cobb-Douglas form of the production function, which the authors employ, the two types of technical change are equivalent.

subcontracting links with domestic firms and the wage increases predicted in a sector due to multinational entry.

We have argued that while foreign firms contributed to competitive pressure in the product market, multinational firms with greater managerial abilities often pioneered the models that leading Indian firms would later adapt, but were not competitors to the same firms in the product space. On the other hand they did transform the factor market- in this instance, the market for software programmers and engineers. In particular foreign competition raised salaries there and forced Indian firms to search for more efficient labour use strategies and build unique organisational capabilities. The significance of this asymmetry in competition in the two markets was that the lack of competition in the product space, left avenues for value-addition reasonably open for domestic firms. Had multinationals competed in the product space as well, it is likely that not many domestic firms would have survived the profitability squeeze nor had the opportunity to build the capabilities required for scaling-up operations.

In the terminology used in Section 1, while there were important demonstration effects of multinational firms but the competition effect was in the main felt in the factor market with far-reaching consequences for the evolution of domestic capabilities in the industry. This in turn is not unrelated to the benefits of efficiency seeking FDI, which usually locates for global export, often noted in the literature on foreign investment. The Indian software story shows that gains in productive efficiency may be intimately connected with where the domain of the competitive process between multinationals and domestic firms lies in the first instance. Competition by multinationals in factor markets can and does induce productive efficiency among domestic firms. When coupled with the scale advantages of large export markets, such competition can have a deep and transformative effect on an evolving industry.

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Figures and Tables

Table 1: Growth of Indian software revenues, 1984-2000

1984	1985	1986	1987	1989	1993	1994	1995	1996	1997	1998	1999	2000
22	26	38	54	105	330	485	734	1085	1750	2650	4000	6300
					228	350	490	670	920	1250	1700	2450
					558	835	1224	1755	2670	3900	5700	8750

Table 2: Periods of entry and types of entrants

Type of entrant	Pre-1980	1981– 84	1985-91	1992-99	2000	Total
Business House firms	7	6	15	54	13	95
Joint Venture	1		3	18	2	24
Multinational Enterprises	0	5	18	68	5	96
Public Sector Enterprises	3		1	0	0	4
US-Indian	1	1	10	31	3	46
Entrepreneurial firms	2	3	14	24	9	52
Entrepreneurs with prior professional experience	5	7	40	93	15	160
Not known	2	2	9	37	5	55
Total	21	24	110	325	52	532

Notes to Table 5:

(1) For classification of type of entrant, see Appendix to the paper.

(2) 10 Multinational subsidiaries were established in 1991, and 25 were established following the second wave of liberalization of foreign investment rules in 1995-96.

Source: Author's computations based on NASSCOM (2001)

Table 3: Types of entrants and their share in revenues and employment (1999-2000)

Type of entrant	% of sales revenue	% in total employment	Revenue per employee (Rs.10^6)
Business House firms	32.8	30.1	128.68
Joint Ventures	4.0	4.2	111.08
Multinational Enterprises	25.6	16.8	180.25
Public Sector Enterprises	2.6	6.0	50.31
US-Indian	6.4	8.1	93.53
Entrepreneurial firms	8.1	10.6	89.91
Professional entrepreneurs	27.9	27.2	116.18
Not known	1.7	4.9	41.14

Source: Author's computations based on NASSCOM (2001)

Table 4: Regional location of software activity, by type of firm (1999-2000)

Type of firm Location	Joint Venture	MNE subsidiary	US- Indian	Business Subsidiary	House	Entrepreneur	Professional Entrepreneur	Total By location
Bangalore	7	31	12	12		16	28	120
Mumbai	4	19	8	35		13	27	129
Pune	2	7	3	3		3	6	32
Chennai	3	6	9	12		8	15	61
New-Delhi	4	16	2	19				111
Noida	1	9	3	3		2	7	7
Gurgaon	2	3	2	7		2	2	19
Hyderabad /Secundrabad		9	7	6		-	5	59
Calcutta	1	4	3	2		7	5	29

Note: Many firms could not be classified by type and so the totals, by location are greater than the different categories of firms reported..

Source: Computed from NASSCOM (2001) after excluding government departments, and liaison offices.

Table 5: Incidence of certification among various types of entrants in 1999 - 2000

Entrant type	Business House subsidiaries	Multinational Enterprises	US- Indian	Entrepreneurial firms	Entrepreneurial (professional IT)
Relative incidence of certification	1.18	1.54	1.53	1.00	0.64

Notes to Table 5:
(1) Firms that had any type of certification, ISO or SEI-CMM were counted.
(2) Relative incidence is computed as: proportion of firms in each category that had certification / average proportion of firms in the industry that had certification. A relative incidence greater than 1 indicates that sub-group had an average certification that was higher than the industry average, which was 0.274.
Source: Author's computations based on NASSCOM (2001).

