Working Paper Series

#2008-050

Comparing Chinese and the Indian Software MNCs: Domestic and Export Market Strategies and their Interplay

Jorge Niosi and F. Ted Tschang

United Nations University - Maastricht Economic and social Research and training centre on Innovation and Technology
Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499, e-mail: info@merit.unu.edu, URL: http://www.merit.unu.edu

Comparing Chinese and the Indian Software MNCs:
Domestic and Export Market Strategies and their Interplay

Jorge Niosi[1]
Professor
Department of Management and Technology
University of Québec at Montréal

and
F. Ted Tschang[2]
Assistant Professor
School of Business
Singapore Management University

August 2008

Abstract
China and India are emerging as major new entrants in the international software industry. Both are rapidly learning through outsourcing with multinational enterprises from advanced nations. Yet, their paths to this dynamic sector are very different. Chinese software firms have focused on their domestic market by working with foreign MNCs, while they move cautiously abroad. Indian firms, despite already being large, continue to expand overseas as well as to climb the value chain. We show that a macro perspective on the global movement of work can be gained by utilizing concepts from different approaches to the MNC. At the same time, the innovation systems perspective is necessary to explain the foundations of the industry. The paper provides hypotheses and performs an initial validation of them. It concludes that the internationalization and learning processes are somewhat different in the Chinese and Indian MNCs, and provides explanations for the different patterns.

Key words: Outsourcing, software industry, industrial development, multinational enterprise
JEL Classification: P45, O14, O32, L23

UNU-MERIT Working Papers
ISSN 1871-9872

Maastricht Economic and social Research and training centre on Innovation and Technology, UNU-MERIT

[1] niosi.jorge@uqam.ca
[2] tedt@smu.edu.sg

Introduction

The software industry is experiencing a major delocalisation trend, from developed to developing countries. In this trend, MNC from both developed and developing countries are playing a major role. In the 1980s and 1990s, India took the lead in attracting this industry, due to its large pool of skilled low cost labour. Ireland and Israel followed suit. Since 2000, China and other developing countries have been entering this fast growing industry.

The first section recalls some landmark contributions to the theory of the MNC, and derives testable hypotheses from these perspectives. The second section summarizes the history of the software industry. In the third section, the paper brings forward a "history-friendly" but contemporary discussion of India and China's MNCs in the global software sector, and finally, by a return to theory to suggest the interest in the future integration of these perspectives.

What we seek to develop in this paper is a way of explaining both the differences and similarities of the growth and subsequent internationalization strategies of Chinese and Indian software firms (to the extent that internalization is taking place). With this in mind, we have chosen to study and compare two giants that present very different trajectories – one emerged (India) and one emerging (China). In the comparison of these two case studies and their different traditions, we hope to develop theory that fits the empirical evidence and stylized facts on software thus far. We will show that, in order to understand the internationalization of emerging economy firms, including with regards to the newer services sectors, we have to understand, on the one hand, the entry mode of the firms (into whichever market – export or domestic – and the learning opportunities the mode presented, and on the other, the relationships local (emerging economy) firms engaged in with foreign clients or multinational providers of those services. As we show,

theories of internationalization based on the now-developed countries can take us so far – we need to infuse a further understanding of how latecomers to the services industries were able to enter. In other words, a process-based view of emerging economy software firms is as critical now as it was to understanding the most recent case – late stage industrialization in East Asia.

1. Theories: multinational corporations and innovation systems

Multinational corporations (MNC) have been the subjects of a multifarious literature. Starting with Raymond Vernon and the product life cycle approach, through the synthetic approach of John Dunning, towards the more recent evolutionary theories of Kogut and Zander, authors have emphasized proprietary advantages of these firms, the internalisation of such advantages in order to slow down the entry of imitators, and the choice of location for foreign investment on the basis of different criteria.

Product life cycles

In the PLC perspective, new industries are born in the richest countries, most often under the aegis of one innovative company (Vernon, 1966). Later, imitators and competitors emerge in the same country where the innovation was created, and compete for such market. In this first phase, many different designs appear and the market is reduced, due to the novelty of the product or service, its uncertain value and usefulness, and the competition of several design. In a second stage, entry rates fall, the industry starts to concentrate in the innovative country, and producers start to export to other nations with similar per capita revenue. In a third phase, products begin to converge towards a dominant design, product innovation falls, and process innovation increases. Also, the first innovators make direct investments in the second cohort countries in order to try to pre-empt the entry of competitors. In a fourth phase, leading companies based in developed

countries invest in developing nations in order to reduce costs, as both product and process innovations in the industry decline. Entry declines sharply: this is a period of shakeout, and strong exit, as well as uncertainty reduction. In the final stage, the industry localises itself in developing countries, and third world multinationals emerge (Wells, 1983).

It is possible to derive testable propositions from the PLC approach.

> Hypothesis #1: The software industry was born in the largest and richest country, then emerged in other advanced nations, and it is now maturing and delocalising towards developing countries. Thus the older MNC are based in the original innovative country.
>
> Hypothesis #2: In the international pecking order, any country that nurtures the industry starts producing for the internal market, exporting products and services and then conducting foreign direct investment.
>
> Hypothesis #3: In the maturation period, third world multinationals emerge; their ownership advantages include, among others "appropriate technology" (software more suited to developing countries) as well as organizational advantages (better capability to hire and train workers from developing countries).

While the international business tradition has focused on the role of multinationals in emerging economies, as of yet, it has not focused as much on hypothesis #3 – that of emerging economies as a generator of multinationals (Ramamurti, 2004). At the same time, to fully understand the paths by which firms in certain economies come up, it is necessary to appreciate the learning and absorptive capability of the emerging economy firms, as well as the possible role of foreign multinational enterprises in those emerging economies (Meyer, 2004). The nature of emerging economy MNC emergence is well represented by and amply studied in India's case for the new services sector. Our paper will examine whether Indian MNCs' are continuing an inexorable march along the 'conventional' MNC developmental trajectory. For the second half of the statement relating to the effects of foreign MNCs, much of the literature has already examined

how “demonstration effects” (i.e. local entrepreneurs striving to imitate MNCs) and movement of labor as the primary channels behind which MNCs influence emerging economies (Meyer, 2004). However, there are also rich studies in the phases of industrialization in electronics and other manufacturing sectors that showed how developed economy clients also assisted their ‘outsourcing’ partners in the emerging economies directly through technology transfer and training.[3] Indeed, our paper illustrates that, for the case of China, and probably in India’s past, such knowledge exchange also occurred in the newer, more knowledge-intensive sectors, where presumably intellectual capital and analytical work is more important than manufacturing process and machinery operation.

The synthetic approach

John Dunning (1988, 1998) built the successful synthetic (OLI) approach to the MNC. He forcefully argued that besides ownership advantages emphasized in the PLC theory, and the related internalisation strategy, MNCs did not all chose the same destinations for their FDI. Location specific factors matter. Across host countries, factors including natural resources, cheap labour, market size, as well as more “institutional” factors, such as intellectual property regulation, incentives for R&D, high-class universities and government laboratories, may present different advantages to different industries at different times. It is worth underlining that the OLI perspective allows a linkage with more macro theories, such as the innovation system approach, that emphasize the key role of institutions in economic development. There is reason to believe that these observations might also apply to emerging markets. Thus, from the synthetic approach, we can derive a few hypotheses:

[3] For examples, see the various studies of Sanjaya Lall.

Hypothesis #4: The destination of FDI of Chinese and Indian MNC will follow existing patterns of export; that is, Indian MNCs will invest in North America and Western Europe, and Chinese MNCs will invest in Japan. Such countries are the largest and more affluent markets of third world software multinationals.

Hypothesis #5: Chinese and Indian MNCs will invest in other developing countries in order to compensate for the depletion and higher costs of their home market labour pool, as well as to exploit their organizational and technological advantages in foreign markets.

The evolutionary approach to MNCs

Kogut and Zander (1993, 2003) built their theory of the MNC on the work of Winter (1986/2006) and Nelson (1991). Companies differ in the quality and quantity of the stocks of knowledge they possess, thus they follow different strategies. There is no representative firm, but a whole range of competencies, strategies and structures. Yet, companies based in the same country may display some similarities as they are submitted to similar environmental constraints. Kogut and Zander also built on the dynamic capabilities approach, which also emerged from the landmark work by Nelson and Winter and was eventually formalized by Teece (1994, 1997).

On these bases, Kogut and Zander pioneered the evolutionary and knowledge-based theory of the MNC. In their view, "knowledge and learning are at the root of understanding how competitive advantage is gained and sustained" (Foss and Pedersen, 2004: 342). For Kogut and Zander, multinational companies produce knowledge and search for new and complementary knowledge, both in their domestic and international markets. Also, a high proportion of knowledge is tacit, embodied in human experience, and circulates within the MNC through its personnel. Firms are social communities that create and use knowledge in the production of goods and services. MNC are firms that combine, create, acquire and transfer knowledge from different national sources.

Hypothesis #6: Software companies based in LDCs invest abroad in order to both exploit and increase their knowledge assets.

Innovation systems

The institutional factors that the OLI perspective has put forward have been more properly taken into consideration by the innovation system approach pioneered by Freeman (1987), Lundvall (1992) and Nelson (1993). Economic development is the result not only of the transfer of technologies by companies of advanced nations into developing countries but also by the concomitant growth of human capital and supporting institutions in such countries. Such supporting institutions nurture the creation of human capital, allow the assimilation and the mastering of foreign technology, and support an evolutionary process through which developing countries upgrade their technological capabilities. These capabilities are upgraded in both the public and private sector. It would be needless to underline the fact that numerous incentives are required to propel companies, public laboratories and universities to conduct R&D and innovation, as to allow them to understand and manage foreign technology. National institutions are required for such assimilation and upgrading, and they must display some degree of congruity and complementarities into a national system of innovation (Mohnen and Röller, 2005; Nelson, 2005)

> Hypothesis # 7: The software industry and software MNC will grow in countries where efficient and effective policy and related national and regional institutional incentives have been put in place to support the development of the industry.

Approach

We will now turn to an examination of the characteristics of the global computer software sector to help us contextualize these hypotheses for the purposes of our cases. We will utilize a

combination of secondary and primary data in order to bring out a general, yet firm-specific understanding of the developmental processes and paths.[4]

2. The computer software sector

The computer software and services sector (CSS) emerged in the United States within the computer manufacturing industry, from which it progressively detached itself. The emergence of the present day industry occurred in the United States through different stages (Hoch et al, 2000).

