Strategies for Developing China's Software Industry

Mingzhi Li, Ming Gao

limzh@em.tsinghua.edu.cn gaom@em.tsinghua.edu.cn School of Economics and Management Tsinghua University, Beijing, China

Abstract

The software industry is deemed an ideal target for a developing country to integrate into the world information and communications technology (ICT) market. On the one hand the industry is labor intensive, and the developing countries have a large labor surplus; on the other hand, it is a worldwide trend for developed countries to outsource a vast amount of low-end, software-related tasks to the low-cost countries and regions, which fits into some developing countries' caliber nicely. India has often been cited as the role model for a developing country to tap into the world software market for its continuous success in the software export sector. In comparison, China's software industry is still negligible in the world despite its sustained high economic growth rate since the economic reform took off in the late 1970s.

This paper aims at examining strategies for developing China's software industry. We use India as a reference because of the similarities of the two countries' stages of economic development and the clear divergence in their ICT structures and development paths. Although the language barrier has often been singled out as the major obstacle for China's software exports, we believe the major reasons for its underdevelopment can be ascribed to the following factors. On the national level, the government attention has been skewed toward the hardware sector in the ICT industry, and there is no clear national vision for the strategic direction for the software industry. On the industry and firm level, software development has been regarded as the art of individual creativity rather than an engineering process. As a result, the importance of quality and standards, the two important critical factors in software development, have been largely neglected. Perhaps an even more fundamental factor lies in the deeply rooted notion that software is an attachment to the hardware and should be a free product. The lack of intellectual property rights protection on the government side also contributes to the low spending on software, which further hinders software firms' incentives to innovate.

Extending Heeks's model of strategic positioning for developing country software enterprises, we conclude that rather than following in the footsteps of India to promote export, China should focus on its domestic software services market in the near term and pursue a more balanced development strategy in the long run. Rather than asking the question of whether China can become a major competitor like India in the world software market, we propose that there are rich opportunities for collaboration between China and world software superpowers, including India. Alliances between Chinese and foreign software firms will help both sides gain benefit from becoming cocompetitors in niche markets of mutual benefit. Cooperation with these international firms will also naturally open up foreign markets for the Chinese software firms.

Introduction

In the past several decades, the world software industry has been developing rapidly and the land-scape has also been changing dramatically. It is no longer predominantly controlled by the developed countries such as the United States and Japan. Deemed the most profitable and promising in the

world information technology (IT) market, the software sector keeps bringing miracles to the world. The success story of India has caught more and more attention of academia, policy makers, and businesses. It is widely believed that the software industry offers developing countries a unique opportunity to "break the shackles of economic under-development as a country."¹

According to Arora and Athreye (2002), although the software industry contributes less than 1% of India's gross domestic product (GDP), it has accounted for more than 10% of the growth of that GDP. The most recent statistics provided by the National Association of Software and Service Companies (NASSCOM) of India indicate, "The [software] industry is gaining significance in the Indian economy with sustainable growth rates, increased contribution to FDI, employment and exports. This industry has led to wealth creation of Rs. 90,000 crore [about US\$18.9 billion, converted by the authors] in the last six years and is expected to attract cumulative FDI worth US\$1.2 billion by 2005." According to the projection of NASSCOM, by 2008, India's software industry will employ 4 million people and will account for 8% of GDP and 30% of foreign exchange earnings.²

To understand the importance of the software industry to a developing country, we need to look at this issue from both the demand side and the supply side. On the demand side, the most obvious reason for developing countries to see India as a role model is because of its success in the export of software services. The hard currency earned on the international markets does contribute to the macroeconomic leverage of the country, but as noted in Arora and Athreye (2002), a more important and underappreciated contribution of the software industry is its exemplar of good entrepreneurship and corporate governance as a source of productivity improvement for all industries. Software is more than just another industry—it improves the users' productivity. Productivity and quality improvements from domestic software production may then be transmitted to other sectors of the domestic economy through various input-output links. In this sense, software is a central intermediate good in the new digital economy, and it thus occupies a special role in the process of informatization and economic development of a country.3

On the supply side, it is generally believed that developing countries have a comparative advantage in developing the software industry relative to the hardware industry. Software is a labor-intensive industry, and there is a relatively low level of entry barriers and little effects of economies of scale (Heeks 1999:2). The labor costs account for 70% to 80% of the total costs in software development, and this proportion is expected to continue to grow as increasing demand pushes up salaries around the world. "Computer science graduates need only PCs and some business orders to become part of the local information economy. With a modem they can even become global 'infopreneurs'" (Heeks 1999:2). Abundant in well-educated and relatively inexpensive labor, the software sector is easily becoming a target for developing countries to enter the information and communications technology (ICT) industry.

