**Unclassified** **DEV/DOC(2003)03**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development **21-Feb-2003**

**English - Or. English**

**DEVELOPMENT CENTRE**

**DEV/DOC(2003)03**
**Unclassified**

**TECHNICAL PAPERS**
**No. 205**

# CHINA'S SOFTWARE INDUSTRY AND ITS IMPLICATIONS FOR INDIA

**By Ted Tschang**

**JT00139721**



**English - Or. English**

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## ACKNOWLEDGEMENTS

This paper was presented at the International Conference on “IT/Software Industries in Indian and Asian Development”, Chennai, India, 11-12 November 2002. The author would like to express his appreciation to the Asian Development Bank Institute (ADBI) for its support of the research on which this paper is based. The usual disclaimers apply.

# PREFACE

Although 40 years ago the average Indian enjoyed a living standard significantly higher than the average Chinese, since then China has only on rare occasions looked to India for development lessons. The development of the software industry is one such instance. Here, India has enjoyed remarkable success over the last decade and a half in building a world-class software industry whose exports are currently running at around $10 billion, making it one of India's leading foreign exchange earners.

Perhaps ironically, it is the Indians who are looking over their shoulders, worrying that, now that the Chinese government has set its sights on this sector, India's dominant position is under threat. How real is the threat? Could China conversely offer Indian software companies attractive opportunities for partnership and co-operation?

To explore the prospects for Indian and Asian software industry and its contribution to broad-based economic development, the OECD Development Centre, in co-operation with the State Government of Tamil Nadu and the Union Government of India, held an international conference on 11-12 November 2002 in Chennai, India. The conference completed the Centre's 2001-2002 Programme of Work on "Globalising Technologies and Domestic Entrepreneurship in Developing Countries".

This paper from the Chennai conference, by Ted Tschang of Singapore Management University and ADBI, examines the characteristic strengths and weaknesses of China's fledgling software industry, comparing and contrasting it with those of the Indian industry. The clearest differences between the two are: *i)* the Chinese industry's domestic market orientation versus India's export orientation; *ii)* China's emphasis on product packages versus India's emphasis on services. The two differences are interrelated inasmuch as China's product-oriented firms would have faced daunting challenges penetrating major export markets in head-to-head competition with the likes of Microsoft, while India's firms have been able to thrive in OECD markets precisely by eschewing products and concentrating on honing their process and project management skills. In future, as China seeks to become an international software power, it will need to master that same skill set, for which strategic alliances with Indian software firms could prove valuable.

Jorge Braga de Macedo
President
OECD Development Centre
18 February 2003

# RÉSUMÉ

L'industrie de logiciels de la Chine est modeste et sous-développée, comparée à son industrie des matériels informatiques, et à l'industrie indienne de logiciels. Toutefois le statut actuel n'est pas nécessairement un bon indice pour mesurer les perspectives d'avenir de la Chine, si l'on s'en réfère à son histoire récente. Ce qui différencie la Chine de l'Inde dans le secteur des logiciels est que la première a établi des liens étroits avec les utilisateurs nationaux, notamment les utilisateurs industriels et commerciaux, développant ainsi l'apprentissage intensif en matière de développement de produits à grande échelle pour un marché national déjà important et sans cesse croissant. L'industrie de logiciels de l'Inde, manquant d'un secteur d'utilisateurs aussi dynamique qu'en Chine, s'est développée en exportant ses logiciels.

Ce sous-développement du marché national constitue-t-il un handicap à long terme pour l'Inde vis-à-vis de la Chine ? Pas nécessairement, si les entreprises indiennes se servent de leurs propres forces en matière de contrôle des processus de production et de gestion des projets, et éventuellement en forgeant des alliances avec des entreprises chinoises dont le point fort est le développement de produits et possédant une clientèle domestique avertie ; ces alliances étant un moyen de pénétrer un marché régional de plus en plus important. Que de telles alliances tactiques puissent évoluer en alliances d'autant plus stratégiques, des joint-ventures sino-indiennes entrant en concurrence avec des multinationales sur des niches du marché mondial, reste toutefois, une question purement spéculative.

Certaines politiques et institutions chinoises — notamment la recherche publique en matière de logiciels en langue chinoise, moteurs de traduction, systèmes de sécurité, etc. — semblent avoir généré un nombre significatif d'avantages supplémentaires, dans certains cas en tant que dérivés de matériel informatique provenant de laboratoires de recherches gouvernementaux. Alors que l'industrie de logiciels de l'Inde repose, en matière de capital humain, sur l'élite de ses instituts régionaux de technologie, il semblerait qu'elle ne dispose pas d'un soutien public en R&D sur les logiciels innovants comparable à celui de la Chine. Elle le devrait peut-être et cela reste une question importante à aborder.

# SUMMARY

The Chinese software industry is small and underdeveloped, compared with its computer and other information technology (IT) hardware industry and compared with India's software industry. Yet, current status is not necessarily a good guide to future prospects, as China's recent history amply demonstrates. An important difference between the Chinese and Indian software sectors is the former's close links to domestic users, notably industrial and commercial users. This has fostered intensive learning in the area of product development for a large and rapidly growing domestic market. India's software sector, lacking such a dynamic domestic user sector until very recently, has thrived on exporting software services.

Does the underdeveloped domestic user base constitute a long-term liability for India *vis-à-vis* China? Not necessarily, if Indian firms can play to their own strengths in process control and project management, perhaps forging alliances with Chinese companies strong in product development and with a sophisticated domestic customer base as a means of penetrating an increasingly important regional market. Whether such tactical alliances could evolve into something more strategic, with Indian-Chinese joint venture companies competing with multinationals in certain global market niches remains, however, a question of speculation.