The evolution of the industry

In the first era (1950-59) independent programming services firms appeared to provide programs that IBM did not already sell embedded in its mainframes. Clients for such programs were government departments and large corporations using the large computers produced at that time. The second era (1959-69) was that of the packaged software products, following the introduction of the minicomputer by Digital Equipment Corporation (DEC). The minicomputer created the first mass market for software, and the new niche added itself to the professional services one, that still subsists. In the third era (1959-81) many independent solutions providers entered the market, as IBM was forced to sell its mainframe unbundled from its software. The fourth period (1981-1994) was marked by the personal computer (PC), and it was the period when the computer software industry became a large and global one. Also, in this era Microsoft, founded in 1975, became the world leader of the industry. IBM decided to outsource its PC operating system (OS) to Microsoft and DOS, and later Windows became the most popular OS. By the end

[4] Much of the secondary and primary data are based on data collected under studies of India and China by the authors. Approximately 27 firms were interviewed in India, and well over 30 firms have been interviewed in China, including eight in the latter that were outsourcing-specific. All the interviews were conducted between 2001 and the present. The interview data are drawn upon for rich process descriptions of selected (if not representative) firms.

of 2007, all Microsoft operating systems still represented close to 95% of the PC market. During this era, the CSS grew by 20% a year to become one of the largest world industries. The present era (1995->) started with the emergence of Internet. A new series of companies were created selling browsers and creating a new niche within the industry: e-commerce. In 2004, IBM became one of the major software and outsourcing companies, through the sale of its PC division to China's Lenovo, yet kept its mainframe manufacturing business.

Today's computer software industry is usually presented as being composed of some 27 niches, including accounting and finance, business intelligence, e-commerce, enterprise resource planning, multimedia, office, operating systems and supply chain management. Microsoft dominates the OS and office niches, while Oracle and SAP try to dominate the enterprise segments under the pressure of the world largest, IBM and Microsoft. The industry is now consolidating itself, as companies once specialised in one particular niche are now "invading" the niches once served by other firms.

Key traits and stylized facts of the CSS industry

The CSS is made of different activities and types of companies. The original software producers are the computer hardware manufacturers, such as IBM, Apple, HP, Sun Microsystems, and Toshiba. The specialised computer software firms are called the independent software vendors (ISVs) such as Computer Associates, Microsoft, Oracle, or SAP. These produce mainly computer software applications, and there are thousands of them in every industrial country. While over decades, the leadership of the sector has changed, over the last decade or more, the top software vendors have remained more or less the same. This suggests the first stylized facts:

- Most software design capabilities are located in developed countries

- The dominance of US vendors remains unabated

The CSS industry is composed of several activities. In terms of employment or sales, the most important of them are software publishing, systems design, systems integration, custom computer programming and data processing.

Some of the larger corporations (HP, IBM, Microsoft, Oracle or SAP) produce a large range of applications. Other companies are specialized in specific niche applications; the largest Israeli companies, for instance, are all market niche players offering applications for specialized markets (Breznitz, 2005). Thousands of software publishers are active in each developed country, most of them being small and medium size enterprises. The fact that firms can in this day and age still start up small and become large if not influential over night suggests the following stylized facts:

- There are low barriers to entry: all that is needed are a small number of programmers and computers with the adequate hardware and software.
- Product development, particularly for prototype software or the first of a kind, can sometimes be completed in terms of weeks or months
- Increasing returns and network externalities are very significant and can lead to small firms becoming leaders over very short periods of time.
- Intellectual property is protected by copyrights, trademarks and patents but this latter mechanism of protection is confined to the largest companies

In rigorous terms, the entire CSS sector is a service industry, even if some of these services are sold as packaged software products. Software “products” are divided into categories as operating systems, middleware and applications. Yet, the industry distinguishes between software “products” (packaged software) and services (all the rest, including the customization and maintenance of products and the provision of services around those products). Yet, the division

between software products and services is increasingly blurring. A piece of software produced for a particular client (e.g. custom made software, or a "service") can later be modified, "packaged" partially or totally, and sold by the thousands of copies, or hosted in a server and provided as another "service" on-line to thousands of clients. Indeed, it is not easy to claim that making products is superior to, and offers higher value added than, services.

The world packaged software industry is estimated to be around US$ 250 billion in 2007, 50% of which is still hold by US companies. North American and Western European companies tend to obtain a larger percentage of sales from applications ("products") but they also provide services (hosting, systems integration, custom software, data entry). Developing countries' firms produce more "services" than "products" as the needs for services like customization, maintenance and the like requires substantial amounts of technically skilled manpower. Table 1 gives some information about the segments of the IT market.

(Table 1 here)

In spite of its large size, the CSS still does not represent the entire picture. Specialized software firms do not create all the software produced every year. Manufacturing and service firms such as aircraft, automobile, electrical appliances, machinery, and telecommunication equipment manufacturers, as well as banks, insurance, engineering firms and other service companies, create software for their own use. This other software ("embedded" software, that is, software imprinted on hardware) is usually not sold separately in the market.[5] The manufacturing or financial corporations (and their clients) based in developed countries regularly outsource some of the

[5] The size of this "embedded " software sector is not known but it may represent, in terms of employment and value added, a chunk of economic activity as large as the computer software industry itself. The frontiers between the CSS and the embedded sector are fuzzy, because at any time an independent software vendor may be acquired by a manufacturing firm and converted into an internal "embedded" software division; conversely, we witness the regular spun of internal software departments from financial services or manufacturing firms.

software development to firms based in developing countries such as China and India. Thus, these countries are exporting software that, if not outsourced, would not appear in any statistics as separate products.

- An offshoring is ensuing: the trend towards international outsourcing specific parts and modules, mostly in developing countries such as China and India, thus integrating independent companies in such countries in the global value chains of the industry, in order to reduce costs, and accelerate product development and service delivery.

As software became increasingly modular, more and more offshoring has taken place under the imperative of cost and quality control:

- Modularity has facilitated offshoring of specific modules and even larger pieces of software – as designed in developed countries – to third parties, increasingly in developing nations.

Taken together, this broader notion of software, along with the service nature of much of software development suggests the need for substantial amounts of human capital, which can be posited as the following stylized fact:

- As a whole, software is a labour intensive industry with highly skilled human capital as its main input.

As developing countries like India first entered the markets, scaling up both firm sizes as well as project sizes became a critical goal. This resulted in the first Indian multinationals – true megaliths that rival some of the largest US software services firms in size.

- There has been an emergence of multinational corporations based in developed countries (the United States in the first place) but increasingly also in developing countries (Indian MNCs being the most evident).

Yet, there are clearer signals now that the countries most successful at developing outsourcing sectors have actually benefited from age-old public policies, but at the same time, there are fewer investments needed in this sector (i.e. fixed costs are lower):

- There is generally a lower need for investments, but public support for higher education and human capital continue to be important in this sector as with prior ones.

The questions this brief review raises are, firstly, whether the Indian firms are approaching the levels of value added activity attained by the "original" CSS firms in the developed regions, and secondly, whether there is room for new players (and whether new paths to industrialization are part of that, containing some of the same initial conditions as India's path). We will now turn to an examination of our two cases to illuminate the answers to these questions.

3. The Indian software sector

Entry into the software industry

The Indian software sector has been extensively analyzed, even if important issues remain to be debated (Arora et al., 2001; Arora and Athreye, 2002; Athreye, 2005; Joseph, 2006). It is clear that Indian companies started their development most often as subcontractors to international corporations based in developed countries. While software exports from India started in the 1980s, the real take-off occurred in the 1990s: from $105 million in 1989, exports attained $6,2 billion in 2000, and around $32 billion in 2007, growing by over 30% a year. The Indian industry target is $60 billion in software exports by 2010. In 2007, software services represent over 22% of total Indian exports ($140 billion) and are its main export item. India is by far the largest software exporter among LDCs, and trails only the US and Ireland in the world.

Also, most exporting firms are Indian owned-and controlled corporations (Table 2). Such corporations learned most often in the course of outsourcing contracts with international corporations. Several issues are worth recalling. The first is the set of factors that explain such a trend. The second is the explanation of the upgrading process, particularly the conditions that mitigate and facilitate this.[6]

(Table 2 here)

3.1. The Rise of India

The most common explanation of India's growth is one in terms of comparative advantage: India has a vast pool of skilled English speaking programmers and engineers, whose salary was historically much lower than those of similar personnel in North America and Western Europe (Athreye, 2005). The second explanation, also put forward in the literature, is in terms of trade liberalization. Despite the earlier protectionist stance of the government, the rules on foreign investment were eventually relaxed in the 1980s, and the Indian software industry eventually benefited from the trade liberalization that took place in the early 1990s. Multinational corporations based in advanced countries invested in the Indian software industry and accelerated learning and knowledge diffusion. Also, trade liberalisation allowed the import of advanced computer equipment, and suppressed taxes on software exports.

A third explanation is in terms of industrial policy (Athreye, 2005; Balakrishnan, 2006). The national government promoted the industry through many different schemes. Many of them were implemented during the import substitution era, including the requirement that Indian firms

[6] Throughout this section, we will rely on a combination of secondary information such as annual reports and news sources, as well as interviews that one of the author has had with firms in the industry (approximately 15 interviews with Indian software firms were conducted in 2001, and follow up conversations were made with employees of selected firms since then).

produce software for nationally owned computer manufacturers. Later, in 1991, the national government set up an organization, Software Technology Parks of India, which built some 41 technology "parks" across the country. The scheme was aimed at promoting exports, and by 2005, over two thirds of exports in the country took place from such parks. Finally, public expenditure in higher education from previous years was high by any standards, and public investment in the Indian telecommunications infrastructure increased substantially since the implementation of the 1991 liberalisation policy.

Another explanation centres on the outsourcing requirements from developed countries, whose labour pool came under pressure as outsourcing and complexity software became a norm with the global increase in IT use and efforts to increase productivity from that use. This demand arose in both the CSS industry and many other software-using sectors. In India, the defining source of work was the 'Y2K' problem, which required many US, European and other MNCs to rework older software prior to the arrival of the year 2000 (Y2K). Thus, even as the basics of the human resource supply and basic organizational capability was forming in response to market needs, it was further enabled by the combined effects of trade, industrial and human capital policies, allowing India to take advantage of this upsurge in outsourcing. Even after the Y2K issue, the outsourcing contracts that firms gained continued to become progressively larger and more complex (Athreye, 2005b). Also, in spite of the fact that the larger companies in Table 2 represented an important share of exports, dozens of other companies are also exporting software form India. Outsourcing within global value chains has represented the main learning opportunity for Indian firms. The early acquisition of capability was also at its heart driven by foreign clients that were hungry to move non-core or non-high-end work overseas. Our own interviews confirm the general impression in the industry that providers learnt from their clients, e.g. an interviewee

at Wipro cited that they learnt a considerable amount from early clients like Nortel in the telecommunication and other sectors (author's interview).