India has always been cited as a good example of how a developing country can leverage these factors to tap into the world software market. "Its success has, for the most part, been a combination of resource endowments, a mixture of benign neglect and active encouragement from a normally intrusive government, and good timing." (Arora et al. 2001:1270)

In contrast, China's software industry is still negligible in the world, despite its miraculous high growth rate of the overall economy in the past two decades. One question arises naturally: "Will China be a major competitor to India in the world software market?" To find answers to this question, NASSCOM vice president Sunil Mehta recently spent 15 days visiting five cities in China including Beijing, Xian, Dalian, Shanghai, and Shenzhen. He commissioned an independent survey of China's hardware and software market and met with government officials and private companies including software, finance, real estate, and placement firms. The basic conclusion was that "there is no potential threat or competition from China to India in the global software market in the near future, and Indian software

^{1.} Remark by Rajat Gupta, managing director of McKinsey, as quoted in Saibal Dasgupta, "Can Indian Infotechs live up to the Hype?" Asiamoney, February 2000.

^{2.} News release from NASSCOM, July 18, 2002, www.nasscom.org.

^{3.} Informatization is a very popular term in China's press and academic world, as well as in the governmental propaganda. Simply put, it means to use the state-of-the-art information and communications technology to transform all the sectors of the economy. It is invented as a counterpart of "industrialization."

companies could look at China as a potential market rather than a competitor" (Kumar 2002).

This paper aims at catching a glimpse of China's software industry and examining strategies for developing China's software industry. We use India as a reference because of the similarities of the two countries' stages of economic development and the clear divergence in their ICT structures and development paths. The paper is organized as follows. In section 2 we describe the current status of China's software industry and provide general comparisons with India. Section 3 introduces Heeks's (1999) model of strategic positioning for developing country software enterprises and it discusses its implications when applied to China. We suggest that China should focus on its domestic software services market in the near term and pursue a more balanced development strategy in the long run. Section 4 further puts China's software industry in the context of the world software market. We argue that China should build alliances with the world software superpowers. Rather than asking the question of whether China can become a major competitor like India in the world software market, we propose that there are rich opportunities for collaboration between China and the world software superpowers, including India. In the concluding section we summarize the roles of software firms, the government, and the nongovernmental organizations (NGOs) in developing China's software industry.

Conceptualization High level design Low level design Coding Testing Support

Figure 1. Waterfall model of software development.
Source: Arora et al. (2001, Figure 1).

The Software Industry in the World's Two Largest Developing Economies: A Comparison of China and India

In a broad sense, the software sector includes all kinds of activities in the IT industry except hardware manufacturing. Software purchased from outside are split about half and half between customized professional services and more standardized products, which themselves are split roughly equally between enterprise solutions and packaged massmarket software (Ghemawat 2000). Developed countries tend to specialize in products and higherend services. In terms of the process of software development, activities involved could be classified into six steps: conceptualization, high-level design, lowlevel design, coding, testing, and support, as illustrated in the waterfall model of software development (Arora et al. 2001) (Figure 1). Typically, steps close to the upper end involve more complicated technologies and analyses, and thus create more value added.

As the two largest developing countries in the world, China and India have similar economic foundations. Both have large areas of territory and a billion-plus population size. Both have been evolving from an agricultural economy toward industrialization over the past several decades. Both remain on low levels in terms of informatization.⁴ Yet both have been gaining more and more attention from other parts of the world as their participation in the

world ICT industry increases with the tremendous rates of economic growth. However, the ICT structure and their software sectors are very different, as is briefly discussed in the following sections.

Economic Overview

Over the last two decades, China has achieved amazingly high economic growth rates, almost unprecedented in the world. Although India's

^{4.} In the Information Society Index (ISI) 2001, China ranked 52 among the 55 countries chosen, and India was 54. The ISI is an index created by the International Data Center (IDC) to measure a nation's degree of informatization, by which all nations are measured according to their ability to access and absorb information and IT.

economy has also grown fast, its overall speed and scale lag behind, as shown in Table 1. For a while, in the 1990s, it seemed that India was beginning to catch up as the GDP grew at around 7% for three years, but it has subsequently gone down to the 5% (or less) benchmark once again. One cause has been China's success in attracting foreign investment—the magnitude of which has been many times that of India. Table 2 indicates that the figures of gross national product (GNP) per capita show a similar pattern.