Certain Chinese government policies and institutions — notably, publicly financed research into Chinese language software, translation engines, security systems, etc. — appear to have generated a significant number of software spin offs, in some cases as derivatives of hardware by products from government research laboratories. While India's software industry relies heavily for its human capital on the elite regional institutes of technology, it would seem to have no counterpart to China's public R&D support for innovative software products. Perhaps it should and that remains an important question to be addressed.

# I. INTRODUCTION

This paper examines the broad characteristics of China's software industry and its implications for India's growth and strategy in the region. Although the Chinese software industry is only a recent phenomenon, it has often been compared to that of India. As such, it has been considered by observers in India and elsewhere possibly to be either a prospective threat to India's software exports[1], or an opportunity for India. Although China's hardware manufacturing industry is better known in the world, software has become an official part of the strategy for new industrial development. The Chinese software sector will also have interesting implications for the kinds of alternative paths to development that may be taken in other countries, both in their own right and in their interactions with India's software industry.

There are many peculiarities to China's software industry which suggest that it may be quite different from India's. In particular, it has somewhat different beginnings, and a distinct structure and role in the economy quite different from India's mainly export services-driven software industry. Whereas India's domestic products market is largely dominated by multinationals, China's domestic firms hold about 33 per cent of the market, with official policy being to increase this to 60 per cent in ten years (Gartner, 2002)[2].

Consequently, a large part of China's industry could follow a different path from India's. This different path has implications for India's industry as it positions itself to take advantages of the opportunities in China.

# II. HISTORY OF THE CHINESE SOFTWARE INDUSTRY

The strength of the Chinese software industry comes in part from the huge market of users and domestic producers, and this is fuelling the need for software of all kinds, including products. There is a conventional belief among industry watchers and government alike that the industry is largely made up of smaller, weaker firms, and that there is a need to grow larger firms. Part of this perceived weakness comes from the process capabilities, which are believed to be poorer than India's. Poor domestic software process capabilities were cited by Huawei, a large Chinese telecoms firm, as a reason why it located a major software development facility in Bangalore, India. Rampant software piracy and high employee turnover could also be two factors that contribute to the small size and relative weakness of China's software firms.

In other research, we point out that some of this conventional wisdom is not quite right (Tschang and Xue, forthcoming)[3]. For instance, the fact that the Chinese software firms are small does not necessarily connote weakness. In particular, the product-oriented firms that have attained a medium size and sufficient branding are doing quite well. The size and unevenness of the market presents many challenges to Chinese firms, and particularly to overseas entrants attempting to enter the market.

The Chinese software industry is also benefiting from its hardware industry, in that the need of domestic manufacturers for embedded software provides advantages to domestic software producers. This point has been discussed previously by others who believe that one strategy for growth would be to focus on software for the domestic sector (Heeks, 1999). This path was followed some time ago by Brazil (Schware, 1992), which had a relatively strong domestic industrial position not unlike China's.

## Origins of the Chinese IT Industry

### *The Early Hardware Industry*

The origins of the Chinese software industry are partly connected with that of the broader IT industry, especially the PC industry, and indeed, some of their origins are similar. As such, it is worthwhile reviewing what we know of the broader IT industry.

The earliest and most well-known IT companies have their origins in a variety of sources, with the more technology intensive ones coming from various government research institutes, universities, and "green field" start ups. Four important modes of IT industry firm formation have been identified by Lu (2000) and form much of the basis for the brief analysis in this section:

*1)* The model of spin offs from the government-funded research institutes in the Chinese Academy of Sciences — as represented by Legend, a PC language card maker that became a full-fledged PC manufacturer.

*2)* The model of university-researched technologies being commercialised by private enterprises which were funded partly by the university and partly by other agents — as represented by Founder, which made its start by developing electronic publishing systems but is now also a major PC manufacturer.

*3)* The model of spin offs from a state run firm — represented by Great Wall, a PC manufacturer.

*4)* The model of a green field start up — represented by Stone Group Corporation, a company that was started by university graduates and whose first products were word processing products.

A few well-known Chinese hardware firms made an earlier start as spin offs from universities, usually as a result of some combination of software and hardware technology. These in turn have given rise to software divisions, or even software spin offs. A case in point is the well-known PC maker Founder, which had roots in Beijing University research on font processing and pictographic publishing systems. Founder illustrates how the combination of government supported research, coupled with private sector investment and entrepreneurship, succeeded in the creation of what became a leading PC maker (Lu, 2000).

The other model is that of Legend, which started with a number of professors leaving the CAS Institute of Computing Technology, eventually to shape another leading PC brand (Lu, 2000, p. 63). Legend came about because government investments in research on Chinese language processing gave the CAS team an important technological edge, which was translated by the spin off into a specialised computer add-on card, and eventually into PC manufacturing prowess.

Stone also got a start in the software-hardware nexus, but it did so by specifically designing Chinese character software to be combined with a Japanese printer. Coupled with cost advantages, the company was able to gain strong market share. Although Stone was started as a Tsinghua University spin off, it also took advantage of talent from the CAS, which was crucial to its products (Lu, 2000).

### *Influence of the Government*

In all of the above models, the government has had a profound influence in its provision of intellectual capital, training and incentives. The Chinese government has assisted the hardware industry in more ways than one. Firstly, it helped realise the model represented by Great Wall: that of allowing a state-run computer company (one of many) to become privatised as a successful PC maker.

The Chinese government also had an early influence on the software and hardware industries by its sponsorship of national research efforts on “core technologies” deemed essential to the nation’s computer industry. Some examples include various large-scale government-funded projects dedicated to developing Chinese competence in core computer technologies, such as the Ministry of Science and Technology’s 863 research

programme, and other government research projects that became the basis for Founder, Legend and other companies. More recently, a series of government "Golden" projects was started to expand the country's e-commerce and infrastructure and various sectoral applications, e.g. e-government (Lovelock *et al.*, 1997).

