Catch-up in Technology-driven Services: The Case of the Indian Software Services Industry

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Past studies on catch-up processes have focused primarily on manufacturing industries. The present paper studies catch-up processes in the context of the Indian software services industry and finds that the existing models are unable to comprehensively explain the catch-up processes in this industry. The authors provide a fresh perspective on catch-up processes based on scientific intensity and production maturity of individual technologies, and propose catch-up paths for individual companies from a technological perspective. Firms initially focus on productionizing highly mature technologies, and then leverage that learning to move into technologies of higher scientific intensity. External factors such as product market conditions play a major role as well in firms' ability and motivation to make such moves.

Keywords: Technological Catch-up, Catch-up processes and paths, Indian software services industry

JEL Classification: O14, O32, O33, L86

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I. Introduction

In the 60 years since independence, India has struggled to build or maintain a competitive position in several industries. Its contribution to world trade has declined. Even in an industry such as textiles in which India had a comparative advantage thanks to factor endowments of raw materials (cotton) and people, India's global market share declined. The country's performance in newer industries like machine tools, engineering goods, and semiconductors was for the most part disappointing too (in recent years, the automobile component industry has provided a bright lining to this picture). India's emergence as a significant player in the software services industry has therefore been the subject of great interest to scholars and practitioners (*e.g.*, Athreye 2005; Arora 2008, *etc.*).

Just a couple of statistics are adequate to establish the success of the Indian software industry. Software exports from India grew from US$ 3.4 billion in 1999-2000 to US$ 47.3 billion in 2008-09 (NASSCOM 2009). The industry is currently estimated to be employing over 2.23 million people.

Why has India been so successful in the software industry? How has it been able to not only become an important player, but in certain contexts (such as testing and maintenance services) be synonymous with the industry itself? The simplest explanation is based on comparative advantage — India had a large supply of qualified human talent at low cost which could provide low cost, basic programming services (Arora *et al.* 2001; Sridharan 2002). However, this view overlooks the simple fact that there are a number of other industrial arenas in which India has a large supply of cheap labour but has failed to make any impact; also there are other countries which have cheap labour for programming but have failed to make headway in the software industry. Thus, though a labour cost based comparative advantage may be one part of the explanation, it is not the whole story.

The Indian software industry success story is not a story of policy-driven success either. The role of the state has been a contentious issue with Kattuman and Iyer (2001) attributing the success of the industry to benign neglect by the state, Arora *et al.* (2001, p. 1267) calling it "a mixture of benign neglect and active encouragement from a normally intrusive government," and Parthasarathi and Joseph (2002, p. 20) noting "a series of state initiatives taken on a systematic and sustained basis played their due role." However, it is clear that this is no analogue of the orchestrated support provided by the Korean and Taiwanese governments to the semiconductor and manufacturing industries. Though the Indian government realised the potential of the software industry sometime in the mid-1980s, it was only in the early 1990s that a truly industry-friendly policy environment evolved, not so much by design, but as a part of the deregulation and liberalisation of the Indian economy that started in 1991.

So then how do we explain the catch-up, and subsequent leadership of India and Indian firms in the software services industry? Are there new dimensions that need to be considered when we look at catch-up? And how replicable is the catch-up process by other countries? That is the subject of this paper. We propose a new model which provides an integrated view of the catch-up process. The first section reviews the existing catch-up models. The second section revisits the Indian software story with a clear chronology, and attempts to reconcile existing models with what really happened. We then focus on the differences and similarities between catch-up processes in technology-led manufacturing and technology-led services, and attempt to gain fresh perspectives.

II. Catch-up Models

A. National-level Perspectives

While Richard Nelson's "Catch-up Project" has once again thrown the spotlight on this issue, the study of catch-up in the development economics context is not new. A little less than fifty years ago, Gerschenkron (1962) explained how support from the state and the creation of new institutions could help newcomers leapfrog existing players as demonstrated by France and Russia in the nineteenth century.

Porter (1990) proposed that a country is more likely to have competitive advantage in an industry when the firms in that industry are under pressure to constantly innovate. This pressure is related to four different environmental factors — factor conditions, demand conditions, presence of related and supporting industries and lastly firm strategies, structure and rivalry. Presence of high-quality factor inputs and highly demanding customers encourage firms to develop new technologies, and presence of end-to-end production and delivery facilities facilitates value capture within the country.