There have been hot debates about whether China can become the world's manufacturing center. Indeed, China's manufacturing base has been growing rapidly, and this includes a large IT sector (more details are discussed in the following paragraphs). More striking, high-technology exports as a percentage of total manufactured exports have consistently been three times as high in China as in India (Table 3). This poses a vivid contrast with the picture of software exports in the two countries.

Software Industry Development

China launched a program of software industry development in the 1980s, almost concurrent with India. But clearly, after two decades of development, the Indian software industry has surpassed China on many accounts. In terms of Indian rupees, the compound annual growth rate (CAGR) of India over the past five years has been as high as 62.3%. In 2000–2001, the software industry in India was worth US\$8.4 billion, of which domestic sales and software exports were US\$2.2 billion and US\$6.2 billion, respectively. As a comparison, China's software industry was worth US\$6.8 billion, with only US\$0.4 billion of exports in the same period.

Clearly, the Indian software industry has adopted an export-oriented approach whereas China's software export is negligible. Although it is natural to link the vast gap in the two countries' software exports to the inherent language advantage of India, linking the software sector to the other ICT market segments might give us a different explanation. The following analysis indicates that one of the major reasons for China's relative slower pace of development of its software sector might be the skewed efforts toward the hardware sector in the ICT industry, and there has been no clearly formulated national

vision for the strategic direction for software development.

Expenditure on Hardware, the Consumption of Software, and IT Services⁵

Although China and India are very close in their levels of ICT development, the compositions of their IT markets show significant differences. The following data were compiled from the Information Technology Outlook 1997 (OECD) (quoted in Wong 2000). China and India have similar percentages of package software in IT expenditure, 4.6% in China versus 5.7% in India in 1995. The percentage of hardware expenditure in China was significantly higher than that of India, 88.1% versus 62.2% in the same year. It is striking that India has a very high percentage of service, 32.1%, which is significantly higher than in most other Asian countries; in contrast, China's percentage of services was only 7.3%, significantly lower than that of most Asian countries (Table 4). It is usually believed that the more advanced a country is in its ICT industry development and diffusion, the higher is its share of spending on software and IT services. However, this reasoning is hard to reconcile with the differences between China and India as shown by other indicators. Our guess is that China's low proportion of software and IT services spending in total ICT expenditure may be due to its explosive adoption of computer hardware relative to that of software and IT services. It is reasonable to believe that with the usage of computer equipment reaching the stage of saturation in the next several years, the percentage of software and IT services will go up significantly.

There are two additional factors that may help contribute to the low proportion of software and IT services spending in China. Chinese customers typically prefer to buy IT services such as IT planning and consulting bundled with a hardware purchase rather than a stand-alone purchase. Consequently, most IT services are delivered by hardware vendors or resellers. Software piracy is also a major reason for the low software spending. It is well known that China has one of the highest software piracy rates in the world. According to the Business Software Alliance (BSA), more than 30% of the business software sold worldwide, or one in every three sold, is fake. This robs software vendors of about US\$12 bil-

^{5.} This paragraph borrows heavily from Meng and Li (2002).

Table 1. Gross Domestic Product (GDP) and GDP Growth of China and India (US\$ million), 1980–2001

	550				***************************************				
	1980	1990	1995	1996	1997	1998	1999	2000	2001
China	201,687	354,644	700,219	816,493	898,244	020'656	991,356	1,079,948	1,159,017
Growth Rate (%)	7.8	3.8	10.5	9.6	80.	7.8	7.1	7.9	7.3
India	186,392	322,737	363,981	397,132	420,782	430,024	445,233	456,990	477,555
Growth Rate (%)	9.9	5.7	8.0	7.3	5.0	6.1	7.1	3.9	4.5
				-				-	

Source: Data for 1980–1998 are from World Bank, World Development Indicators 2000; data for 1999–2001 are from the World Development Indicators database.

Table 2. Growth of Gross National Product per Capita (%), 1992-1998

	1992	1993	1994	1995	1996	1997	1998
World Average	0.27	-0.14	1.40	1.30	2.29	2.20	-0.03
China	12.71	11.81	11.42	7.88	8.71	7.46	6.40
India	3.46	3.08	6.07	6.37	5.68	3.22	4.29

Source: World Bank, World Development Indicators 2000.