Perhaps the government's most important role comes through its support of national research and development in the several dozen research institutes of the Chinese Academy of Sciences (CAS), a number of which also participated in the development of these core software and hardware technologies.

It is reasonable to say that the research institutes served not only as a nurturing ground for technology, but also as a holding area for scientific and engineering talent, keeping them engaged until such time as private sector opportunity emerged. Otherwise much of the scientific talent would have atrophied in unrelated pursuits. While government-financed research often gave prospective entrepreneurs a competitive edge, the companies were created and made successful largely by "private" efforts (e.g. university entrepreneurs and private investments). It is worth reiterating that some of the earliest and most well-known PC makers were based on some kind of technology related to software.

Finally, another phenomenon commonly seen in China is the use of government procurement, especially at regional and municipal level, to enable local firms to bid and supply IT systems. This has been instrumental in many cities like Shanghai and regions like Shandong. Many of the larger systems integrators like Wenda in Shanghai and Top in Chengdu have benefited directly from these policies.

The Chinese government has also developed many of the same policies for the software industry, but much support has been along the lines of infrastructure provision (e.g. many provincial governments invest huge amounts of time and money in software technology parks), incentives (e.g. recognition programmes), and provision of skills. In this regard, the Chinese government appears to be trying to avoid getting into the industry directly, and is simply seeking to foster the same basic conditions for industrial formation suggested by the Indian experience.

### *The Software Industry's Origins*

In the earlier success stories discussed above, the issues of software and hardware are intertwined, since many of them developed technologies that involved some amount of software, often embedded in hardware.

We show elsewhere that, as in hardware, there is also a strong influence of research institutes, government spin offs, and universities in the formation of the more recent pure software firms (Tschang and Xue, forthcoming). Various institutes of the Chinese Academy of Sciences, such as the Institute for Computing, the Software Institute, and even the Institute for Natural Resources, have been the seedbed for a number of start ups in the information security, operating systems and geographic information systems areas respectively.

The early hardware firms have also launched into software. The four models described in Lu's case studies are only representative of the best PC firms. Although the early hardware firms had established themselves in the market for both personal computers and highly specific types of software technologies, such as character recognition, they did not have much capability in systems and application software. Over the years, many have established software arms, such as the Legend Group, which recently separated its software arm and renamed it Digital China. However, the investigation of these firms can be complicated as some firms still keep a hand in multiple activities such as software development and systems integration. This is done partly because systems integration gives firms a chance to promote their software as well as to make profits off hardware sales.

Another possible source of software firms is the systems integration business. The rise of the hardware (i.e. PC) sector accompanied the increasing use of computers in Chinese business and society. Along with this came a large number of firms dedicated to systems integration, or the configuration and installation of hardware and software in different custom arrangements for customers. This was in part due to the lack of sophistication of customers, and was not unlike the early stages of US software applications development, where firms had to build customised applications for small customers.

Finally, we cannot ignore the new breed of software firm that, much like Stone in the area of hardware, comes about largely through the actions of private individuals. With the increase of venture capital in China, there have been increasing numbers of firms formed by individuals of varying background.

### *Comparison of Origins with India*

While the Indian software industry did have some roots in the defence industry, especially around Bangalore, it is reasonable to say that it did not have the same level of sustained overt government support as the Chinese IT industry. A number of Chinese firms have been spun off from institutes and universities. There are a few parallels, such as India's Computer Maintenance Corporation, which started as a government subsidiary and, in fact, has arguably done more than most firms in India to advance the overall impacts of IT on the masses, with its public sector projects on the Indian railways reservations system, and in many other semi-public projects since then.

# III. CURRENT STATUS OF CHINA'S SOFTWARE INDUSTRY

## Characteristics of China's Software Industry

Since China is a huge country with a diverse software industry, there are a number of dimensions relevant to understanding the industry. We will examine the following dimensions:

— the industrial structure and main characteristics of the industry;

— the human resources situation;

— the regional distribution of companies;

— firm size characteristics;

— the main activities, e.g. systems integration and packaged software, domestic sales versus exports.

The Chinese software industry appears to be moving forward on many fronts. Currently, the software industry represents already a fairly large proportion of the overall computer industry, as shown in the table below, but still accounts for a very small proportion of the country's GDP.

Table 1. **Output of Software, Computer Industry and Total GDP**

| | Output of software industry (100 million yuan) | Output of computer industry (100 million yuan) | Software as proportion of computer industry (%) | Total GDP (100 million yuan) | Software as proportion of GDP (%) |
|---|---|---|---|---|---|
| 1999 | 442 | 1 720 | *25.6* | 82 000 | *0.54* |
| 2000 | 593 | 2 150 | *27.6* | 89 000 | *0.67* |
| *Growth rate (%)* | *34* | *25* | - | *8.5* | - |

*Source:* CSIA (2000).

The growth rate of China's software sector is still on average below that of India's, which at its zenith between 1999 and 2000, grew by 53 per cent (it has since dropped to about 25 per cent between 2001 and 2002). This suggests that a different growth path is at work for China, possibly one where firms have weaker capabilities or face market conditions unlike those facing India's export sector.

### *Industrial Structure and Characteristics*

The growth rate of different sectors is shown in the table below. The services component is the largest in total sales, where services can range from outsourcing computer services to systems integration. (Other types of services like maintenance and customer service are also important to the industry.) Exports are low but are increasing rapidly year on year.