3.2. Upgrading

Upgrading in Services

Since the early 2000s, Indian firms have been moving up the value chain, in part driven by the natural needs of their clients (Arora et al 1999), and in part by the Indian firms' desire to upgrade themselves. Since most Indian firms started on a technical basis (i.e., providing programming, skills then, higher level project level capabilities incorporating those same skills), their natural tendency has been to build strong technological capabilities, and to hone their employees' skills at the latest technology – be it programming languages or technological domains like wireless communications. An example of this is Wipro, which has been an exemplar in how it developed its technical and R&D competencies in the telecommunications industry and other engineering sectors.

It is partly because of this reputation for technical excellence that Indian software services firms have received the perception that they are caught in a technical "services" trajectory that is possibly lower value-added than a "product" based one; this is in fact what some industry actors also believe to be the case. This is somewhat misleading: many "products" (packaged software) are no more complex than many "services" (i.e., custom made or "customized" software) in which several Indian firms excel, and the margins have on average been good for the better services firms. Systems integration for instance is one of the most complex tasks, one in which US firms like EDS, Accenture and IBM have a commanding market share. Indian firms, in contrast, have found it more difficult to move into this sphere of work. As a result, Indian firms

like Infosys have been attempting to move into higher "systems ends of the software value chain as soon as they can. However, Infosys also reported difficulty in moving into "end-to-end" systems work, in part because clients did not want to relinquish the highest ends of the work to their contractors.[7]

Another services trend has been the increasing spread of "customization" and other services work to other geographic regions. Wipro has been in Japan for some years, and many Indian majors including Tata Consultancy Services (TCS) are establishing themselves in China. TCS, the largest Indian software firm, has perhaps the most developed multinational strategy in the developing countries. TCS has also developed a large Latin American focus, with some 2530 employees and over $100 million sales for the year in Latin America alone.[8] By mid 2007, there were 5000 TCS employees in the region, including 800 in Uruguay and 3600 in Brazil and Chile. Such a strategic investment was linked to a $260 million outsourcing contract from ABN AMRO Latin America, and another similar contract for application development from the same Dutch Bank in the same region. Late in 2007, TCS was creating a centre in Guadalajara, Mexico, that will hire 500 professionals in the short term to deliver a $400 million contract to the Social Security System of Mexico. In all, by early 2008, TCS had over 100,000 employees in 47 countries and had revenues of $4.3 billion in fiscal 2007 (Table 3).

(Table 3 here)

Upgrading via products

Despite the strength of services, products have continued to provide an allure to many Indian companies, either as a dominant strategy or as part of a portfolio of products and services. This is

[7] Annual reports, various years.
[8] The Hindu, June 20, 2006.

no doubt due to the observation that the largest and most successful software companies in the world are essentially own brand product makers.

Development of products: At the one extreme of the product spectrum - with the most risk and potential for the highest profit margins of all strategies - is the own brand product strategy. Some Indian companies are already selling their own products with their own brands and trademarks, although it has been noted elsewhere that this is a particularly difficult path to follow (Athreye, 2005). The quintessential case for India has been that of I-Flex – which we will discuss in detail as it illustrates the complex challenge of building an own brand products company.[9] I-Flex was founded in 1991 as a joint venture with Citicorp, with its earlier incarnation being that of an internal subsidiary providing services to Citicorp. From the beginning, I-Flex's leadership focused on products, and earmarked financial products as their only sector of focus. It turns out that the competition in financial products was less competitive than in other sectors, with existing competitors having legacy systems. I-Flex showed acumen by initially branching into other emerging markets such as Africa and South East Asia, where competitors were weakly represented, and where their lower cost software. They initially started with a comprehensive banking product called Microbanker, but eventually worked on a state of the art replacement called Flexcube that embodied major (software) architectural improvements. This product featured a modular architecture, so that new features could be added on in an extensible manner. I-Flex worked with banking clients in countries such as Thailand to populate their product with new, relevant features, and also developed a strong group of domain-trained professionals to further infuse domain knowledge into the product. I-Flex eventually won over more and more

[9] This section is based on Baba and Tschang (2004) as well as notes from a study described in Tschang, Amsden, and Sadagopan (2003).

clients in developed markets, and was deemed so successful that in 2006, Oracle acquired a majority stake in it, primarily to serve as a domain rich entry to higher value work in the financial sector. Despite the success of I-Flex, no other firm has been able to follow its path, in part because of the so many things that have to be done right, and in part because products is an inherently risky strategy to begin with. Indeed, many Indian firms combine a form of product strategy with services.

Because of the low probability of success in own brand products, many Indian firms are moving into product development in a more measured way, often via the development of products as a service, or the "co-development of products" (i.e. working on behalf of a client). Such activities does not carry the risk of making one's own brand product for the international marketplace. Examples of development for other product vendors include Tata Consultancy Services development of a popular product for Microsoft, called Quadrem, an electronic marketplace. There are numerous other examples of such arrangements (see Table 4).

(Table 4 here)

Moving to the Domestic Market: In contrast to the Chinese situation, the Indian domestic market is starting to take off *after* the export opportunities first occurred. NASSCOM recently observed that the Indian market for IT hardware and software could be as large as 15.9 billion, having grown by 29% in 2006. As a result, Indian firms have recently been eyeing their own market as a potential area of growth (e.g. Infosys' Finacle financial product which is also sold in the Indian market). The three largest Indian software multinational corporations (TCS, Infosys and Wipro) are not by any means alone in this. There are dozens of other similar firms. Subex, a telecommunications software firm founded in 1992, has by now operations in 60 countries, having acquired in 2004 Alcatel FMS in the UK, in 2006, Azure Solutions in the UK (for $140

million) and in 2007, Syndesis in Canada ($164 million). This year it was quoted in the London Stock Exchange. It passed the $100 million mark in sales and 1500 employees.

In summary, it appears that despite the challenges of creating own-branded software products, other paths offer a less difficult transition from custom-made software to products or intellectual property creation.

Indian MNCs are showing different paths to internationalisation. The vast majority of their subsidiaries are located in developed countries. These have mostly been front end sales offices to deal with clients, but firms like Infosys are beginning to develop consulting operations. The old wave of international branches were located close to their outsourcing markets (most often the United States, Canada and the United Kingdom). These were the result of greenfield investments. The new wave of foreign subsidiaries is the result of the strategy of acquiring niche product and other services companies, and using them in every possible market. Also, some of the largest Indian companies are creating subsidiaries in developing countries (Asia and Latin America) in order to compensate for the increasing costs of Indian engineers and programmers. Table 5 gives an idea of some MNCs based in India.

(Table 5 here)

3.3. Upgrading Technological Capability and the role of acquisition

One major issue faced in upgrading technological capability is the source and strategy for its development. To reiterate, after the initial phase of technological learning (from clients), firms like Infosys have faced the choice of either growing capability organically (in-house), or to obtain it from external sources (acquisition). Historically, the organic growth mode was most dominant.

Recently, acquisitions have been increasingly used to acquire competencies, so we will focus on this to better illuminate the ongoing changes in the industry:

Many of the largest Indian services companies are adding to their capability by buying foreign companies with "products" and specific expertise. For instance, in 2006, I-Flex acquired Mantas, a US-based anti-money laundering and compliance software company, for about $122 million US. The acquisition trend is also increasing in the top three firms, Infosys, Wipro and TCS. Acquisition can be said to be done with at least three purposes in mind (although these are hard to disaggregate): to grow a new internal division or software segment, to gain access to technological expertise, and to create a "beachhead" in another country to deliver services and products to that market. The first two rationales for acquisition appeared to factor into I-Flex's decision, as well as Wipro's acquisition of SpectraMind for its business process outsourcing work. The third appears to be illustrated by Wipro's recent acquisition of small telecom equipment firms in Scandinavia, as well as by Infosys' acquisition of small product firms in Australia and elsewhere. In part, Indian firms are also in effect recognizing the governance of the value chain, at least as it exhibits the power of dominant firms, since many of their acquisition targets are in foreign markets, and may be intended to serve as "bases" to help the Indian firms to operate in those markets. Their acquisition ability is enabled by the higher market capitalization of Indian companies (relative to their targets) as well as their need for specific knowledge and capabilities.

In sum, many Indian companies have gone through a phase of learning through outsourcing in India, and have moved from offering outsourced application development for other companies, to working in other regions, as well as moving up in the value chain to producing customized

software and “products” for very large customers in industry and government; in cases creating their own product brands. Some product firms are trying to become world leaders in specific niches. Aside from I-Flex, such companies include Brainvisa in e-learning, Subex in fraud telecommunications software, and Hexaware in human resources software. The upgrading of technology capability in order to perform this advanced work is accomplished through different channels, not the least being by the acquisition of foreign firms (and their capability and presence in markets). The idea that an Indian software firm can upgrade along the GVC by purchasing a product company is not without precedent. For instance, China’s Lenovo’s global ambitions drove its acquisition of the IBM brand of personal computer. Perhaps another greater differentiator in software is the ability of firms to couple product development to customization services, in effect deriving benefits from both sides of the VC, or alternatively, to even forego the product sales stage in lieu of a pure service (e.g. Web-based service) route.

4. The Chinese software sector

In the case of China, the Chinese firms’ capabilities are somewhat behind India’s because of the China’s follower status. Even then, the industry is thriving, in large part due to domestic and regional opportunities. Our data are organized around the origins of the industry, the factors that appear to drive industry locating behaviour and growth, and the manner by which firms have upgraded themselves technologically by their work with MNCs.

The Chinese software industry was in the early 2000s considered by the central government to be so critical to industrial development that, along with semiconductors, it was promoted along with semiconductors as one of two new lead sectors (Tschang and Xue, 2005). The government has played a key role in the software industry by forming human capital, such as in funding software

engineering training programs; by funding research at universities and government research institutes as well as in the companies themselves; and by procurement policies which have helped selected product companies. Regional governments have also provided infrastructure by way of building science parks.