Table 3. High-Technology Exports (% of Manufactured Exports), 1997–2000

Country	1997	1998	1999	2000
China	12.7	15.1	16.8	18.6
India	4.8	4.1	4.3	NA

Source: World Development Indicators database.

lion a year (excluding the duplication of games), or 15%, of the total revenue generated by the software industry. The countries with the highest software piracy rates were Vietnam (97%), China (94%), and Indonesia (89%). The countries with the highest dollar losses were Japan (US\$1.6 billion), China (US\$1.1 billion), and Korea (US\$302 million).

Infrastructure

Infrastructure that is of importance in the software sector includes the availability of power and the quality of the telecommunications infrastructure (bandwidth and telecommunication penetration). The following data show that China is far more advanced than India in terms of its infrastructure development.

Table 5 gives data on the electric power consumption per capita of China and India. In every year the consumption level of China is almost double that of India. Although power supply is not an issue in China's software firms, it is a serious bottleneck in the Indian context. According to Arora and

Athreye (2002), costs for power are the second highest expenditure, and many software firms generate their own power. Infosys, a leading software firm headquartered in Bangalore, supplied examples.⁶ In addition to having its own phone system, Infosys stocked 11 tons of back-up batteries to keep its computers running and 4,000 gallons of diesel fuel to power its generators in the event public electricity fails.

With the software development delivery model increasingly moving toward outsourcing and offshore services, a robust and reliable telecommunications infrastructure has become a priority. Issues such as teledensity are important for enhancing Internet penetration in a country, which in turn will spur the growth of the domestic software and services market as well as other industry segments such as e-commerce. Both China and India have advanced rapidly in their telecommunications industry, but China has a significant advantage. In 2000, China's fixed lines and mobile telephones were 177.6 per 1,000 people, almost five times that of India (Table 6).

More specific measures of ICT diffusion and adoption, especially those pertaining to the "new ICT" of Internet, e-commerce, and wireless technologies, further confirm the contrast between China and India. According to the World Bank's World Development Indicators, in terms of home PC owner-

Table 4. Estimated Composition of IT Market in China and India, 1995 (%)

	ı	Percentage of IT Expenditure	
Country	Hardware	Packaged Software	Services
Mainland China	88.1	4.6	7.3
India	62.2	5.7	32.1

Source: Organization for Economic Cooperation and Development, Information Technology Outlook 1997 (quoted in Wong 2000).

^{6.} Rao, S. S. 1997. "Silicon Valley Goes East—Way East," Forbes, November 17, p. 159.

Table 5. Electric Power Consumption (kwh per Capita)

Country	1997	1998	1999
China	701.8	721.6	757.8
India	347.3	363.5	379.2

Source: World Development Indicators database.

Table 6. Fixed Lines and Mobile Telephones (per 1,000 People)

Country	1997	2000
China	66.8	177.6
India	19.5	35.5

Source: International Telecommunication Union, World Telecommunication Development Report.

Table 7. Personal Computers (per 1,000 People)

Country	1997	1998	1999	2000
China	6.0	8.9	12.2	15.9
India	2.1	2.7	3.3	4.5

Source: World Development Indicators database.

ship, China's 15.9 per 1,000 homes was more than three times that of India in 2000 (Table 7).

The rate of China's Internet usage has been increasing explosively in recent years. As one of the most authoritative resources on China's Internet development, the China Internet Network Information Center (CNNIC) issues a report on the newest development every 6 months. In January 2001, the international bandwidth connecting China's Internet abroad reached 2,799 megabytes, double that of July 2000. The number of Internet users was 22.5 million, 4.5 times that of India and a 33% increase from July 2000 (Table 8). The number of computers

with Internet connection was 8.92 million, a 37.2% increase.

Education and Human Capital

The combination of China and India's population accounts for almost one-third of the world total. As shown in Table 9, China's adult literacy rate is significantly higher than that of India, but the relatively higher ratio of India's college degree holders reflects its advantage in tertiary education. Both countries need to enhance the education level of their citizens. In both categories, scientists and engineers as a percentage of population and reserves of scientists and engineers, China has a clear advantage. For the software sector in particular there has been evidence showing that both countries are facing the challenge of a tight labor market.

India has emerged as one of the top IT resource providers, mainly because of its ability to churn out highly skilled workers every year. The Indian school education system places great emphasis on mathematics and science, resulting in a large number of sciences and engineering graduates. The English medium of education also helps in nurturing topclass English-speaking human resources. Government institutes such as the Indian Institute of Technology (IIT) and the Indian Institute of Management (IIM) churn out quality graduates every year. There are a large number of other government and private institutes all over the country that also contribute to India's skilled IT-related labor force.