The proportion of China's software industry output that is export-based is only about 5.6 per cent in 2000, versus about 70 per cent for India in 1998 (i.e. exports of 4 billion out of $5.7 billion) (NASSCOM, 2000). As noted earlier, the percentage of China's industry that is product-based is also quite high, accounting for about one third of the total in 2000.

Table 2. **The Industry Breakdown by Major Sector: Sales**
[100 million yuan (about $12.5 million) and growth rate]

| | Software products | Services | Exports | Total |
|---|---|---|---|---|
| 1999 | 182 | 239 | 21 | 442 |
| 2000 | 238 | 322 | 33 | 593 |
| *Rate of growth (%)* | *31.8* | *35* | *57* | *34.3* |

*Source:* CSIA (2000), p. 2.

In 2000, of the total product sales of 23.8 billion yuan shown in the table, packaged software products are reported to be about 1.5 billion yuan. This is an underestimate, however, because it only represents direct sales of computer retailers, which are estimated to be about 10 to 15 per cent of the actual total[4]. Of this packaged software, about 65 per cent of the sales come from application products, 21 per cent from supporting software and 14 per cent from system software. So in fact, software products are likely to be a greater proportion of the software industry in China than the table suggests.

The rate of growth of total software sales was an astronomical 330 per cent in 1992, but fell to a more modest rate of 34.3 per cent by 2000 (the latter is shown in Table 2)[5]. This modest rate at this still early stage may not be so surprising, given that a large part of China's industrial demand for products is probably focused for the time being on low value added or low cost products.

Table 3. **Growth in Sales of Types of Products for Selected Years**
(100 000 yuan)

| | 1992 | 1996 | 2000 |
|---|---|---|---|
| System software | 1.6 | 8.5 | 33.2 |
| Supporting software | 5.4 | 20.0 | 49.6 |
| Application software | 12.8 | 63.5 | 155.0 |
| Total | 19.8 | 92.0 | 238.0 |
| *Rate of growth (%)* | *330* | *35* | *31* |

*Source:* CSIA (2000), p. 5.

### *Focus on Products*

The main difference between China and India appears to be the strong domestic product focus of the Chinese industry (as opposed to providing export services, which is the mainstay of India's industry). A significant number of the firms known to have better capabilities and business models are product-focused.

The Indian industry also has a domestic products segment, albeit one that is still a smaller proportion of its industry than China's and faces a smaller-sized market.

Although the role of multinationals in China should not be marginalised, thus far it appears that, in contrast to India, multinationals have not had a great impact on domestic Chinese firms, either in terms of employee experience or training, or by being clients for the firms. The biggest impact appears to be in terms of competition at the high end of products and services, with multinationals having secured about two-thirds of the domestic products market.

Some aspects of the Chinese economy are expected to have positive influences on the industry's growth, such as the strong manufacturing sector, which uses software in many products even beyond computer equipment, e.g. telecommunications equipment (some of which is now 50 per cent comprised of software), consumer electronic products, and automated machinery. There are about 20 million small- to medium-sized enterprises in China, which provides a substantial business user base[6]. This base is expected to increase the domestic (packaged) software market from $10 billion to $100 billion in five to eight years (CSIA, 2000).

Furthermore, the proportion of the population with personal computers is ever increasing, reaching nearly 29 million in 2000, and the proportion of mobile telephone users has rapidly increased, reaching 145 million telephone users in 2000, of which 85.2 million were mobile users (Tan and Wu, 2002, citing various sources)[7]. This PC market is so large that it could comfortably sustain the expansion of a number of domestic manufacturers, with six of the largest vendors being Legend (9.1 per cent of PC market revenue, based on revenue of $271 million for 235 535 shipments), Tonru (4.9 per cent), Founder (2.9 per cent), Great Wall (2.2 per cent), and Langchao (1.2 per cent) (Stone was also amongst the largest, but not tracked for this period) (Gartner, 1998). The low cost of Chinese PCs has caused US, Japanese and even Taiwanese producers either to lose market share or be forced into local joint-venture operations.

Although the proportion of the PC user base is still small and has been said to be holding back e-commerce, there appears to be enough critical mass of business and household users to sustain a viable population of software firms. The question is whether this population of firms (or some subset thereof) will continue to grow in size and strength, perhaps with some consolidation, or whether they will remain small and weak because of competitive dynamics, e.g. sustained downward pressure on costs with resultant low quality.

### *Human Resources*

Table 4 shows that the total number of graduates in computer-related fields and workers in the software industry is steadily growing. Other estimates put the pool of IT professionals at about 150 000 in China for 2001, versus about 522 000 in India, based on graduates of 50 000 and 73 218 per year respectively, and a total demand of 350 000 and 400 000 respectively (Gartner, 2002). Like India, China also suffers an outward migration of graduates to the US and elsewhere.

In recognition of the low number of graduates, the national and local governments are instituting large-scale plans, such as the designation of 35 universities nationwide for national software engineering programmes. Cities like Shanghai and Jinan are actively developing software engineering curricula and enlarging existing institutions to feed their growing local industries.

Table 4. **Software Workforce**

| Year | Number of software professionals | Number of graduates in computers and software |
|---|---|---|
| 1998 | 132 000 | 29 000 |
| 1999 | 150 000 | 33 000 |
| 2000 | 186 000 | 41 000 |

*Source:* CSIA (2000), p. 12.

Despite the slow growth of software professionals, there did not appear to be major shortages of most types of personnel in the firms that we interviewed in Tschang and Xue (forthcoming). A greater problem could be posed by the skills of the workforce. Only about 10 per cent of the IT workforce has experience with complex programming tasks, and project management ability continues to lag behind India's[8].