In the early stage of the industry (up to 2001), many Chinese software firms first attempted to work on a product model (sometimes involving a basic product that was customized for no more than a few customers), or a systems integration model. By working in their domestic market, Chinese firms have in effect managed to move (or to be positive, "leapfrog") straight into services. There have been some successes at products, including Kingdee and UFIDA in enterprise management software, Kingsoft for language translation and office productivity software, Tongtech for middleware and Red Flag software for Linux operating systems. Interestingly, none of these firms had government origins (although some such as Red Flag software did initially benefit from government procurement contracts, and many benefited at least partly from government funding of R&D). Other product companies strong enough to compete at the middle end or near the high end of the market include those making financial and enterprise software. However, all of these typically compete only in the domestic markets, and foreign multinationals have become very strong at the high end of the markets, suggesting that the early capabilities of domestic firms were wanting enough to make it hard for them to catch up. Arguably, the only firm that have managed to compete one on one with multinationals in the same product market has been Red Flag, and this because they have partly been aided by state support (namely purchasing contracts), and partly relied on the global open source community for the operating system code. While they benefited early on from government research support, Red Flag has also made a success of their deeper knowledge of the highly local markets. Their

distributor and training networks are considered more effective by many customers over Microsoft's, and as a result, over the last few years, they have recently scored more successes with server sites than Microsoft.

Despite the successes of some firms in the domestic market, many Chinese software companies – product and services firms alike – are finding it hard to compete in that market. Their early capabilities were ill-formed or immature, and they have never been able to upgrade themselves. For example, the largest of the early systems integrators thrived on simple work, e.g. connecting off-the-shelf hardware and software, but most are now facing low margins and poor prospects for growth. The road for product companies has also been generally hard due to a variety of reasons, including a lack of customer IT maturity, fragmented markets, and intense competition on the low end from low cost domestic imitators and at the high end from financially well-off foreign MNCs with advanced technology (Tschang and Xue, 2005).[10] Another problem facing systems integration was that it generally involved a lower form of work, including installation of hardware and packaged software (made by other companies) and networking. One of the largest systems integrators that we interviewed earlier admitted that their profits were quite low, and in fact, there have also been recent reports of other systems integrators suffering low margins (Tschang and Xue, 2005). According to one interviewee, they may also have difficulty in trying to upgrade themselves along the value chain. It was partly because of this that Chinese firms started to see outsourcing as a way out. According to an official from the Beijing Software

[10] In certain types of software such as enterprise software, the best Chinese firms tend to service only the small and medium enterprises, while in other software such as personal computer-based software, the best Chinese firms can compete with MNCs to some degree. However, other weaknesses in the firms or market can affect firms' performance (Tschang and Xue, 2005). Piracy is one of the problems that afflict product firms. One well known product company that we interviewed (both in 2001 and 2006) noted recently that their well known product was so heavily pirated that it became a money loser, and it was only the government stepping in to require their software in procurement contracts which helped to save this line of business for them.

Industry Productivity Centre (BSIPC), the margins from outsourcing were in the 30% range for the better Chinese firms (which mirrors margins from India), as opposed to being on the order of 10% or less – as product and systems integration companies have experienced. Thus, the outsourcers have ostensibly avoided trying to make products or to undertake systems integration work.

While there have been small amounts of software exporting activity, with software outsourcing exports of $600 million in 2004, this was forecasted to increase to $4.7 billion by 2009, or a compounded annual growth rate of 51%.[11]

4.1 The Japanese market and the emergence of outsourcing in China

China's outsourcing industry has grown year on year, reaching 1.43 billion USD in 2006, as shown in the table below. Outsourcing in the form of exports of software services was already well underway in China by 2001, but in the beginning, firms were mainly focused on the Japanese market. Interestingly, most of the outsourcing firms that have succeeded in the Japanese "market" (i.e., working for Japanese systems integrator clients on work for Japan) started independently of the other services and products firms, suggesting that the competencies needed were completely unalike. Furthermore, not all of the few earlier firms that tried to move into software outsourcing have been successful, against suggesting that prior competencies might hold one back. This is not unlike the early experiences of Indian services firms that tried to move the other way - into products.

[11] Statistics are from International Data Corporation (http://www.idc.com).

In 2006, China's software outsourcing markets comprised of Japan (61%), the US (21.8%), Europe (4.7%) and others (12.5%). The Japanese market accounted for 872 million USD (CCID). The Japanese market still accounts for 59% of China's outsourcing revenue, versus the US market's 23%.[12] While the bulk of the firms that we interviewed serviced US MNCs, the size of the Japanese market, and its attraction for Chinese firms that want to go directly offshore, make it worthwhile describing the model at least in brief. At least two firms (Sinocom and Neusoft) have a very significant presence in the Japanese software outsourcing market. Japanese systems integrators are their main clients – these in a sense occupy the same market niches as the US systems integrators like Accenture and EDS. For Neusoft, 38.5% of their work is for Toshiba and ALPINE, while 15.4% is for mobile phone manufacturers like Sony-Ericsson, Nokia and Motorola, 12.8% is for Sony and Panasonic, 12.8% for Hewlett Packard, and 20.5% for other firms. One of the issues that Chinese firms have reported in dealing with Japanese clients is the greater degree of control and specificity that is exercised by these clients.

Insert 1: Size of China's Software Outsourcing Services

Year	2002	2003	2004	2005	2006
Market size (100 million US$)	3.25	4.70	6.33	9.20	14.30

Source: CCID consulting, 2007a

With the rise of government interest in the early 2000s, further efforts were made to improve the capability of the workforce and firms. Beijing, Shanghai, Xian, Dalian, and Shenyang were amongst a number of cities attempting to outsource to the Japanese and US markets, and in fact, the first three as well as Tianjin, Shenzhen and Chengdu were designated by the national

[12] In another report, the Japanese market accounted for 59% of China's outsourcing revenue, versus the US market's 23%. Data from Analysis (http://www.analysys.com)

government as software export bases.[13] In 2001, a common strategy of regional governments in Xian, Dalian and other cities was to create science parks as well as to provide training on the Japanese language - a skill that many Chinese were able to pick up due to compatibilities in the written language scripts.[14] Many firms were seeking to imitate the success of Neusoft, a Shenyang-based firm that had the strongest export performance from 2001 through 2005. As we showed earlier, it achieved this mostly by servicing the Japanese market. Other firms have come up in the ranks, with one of the most successful of all outsourcing firms in Beijing recently being Sinocom, another firm focused 90% on Japan. More recently, many software companies have also focused on BPO, in particular, to the Japanese and Korean markets.

4.2. MNCs and outsourcing needs from the Chinese 'domestic market'

Since 2001, and especially in recent years, another new set of outsourcing providers has emerged in China (as with the outsourcing providers to Japan). This new breed of firms stress work and for and relationships with Western multinationals to service the Chinese market. In order to discuss this trend, it is necessary to understand the role of foreign (Western) MNCs and the domestic market. This has in some way been concomitant with the rise of firms from other markets entering China. There has perhaps no stronger interest exhibited by MNCs to enter a developing country for its market than has occurred for China. MNCs have dominated the software sector in China, including firms such as Microsoft, Oracle, and BEA, and software services and systems integration companies like IBM and Accenture. According to an

[13] According to CCID Consulting (2007b); also supported by interviewees at the Xian software park, a Shanghai software engineering association, and the Beijing Software Industry Productivity Centre.

[14] The Chinese government has been quite strategic in its support of software enterprises (Tschang and Xue, 2005), but much of this followed an R&D investments approach. With the growing success of exports, the government has also focused its efforts on promoting outsourcing. Along with its historical investments in research and education through the universities and Chinese Academy of Sciences research institutes (both of which are sources of spin-off companies), in 2001, the Chinese national government announced plans to designate 35 universities as centres for software engineering programs. This would provide as many as 17500 more graduates to the labour force.

interviewee at the Beijing Software Industry Productivity Centre (BSIPC), many of these foreign MNCs suffer from a location disadvantage (in sourcing labour and accessing clients) when trying to service the Chinese market, especially as it becomes fragmented across cities and sectors. Interpersonal relationships or "guanxi" have been said to be as vital to conducting business in the Chinese software sector as in other sectors (Saxenian, 2003). The difficulty of entering the Chinese market may be due to many differences in standards, administrative rules and programs across regions and cities.[15] In this environment, MNCs have a greater need to "localize" products and content. On the other hand, many Chinese product and systems integration companies do not have the capability to do higher end services like systems consulting and design, but do have lower level capabilities like localization, customization and software-hardware systems integration. Thus, a convenient marriage was waiting between MNCs and selected domestic firms that the former could outsource some of their basic needs to.

4.3 The emergence of new Chinese outsourcing firms

The origins of the (recently rapidly growing) outsourcing domestic firms that service the MNCs in the domestic economy are largely private, and none appear to have been government-owned or to have involved government investments.[16] As noted earlier, a key aspect of the recent Chinese outsourcing pattern has been the way in which firms are connecting closely to foreign markets, or to MNCs operating in China. We interviewed eight of the firms considered to be rapidly growing

[15] There are also at least three markets – corporate, government and private. However, the governmental market is strongly bound by policy and regulations, and many software and systems contracts in the past supported domestic firms. Furthermore, some Chinese corporate customers have, at least in the past, been difficult to sell services to. According to one software firm that we interviewed in 2001, many customers did not have strong IT capability, and could not see the value in IT, let along understand how to integrate IT into their business functions.

[16] In contrast, Tschang and Xue (2005) estimated that as many as a third of the largest systems integrators, and some number of other firms with stronger capabilities (e.g. firms engaged in product development), appear to have government roots.

or occupying niches.[17] Most of these represent this new breed of private firm, and many started by doing localization and testing for larger MNCs trying to enter China.[18] A classic case is BeyondSoft, which started by doing the localization and testing of products for MNCs trying to enter the Chinese market, including all of Microsoft's products in China, and Hewlett Packard's products for Asia. Over time, it has systematically worked its way up into higher level work, including managing offshore development centres for their clients. According to the CEO, they try to learn organizational strategies from Indian companies and Western clients alike (author's interview). For instance, they found that successful firms had engaged in knowledge management, and in mirroring client's organizational structures in their own organizations, and consequently developed some of the same internal organizational strategies. Over time, they managed to develop application development and maintenance, and to service MNCs' global work. At one point in time, they were trying different strategies, such as opening dedicated offshore development centers for MNC clients, as well as exploring joint ventures with Indian outsourcing providers. Like other outsourcing companies in Beijing, they started to realize the limits of the local labor pool for technical talent, and started to open new centers in the so-called "tier 2" cities like Dalian, Wuhan and Tianjin. These new locations helped them to source the labor to grow at annual rates of about fifty to one hundred percent for the years after 2001.