In 2001, the number of people currently employed in China's software companies was 335,000 (State Information Center 2002). However, the demand-supply gap is overwhelming. To cope with the language issue, China is aggressively training its people in English. Government sources estimate that about 20 million people are undergoing English language training. To train its students in both IT and English, the government is investing huge sums. For instance, the top 10 universities received more than \$200 million from the Ministry of Education

Table 8. Internet Users (1977–2000)

Country	1997	1998	1999	2000
China	400,000	2,100,000	8,900,000	22,500,000
India	700,000	1,400,000	2,800,000	5,000,000

Source: World Development Indicators database.

Table 9. Reserve of Technically Trained Personnel, 1995

Country	Adult Illiteracy Rate (%) Male Female	Scientists/Engineers in R&D per Million Population, 1981–1995	Population, Millions	College Degree Holders as Percentage of Population over 25 Years Old	Reserve of Scientists/ Engineers
U.S.		3,732	263	_	981,516
Japan		5,677	125	_	709,625
China	10 27	537	1,200	2.7	644,400
India	35 62	151	929	7.3	140,247

Source: World Bank, World Development Reports (1997) and (1999).

and were encouraged to have research and development alliances with international firms and academia. In another project, thousands of top scientists, engineers, theorists, and especially young and middle-aged scientists are being trained to meet the demand for such professionals in the next 5 to 10 years. Under this program, the total number of skilled personnel in China will increase to 83.5 million by 2005, with the number of professionals reaching 54 million. It is reasonable to believe that a significant portion of these human capital reserves will be employed in the software sector and will help overcome the shortage in supply.

The comparative analysis between India and China indicates that China has advantages in the overall economic situation, education level, and human capital reserve; China also scores higher on parameters such as size of the domestic market and quality of infrastructure. Therefore, the reasons for the underdevelopment of China's software industry need to be analyzed in greater detail. The data clearly indicate that China has placed more emphasis on developing its hardware sector and has had no clear vision for the software direction. To develop China's software industry, the positioning issue needs to be put on the first priority, followed by strategies on the national, the industry, and the firm levels.

Strategic Positioning for China's Software Industry

Heeks (1999) outlines some generic approaches to a developing country's software production. Two dimensions, the target market served (domestic vs. export) and the types of business intended (service vs. packages), are used in analyzing the strategic positioning for a developing country. As illustrated in Figure 2, five positions, A through E, are delineated.

Positions A and B represent export-oriented strategies. These two positions appear more attractive to countries with cheap labor. India has developed the best model for success in position A, and Israel has been successful in position B. One estimate suggests that India has 16% of the global market in customized software and that more than 100 of the Fortune 500 have outsourced software development to India.⁷ Israel is emerging as a source of entrepreneurial firms developing software products in areas such as security and antivirus technology. In 1997, there were about 300 software firms in Israel, employing nearly 10,000 people, with total revenue of more than US\$1.5 billion. A large fraction of the firms are engaged in developing software packages, often technically highly sophisticated, for export markets (Arora et al. 2001).

As a latecomer in the software export market, China faces insurmountable obstacles in position A in the near term. A number of developing countries, such as India and Singapore, arrived on the export scene many years ago. Also, countries in the European periphery, such as Ireland, Israel, and Hungary, have been low-cost software export bases since the early 1990s. These countries have already built up contracts, policies, infrastructure, working methods, track records, and so on. As a result, the more established players threaten to consolidate their positions while squeezing out latecomers (Heeks 1999). Contrary to the myth that China can offer cheap labor in software production, a study by NASSCOM finds that the average wage costs in China are 15%

^{7.} Dataquest, July 31, 1996, pp. 43-44.

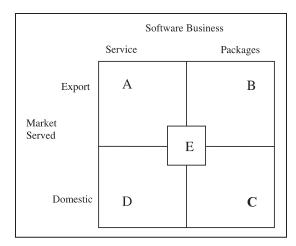


Figure 2. Strategic positioning for developing country software enterprises.

Source: Heeks (1999, Figure 1).

to 20% higher than in India.⁸ The higher costs plus the language barrier create additional disadvantages for China in the world software exports market.