Because of the shortage of skills in China, the hourly wage rates for professionals (i.e. developers with about two years experience) can range widely, from about $12 to $25 in China, versus about $24 in India (Gartner, 2002)[9]. While these numbers in both China and India are debatable, the wider range in China reflects the uneven nature of the Chinese labour market. Some professionals will be paid higher than others, depending on their experience, the company's ability to pay, and widely differing compensation packages, which can sometimes include housing and cars.

### *Regional Dispersion of Industry*

The regional picture is also enlightening. The table below shows key statistics for the top seven regions (as measured by the number of companies, but many are also at the top in terms of the number of employees and other statistics), and the total for 25 regions (excluding Beijing, which has a very large number of firms).

Table 5. **Key Characteristics of Major Software Producing Districts**

| Industrial District | Number of companies | Number of people / district | Sales (100 million yuan) | Product Sales (100 million yuan) | Service Sales (100 million yuan) | Exports ($10 000) |
|---|---|---|---|---|---|---|
| Guangdong | 1 500 | 40 000 | 135 | 47 | 78 | 122 |
| Shanghai | 600 | 12 637 | 48 | 12 | 12 | 7 276 |
| Liaoning | 600 | 15 000 | 40 | 25 | 12 | - |
| Shaanxi | 500 | 6 000 | 32 | - | - | - |
| Jiangsu | 2 000 | 12 900 | 25 | 15 | 10 | - |
| Shenzhen | 600 | 23 000 | 23 | 14 | - | 1 250 |
| Shangdong | 540 | 30 000 | 21 | 12 | 10 | - |
| Total (25 districts) | 8 682 | 184 622 | 474 | 155 | 131 | 17 009 |

*Source:* CSIA (2000), pp. 6-7.

Beijing is by far the largest software producing district, with a balanced industry including packaged, industrial, and security software, as well as exports. Beijing's prominence is in part due to its being a centre for government and leading educational and research institutions, as well as the base for a number of well-known computer firms. The software industry in Beijing is located in the Zhongguancuan area of Haidian district, which has two of the leading universities in Beijing University and Tsinghua University, as well as headquarters and large facilities of a number of important early IT companies, such as Founder.

Shanghai has fewer companies but is a leading centre for overseas investment, finance, and high-tech industries, including electronics and semiconductors. The infrastructure, universities and government support in Shanghai are also very strong. However, it is a puzzling fact that, despite these advantages, Shanghai is still not known for any sizeable software companies, other than systems integrators. However, it is quite likely that the Shanghai region will do better at integrating services with other sectors such as finance and manufacturing, as well as consulting, given its better facility with English and exposure to foreign investors.

Finally, Xian, the leading industrial centre for the western part of China, is also mounting a strong software push. Xian's policy is focused on the export services market, with an apparent emphasis on the Japanese market. There are also some domestic product companies. Jinan (in Shandong province) has been a centre for heavy industry, and it is developing a number of companies focused on industrial applications.

Other regions with heavy concentrations of high tech also have heavy concentrations of software firms, e.g. Shenzhen near Hong Kong (where Huawei is headquartered) and Guangdong in the southern coastal area. However, the software activity appears to be quite dispersed across the country, and some cities like Chengdu in Sichuan province that do not even have large numbers of firms may have at least one large well-known software firm.

### *Firm Size*

According to the CSIA, there are about 5 700 software producers in the country (out of the more than 10 000 firms dealing with software), but of the 5 700 firms, only about 50 have above 1 000 employees, and 70 per cent have fewer than 50 employees. About 30 per cent are government-owned, 60 per cent are private, and the remaining 10 per cent are of mixed parentage.

The average of 21 employees per firm in Table 5 shows that there are many small companies in the software industry. Furthermore, there is a great degree of variation, e.g. the hardware producing districts such as Guangdong and Shenzhen and heavy industrial region of Shangdong have much larger numbers of people, and larger numbers of employees per firm than the other districts. This suggests that some districts have differing technological capability and type of activity, with some such as Guangdong having firms that are actually lower value added, e.g. based on systems integration and other low-end services.

The top 69 Chinese software firms comprise about 25 700 million yuan in sales, which is under half of the total output of the software industry. This contrasts with India, where in 1998-99, the top 25 firms accounted for nearly two-thirds of software export revenues.

Not surprisingly, when ranked by sales, the top Chinese software firms are dwarfed by the top Indian ones. Their relative sizes as ranked by number of employees are also quite different: the largest pure software companies in China such as Top and ChongRan have about 2 000 to 3 000 employees, while a number of Indian companies already have upwards of ten thousand employees. The Chinese numbers also include a number of firms that do more lower value added work like systems integration.

Table 6. **Comparison of Revenues for Top 10 Indian and Chinese Software Companies**
(in dollars using estimated exchange rates of 48 rupees = 1 dollar; 8 yuan = 1 dollar)

| Top Indian companies (in sales) | Approximately FY 02 sales ($ million) | Top Chinese companies (in sales) | Approximately FY 00 sales ($ million) |
|---|---|---|---|
| TCS | 809 | Founder | 438 |
| Infosys | 532 | PuTian | 186 |
| Wipro | 479 | Legend | 175 |
| Satyam | 355 | DongFang | 134 |
| HCK | 275 | ChongRan | 126 |
| Patni | 153 | ChangTian | 125 |
| Silverline | 126 | TsingHua DongFang | 115 |
| Mahindra | 113 | YianTai | 107 |
| Pentasoft | 96 | CVIC | 94 |
| HCL Perot | 94 | Top | 93 |

*Sources:* NASSCOM (www.nasscom.org); CSIA (2000).

The Chinese software industry is perceived by many observers, including the national government, to consist of too many (undesirably) small companies. In part, the smaller size of Chinese software firms is due to their early stage of growth and the fact that they have not yet mastered the art of managing growth in technical capability, process, project size and numbers of projects.