Other firms like Worksoft have also come into outsourcing by similar paths to Beyondsoft's. Despite the "work for MNCs' locally" being the dominant strategy, there are variations within this path, and room does exist for other paths. For instance, Worksoft has focused on ODCs far more than other firms. Another large firm - IStoneSoft - started as the technical department of

[17] IStoneSoft, BeyondSoft, WorkSoft, ChongRan, United Innovation, Symbio, Hexin, Objectiva, and Ufida.
[18] ChongRan (or CS&S) – is a more diversified, formerly government owned firm which was interviewed earlier and which is included for comparison purposes.

another firm – Asia EC – and developed consulting expertise through servicing domestic clients. They spun off in 2001, accumulating a number of clients from that previous line of work. As they grew, they also started to subcontract from MNCs. Like the Indian firms, the Chinese firms also learn from (i.e. build capability through interaction with) MNCs. One firm that managed to make a transition from earlier roots – namely as a state-owned software enterprise, is ChongRan, which has learnt from working from Microsoft and other clients. Finally, another secondary strategy is the focus on niche markets, which some of the smaller firms have done. Examples include Objectiva (a software developer for the document processing industry), which was eventually acquired by one of their clients, and Symbio which operates at the higher value end of the market.

(Table 6 here)

Many of these outsourcing firms have their leadership and 'client engagement' levels of management staffed by Chinese (or overseas Chinese, like Taiwanese) with overseas experience and fluency in English. A number of Chinese have returned with valuable experience from Silicon Valley in recent years, in part because of the downturn there in the early 2000s.

Interestingly, as a sign of the industry's phenomenal growth rate, the 2001-2004 timeframe, which included the time the Chinese national government was first interested in promoting outsourcing, these firms in the current "top tier" were at the time not considered to be even large or capable enough to warrant attention. Not all firms have succeeded, however. According to interviewees, the government initially supported firms like UFSoft (or "Ufida"), which had demonstrated strengths in other areas like products, or firms that were strong in the Japanese language. However, some of these government-promoted companies are now lagging behind the other, newer firms (i.e. have slower growth rates). This mirrors the effect seen in the products side of the software industry.

4.4 Industry capability

Thus far, we have been discussing a story that relates to the GVC. However, there is a capability side to the Chinese software industry story as well. Many Chinese software firms had up till a couple of years ago been slowly climbing the organizational "process maturity" curve, with the software engineering institute's (SEI) capability maturity model (CMM) level 3 or ISO 9000 certification being common to many of them. As of 2007, only about seven firms had reached CMM level 5 – the highest certification – and not all of them were of significant size or reputation (relative to the rest of the Chinese industry). This contrasted with the Indian firms, where many (over 50 as recently as a few years ago) had achieved CMM level 5. While even more Chinese firms are achieving CMM level 5, the fact is that most of them do not do very advanced work, and this may be due to the nature of their capability or their clients' needs. It is a general observation within the industry and by consulting firms alike that the industry is still operating mostly at the low end, and has some way to go in order to reach the higher value added range of work (CCID Consulting, 2007a). As a result, the work that is done in China may actually contain less value added than India, never mind that Indian firms also face a similar type of "upgrading to high end work" problem. For example, Neusoft, the largest company and the one for which the best data is available, has a revenue per employee of about 25 thousand USD, which is about 30% less than that of India's largest firm's - TCS.

One possible reason why the work coming to Chinese firms is still at the low value added end could be the proverbial chicken and egg problem – getting advanced work when the capability and experience is not there yet. Another may have to do with the nature of their position in the value chain: They cannot exercise full jurisdiction because of the issue of power (of the client)

and position (of the provider) in the value chain. Unlike some of the Indian firms, most of the Chinese firms' clients appear to be the international software vendors themselves. Since these ISVs are acting as vendors to other Chinese industries, their tendency has been to try to keep the highest value work to themselves. As one interviewee noted (not fully substantiated), Chinese firms had or would have a difficult time crossing the "chasm" between doing application development for the vendors, and working on services for the vendors' clients, in part because many vendors' clients were in the US or were "captured" by the clients. In contrast, many clients of the Indian software firms are actually end users of vendor software, where software is not part of the latter's core business. Thus, given the "cost centre" nature that this work represents to the the Indian firms' clients, the clients may have no compunction about outsourcing as much of it as possible.

Another issue facing the industry is the smaller scale of firms and the difficulty of growing quickly. Only five firms had over 2,000 employees, with the largest, Neusoft, having 4,000. This contrasts to the largest Indian firms being an order of magnitude larger in size. While there is sufficient human capital when the entire country is considered, firms have a difficult time scaling up when they consider the need to screen potential employees for proficiency in English or other foreign languages, process capability, and other factors where India tends to have a clearer edge.

As a whole, China possesses the base of skills to develop a strong software industry, but this will take time. According to some interviewees, one of the bigger problems they may face is the need to have stronger language skills and even the appropriate cultural backgrounds to engage with a range of Western clients. This may be why in the near future, at least, the East Asian outsourcing market will be a more profitable area for it.

What the Chinese case suggests in relation to the India case is that the actual position of the client in the entire value chain of the industry may be vital to understanding the degree of value that the provider can eventually extract from the value chain. If MNC clients can coordinate the outsourced work by controlling the highest stages of the value chain, they may be more willing to outsource more of the value chain to the provider – as is done in India.

In general, there is a need to recognize how the domestic market focus has started the industry somewhat differently, and can play a protective role for nascent firms by forcing cooperation between them and the larger MNCs. Thus, different actors can interact differently and shape an outsourcing industry. However, despite the presence of government policy in shaping the environment for factor inputs (e.g. labour), the policy of selecting firms has by and large been unsuccessful, and recent entrants have not originated from state institutions or been the beneficiary of state resources.

4.5 The emerging 'regional' Chinese software MNC

The largest Chinese software firms are experiencing ultra rapid growth, both in products and outsourcing. As a consequence, they are exporting products and services, and moving aggressively abroad. While the model for internationalization has been established most strongly by specific companies in other sectors, such as Haier for white goods, and Lenovo for laptops, in software, lead product makers in the domestic market such as China National Software & Service Company, Kingdee and Ufida have started creating subsidiaries to serve customers of their enterprise management software in parts of South-East Asia. Outsourcing firms such as Longpro and Neusoft are creating or acquiring subsidiaries abroad in order to be close to their outsourcing

clients. The size and growth of the Chinese economy has allowed some companies to leverage on the development of their own products for their domestic markets, and to engage in the subsequent export and investment cycle predicted by the PLC theory. Other emerging Chinese MNCs are following a pattern more similar to the Indian one. Table 7 presents some examples.

(Table 7 here)

5. Back to theory

When the original theoretical discussions are now brought into confrontation with the evidence from the Indian and Chinese software industries, we may conclude that the PLC-OLI theory draws a very "sketchy" picture of the evolution of the sector. It is clear that hypothesis #1 is confirmed by historical evidence: the CSS and the first MNC are born in the US, the richest industrial country; it is also the case that the innovators based in that country exported to and invested in the second and third cohort nations. The technology is now being transferred to less affluent countries in order to reduce costs and penetrate new markets. Thus, there is support for hypothesis #3, third world multinationals are being created as a result of the international diffusion of the technology. All these processes generally correspond to the PLC-ILC model. However, Indian firms started producing for foreign clients and have lately turning back to their home market. Hypothesis #2 appears to be borne out more clearly in China (and possibly will eventually apply to other LDCs) than to India, but this is not to say that a domestic market will form strong companies. Even in China's case, with the strongest domestic market possible, the companies being borne are still not yet competitive with India's (on outsourcing services), or with Western MNCs (on products). In the end, the real story is really about how firms move to or from their home and foreign markets, depending on market conditions and their initial starting conditions.

Indian firms are clearly investing in North America and Western Europe (particularly in the UK), where they export the majority of their services. Also, a few Chinese firms, such as Longtop and Neusoft try to develop a similar strategy, but by necessity have had to take small first steps to the regional market first. This is in accordance with Hypothesis #4 as well as the PLC predictions. However, fewer Chinese firms than Indian ones have made their mark abroad. We find some evidence of both Chinese and Indian firms investing in developing countries (as in hypothesis #5), such as TCS in Latin America for services, though this is not so much the case for China's product firms, e.g. for Kingdee, the attraction to Asia Pacific and other markets has thus far been mainly for sales and distribution.[19]

In relation to hypothesis #6, Indian firms more clearly, but also some of the largest Chinese firms are both exploiting and increasing their strategic knowledge assets abroad. The largest Indian firms (with the Chinese firms to a much lesser extent, if at all) are creating operations and even greenfield subsidiaries in other countries to exploit their capabilities as software outsourcing and development centres. Indian MNCs are also acquiring foreign companies with proprietary products to increase their knowledge assets, as well as to use these as bases to service clients in their home markets. The smaller and younger Chinese firms are forging alliances with US, and Asian partners in order to compete in international markets. There is thus limited but wide support for hypothesis #6 and the evolutionary theory of the firm. The caveat for this is that there may be other reasons that firms engage in acquisition, e.g. to use their acquisition targets as a front end for their outsourcing activities.

[19] In fact, some activities border on confirming or disconfirming the hypothesis. For instance, while India's I-Flex has about 400 employees in its Singapore offices servicing the region (according to the author's research), it is not clear whether Singapore should be considered as a "developing" region as far as financial software product development, or as an advanced market where advanced skills are available to be invested in acquiring.

Finally, both China and India have targeted the software industry in their development plans. India, however took the lead, and is reaping the rewards of a first mover, albeit a very large one. The very large caveat is that, despite the advantage of the domestic market, Chinese firms - both outsourcing and products related - needed a strong leg up, e.g. clients that helped them, and in the case of product firms, had the assistance of the government.