Table 6: Trends in labour productivity

Year	1994	1995	1996	1997	1998	1999
Full sample	6.21	5.52	5.33	4.46	4.81	4.58
Large firms	7.36	5.69	5.27	4.76	5.31	5.03
Medium-sized firms	4.15	4.68	5.22	3.71	3.80	3.72
Small firms	10.06	9.43	7.45	6.07	4.69	4.35

Note: Labour productivity is defined as revenue per unit of the wage bill, and is computed from balance sheet data of 66 software firms.
Source: Kumar (2001): Table 10, page 4283.

Table 7: Changes in size, employment and revenues of the median firm

	1994-1995	1996-1997	1999-2000
Size of Authorised capital (Rs. Million)	7.8	12.5	40
Sales Revenue (Rs. Million)	28	38.36	50.43
Export Revenue (Rs. Million)	20	25	27.44
Total employment	85	115	100
Employment of software professionals	66	90	66.5
% software professionals in total employed	77.6	78.3	66.5
Revenue per employee (Rupees Million)	0.33	0.33	0.50

Source: Nasscom (2001, 1998, 1996)

Figure 1: Growth of Indian software revenues, 1984 - 2000

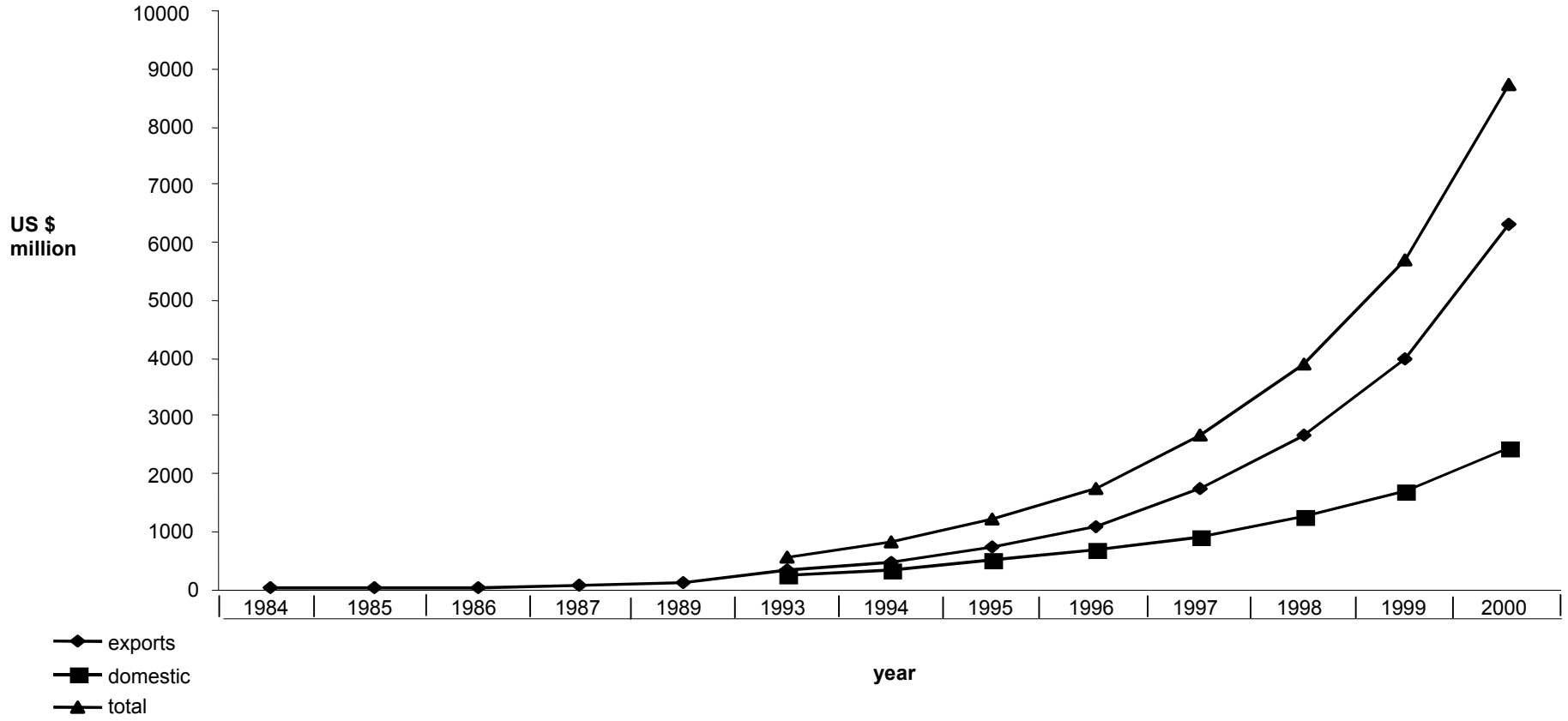
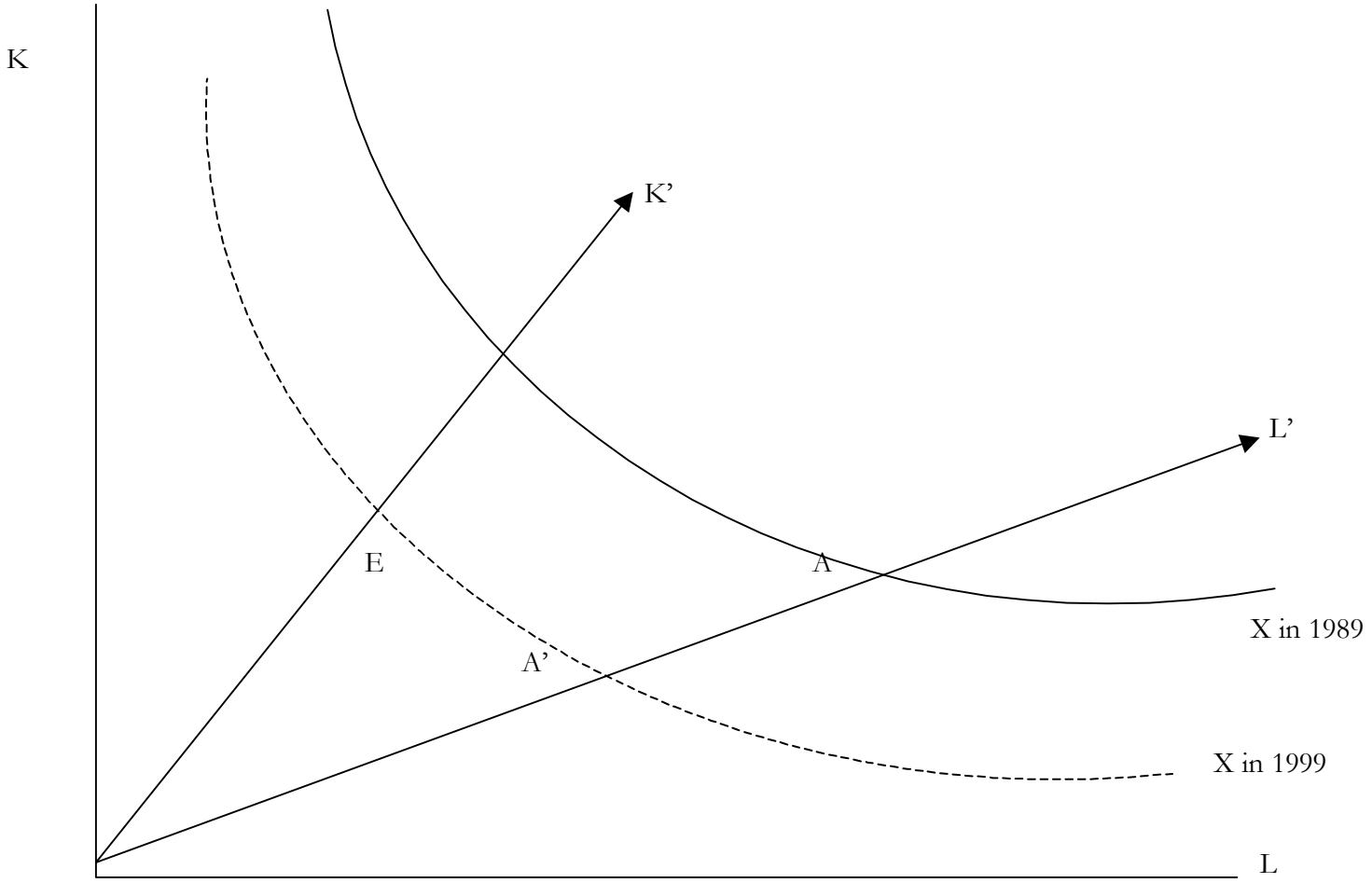