The conventional belief also suggests that many smaller firms are not growing, i.e. are not making much money. In part, this small size may be due to the recentness of the industry's development. Many firms interviewed in Tschang and Xue (forthcoming) have only existed for a few years, whereas many of the largest Indian companies have been around for two decades, and have only reached their currently large sizes through steady growth followed by a growth spurt in the 1990s. Furthermore, China's software industry has largely focused on domestic markets, which may act as a further constraint on its size.

**Alleviating Confusion: Definitions of Products versus Services**

A discussion of the software firms and concentrations of firms across the country can obscure some not so obvious details. Many of the largest firms are doing either systems integration, or a combination of products and systems integration. This translates to regional differences as well. According to this classification, of the 13 largest firms in Shanghai (those above 100 million yuan in revenue), nine are systems integrators (i.e. doing a lower value added kind of work), while Beijing has only five out of its 17 firms in systems integration, the rest being either in products or some mixture of systems integration and products. This suggests a lower level of capability at least in these particular Shanghai firms.

Clearly, the differences between products and services like systems integration (and mixtures of the two) will have to be defined better in order better to analyse the Chinese software situation as a whole, as well as to measure the capabilities of the firms. Some product work resembles services more than packaged products, since it may involve making just a few "copies" or versions of a product, but it would not be termed systems integration. We call these "customisable products". Some products like certain firms' enterprise resource planning software packages have to be 50 per cent customised. This will depend on the level of sophistication of the customer, and the degree to which specifications have to be changed for each customer.

Customisable products may involve a higher level of firm autonomy than is typical in export services, i.e. the software developer may have to do higher end work with greater responsibility, e.g. the requirements analysis and initial high level design stages[10], and the ownership of the intellectual property allows the developer to make customised copies for additional customers.

Thus, since some of the "product" work that firms claim to be doing is done on a custom basis and charged on a project basis, and thus is not even close to being development of "packaged products" with brand names, the outputs are more appropriately called customisable products or even services. Furthermore, at this early stage of the industry, when branding is still a problem for many firms, customised products may be a more effective strategy to promote their capabilities.

The notion of services also varies widely, to include everything from systems integration to “IT solutions” and export services. In terms of export services, as in India, Chinese export services can also embody a wide range of activities, from work that is just utilising programming talent, to work requiring partial product development activities (since sometimes requirements analysis or systems design are not outsourced to the service company).

# III. COMPARING CAPABILITY OF CHINESE AND INDIAN SOFTWARE FIRMS

As a first step to examining the possible ways in which Indian and Chinese software expertise might interact, we examine their respective levels of capability. Knowing this will give a first approximation for determining whether complementary areas of expertise have emerged, and whether these can be shared or learned.

Capability can be measured by different dimensions such as:

— individual technical skills;
— process maturity;
— management capability;
— technology;
— revenue model;
— product marketing capability.

We consider each in turn.

## Individual Technical Skills

As in India, individual technical skills are quite good in China. Chinese programmers from universities such as Tsinghua University in Beijing have been placed in the top ranks in international programming contests. The problem is that without practical and systems knowledge (such as software engineering processes), or experience for that matter, Chinese programmers will continue to be at a disadvantage.

## Process Maturity

On the whole, most Chinese firms are not at a high enough level of process maturity to compete with Indian firms. The main benchmark for measuring software process maturity is the Software Engineering Institute's Capability Maturity Model (CMM). Whereas at the high end, India has about 32 firms that have reached level 5, the highest level, China only has one thus far (Gartner, 2002). A much longer road lies ahead for firms planning to upgrade their process maturity, especially since attainment of level 5 requires demonstration of substantial organisational capability.

It is well known that Indian firms are making significant strides in their process capabilities. For instance, Infosys' knowledge management practices are becoming renowned, as is Wipro's technical and management expertise. Other companies such as Ramco have developed in-house process platforms to increase productivity and flexibility of their software development. While these are issues that many Chinese firms have not even considered yet, the question remains whether these process capabilities are somewhat static in nature once they are achieved, or whether further evolution in capabilities can keep India ahead.

**Management**

While in the past, India did not have enough systems analysts and other middle-level management personnel, it appears likely that with the reduced pace of growth in recent years, and the return of thousands of Indian software professionals as a result of the US economic downturn, many Indian firms should have been able to overcome their difficulties by now. Chinese firms by contrast are still having some trouble in upgrading their management techniques. Eventually, they may have to find a different way of managing that can blend the best of international practices with local traditional situations. Certainly, the invitation of many Indians to lecture on software process in China, coupled with the opening of training institutes such as India's NIIT training centres in China, will help speed up that process of exposure.

**Technology**

Technology appears to be one of the most important competitive advantages that distinguish the strong firms from the weak. We define technology in this case to be technology created by strong research achievements or capabilities. Examples of Chinese technology-relevant public research expertise can be found in the operating systems and security areas, where companies have benefited by getting their technology from close association with universities and the CAS institutes.

The origins of the more product-focused Chinese companies appear to contrast with the types of technology learnt in India, where much of the technology was learnt through technology transfer from multinationals or acquired from the open market (e.g. programming languages). The Indian firms, however, have managed to cultivate this into a base of expertise on the latest software technologies, including Java-based components and Microsoft's proprietary platforms.

The Indian firms have also shown themselves to be capable of making products. The major software service exporters including Infosys, Satyam, and Wipro have each launched one or more products. However, these have either not been successful or have had a limited impact in markets. It has only been the medium-sized (now larger) product-focused companies like I-Flex and Ramco that have really tried to make a living off products in the international market, also with mixed results.