Taking Porter's model at face value, it would almost seem as though newly industrialising countries (NICs) are condemned to perpetual mediocrity. While many NICs start with some availability of basic factors like raw materials or people, they lack the sophisticated factor inputs that Porter refers to. Building these is difficult in a situation where demand conditions are weak, and related and supporting industries face problems similar to the industry under focus (Khanna and Palepu 1997). Local firms have typically been protected and thereby sheltered from competition or, in more open markets such as in Latin America, swamped by multinationals. There are thus significant barriers to global competitiveness.

In spite of this, there have been several examples of successful "latecomer industrialisation." Japanese success in the automobile industry, Korea in the consumer electronics industry, Taiwan in the semiconductor industry, and more recently, India in the software industry are examples of countries (and their local firms) creating a national competitive advantage.

Korea first targeted relatively mature industries such as the chemical industry and then slowly moved into more sophisticated industries like automobiles, shipbuilding, electronics, and telecommunication. Korea's success in such diverse industries has been explained in many different ways. One school of thought argues that Korea distorted prices and thereby created incentives for industrialisation in new areas (Khanna and Palepu 2004). Another school of thought believes that the Korean government has played a key role on multiple dimensions — by supporting the chaebol with cheap funds; by protecting the domestic market from foreign competition (Cho, Kim, and Rhee 1998); by supporting the creation of domestic technological capability (Mathews 2002), *etc.* Cutting across these different perspectives, what emerges is a strategic partnership between the state and industry in which "national champions" were allowed to take on high levels of debt and provided protection but were in return expected to develop a strong export orientation and, later, focus on technology development (Amsden 2001). Local firms created an absorptive capacity within themselves, and created technological capabilities through leveraging partnerships with a wide variety of international players. More importantly, the firms did not remain content with absorbing what they learnt from their partners but went on to improve upon these technologies and become global players in their own right (Mathews and Cho 2000). The Taiwanese story is similar except that large national champions are replaced by networks of smaller companies and a greater role is seen for public sector technology organisations in absorbing and diffusing technologies. Common to both Korea and Taiwan is the creation of an institutional capacity to promote the absorption and diffusion of diverse capabilities (Mathews and Cho 2000). A third variant of this model is that of Singapore which has been able to attract top multinationals to set up manufacturing facilities and hopes to use its Economic Development Board and state-sponsored venture capital to diffuse capabilities to local firms.

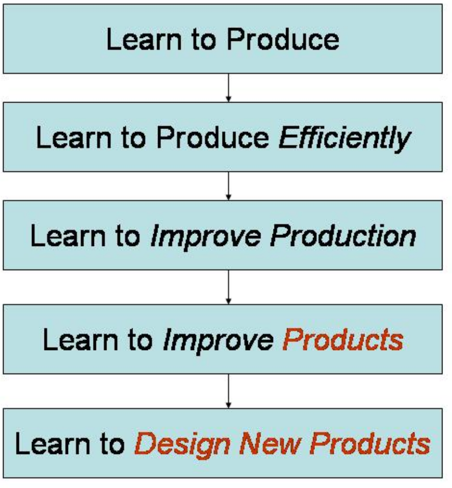
While the lack of resources could be an impediment to industrialisation and market access could be another barrier, latecomers can have certain advantages as well. For one, they are not locked into existing technologies (Schilling 1998) or different forms of organisational and institutional inertia.

B. Industry and Firm-level Perspectives

The above discussion suggests that there are differences in the nature of catch-up across nations. We now turn our attention to some of the firm-level catch-up models.

Wong (1999) has proposed a comprehensive 5-category typology for catch-up by manufacturing firms. The first type — "Reverse value chain" — is exemplified by the move of Taiwanese computer and peripheral manufacturers from manufacturing their products at low cost to the specification of branded manufacturers to their current position as "Own Design and Manufacture" (ODM) suppliers where they take complete responsibility for end-to-end design and manufacture. The second type — "Reverse PLC Innovation Strategy" — describes the transition of memory chip makers such as Samsung from imitators to innovators under their own brand. The third type — "Process Capability Specialist" — is represented by Taiwanese foundries on hire such as TSMC that are leaders in the processes that govern the manufacture of semiconductor chips. Companies from all over the world go to these Taiwanese foundries to have their chips fabricated because of the manufacturing competence of these companies. The fourth type — "Product Technology Pioneer" — is rare because it involves risky investments in research and development, and a market presence in developed markets. Finally, the fifth type — "Applications Pioneer" — adopts contemporary technology to solve problems of local relevance in a more comprehensive manner than companies elsewhere.