The export-oriented approach also has some serious side effects that diminish the attractiveness of position A. The software industry targeting position A tends to evolve into an "export enclave" in which skills and technology fail to trickle down into the domestic market. According to Arora and Athreye (2002), the net benefits of Indian software industry and its growing productivity are largely passed on to its customers—most prominently the United States—which accounts for more than 60% of all of India's software exports. The problems of a "brain drain" are still acute, when India loses around 15% of its software workers every year, largely to the United States. Arora and Athreye also conclude that software has not played the traditional role of a leading sector in India's economic growth, at least partly because of its poor linkages with the rest of the economy. Taking all these factors into account, it will be wise for China not to promote software export too eagerly, that is, without calculating the opportunity costs.

Position C is termed as "a third world Microsoft" with a question mark in Heeks (1999). Enterprises in developing countries targeting position C often suf-

fer from formidable competition from strong international rivals. Pirated packages also pervade most markets in developing countries. Thus, the domestic package strategy represented by position C may not be a viable strategy for most developing countries. The long battle between the Chinese domestic software product King WPS and Microsoft word processing software package MS Office illustrates clearly the difficulty of position C. WPS was the first software package processing documents in the simplified Chinese language. After being introduced into China's market in 1988, it soon became the monopoly provider in China's word processing market. By 1994, more than 10 million sets of WPS had been sold. The market landscape has changed dramatically since Microsoft entered the Chinese market with its Chinese version Word 6.0 in the same year. Starting from 1996, with the Windows operating system being widely popular, the Windowsbased MS Office took most of the market share from the DOS-based WPS.9 Interesting enough, in a TV interview, the president of the King Software (the company producing WPS) said that the biggest threat facing the company comes from software piracy rather than from Microsoft.

Position D focuses on the domestic software services market. As pointed out in Heeks (1999), the vast majority of firms in developing countries occupy this market segment, largely because it is by far the easiest to enter. Position D can also be a good starting point for progressing into exports. A sizable and demanding domestic market could be the springboard from which to launch into the export market by providing a base of relevant skills, experience, user feedback on products, and track record. Also, a sizable domestic market will draw large numbers of IT multinationals into collaborative relationships with local partners to serve that market. As these relationships deepen, an export component often emerges. Considering China's characteristics, position D is the most appropriate starting point for China to develop its software industry.

The development of the domestic software service market in China is still in its infant stage. In 2000, China's software service market was worth

^{8.} News release from NASSCOM, July 18, 2002, www.nasscom.org.

^{9.} The battle between WPS and MS Office is becoming more intense. In 2001 WPS changed its name to WPS Office and introduced multiple versions compatible with MS Office documents, which has put great pressure on Microsoft. WPS has also won a few big contracts from the Chinese government in 2000 and 2001.

about \$4 billion, making up only 15% of the whole IT market. This share is less than half of the world average level. From 1992 to 2000, the proportion of the service sector to the whole software industry was consistently around 55%, much smaller than that of the United States and Japan, 63% and 76%, respectively (State Information Center 2002). However, the high economic growth will warrant great demand for software products and services in the future. According to one estimate of China's Ministry of Information Industry, the size of China's software market will be around \$30 billion in 2005. which then will account for more than 3% of the world market. Therefore, unlike most other developing nations of small market size, position D may provide Chinese firms with a good development opportunity.

The informatization of China's firms in various industries is still under way. Further steps will, more than ever, require customized software and services to meet the specific needs of Chinese firms. The digitization of Chinese family life is still to come, which in turn will offer even more opportunities for software companies to offer a variety of "family informatization solutions." Microsoft's \$6 billion contract with the Chinese government and its business connection with many local IT firms show its special interest in China's software markets. The arrival of many Indian software giants in Shanghai also implies an imminent upsurge.

Position D is also a survival strategy for China when facing fierce competition from foreign software superpowers. Software services comprise much more than just packaged CD-ROM software. Customized software development generally involves close interaction between the development team and the end user. There could be no better way to build up a lifetime relationship with clients. These firms will impose huge demands with regard to software products and services. Compared with foreign software firms, the Chinese software companies have the advantages of language, culture, and government support.

Position E in Figure 2 represents the other main success story of developing country software, with a theme of specialization for niche markets that include sectoral niches (banking, insurance, health administration, hotel management, mining and forestry, etc.), application niches (Web browser addons or text-retrieval utilities), and linguistic niche for

regional languages. With high economic growth rates, large Chinese firms are thriving in various industries, and they are becoming more and more outward looking. As a result, position E will provide thriving market opportunities for China's software industry.

China should not be eager to follow the lead of India on the way toward the prosperity of the national software industry. The best strategic position for China's software industry is one that puts more focus on the domestic market (position D) and combines featured products with extensive services (position E). China should also pursue collaboration and cooperation with countries such as India and the United States in niche markets of mutual benefit. Cooperation with these international firms will also naturally open up foreign markets for the Chinese software firms.