**Revenue Model: Mix of Product and Service Capabilities**

The revenue model has implications for how a company can sustain its growth. While some Chinese product-focused firms have managed to grow, as with the medium-sized companies in India such as Ramco, other Chinese firms have found it difficult to grow by products alone. In such situations, Chinese firms have tried to combine product sales in systems integration solutions. This is not unlike what Indian product firms did in using export services to fund their product development efforts.

**Product Marketing Capability**

China's markets for software in different provinces are quite fragmented and difficult to break into, given the different standards across provinces (and even across industrial sectors). Existing relationships between firms local to those provinces and their customers or institutions may also form barriers to entry for other firms. In order to market and expand nationally, software firms have had to adopt different techniques in these conditions. There appear to be at least two ways to market products in China: through product branding, and through relationship sales (sales through affiliates, agents or even systems integrators). Some Chinese product firms have managed to establish themselves with strong domestic brands in specific sectors. Those that have not rely mainly on the latter marketing method.

**Capability as a Differentiator in the Marketplace**

The deepening of technological or other forms of capability is one way in which stronger companies differentiate themselves from their weaker rivals. There are many small, weak companies in China which compete on cost alone, and in a competitive market, these can make it difficult for the better companies to climb out of the pack. Some firms have tried to move to more technologically-sophisticated products at the higher end, so as not to compete with the many smaller companies who could not compete at that level, but this can prove difficult without the right skilled manpower (e.g. properly trained software engineers) or if the market does not support the move (e.g. customers expecting cheap products with lots of free customer service).

# IV. ENGAGEMENT STRATEGIES FOR THE INDIAN SOFTWARE INDUSTRY

To summarise the previous discussion, the Chinese and Indian software industries have the following capabilities listed in the table. Each of the above elements in the table is generalised from the firms that we have interviewed in past research (and for some elements, just a few firms). The table supports the observation that India is strongest in its process capabilities and management, while some Chinese firms are strong in their research, or strong in the branding of their products.

Table 7. **Comparing Different Types of Capabilities in China and India**

| Aspect of Capability | China | India |
|---|---|---|
| Software Process Capability | Weak at individual and organisational level (relative to India). | Strong in software process, continually climbing the value chain. |
| Management | Weak management in many firms (relative to India). | Strong management in top firms. |
| Technology | Strong lab research in institutions, strong linkages between universities and firms. | Weak in university-based research and links between universities and firms, strong in commercial technology (partly from multinational clients). |
| Revenue Model | Product sales, with systems integration as additional revenue generator. | For product firms, services are used to sustain product development. |
| Individual Technical Skills | Strong. | Strong. |
| Product Marketing | Strong local product branding.<br>Weak marketing capabilities. | (Product) branding is immaterial to service firms.<br>Weak marketing capabilities. |

Gartner and other commentators have suggested that this devolves to a very straightforward proposition: that Chinese skilled labour and management is going to be even scarcer than India's, and so India should send its higher level people to China to help manage and develop the upgrading of Chinese capabilities. Another proposition that follows is that Indian firms could probably make use of Chinese labour to take care of Chinese outsourcing needs. This has led to Satyam and other Indian firms setting up operations in China.

Let us step back and view this in more macro terms, considering what multinationals' experiences in China have been, and what the range of engagement scenarios could look like.

## Lessons Learnt in Engaging China in the Past

Indian firms will have to recognise what many Western and Japanese multinationals have learnt about operating China over the years. Some of these lessons include:

— Engagement is better than avoidance.

— Long term presence is important to growing the base — this was certainly the case with European car manufacturers such as Volkswagen which, unlike the American auto companies, stuck with the Chinese market over the long term, and have now achieved substantial branding and market share.

— Working with local partners is important — this has been true of any business, big or small. The vagaries and difficulties of working with the wrong (unreliable) partners is also evident, and dictates that potential partners be chosen wisely.

— There is always a danger of "knowledge seepage", e.g. domestic firms walking away with the knowledge gained through collaboration — this was what happened with Japanese motorcycle makers, who have seen local imitators steal substantial market share from them.

## Engagement Strategies

At the broadest level of decision making, the quandary facing Indian firms can be couched as a tough choice: to engage in China and face prospect of knowledge seepage to potential future competitors (but also the prospect of continued collaboration), or to avoid engagement and eventually face a competitor anyway (albeit perhaps a few years later than otherwise).

These strategic options for dealing with China can be summarised in a simple table that illustrates the likelihood of competition and co-operation in two different time periods. The time periods stylistically represent two stages of capability development. Inherent in scenario 2 is the possibility that China's capability may catch up with India's, in which case there may be a decision to compete.

Table 8. **India-China Engagement Strategies over Two Stages**

| Time period 1 / Time period 2 | Compete | Co-operate |
|---|---|---|
| Compete | Scenario 1<br>Compete in time period 1<br>Compete in time period 2 | |
| Co-operate | Scenario 2<br>Co-operate in time period 1<br>Compete in time period 2<br>(with catching up) | Scenario 3<br>Co-operate in time period 1<br>Co-operate in time period 2<br>(with or without catching up) |

### *Scenario 1: Engaging or Disengaging a Competitive Threat*

One scenario is based on China's current ambitions to move into the export services market, where it would be competing directly with India. This was the original concern within the Indian software industry.

For now, however, China has focused on its strengths such as embedded systems, and in software services for countries like Japan, where the natural similarity of the written language may help Chinese to work better. Since Japan is not necessarily India's forte (Wipro's significant inroads into Japan notwithstanding), the competitive scenario is unlikely to be borne out soon on a large scale.

While India does have process capability and language facility that far outstrips China's, the degree to which India maintains its export prominence will probably rest on the degree to which the evolution of India's capabilities continues to stay ahead of China's advances in process and business practice.