Wong's typology considers a range of issues such as learning, capability-building and market dynamics. Forbes and Wield (2002)



Source: Forbes & Wield, 2002.

FIGURE 1
HIERARCHY OF CATCH-UP IN FORBES & WIELD (2002) MODEL

integrate the different approaches of Wong into a single framework by concentrating on greater value addition by the enterprise based on the development of technological capabilities by the firm. They emphasise the importance of incremental, shop-floor innovation as the driver of such value addition. They use examples such as Tanzanian Breweries, Hero Cycles, Grupo Vitro, and Cemex to show that companies can add value by first improving their internal operational performance and then slowly graduating to design and branding of their own products. A possible sequence is: learn to produce; learn to produce efficiently; learn to improve production; learn to improve products; and, finally, learn to design new products (see Figure 1). In this way, companies can move from being followers to leaders. However, their conception of leadership is not quite one of global leadership, for they envisage companies from Newly Industrializing Countries working within the technological frontier established by front-runners from the developed nations. They suggest that an effective approach for followers is to concentrate on pushing the design frontier in terms of meeting the needs of users in diverse markets.

The above perspectives have looked at the primary challenge of catch-up as obtaining technological capabilities. Researchers in international business and strategy have also recognized the importance of resources and capabilities, but have taken a broader view of what resources are required to catch up. They have also paid more attention to changes in global product markets, changes in the strategies of established multinational corporations and their competitive dynamics. Prominent among these has been Mathews (2002).

Mathews (2002) seeks to identify the process of evolution of latecomer multinational enterprises — companies that have in a short span of time established themselves as significant global players in spite of the lack of resources faced by them in their countries of origin. Their ability to capitalise on the opportunities offered by globalisation has been enhanced by their willingness to experiment with a number of strategic and organisational innovations.

Changes in global markets for goods and services provide opportunities for companies from NICs. As competition has become more intense, there has been strong pressure on companies to focus on those activities that they are best at doing and to outsource all other activities. For example, the shoe company Nike focuses on shoe design and the entire chain of marketing activities in which it believes it can create maximum value. It gets all its manufacturing done by companies in low wage cost economies and only supervises the quality of production. In hyper-competitive conditions, no company can afford to be uncompetitive at any stage of value chain. Firms from NICs have seized this opportunity to become part of the global value chain of buyers.

According to Mathews, latecomer multinationals are not constrained by the inertia that besets incumbent multinationals. Since they are practically "born global" they do not have to contend with the tradeoffs confronted by the existing MNCs, such as those between global integration and local responsiveness. While incumbents are preoccupied with how to protect their competitive position, latecomers are nimble and adaptable at making use of new opportunities, often arising from the same incumbents. Latecomers rapidly create a global presence and then use this presence to gain access to resources they would otherwise not have. While incumbents' advantage is built around inimitable resources, latecomers seek out, from the same incumbents, resources that are imitable, substitutable and transferable and use these to build their own resources and competencies.

Mathews and Cho (2000) propose that industries having characteristics of rapid turnover of products and high levels of competition, predictability of technology trajectories, availability of product and process technologies, and the availability of leverage trade-offs are likely to be good candidates for application of the leverage-based approach.

III. India's Success in Software Services Re-visited

India's presence in the software industry goes back as far as 1970 when Tata Consultancy Services (TCS), a part of the Tata conglomerate entered this business. Hardware and software development in the academic and research sector predates this and goes back to the 1950s at the Tata Institute of Fundamental Research. The Indian Institute of Technology at Kanpur that was set up with American support also developed excellent computational facilities in the 1960s and by 1970 many IITK graduates were using computer simulations extensively in their assignments and project work. TCS and another Tata company, Tata Burroughs Ltd. (later renamed as Tata Unisys Ltd., and now known as Tata Infotech Ltd.) slowly built up their project experience and reputation by sending promising fresh engineering graduates from the top institutions to work on projects in the United States after a quick in-house training course. At that time almost all development took place at the client's site. There were a number of reasons for this. The offshore model was not possible because of the computer import policy that caused long delays in the import of computers — no client would be willing to wait that long. Further, telecom facilities were difficult to arrange and even if available were of high cost and low reliability. Customers were yet to build up confidence in Indian software capabilities and Indian companies also lacked project management skills that could ensure management of complex software projects in India.