Cocompetitors in the World Software Markets: Building Alliances with India and Other Software Superpowers

Analysis based on the framework of Heeks (1999) indicates China should focus on its domestic market as a starting point and with an eye toward a more balanced strategy in the long term. One problem in Heeks's framework is that it does not take into consideration the interaction between domestic and foreign software firms. In the era of globalization, cooperation and collaboration are becoming central themes, especially in the ICT industry. Although most people keep asking the question whether China will become a major competitor of India, we believe there are abundant opportunities for the Chinese software industry and firms to build alliances with Indian firms as well as with other software superpowers. They will both benefit from becoming cocompetitors in the world software markets.

The huge market potential of China will undoubtedly become the central battlefield for the world software firms. The exploding growth of China's domestic market and its increasing share of ICT products and services are indicators of its growing importance. "This growth is being supported by the favorable regulations and government policies in the country that enable it to attract a large share of FDI flowing into Asia, other trends contributing to

China's success include its emerging strength in hardware related technologies like embedded software and the growing trend among Japanese companies for setting up offshore facilities in China," as commented by Arun Kumar, vice chairman of NASSCOM.¹⁰

On the Indian side, to sustain their performance, the leading Indian firms are making strong efforts to move up the value chain by acquiring better software project management capabilities and deeper knowledge of business domains, and by reducing costs and improving quality through the development of superior methodologies and tools (Arora and Athreye 2002). These practices will bring good models to the Chinese firms that are struggling with problems of quality improvement and standardization of software development processes. The experience gained in the international market by the Indian software firms will also become an inspiration to the fledging Chinese software firms.

Most Chinese software companies do not have the domain expertise or project management skills that Indian companies have acquired. Building on their strengths such as deep expertise in the area of call centers, the world's best software engineers, CMM level 5¹¹ software quality, software project management skills, and its huge presence in Silicon Valley, the Indian software industry will have good opportunities to tap these opportunities in the Chinese market. There are big opportunities for enterprise applications and solutions such as enterprise resource planning (ERP) and supply chain management (SCM). Most of the companies in China are using legacy mainframe-based systems, that are being transformed into or replaced by new systems and the trend of global companies setting up manufacturing bases in China will accelerate the demand of ERP and SCM applications. Banking and telecom were other potential areas for software products and services. According to statistics from the Research Center of Computer and Microelectronic Industrial Development, of the Ministry of Information Industry, China's market of ERP, which helps businesses manage the whole process of their operations, nearly doubled its growth rate from 570 million RMB yuan (about US\$69 million) in 2000 to 870 million RMB yuan (about US\$105 million) in 2001.

There is also the distinct possibility of both India and China working jointly on some projects. Some Indian software firms including Infosys, TCS, Satyam, WIPRO, ZenStar, and Pentasoft have already set up bases in China. Similarly, a large Chinese telecommunications firm, Huawei Technologies, has set up a research and development center in Bangalore where 180 Chinese programmers work alongside locals. Rather than a zero-sum game, China and other nations may be able to participate in the international division of software labor through collaboration (Arora and Athreye 2002).

Summary and Conclusions

To develop China's software industry, strategies at the national level, the industry level, and the firm level all have to be clearly formulated. In the process of a nation developing its software industry, the national government could and should play important roles. In the take-off period of India's software industry, the government uses a broad set of favorable policies to foster the industry, including investment in economic infrastructure, investment in hardware equipment, and reduction of tariffs and taxes. Besides, the Indian government gave all the e-government projects to domestic software firms and became the biggest client of the software firms. It is hard to imagine India's success in its software industry without support from the government. In the current stage of China's software industry development, the domestic firms are much weaker than the foreign giants and they do not have the capability to compete with them. The favored and skewed government policies are necessary for the growth of the domestic software firms and for preparing them for competition in the global markets. Besides, other crucial issues important to the software development such as antipiracy, standards, inputs of

^{10.} News release from NASSCOM, February 6, 2002, www.nasscom.org.

^{11.} CMM (capability maturity model) is a structured process for software development associated with the Software Engineering Institute (SEI) at Carnegie Mellon University. It consists of five maturity levels, with level 5 the highest. Though initially developed as a means of providing improved software systems for the U.S. Department of Defense, the CMM is becoming popular among world software firms, especially in India, as a means of signaling their software development capabilities to clients.

finance, and human capital also need support from the government.