However, the specific processes through which technology was transferred to LDC go far beyond international trade and foreign direct investment by the original innovators. These other processes encompass above all the outsourcing practices, in other terms, the insertion on LDC firms in global value chains, as well as a clear evolution of these LDC firms towards increasing participation in the highest value-added segments of the value chain. More and more often we see Indian firms participating in the development of entirely new applications, mostly marketed by large Western software companies, but sometimes sold under the trademarks of Indian companies themselves. Secondly, it may be less critical as to whether firms start first by exports (as Indian firms have done), or on products and services for the domestic market (as Chinese firms have done). What is perhaps more important is that firms have opportunities to build competencies and deeper connections to the global value chains, and occupy defensible market niches. Ultimately, some convergence does seem to be occurring, as with Indian firms now looking to the domestic market, and Chinese firms moving towards international outsourcing. The other common trait is that both industries have encountered resistance in moving to the higher end of work, and that to some degree, products and services do not easily mix. Outsourcing companies, especially in China, have tended to be new entrants, and not firms that had earlier lives as product companies. Product firms in China often think differently, at least initially, and thus have to follow a different

path. In contrast, many Indian services firms have tended to be reluctant to get into the products business. On the other hand, some Indian firms have also used their services work to fund their product development. Taken as a whole, all of this suggests a complex picture between the functions and strategies of products and services.

Also, high value added outsourcing as well as the need to move closer to original software design is pushing the Asian companies to acquire independent software publishers in Canada, the European Union and the United States. These third world multinationals are thus not simply expanding themselves in other developing countries, but they are aggressively moving towards the countries where “original software” is produced. Their technological capabilities expanded through the penetration of new markets; they started learning from their outsourcing clients; now they are learning from final customers and competitors.

This delocalisation of the CSS industry is not a purely economic process as depicted by the PLC-OLI model. Its institutional dimensions are key. For both China and India, higher education has been a priority for decades. The public support of the industry through export promotion, technology parks, and government procurement is evident in both countries. The insistence of the innovation system perspective on the importance of institutions is thus well supported by our history-friendly narratives. In addition, the processes through which technological capabilities are acquired are neither lineal nor identical from one country to the other, as the cases of Chinese and Indian software firms tend to show.

6. Conclusions

The Chinese and Indian software industries have followed two different paths, but are to some degree qualitatively if not quantitatively converging on one another as they continue to diversify and increase value added activities. It is difficult to identify representative firms, as companies can develop many different strategies in order to compete and increase their capabilities and profitability – even as they all operate within the same overall "envelope" of paths, namely, the participation in a global or other defined value chain. Some of the Indian firms have aggressively moved into BPO in other developing countries while others are more prone to develop their own products under their own trademarks; still others are moving into the development of custom software and new application development for established firms. Yet, in spite of their differences, the largest Indian firms show a persistent pattern of moving up within the international value chain towards higher value added segments.

The Chinese and Indian software firms have also emerged, or are emerging, in the international markets. Indian MNCs are by far the largest and most active. However, Chinese firms are appearing with their own products, designed for their fledging domestic market. Conversely, Indian firms are acquiring foreign designed products through the takeover of niche firms based in North America and Western Europe, but also as part of a wider desire to integrate products into their portfolio, and to develop bases for continuing to add value to their overseas operations.

In addition, cultural factors matter in explaining the specific patterns of growth and catching up. It may be the case that the linguistic abilities of Indian programmers and managers helped them to more easily assimilate Western technologies and organizational practices, giving Indian firms a head start (and continuing to provide one as compared to their Chinese counterparts). However,

Chinese companies are learning from their Japanese clients, as well as from Western competitors in their domestic market. Multiple learning processes are thus at work through which the most dynamic firms in both countries are increasing their capabilities and catching-up with industry leaders.

There is no universal best way to catching up among LDCs either. China and India are showing important differences. While other countries are following behind, including ones in South East Asia, Eastern Europe and Latin America, for the most part, the important mechanisms appear to be at firm level. These differences are evident in the markets they conduct outsourcing for (each country has taken advantage of different linguistic abilities); the size of their domestic markets has also played a large part. Chinese firms were initially less prone to become international and to search for foreign markets, due to the size of their own domestic demand, but are now venturing out internationally to both exploit their cultural position (through outsourcing subsidiaries in Japan and the USA and through partnerships and subsidiaries for product sales in the Asia-Pacific). Indian firms are moving abroad in order to exploit knowledge in the labor pools, as well as to find new markets in Asia, Latin America, North America and Western Europe – this being a consequence of the small size of their national market. They are also acquiring product subsidiaries in advanced countries to increase their knowledge assets and accomplish other strategic goals.

Table 1: Global IT expenditures, 2006-7
(Amounts in USD billions)

	2006	2007	Growth (%)
IT services	467	496	6.3%
BPO	421	462	9.7%
Packaged software	230	249	8.3%
Hardware	452	478	5.8%
Total	1570	1685	7.3%

Source: IDC, NASSCOM, according to TCS, 2007-8 *Annual Report*, p. 55.

Table 2: The top IT software and service exporters (excluding ITES-BPO) from India, 2004-5.

Rank	Company	Exports (U$M)	Country
1	Tata Consultancy Services	1,644	India
2	Infosys Technologies	1,502	India
3	Wipro Technologies	1,198	India
4	Satyam Computer Systems	745	India
5	HCL Technologies	588	India
6	Patni Computer Systems	342	India
7	I-flex Solutions	245	US (Oracle)
8	Mahindra British Telecom	202	India-UK JV
9	Polaris Software Labs	154	India
10	Perot Systems TSI (India)	145	US
11	Hexaware Technologies	129	India
12	Larsen & Toubro Infotech	123	India
13	MASTEK	121	India
14	iGate Global Solutions	118	India
15	Siemens Information Systems	111	Germany
16	Mphasis BFL	103	India-US JV
17	Tata Infotech	102	India
18	NIIT Technologies	99	India
19	Flextronics Software Systems	94	US
Total		7765	

Source: Nasscom, as compiled by Balakrishnan (2006), and completed.

Table 3: Largest Indian software multinationals

Rank	Company	Employees 2007	Sales 2007 (US$)	Sales per employee (000$)	Year Founded
1	TCS	110,000	4.3 billion	39	1968
2	Wipro	79,832	3.47 billion	43	1945
3	Infosys	88,601	3.1 billion	35	1981
4	Satyam	49,200	2.1 billion	43	1987
5	HCL Technologies	42,000	1.4 billion	33	1976
6	Patni Computer Systems	14,000	560 million	40	1978
7	Hexaware Technologies	7,068	253 million	36	1990
8	L&T Infotech	7,000	250 million	36	2001
9	Polaris Software Labs	8,500	225 million	26	1988
10	Mindtree	5,500	165 million	30	1999
11	NIIT Technologies	4,500	221 million	49	1981
12	KPIT Cummins	4,200	102 million	24	1990
13	Zensar Technologies	4,100	143 million	35	1991
14	Geometric Software	3,000	99 million	33	1984
16	Subex Azure	1,200	100 million	83	1992

Source: Annual Reports, company websites

Table 4: Some Indian software companies and their products

Name of firm	Product specialty	Representative proprietary products	Live US trademarks
Accord Software	Communications	SmartWoks, AutoSensorLab	No
Brainvisa	e-learning	RapideL, bvlite, bvLMS	Yes
Cynapse	Internet	Cyn.in, SyncNotes, SafeKeys	Yes
Geometric Software	Engineering	CAMWorks, DFMPro	Yes
Infosys	Banking, others	Finacle	Yes
Nucleus Software	Banking & finance	FinnOne Suite, Cash@will, BankONet, PowerCARD, FMS	Yes
Sasken	Communications	Wireless protocol stacks	Yes
Subex Azure	Communications	SubexAzure	Yes
TCS	Finance	BANCS	Yes
Virinchi	Enterprise	Enterprise Enabler 3.0, PEE, CPE, e-logistics, e-sales, e-trading	No

Source: Annual Reports, USPTO

Table 5: Three Indian software MNCs

TCS is the largest and oldest Indian software MNC. It was founded in 1968, within the Tata group of companies. By the end of 2007, TCS had 116,300 employees in 57 countries, and US$5.7 billion in sales. By 2008, TCS has nine Innovation R&D labs in India, as well as one in California and another in England. Its oldest lab is located in Pune, India, and was established in 1981. It conducts R&D (1.3% of sales) in software and process engineering. TCS has been growing abroad through both greenfield investments (i.e. UK, 1975, Hungary, 2001; Uruguay, 2002; Argentina, 2005…), and acquisitions (Chile, 2005, Australia, 2006; England, 2006; Sweden, 2006; Switzerland, 2006…). TCS is mostly a BPO and consulting software firm. However, many of these new subsidiaries have their own products, which are complementary to TCS ones. In 2006, for instance, TCS bought for US$26 million, Financial Network Services Pty, an Australian software firm with BANCS, a high-performance banking solution installed in 115 banks over 35 countries. The software is now in use in the major banks of India, and is making its way towards Latin American banks through TCS subsidiaries in the region. By 2007, BANCS was the second most used universal banking solution and the third retail banking solution in the world. In 2007-8, TCS revenues were obtained from North America (50%), UK (20%), Continental Europe (9%), India (8%), other Asia (5%) and other America (5%). By segments, its revenue was divided into 75% IT solutions and services (mostly applications development and maintenance), 6.5% infrastructure services, 6.2% BPO and other.
Infosys is headquartered in Bangalore. Founded in 1981, it had 94,000 employees in June 2008, with total revenue of $4.2 billion USD. Established in the United States since its early years, it has offices in 13 European countries, as well as in Australia, Canada, China, Japan, and the Philippines. It opened its first Latin American subsidiary in Monterrey, Mexico in 2007. Like the other Indian software MNCs, Infosys tries to locate itself in fast-growth markets and not only in low-growth traditional developed countries. North America represents 62% of Infosys revenues, Europe 28%, India 1.8% an the rest of the world 8.6%. As a percentage of revenue, since 2004 Europe is growing and North America is declining. In terms of services, application development and maintenance represented 445% in 2008, against 24% of consulting services, 7.5% of testing services, 6% of BPO and others. Products represented 3.6% of total revenues, and growing.
Wipro was founded in 1945, and diversified in information technology in 1980. Its IT arm has now 95,000 employees and total revenue of $5 US billion. Headquartered in Bangalore, it has now subsidiaries in 29 countries. Since 2003, Wipro has been acquiring companies in Europe in order to obtain skills and competencies as well as niche technologies in financial securities, utilities and retail trade. By mid-2006, Wipro had spent $310 million in acquiring over ten firms. Another six companies were bought in 2006-7. Its compounded annual growth rate has been over 25% for the last ten years. Wipro was the first company in the world to win the PCMM (People Capability Maturity Model) certification from the Software Engineering Institute at Carnegie Mellon University. In 2008, 55% of its revenues came from application development and maintenance, 12% from technology infrastructure service, 11% from package implementation, 12% from testing services, 8% from BPO, and 1% from consulting. In geographical terms, 63% of revenues came from North America, 32% from Europe, 3% from Japan and 10% from the rest of the world. Products represented 3.8% of sales.