### *Scenarios 2 and 3: Complementary Engagement Followed by More Co-operation or Future Competition*

In reality, because of the complexity of the Chinese and Indian industry's characteristics, engagement may take on the more complicated forms of scenarios 2 and 3, as opposed to the outcomes of scenario 1. Indian firms should recognise how to play to their strengths in order to complement those in Chinese firms.

Scenario 2 arises when we consider the tendency for Chinese firms to focus on the domestic product market, and that Chinese firms are seeking to leverage their products with systems integration and other services.

For instance, Enterprise Resource Planning (ERP) software makers have to have several things in place. Due to customers' lack of sophistication, the success of the ERP implementation depends strongly on consultants that can work with their customers to implement their systems. Companies that failed did so because of the trouble caused in inserting their software into older enterprises with traditional (top down) management styles, thinking and employee behaviours. However, Chinese firms appear to have insufficient consultants to be able to sell products to customers needing strong support.

India's strengths in higher end services enhance the prospect of collaboration. Indian firms might be able to work as partners on the services side with Chinese companies that wish to focus on products. This would also help carry India's firms more easily into the various regions of China. Multinationals in China have not shown themselves willing to venture far from the high value spectrum, or the packaged products spectrum. In this regard, the combination of low cost Chinese programmers and low cost Indian consultants could be a very potent force.

Invariably, Chinese firms will want a piece of the services pie, which would lend credence to scenario 2 of future competition erupting in the services space, at least in China. However, Indian firms are starting to show themselves quite adept at moving within the consulting and systems space. Again, as in scenario 1, this will depend on whether the gap between India and China in services and accompanying technologies will widen or shrink. If Indian firms are able to maintain a comfortable lead in this area, they may preserve the outcome of scenario 3, that is, encourage the Chinese firms to co-operate.

To facilitate this sort of complementary engagement, joint ventures may be needed. Indian firms will have to work closely with Chinese partners to develop consulting practices. In the end, the real answer to how successful Indian firms are in China will probably rest on human factors: are Indians willing to relocate to China and adapt themselves to the Chinese situation? Indian firms may also choose to go it alone, but this runs into the difficult task of navigating the local politics and markets of each of China's provinces.

### *Scenario 4: India Learns from China*

While many have been talking about how, in software, China can learn from India, a fourth scenario might be that of India learning from the Chinese situation (not shown in the table). The strength of Chinese policy towards research and innovation has allowed Chinese companies to compete head to head with the US and other countries on Linux, translation and even security software on their own home ground. India has not really provided strong research support to its universities. The number of top Indian universities may equal the number in China. However, without much funding, these universities have become teaching institutions more than anything else, and the situation of graduate students engaging in large research projects or Indian firms and/or the government funding such research is probably not commonplace. The enactment of an appropriate research policy requires a significant body of scientific advice, which Indian firms are quite well positioned to give, given their connections to multinational partners and the latest knowledge. Indian firms and their government will have to form a new basis for co-operation. Joint university-industry-government research centres would be one such model.

# V. CONCLUSIONS

The Chinese software industry's orientation is clearly substantially different from India's in that a number of companies are focused on making products for the domestic market. The service companies are nowhere near as well developed as those of India, as judged by several indicators of capability. Thus, the basic structure of China's software industry consists of a mixture of product firms (which also offer some mixture of low- and high-end services), and low-end service firms.

It is clear that the Chinese domestic market (and therefore the industry) has some advantages, such as the large and growing manufacturing, business and consumer markets. The world market orientation of many manufacturing firms makes them demanding users. Domestic market competition is keen, however, to the point where, as standards, technologies and markets mature, there is likely to be a major shakeout of firms in the coming years.

The competition from multinationals is especially strong in the packaged software and high-end markets. Chinese firms' advantage in competing with multinationals so far has been in addressing the needs of small- and medium-sized enterprises, using a mixture of services and products to provide for the latter's needs.

The implications of these Chinese characteristics for India can range quite widely. At one level, India can see China as a competitor, and at another, as a partner. This is made more complicated when it is realised that the relative competitive advantages of the two countries' industries may change over time. Thus, co-operative or competitive situations may remain as such, or a co-operative situation can turn competitive. Whatever the case, the chances are that India will have to partner with Chinese firms in order to get access to the Chinese market.

The competition scenario raises the spectre of the flight of Southeast and East Asian manufacturing to cheaper Chinese shores (despite marked manufacturing process improvements). This raises the question of whether software is yet another cost-based industry where India could quickly lose comparative advantage.

# NOTES

1. NASSCOM presentation materials, 2002.
2. Another estimate of the domestic share of products puts it at 40 per cent (CSIA, 2000).
3. The study was based on interviews of 27 Chinese firms as well as national and provincial government officials, and software associations.
4. The software product numbers are based on direct sales from retailers who only sell computer software. This excludes bookshops, supermarkets and other outlets, in addition to original software loaded onto manufacturers' machines.
5. The high number in initial years may be due to data reporting issues.
6. Gartner estimates about 6.8 million SMEs, defined as companies with anywhere from one to 500 employees (Gartner, 2001).
7. This is based on shipments of 7.4 million units in 2001 for China, vs. about 1.8 million for India. Nevertheless, India's PC shipments grew three times faster than China's in the same period (Gartner, 2002).
8. *Far East Economic Review*, 11 July 2002, p. 38.
9. The numbers for annual salaries are significantly lower than the hourly rates would suggest if they were to be scaled up to annual salaries.
10. Typically, software involves a product lifecycle consisting of stages such as the following: requirement analysis, high-level design, detailed (component) design, coding, integration and testing.

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