On the industry level, NASSCOM in India is a good example for China's software industry. Considered another asset of the Indian software industry, NASSCOM is the apex umbrella organization for IT software and service organizations in India. Formed in 1988, NASSCOM's objective is to act as a catalyst for the growth of the global competitive software-driven IT industry in India. NASSCOM is a nonprofit organization with more than 870 member companies that collectively contribute to more than 95% of revenues of the Indian software industry. Its members include software, Internet, and ecommerce companies spanning private and public sectors that include homegrown companies and multinationals. In comparison, NASSCOM's counterpart in China, the China Software Industry Association (CSIA), is not playing an important role in China's software industry. Because of the long history of China's planned economy, usually the government plays a strong role in industry development; therefore, almost all the NGOs are loosely organized and lack the resources and expertise in facilitating the participating companies. It is expected that NGOs such as CSIA will play more and more critical roles in industries.

Enterprise tactics, such as the ability of successful firms to identify growth markets and to access necessary inputs are crucial to China's development of its software industry. Also, the issues of standardization and reputation for quality are crucial for a software firm to be competitive in the world market. The success of India's software export sector to a large extent has been due to its relentless pursuit of quality and standards. As many as 201 Indian firms have received the CMM certification. Of the 58 software development operations worldwide that had achieved CMM level 5 certification by October 2001, 32 were located in India. In contrast, software is still mostly regarded as the art of individual creativity rather than an engineering process in China. There was no industry standard available in China for software products and services before 2001. According to one survey conducted by the CSIA in March 2001, more than 70% of the firms have no more than 50 employees, and most of these firms know little of software engineering; the individual intelligence of "coding geniuses" plays a bigger role than quality standards. By April 2002, only 23 Chinese software companies received the CMM certification.

As a latecomer in the world software industry, China does not have the conditions to pursue the Indian model of aggressively pursuing the U.S. software outsourcing markets. In the near term, China's software industry needs to build a firm foothold in the domestic software service markets as the starting point. In the long run, a path of balanced development viewing both the domestic and the international markets should be followed. Building alliances and collaboration with foreign software superpowers will also speed up China's software industry development.

Acknowledgement

We thank Ernest J. Wilson, Michael L. Best, Kai Reimers, and four anonymous referees for helpful comments and suggestions. All remaining errors are ours. Financial support from the National Science Foundation of China (Project 70231010), the Ministry of Education (Project 01JAZJD630007), and the Tsinghua University 985 Research Funds are gratefully acknowledged.

References

Arora, A., V. S. Arunachalarm, J. Asundi, and R. Fernandes. 2001. "Indian Software Services Industry." *Research Policy* 30:1267–1287.

Arora, A. and S. Athreye. 2002. The Software Industry and India's Economic Development. *Information Economics and Policy* 253–273.

Dasgupta, S. 2000. "Can Indian Infotechs live up to the Hype?" *Asia money* (Feb 2000).

Dataquest. 1996, July 31, 43-44.

Ghemawat, P. 2000. "The Indian Software Industry at the Millennium," Working paper 9-700-036, Harvard Business School.

Heeks, R. 1999. "Software Strategies in Developing Countries." Working paper, Development Informatics.

International Data Center. 2001. *The IDC/World Times Information Society Index*. From www.theinfo-shop.com/study/ id7816_the_ictc_world.html

- Kumar, A. 2002, April 3. "China No Threat to Indian Software in the Near Future." Financial Express. Retrieved from www.financialexpress.com/fe_full_story.php?content_id=5872.
- Meng, Q. and M. Li. 2002, June. "New Economy and ICT Development in China." *Information Economics and Policy* 275–295.
- National Association of Software and Service Companies of India. 2002, July 18. Press release. Retrieved from www.nasscom.org.
- Rao, S. S. 1997. "Silicon Valley Goes East—Way East." *Forbes*, November 17, 159.

- Saxenian, A. 2001. "Bangalore: The Silicon Valley of Asia?" Working paper, National Entrepreneurship Research Center of Tsinghua University.
- State Information Center, China Information Industry Association. 2002. *China Information Almanac* 2001. Beijing: China Information Almanac Office.
- Wong, P. K. 2000, October. "ICT Industry Development and Diffusion in South East Asia." Paper presented at the ASEAN Roundtable 2000 on New Development Paradigms in Southeast Asia: The Challenge of IT, Singapore.
- World Bank. 2000. *World Development Indicators* 2000. Washington, DC: World Bank.