A turning point in government policy towards software exports was the Government's permission in 1985 to Texas Instruments to set up a development centre in India with direct data transfer to its headquarters in the U.S. This decision was taken over-ruling a number of objections regarding security. This enabled the provision of software services "at a distance" though at high cost.

By the early 1990s, a number of other changes took place that facilitated the quick growth of the software sector. The hardware technology changed to client-server, and this opened up a new market for migrating and reengineering applications that had been originally written for mainframe computers. Systems integration between existing mainframes and new client-server networks also became a significant area. Large

American companies called in consultants to help them make these technology transitions but the consultants were hamstrung by the limited availability of qualified manpower that could do the job. Indian companies like TCS and new companies that had a presence in the market became a natural source of qualified software manpower for these consultants and the "body-shopping" model thrived. At that time, a global division of labour began to emerge where international consulting firms undertook the consulting and system design, and Indian services firms did the coding, testing, and maintenance of the software.

This phase coincided with the liberalisation of the Indian economy that started in 1991. The government became export friendly; therefore, raising financial resources both domestically and in external markets became easier. The government-sponsored Software Technology Parks of India offered data communication services by-passing the telecommunications utility; thus telecom services though still expensive, were at least available. Tax breaks for software exporting firms completed the government incentive package.

Acknowledging India's status as a provider of high-quality software, a number of prominent MNCs created their own development centres in India in the mid-1990s. Today, the list of companies includes Hewlett Packard, Oracle, Sony, Sharp, LG, Bosch, Daimler Chrysler, and almost any multinational that has a significant budget for information technology.

In the late 1990s, a number of top Indian software companies includeing Wipro and Infosys issued stock and had themselves listed on foreign bourses such as Nasdaq and the New York Stock Exchange. Indian companies made the best of two important market booms — the "Y2K problem" that involved ensuring that existing programs did not suffer glitches as the world entered the new millennium, and a little later the internet boom that saw companies the world over rushing to set up a web presence, conduct commerce over the internet, and use the power of the internet to improve their business effectiveness and efficiency. The "dotcom boom" also saw the rise to prominence of Indian techies as successful entrepreneurs, CTOs, and VCs in Silicon Valley which had an overall positive impact on the Indian software industry in terms of its reputation and ability to generate more business. The presence of qualified Indian techies in senior positions in customer firms was another important factor that helped Indian software services firms secure business from American companies. It is worthwhile noting here that the large community of Indian techies in the United States was an unintended consequence of brain drain from India during the 1960s, 1970s, and 1980s.

The post-dotcom recession in global markets saw a blip in the performance of the industry and growth rates declined though still remaining at the healthy 20%+ level. This was possible because as major world companies struggled to deal with the recession, they looked at new ways to bring down costs. The provision of high quality software and related services by Indian companies offered a useful and reliable way of doing this. This coincided with a maturing of Indian software companies' project management capabilities and there was a sharp change in the software business model to offshore provision of services from India. Quality certification became more important as the development was no longer taking place under the eye of the customer but 10,000 miles away. Indian software companies took the lead, becoming the leaders in obtaining the SEI-CMM certification at the higher 3, 4, and 5 levels. By 2002 itself, 60% of the SEI CMM Level 5 certified companies in the world were in India (NASSCOM 2002).

Around this time, Indian software services companies began making attempts to ascend the value curve in software development. Ironically, though, one prominent shift was "downwards" into business process outsourcing. Efforts to develop software products remain few and far between (Krishnan and Prabhu 2002) and attempts to graduate to consulting though more widespread have not been particularly successful. Indian software companies have generally attempted to differentiate themselves through a number of indirect methods such as transparency in corporate governance, innovations in human resource management and quality certification rather than product-market strategies.

Indian software services firms have used both strategic and organizational innovations to strengthen their competitive position. Strategic innovations include the move into business process outsourcing to secure customer lock-in through better integration with customers' global value chains, and organisational innovations include the creation of dedicated Offshore Development Centres (software development centres dedicated to a particular customer so as to give the customer a sense of ownership and control) and, more recently, Proximity Development Centres (centres located physically close to customers that can be highly responsive to customer needs). These companies also realised early the importance of processes and quality thanks to their interaction with a number of top global multinationals such as General Electric, Citibank, and Reebok. They have built further on this client-inspired learning to establish global standards of delivery and quality, confirmed by independent certification. Smaller Indian companies have "learnt" from the larger ones, though often by imitation and movement of people rather than direct interaction.