Table 6: Top 20 Software Services Outsourcing Firms in China (2007)

Ranking	English name	Employee	Capability level (CMM)	Representative Customers	Markets *
1	**Neusoft Group Ltd.**	12,000**	CMM5, CMMI5	Nokia□IBM□SAP□NEC	US, Japan
2	**Insigma Technology**	4000	CMM3 ***	State Street Corporation, Microsoft, Hitachi, NEC, Tokyo Stock Exchange, Nomura Securities	US, Japan
3	**hiSoft Technology International Ltd.**	>2300	CMM5	IBM, Oracle, Bea, Autodesk, HP□Microsoft□Toshiba□Mitsubishi	US, Japan
4	**Dalian Hi-Think Computer Technology Co., Ltd.**	2359	CMM5	GE, NEC Group, Hitachi, NTT DATA, Nihon sys,Ltd. Mitsubish, Sony	Japan, US, Europe
5	**Chinasoft International Ltd**	4,400	CMM3	Microsoft, IFC	US, Japan
6	**Camelot Information System (China) Corp., LTD**	>1500	CMMI3	IBM,SAP, Accenture, Bearingpoint, HP	US, Japan
7	**Beyondsoft**	800	CMMI 3	Autodesk, Cannon, HP, Kyocera, Microsoft, Oracle, CA, Fuji Xerox, IBM, McAfee, SAP, Siemens, Sony Ericsson, Sun, Websense and Zultys	US, Japan Asia Pacific
8	**Worksoft Creative Software Technology Ltd**	1000	CMMI 2	IBM, Microsoft, Hewlett-Packard, Oracle, General Electric, Sony, Panasonic, PeopleSoft, TIBCO, Siemens, Roche	US, Europe, Japan
9	**NEC Advanced Software Technology (Beijing) Co., Ltd**	850	CMMI5	NEC	Japan
10	HANNA (Shanghai) Strategies Ltd	800	-	-	-
11	Shanghai Chuwa Software Co., Ltd	1300	CMMI 3	NRI, Mitsubishi, Fujitsu	Japan
12	**Shanghai Wicresoft** Co., Ltd	1000	CMM3	-	Japan, US

13	**iSoftStone Information Service Corporation**	3500	CMMI5	Motorola, Symbio, Sony Ericsson, GlaxoSmithkline	US, Japan, Europe, Korea
14	**Trans Cosmos Information Creative (China)** Co., Ltd.	620	CMMI3	-	Japan
15	**Fujian Fujitsu Communication Software Co**., **Ltd**	257	CMMI 5	Fujitsu, CISCO, ORACLE, IBM, HP, MICROSOFT	Japan
16	**DGT**	1000	CMM3	GE, Microsoft	US
17	**iVision Shanghai Co., Ltd.**	162	-	Mitsubishi, SAP, IBM, IT Frontier, Microsoft	Japan
18	**Dilingtong**	200	CMM3	Mitsubishi	Japan
19	**Nanjing Fujitsu Nanda Software Technology Co., Ltd**	215	CMMI5	Fujitsu	Japan
20	**Intasect Inc**	180	-	-	Japan

Notes

1. Table has been constructed from data from a China outsourcing website as well as from company websites and annual reports.
2. While revenues are not available for most of the firms, six of the top five firms have revenues in the 100 to 200 million USD range.
3. This table should only be used for representative purposes, as other lists of top 20 companies do not include some of the companies in this list, nor do some of the more sizeable companies in other lists show up in here.

* Markets may be the origin of clients, but may not be the ultimate destination of the work.

** This is for the total number of employees, including outsourcing. The outsourcing division alone reports 4,000 or more employees.
*** Multiple subsidiaries within this holding company hold varying CMM levels between 2 and 3.

Table 7: Chinese firms abroad

Longtop was founded in 1996, and headquartered in Xiamen, Longtop is a more traditional outsourcing service provider, targeting the rapidly growing Chinese financial industry, with offices in Atlanta, New York, Seattle, and Toronto. In 2007, Longtop entered the New York Stock Exchange. Longtop had 1659 employees in March 2008, and revenues (in 12 months ended March 2008) of 66.6 Million USD, up 67% year-to-year. Also in 2007, Longtop acquired Minecode, a 150-employees firm based in Seattle, WA. This was the first international acquisition of Longtop. Minecode has complementary capabilities in application development, testing, data warehousing, and knowledge management. Longtop has five solution delivery centres, three research centres (Beijing, Shanghai and Xiamen) and 39 service centres located in 20 provinces throughout China.
Kingdee. Headquartered in Shenzhen, Kingdee International Software Group was founded in 1993. Chinese leader in ERP solutions, the company is quoted in the Hong Kong Stock Exchange since 2005. In 2007, Kingdee has announced alliances with IBM to enter the e-commerce application market, and with Microsoft for other products targeting the Chinese market. Kingdee owns three ERP products, including K/3, the ERP product with the largest number of users in China, and is developing in Asia Pacific (Indonesia, Malaysia, Singapore, Thailand, and other countries) through subsidiaries and joint ventures. Kingdee had 4000 employees in 2008. Sales figures for 2007 were 112 million USD.
UFIDA Software was founded in 1988; headquartered in Beijing, it is quoted in the Shanghai Stock Exchange. In 2007 UFIDA's revenues were 1.1 billion CNY (160 million USD). UFIDA is one of the largest Chinese software firms, with 6175 employees (as of June 2008), operating in all areas of management software and mobile communications. Its proprietary products include U8, an integrated management solution for SMEs. Close to 60% of its sales come from its ERP solution. Besides, UFIDA conducts global software outsourcing, particularly to the Japanese market. UFIDA opened its Tokyo subsidiary in 2004. UFIDA also has subsidiaries in Singapore and Thailand and its software is used throughout Asia-Pacific.
Neusoft is the largest software company in China with over 12,000 employees in July 2007 and sales of 355 million USD in 2006; the company is quoted in the Shanghai Stock Exchange since 1996. Two Northeastern University (Shenyang, China) professors founded Neusoft in 1991. Neusoft is still headquartered in Shenyang. It is now the number one outsourcing company in China, and has subsidiaries in Japan and the United States (since 2001) through greenfield investments, as well as service centres in the Hungary, India, and the United Arab Emirates. Neusoft has several R&D Centres in China, the oldest one being located at Northeastern University. In 2007, Neusoft became the first Chinese company to be ranked in the Global Outsourcing Top 25 in the world.

References

Arora., A., Arunachalam, V. S., Asundi, J., Fernandes, R. (2001), 'The Indian software services industry', *Research Policy*, 30 (8), 1267-1287.

Arora, A. and Athreye, S. (2002), 'The software industry and India's economic development', *Information Economics and Policy*, 14 (2), 253-273.

Athreye, S. (2005), 'The Indian software industry', in A. Arora and A. Gambardella (Eds.), *From Underdogs to Tigers: The Rise ad Growth of the Software Industry in Brazil, China, India, Ireland and Israel*, New York, Oxford University Press.

Athreye, S. (2005b), 'The Indian software industry and its evolving service capabilities', *Industrial and Corporate Change*, 14 (3), 393-418.

Baba, Y. and Tschang F. T. (2004). 'Corporate Strategies in Information Technology Firms', in The New Economy in the Asia-Pacific, P. Drysdale ed., Routledge.

Balakrishnan, P. (2006), 'Benign neglect or strategic intent? Contested lineage of Indian software industry', *Economic and Political Weekly*, 9 Sept. 2006, pp. 3865-3872.

Basant, R., P. Chandra and L. K.. Mytelka (2001), 'Inter-Firm Linkages and Development of Capabilities in the Indian Telecom Software Sector,' *Economics Series No. 14*, East-West Centre: Honolulu.

Bresnitz, D. (2005),'The Israeli software industry', in A. Arora and A. Gambardella (Eds.), *From Underdogs to Tigers: The Rise ad Growth of the Software Industry in Brazil, China, India, Ireland and Israel*, New York, Oxford University Press.

Dunning, J. (1988), 'The eclectic paradigm of international production: a restatement and some possible extensions', *Journal of International Business Studies*, 19 (1): 1-31.

Dunning, J. (1998), 'Location and the multinational enterprise: a neglected factor?', *Journal of International Business Studies*, 29 (1): 45-66.

Figueiredo, P. N. (2002), 'Does technological learning pay off? Inter-firm differences in technological capability-accumulation paths and operational performance improvement,' *Research Policy*, 31(1), 73-94.

Foss, N. and T. Pedersen (2004), 'Organizing knowledge processes in the multinational corporation: an introduction', *Journal of International Business Studies*, 35: 340-349.

Freeman, C. (1987), *Technology Policy and Economic Performance*, London, Pinter.

Goldstein, A. and Tschang, F. T. (2004), 'Production and Political Economy in the Animation Industry: Why Insourcing and Outsourcing Occur,' DRUID Summer Conference 2004, Elsinore, Denmark.

Hung, S. W. and Tang, R.-H. (2007), 'Factors affecting the choice of technology acquisition mode: An empirical analysis of the electronics firms in Japan, Korea and Taiwan', *Technovation*, (in press).

Joseph, K. (2006), *Information technology, Innovation System and Trade Regime in Developing Countries: India and the ASEAN*, Houndmills, Palgrave Macmillan.

Kogut, B. and U. Zander (1993), 'Knowledge of the firm and the evolutionary theory of the multinational corporation', *Journal of International Business Studies*, 24 (4): 625-646.

Kogut, B. and U. Zander (2003), 'A memoir and reflection: knowledge and an evolutionary theory of the multinational firm 10 years later, *Journal of International Business Studies*, 34: 505-515.

Lee, J. and J. Slater (2007), 'Dynamic capabilities, entrepreneurial rent-seeking and the investment development path: The case of Samsung', *Journal of International Management*, 13: 241-257.

Levinthal, D. (2006), 'The Neo-Schumpeterian theory of the firm and the strategy field', *Industrial and Corporate Change*, 15 (2): 391-394.