Figure 2: Effect of rising software salaries on software production due to multinational entry



Appendix on data sources

Figure 1 is based on two sources of data. Data for 1984-89 are as quoted in Lakha (1994), while data for 1993-2000 are based on NASSCOM reports.

Tables 2-7 of the text are based on computations from the NASSCOM 2001 register. The data source is described and the computations are explained in this appendix.

The National Association of Software and Service Companies was established in the late eighties as the Industry association and its membership has grown steadily since. NASSCOM brings out yearly registers, which contain information about its member companies. The data reported are not the company's balance sheet data but are based on a questionnaire required of their members by NASSCOM. The register gives details about the sales revenues (export and domestic), certification, employment and the years of establishment of various firms. These data are signed by the auditors to each company and as such represent the most reliable data with broad coverage for the industry as a whole.

We added a classification of entrant type by visiting the web sites of different firms in the 2001 register. The following different types of entrants (reported in Table A.1) were identified and are used in the tables 2-6:

Table A.1: Types of entrant firms

Entrant Type	Description
Missing	If the origin of the firm could not be determined
Professional Entrepreneur	If a firm was started by professionals with prior experience in IT or IT management.
Entrepreneur	If a firm was started by an existing individual entrepreneur in fields other than IT
Multinational Enterprises	If a firm was started as a multinational subsidiary
US-Indian	If a firm was started by people of Indian origin and incorporated in the US
Public Sector Enterprises	If a firm was started as a public sector unit/enterprise
Business House subsidiaries	If a firm was started as an arm of a existing business house
Joint Ventures	If a firm was started as a joint venture