IV. Using Existing Models to Explain the Success Story

In the context of Porter's model of national competitive advantage, India was well-placed on the input side. Certain factor conditions such as an English language-knowing and mathematically literate workforce, a strong higher education system (particularly in engineering) that graduates large numbers and a culture that stresses the importance of education have undoubtedly helped the growth of the software industry in India. However, demand conditions within the geography have hardly been conducive to the growth of a sophisticated software capability. There is no clear evidence of the Indian software industry having benefited from large government contracts; there is clearly no parallel with the U.S. where defence spending supported the establishment and growth of computer science in U.S. universities and the rapid growth of defense-related markets for software created opportunities for the employment of software developers, many of whom went on to use their skills in civilian markets (Mowery 1999, p. 157).

The Government can take credit for creating a strong engineering education system which has provided much of the top talent of the Indian software industry. But, there was no apparent effort to build specific capabilities through large projects till the late 1980s, when the state-owned CMC Ltd., undertook such projects as the computerization of the railway reservation system. In fact, for a long time the Indian government was more preoccupied with the creation of a computer hardware capability (Subramanian 1992), though ultimately success in this area was also limited to a few niche achievements such as a parallel processing capability at the Centre for Development of Advanced Computing at Pune. As a result, there was neither much investment nor much success in developing related and supporting industries.

The above discussion suggests that Porter's diamond doesn't comprehensively explain India's success in the software industry. The Japanese and Korean models of latecomer industrialization do not explain the success either, with Government support and direction for the software industry being conspicuously absent. In fact, several industry leaders have commented on the problems faced by them in dealing with the Government machinery in the 1970s and 1980s. For example, firms importing computers had to commit to a certain amount of software exports and then get several permissions from various authorities before finally being able to procure them.

Similar concerns crop up when using other firm-level models to explain the Indian software success story. Indian software services companies are undoubtedly leaders in software development and engineering processes, and therefore their closest description in Wong's typology could be in the third category as process capability specialists. But their success (and financial returns) has gone well beyond what has been achieved by Taiwan's silicon foundries. While Forbes and Wield suggest how companies could move from followers to leaders, they expect the companies to catch-up technologically with firms from developed nations. However, we see the Indian software firms catching up with, and sometimes even overtaking firms from developed nations in terms of process capabilities rather than technology. The leadership derives from building complementary capabilities rather than taking on the incumbents head-on. One could make the same comments regarding the Mathews (2002) model. While the Indian software companies display the three features — linkage, leverage and learning, the linking and learning has been in processes rather than in technology.

V. Catch-up in Technology-driven Services: A Fresh Comparative Perspective

While the traditional catch-up perspectives focus on high technology industries or sectors, we find examples of firms learning the rules of the market through low-technology products and then use opportunities created by technological discontinuities to catch-up with the leaders. For example, Mathews (2002) notes how the Korean companies focused on relatively standardized products such as DRAM to form and deepen relations with the OEMs before emerging as serious players in the broader memory segment. A similar pattern can be found in televisions where the Korean chaebol entered the commoditized CRT segment and emerged as the leaders when the technology shifted to LCD displays.

Considering technology to be the primary unit of analysis rather than industry or sector provides a fresh perspective into the nature of catch-up processes. We propose to classify technologies into four types