Lundvall, B.-A. (Ed.)(1992), *National Systems of Innovation*, Pinter: London.

Malerba, F. (2002): 'Sectoral systems of innovation and production', *Research Policy*, 31, 247–264.

Malerba, F. (Ed.)(2004), *Sectoral Systems of Innovation*, Cambridge University Press: Cambridge.

Malerba, F. (2007), 'Innovation and the dynamics and evolution of industries: progress and challenges', *International Journal of Industrial Organization*, 25, 675-669.

Malerba, F. and Orsenigo, L. (1996), 'The dynamics and evolution of industries', *Industrial and Corporate Change*, 5 (1), 51-88.

Meyer, J. E. (2004). 'Perspectives on multinational enterprises in emerging economies', *Journal of International Business Studies*, 35: 259-276.

Mohnen, P. and L. Röller (2005), 'Complementarities in innovation policy', *European Economic Review*, 49, 1431-1450.

Nelson, R. R. (1991), 'Why do firms differ and how does it matter?', *Strategic Management Journal*, 12, 61-74.

Nelson, R. R. (Ed.)(1993), *National Innovation Systems*, Oxford and New York, Oxford University Press.

Nelson, R. R. (2005), *Technology, Institutions and Economic Growth*, Harvard University Press: Cambridge.

Ramamurti, R. (2004), 'Developing countries and MNCs: extending and enriching the research agenda', Journal of International Business Studies, 35: 277-283.

Teece, D. and Pisano, G. (1994), 'The dynamic capabilities of firms: an introduction', *Industrial and Corporate Change*, 3 (3), 537-556.

Teece, D., Pisano, G. and Shuen, A. (1997), 'Dynamic capabilities and strategic management', *Strategic Management Journal*, 18 (7), 509-533.

Tschang, F. T., A. Amsden and S. Sadagopan (2003), 'The Indian Software Industry: A Framework for Upgrading Technological Capabilities', Discussion Paper, Tokyo: Asian Development Bank Institute.

Tschang, T. and A. Goldstein (2004), Production and Political Economy in the Animation Industry: Why Insourcing and Outsourcing Occur, DRUID Summer Conference 2004, June 14-16, 2004, Elsinore, Denmark.

Vernon, R. (1966), 'International investment and international trade in the product life cycle', *The Quarterly Journal of Economics*, 80 (2): 190-207.

Wells, Jr, L. T. (1983), *Third World Multinationals*, MIT Press: Cambridge.

Winter, S. G. (1968/2006): 'A Neo-Schumpeterian theory of the firm', *Industrial and Corporate Change*, 15 (1), 125-141.

Yoshikawa, T. (2003) , 'Technology development and acquisition strategy', *International Journal of Technology Management*, 25 (6–7), 666–674.

The UNU-MERIT WORKING Paper Series

2008-01 *Science, Technology and Development: Emerging concepts and visions* by Luc Soete

2008-02 *Reframing technical change: Livestock Fodder Scarcity Revisited as Innovation Capacity Scarcity. Part 1. A Review of Historical and Recent Experiences* by Andy Hall, Rasheed Sulaiman V., Mona Dhamankar, Peter Bezkorowajnyj & Leela Prasad

2008-03 *Reframing technical change: Livestock Fodder Scarcity Revisited as Innovation Capacity Scarcity. Part 2. A Framework for Analysis* by Andy Hall, Rasheed Sulaiman, V. and Peter Bezkorowajnyj

2008-04 *Reframing technical change: Livestock Fodder Scarcity Revisited as Innovation Capacity Scarcity.Part 3. Tools for Diagnosis and Institutional Change in Innovation Systems* by Andy Hall, Rasheed Sulaiman and Peter Bezkorowajnyj

2008-05 *Is Inter-Firm Labor Mobility a Channel of Knowledge Spillovers? Evidence from a Linked Employer-Employee Panel* by Mika Maliranta, Pierre Mohnen & Petri Rouvinen

2008-06 *Financial Constraints and Other Obstacles:Are they a Threat to Innovation Activity?* By P. Mohnen, F.C. Palm, S. Schim van der Loeff and A. Tiwari

2008-07 *Knowledge-based productivity in 'low-tech' industries: evidence from firms in developing countries* by Micheline Goedhuys, Norbert Janz and Pierre Mohnen

2008-08 *The Voyage of the Beagle in Innovation Systems Land.Explorations on Sectors, Innovation, Heterogeneity and Selection* by Martin Srholec & Bart Verspagen

2008-09 *Crafting Firm Competencies to Improve Innovative Performance* by Boris Lokshin, Anita van Gils & Eva Bauer

2008-10 *The Economics and Psychology of Personality Traits* by Lex Borghans, Angela Lee Duckworth, James J. Heckman & Bas ter Weel

2008-11 *Embedding Research in Society: Development Assistance Options for Supporting Agricultural Innovation in a Global Knowledge Economy* by Andy Hall

2008-12 *Playing in Invisible Markets: Innovations in the Market for Toilets to Harness the Economic Power of the Poor* by Shyama V. Ramani

2008-13 *Explaining Success and Failure in Development* by Adam Szirmai

2008-14 *Running The Marathon* by William Cowan, Robin Cowan and Patrick Llerena

2008-15 *Productivity effects of innovation, stress and social relations* by Rifka Weehuizen, Bulat Sanditov and Robin Cowan

2008-16 *Entrepreneurship and Innovation Strategies in ICT SMEs in Enlarged Europe (EU25)* by Kaushalesh Lal and Theo Dunnewijk

2008-17 *Knowledge Transfers between Canadian Business Enterprises and Universities: Does Distance Matter?* By Julio M. Rosa & Pierre Mohnen

2008-18 *Multinationals are Multicultural Units: Some Indications from a Cross-Cultural Study* by Nantawan Noi Kwanjai & J. Friso den Hertog

2008-19 *The Innovativeness of Foreign Firms in China* by Branka Urem, Ludovico Alcorta and Tongliang An

2008-20 *Beyond the emission market: Kyoto and the international expansion of waste management firms* by Ionara Costa, Asel Doranova and Geert-Jan Eenhoorn

2008-21 *The 'making of' national giants: technology and governments shaping the international expansion of oil companies from Brazil and China* by Flavia Carvalho and Andrea Goldstein

2008-22 *If the Alliance Fits . . . : Innovation and Network Dynamics* by Robin Cowan & Nicolas Jonard

2008-23 *Facing the Trial of Internationalizing Clinical Trials to Developing Countries: With Some Evidence from Mexico* by Fernando Santiago-Rodriguez

2008-24 *Serving low-income markets: Rethinking Multinational Corporations' Strategies* by Shuan SadreGhazi and Geert Duysters

2008-25 *A percolation model of eco-innovation diffusion: the relationship between diffusion, learning economies and subsidies* by Simona Cantono and Gerald Silverberg

2008-26 *New Europe's Promise for Life Sciences* by Sergey Filippov and Kálmán Kalotay

2008-27 *A closer look at the relationship between life expectancy and economic growth* by Théophile T. Azomahou, Raouf Boucekkine, Bity Diene

2008-28 *Regional Capital Inputs in Chinese Industry and Manufacturing, 1978-2003* by Lili Wang & Adam Szirmai

2008-29 *Worker remittances and government behaviour in the receiving countries* by Thomas Ziesemer

2008-30 *Strategic motivations for Sino-Western alliances: a comparative analysis of Chinese and Western alliance formation drivers* by Tina Saebi & Qinqin Dong

2008-31 *Changing Configuration of Alternative Energy Systems* by Radhika Bhuyan and Lynn Mytelka

2008-32 *Promoting clean technologies: The energy market structure crucially matters* by Théophile T. Azomahou, Raouf Boucekkine, Phu Nguyen-Van

2008-33 *Local Knowledge Spillovers, Innovation and Economic Performance in Developing Countries: A discussion of alternative specifications* by Effie Kesidou and Adam Szirmai

2008-34 *Wage effects of R&D tax incentives: Evidence from the Netherlands* by Boris Lokshin and Pierre Mohnen

2008-35 *Cross-border Investment and Economic Integration: The Case of Guangdong Province and Hong Kong SAR* by Naubahar Shari and Can Huang

2008-36 *Radical versus non-radical inventions* by Wilfred Schoenmakers, Geert Duysters & Wim Vanhaverbeke

2008-37 *Localized Innovation, Localized Diffusion and the Environment: An Analysis of CO_2 Emission Reductions by Passenger Cars, 2000-2007* by Bart Los and Bart Verspagen

2008-38 *The economic impact of AIDS in sub-Saharan Africa* by Théophile T. Azomahou, Raouf Boucekkine, Bity Diene

2008-39 *Further results on bias in dynamic unbalanced panel data models with an application to firm R&D investment* by Boris Lokshin

2008-40 *A multilevel analysis of innovation in developing countries* by Martin Srholec

2008-41 *Experimentation with strategy and the evolution of dynamic capability in the Indian Pharmaceutical Sector* by Suma Athreye, Dinar Kale & Shyama V. Ramani

2008-42 *The Impact of Social Capital on Crime: Evidence from the Netherlands* by I.Semih Akcomak and Bas ter Weel

2008-43 *Portrait of an Odd-Eyed Cat: Cultural Crossing as a Trademark for a Dutch-Thai Strategic Alliance* by Nantawan Noi Kwanjai & J Friso den Hertog

2008-44 *The challenge of measuring innovation in emerging economies' firms: a proposal of a new set of indicators on innovation* by Luciana Manhães Marins

2008-45 *Intra-firm Technology Transfer and R&D in Foreign Affiliates: Substitutes or Complements? Evidence from Japanese Multinational Firms* by Rene Belderbos, Banri Ito, Ryuhei Wakasugi

2008-46 *To Be or Not to Be at the BOP: A One-North-Many-Souths Model with Subsistence and Luxury Goods* by Adriaan van Zon and Tobias Schmidt

2008-47 *Habit Formation, Information Exchange and the Social Geography of Demand* by Zakaria Babutsidze and Robin Cowan

2008-48 *Agenda Disputes and Strategic Venue Preferences: The Doha Crisis and Europe's Flight to Regionalism* by Francisco P. Toro

2008-49 *The determinants of the outward foreign direct investment of China and India: Whither the home country?* by Paz Estrella Tolentino

2008-50 *Comparing Chinese and the Indian Software MNCs: Domestic and Export Market Strategies and their Interplay* by Jorge Niosi and F. Ted Tschang