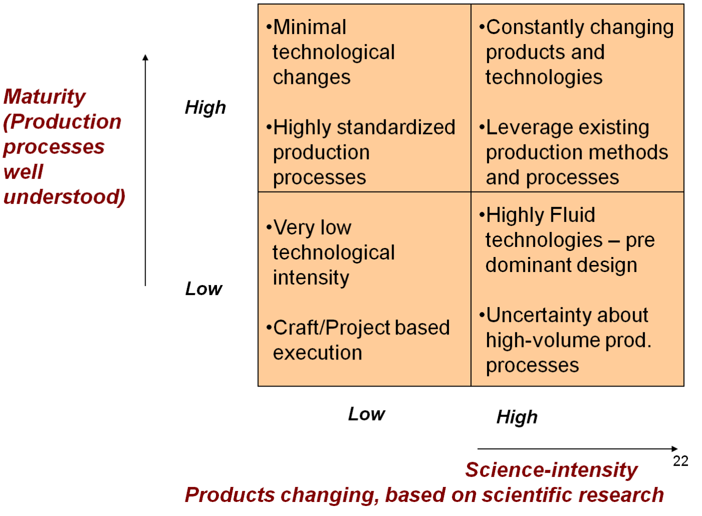


FIGURE 2
PROPOSED CLASSIFICATION OF TECHNOLOGIES

as shown in Figure 2. We use two principal dimensions: the maturity of production processes (*i.e.*, the extent to which production processes are well understood and the knowledge of how to set up production processes is available commercially) and science intensity (*i.e.*, the extent to which the creation of new products depends on scientific research and science-driven development processes).

The catch-up trajectory will be in a clock-wise direction as shown in Figure 3. Technologies in the lower left quadrant are mature, but have a low level of production process maturity. There exists a significant role for companies from emerging economies in "productionizing" these technologies and moving it into the upper left quadrant. A good example in the manufacturing context is the ship-building industry. The technology component in ship-building was quite mature, and the Japanese and Korean ship-builders caught up and overtook the incumbents by adapting mass-manufacture production practices into ship-building.

After mastering production processes and establishing themselves, companies shift attention to technologies in the upper right hand quadrant. In the semiconductor industry, for example, chaebol such as Samsung achieved maturity in production processes (for DRAM chips), and then shifted attention to the high science intensity of creating new chips. Of course, the most advanced new chips may involve moving to

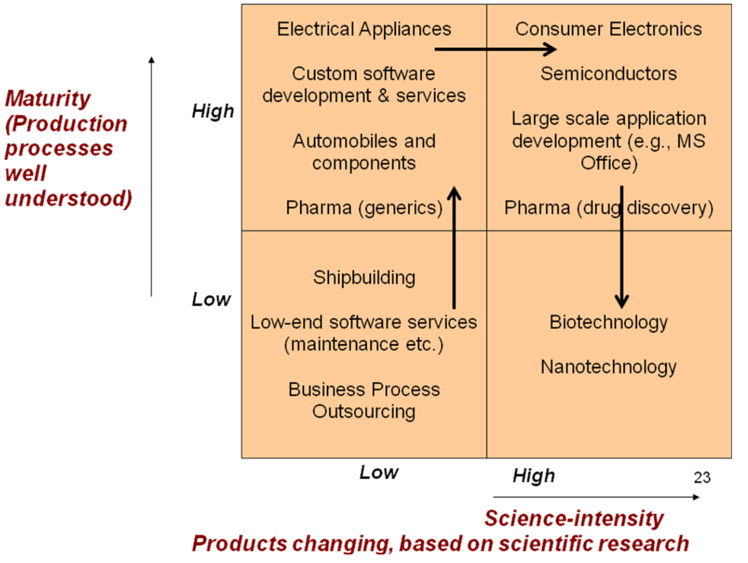


FIGURE 3
CATCH-UP TRAJECTORY OF COMPANIES

the bottom right hand quadrant where production processes also need to be innovated.

Korean companies are also moving into new areas such as biotechnology which have both low levels of maturity of production processes and very high science intensity of production processes. This is the most challenging quadrant as far as catch-up is concerned. This is the quadrant in which the overall ecosystem of research and academic institutions and the existence of a dynamic national innovation system play a key role.

When Indian companies entered software services, the industry clearly fell in the lower left quadrant, *i.e.*, low level of the maturity of production processes and low science intensity. Software was seen as more of a craft activity. Over time, Indian software services companies played a significant role in "productionising" software services and moving it into the upper left quadrant. As Arora *et al.* (2001) mention, companies predominantly adopted two complementary strategies. The first was sector specialization, with companies building up domain knowledge in focused sectors, and offering "solutions" to customers in these sectors. The second strategy was developing good software development methodologies, high quality standards, and in-house tools enabling them to deliver solutions in a timely and high quality manner.

One sees a similar pattern in the pharmaceuticals industry as well, where Indian firms competed in the upper-left quadrant by mastering production of generic pharmaceuticals. However, so far, there hasn't been much success in the right-side quadrants, *i.e.*, technologies with higher science intensities such as software products, drug discovery based pharmaceuticals and biotechnology.

There are several constraints that companies face when they try to move into the right-side quadrants and up the value chain. As noted earlier, a dynamic national innovation system is critical in supporting such moves. Developing technologies with high scientific intensity requires risky and large investments in R&D and manufacturing. Also as Krishnan and Kumar (2003) argue, firms need to have the willingness to ascend the value chain, in addition to firm-level capabilities and product-market opportunities and capabilities.

In fact, product-market opportunities have played a very important role in the Indian software services story — both in driving the rise and now inhibiting the move into the right-side quadrants. Discontinuities in markets and technologies,[1] pressures to disaggregate supply chains, and synergy between the country-of-origin and the type of product/service offered (*e.g.*, the Indian cultural affinity for mathematics cited earlier) have worked in favour of Indian software services companies. Availability of knowledge in the market was not a problem, and in any case the evolution of new technologies meant that Indian companies could "leapfrog" ahead. Indian companies have been slowly able to penetrate decision-making networks thanks to the emergence of software industry leaders as important players on the global stage. Strong English language and communication skills and cultural adaptability have made this process easier. Moreover, the software services industry does not suffer from hypercompetition or aggressive price-cutting. Growth levels have always remained above 20%, even in the post-dotcom recession in the global markets. As noted earlier in the paper, companies could continue growing rapidly with relatively minor adjustments to their business models and strategies. As a result, there was no motivation for companies to make the risky investments required to move into the right-side quadrants.

[1] The chief trends were the move to client-server models, the dramatic rise of the internet, and the rapid increase in the strategic importance of IT in large corporations.

VI. Conclusions

The success of Indian software services firms raises the question whether the process is replicable by firms in other countries. Given the organizational embeddedness of software process capabilities, the other factors required to be successful in this industry (such as people management capabilities, domain knowledge, and customer relationships), and the path dependence of the Indian software success story (Indian software companies co-evolved with major changes on the demand side such as the move to client server technologies, an increasing focus of large multinational corporations on their "core competence," and the dramatic growth of the internet/e-commerce), catch-up in this industry is difficult for new firms. This phenomenon is corroborated by the fact that the largest Indian software services companies grow at a much faster rate than the small and medium ones, and that software services firms in other major geographies (such as China) have made little headway. Building more "all-encompassing organizational capabilities" is more important than just building technological capabilities. Also, as in the case of manufactured products, some features of the external market are important facilitators of catch-up (and forge ahead) in technology driven services. These include discontinuities in markets and technologies, pressures to disaggregate value chains, and the absence of forces that induce a downward spiral in prices.

One could also argue whether Indian software companies can at all be classified as high technology companies. What they have been able to display is the ability to quickly absorb new technologies and ramp-up internal delivery capabilities in a short time to meet customer requirements, and at the same time deliver on-time with a reasonable level of in-built quality. They have proved quite adept at generating business from "Fortune 1,000 companies." Thus the Indian software industry model can be described as using cost arbitrage as an entry strategy in an emerging business and opportunistically expanding this business while at the same time building more sophisticated organisational capabilities within (Athreye 2005; Ethiraj *et al.* 2005). This has been facilitated by the fact that the services model does not involve too many irreversible commitments to investments in areas like research and development or product development and that the basic skills required are fairly generic.

However, the same factors that have helped the rise of the Indian software companies seem to be inhibiting their move to the right-side quadrants. As noted earlier, demand conditions have been remarkably good throughout the short history of the industry. The constant pressure to cut costs in advanced economies has ensured that demand has always outstripped supply. As a result, the incumbents were more involved in developing clients through existing services rather than developing new technologies. Entry into new businesses, if any at all, was primarily in close adjacent areas which are amenable to existing models.

A good example is the move into Business Process Outsourcing by existing software services players. The industry was in the lower-left quadrant when the Indian players started entering. Mirroring the software experience, the initial value was primarily cost arbitrage. New communications technologies such as VoIP, and the crashing cost of international bandwidth made the cost structure particularly attractive, but also lowered the cost of entry. Companies, in an attempt to retain pricing power started differentiating themselves on basis of quality and process efficiencies. As a result, the processes started getting "productionized"—just as in other industries mentioned earlier, and BPO started moving into the upper-left quadrant.

A rather striking feature of the Indian software industry is the reluctance to move away from the dominant paradigm of offshoring and leveraging the learning gained in the process to improve efficiencies. Moves to the right-side quadrants require willingness to experiment other models, and more generally a greater level of risk tolerance, in addition to the existence of a scientific eco-system.

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