

## Research Article

# Unintended Technology Transfer to Chinese Software Firms from Japan Through Offshore Software Development

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### **Abstract**

*Since the end of the 1990s, some Chinese software firms have undertaken offshore software development for Japanese firms. They are engaged not only in coding and testing, but also in design. The results of our interviews with Chinese and Japanese firms show that Chinese firms have acquired design skills through these joint developments. Japanese firms did not intentionally implement technology transfer, but the practice of offshore development did have this effect. In addition, we identify that the main reasons Japanese firms entrusted software design to Chinese firms were quality control and cost reduction of their software development projects. Currently, Chinese firms are employing the transferred skills for their own domestic projects, indicating that the export of software services has contributed significantly to the expansion of the domestic market. We conclude that China should focus on both domestic supply and export of software services as a strategy for developing its own software industry.*

## 1. Introduction

The Chinese software industry has grown at a tremendous rate over the past decade. Its sales increased from RMB75.1 billion (US\$9 billion) in 2001 to RMB1.3364 trillion (US\$200 billion) in 2010, with a large proportion of this increase attributed to the domestic market. Although exports accounted for only a small proportion of these sales, they also increased sharply, from US\$1.71 billion in 2007 to US\$9.74 billion in 2010.<sup>1</sup> Of the 2010 exports, 27% were to the United States and 24% were to Japan (Ministry of Commerce, 2011).<sup>2</sup> Some argue that Chinese software firms have fallen behind their Indian counterparts in terms of internationalization: "Indian firms invest in 'offices' or 'beachheads' in North America and Western Europe, where they export the majority of their services. Chinese firms do not seem to be entering Japan or the USA in the same way" (Niosi & Tschang, 2009, p. 290). Even so, the recent rapid increase in

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1. Figures exclude embedded software.

2. In 2004, 60% of exports were to Japan (China Software Industry, 2005). The decline in the Japanese share of software exports was primarily the result of rapid expansion of exports to Western countries.

exports suggests that the internationalization of the Chinese software industry has already begun this process.

Studies of the Chinese software industry agree that strong domestic economic growth and support from the Chinese government promoted the industry's rapid expansion; however, the industry faces many obstacles to further development, such as a lack of consulting capability, a shortage of highly skilled engineers, and rampant piracy (Huang, 2011; Tschang & Xue, 2003, 2005; Wong & Wong, 2004; Zhang, 1999; Zhang, Fu, & Liu, 2001). Large revenue losses caused by piracy have seriously constrained local firms' further R&D investments in software products (Ju, 2001). The shortage of engineers with English language proficiency, workers who are indispensable to expanding international business, is also emphasized (Gregory, Nollen, & Tenev, 2009; McManus, Li, & Moitra, 2007). Therefore, some studies insist that China must produce more graduates<sup>3</sup> with better information technology (IT) skills and greater English-language fluency to enable them to gain employment with multinational firms operating in China or with local companies with global ambitions (Farrell & Grant, 2006).

Nevertheless, the literature overlooked the important point that the process of offshore software development has helped Chinese firms acquire advanced technology. Since the end of the 1990s, some Chinese firms have provided software development services for foreign firms in the areas of coding and testing, as well as design. Because design skills and business knowledge are difficult to obtain using a team's own efforts, Chinese firms gained these skills and this business knowledge through joint developments with Japanese firms. After working with the Japanese firms, the Chinese firms then exploit these transferred skills for their own domestic projects. Therefore, the technology that Chinese firms acquire from Japan effectively contributes to the expansion of China's domestic software market.

This article analyzes the technological progress of the Chinese software industry from the viewpoint of international division of work. Through information obtained from interviews with Chinese and Japanese firms, we show that offshore software development

has led to unintended technology transfer to Chinese firms. Finally, we propose strategies to aid the ongoing development of the Chinese software industry.

This article is organized as follows: Section 2 examines the literature on the development of the Chinese software industry. Section 3 explains the methodology employed for the case study. Section 4 reveals the changes in the division of work between Japan and China at the end of the 1990s. Section 5 clarifies the manner in which Chinese firms achieved technological progress. Section 6 discusses the reasons underlying these changes. Section 7 analyzes the technology transfer process from the viewpoint of social capital. Section 8 provides concluding remarks.

## 2. Literature Review

This section examines the literature related to the technological progress of the Chinese software industry and the strategies for the advancement of software industries in developing countries.

### 2.1 Technological Progress in the Chinese Software Industry

Chinese software firms emphasize technological progress. Almost all Chinese software firms have incurred R&D expenditures that, as a percentage of total costs, are significantly higher than the corresponding share of Indian software firms' costs (Gregory et al., 2009).

The government's role is an important point of contention in the literature. The Chinese government has undertaken substantial efforts to introduce foreign technology and develop its science and technology, particularly since 1978 (Bianchi, Carnoy, & Castells, 1988; IDRC, 1997). Yang, Ghauri, and Sonmez (2005) apply Porter's diamond theory on the competitive advantage of nations to the Chinese software industry. They show that the government's role is significant for the software industry's future development. Li, Lin, and Xia (2004) propose promoting open source software (OSS) as the Chinese government's strategy to foster development. The adoption of OSS would weaken Microsoft's dominance in the upstream operating system market and promote collaboration among firms in the Chinese

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3. Wilson and Segal (2005) also asserted that China requires some restructuring of the social pipeline that produces software engineers, software managers, salespersons, systems integrators, and so on.

software industry. In fact, the Chinese government's policy has focused on establishing standards using Linux-based operating systems as alternatives to Microsoft Windows, and on developing domestic office automation products as alternatives to imported application software (Suttmeier & Xiangkui, 2004).

Brain drain has been a serious problem for China's IT industry. For instance, from 1978 to 1999, only 14.1% of Chinese IT professionals who went to the United States eventually returned. However, brain circulation is also occurring; in the 2000s, the number of returnees steadily increased,<sup>4</sup> some lured by the promise of lucrative market opportunities. In addition, Chinese policy makers have encouraged them to return to work for Chinese firms or undertake their own technology enterprises (Saxenian, 2003, 2006). The national "One Thousand Talents Scheme," implemented in 2008, involves benefits such as a lump-sum payment of one million yuan (US\$144,000) to competent returnees.

Internationalization of business activity is one of the most important factors for technological progress in the Chinese software industry. Indeed, many foreign IT firms have established R&D centers in China. For instance, with the support of SAP headquarters and SAP Labs North America, SAP Labs China, a subsidiary of SAP AG (Germany), helped Chinese IT workers accumulate skills and experience, and then develop new products (Jui, 2010). In the case of Japanese firms, the Hitachi Information and Telecommunication Systems Group founded its technology center in Beijing in 2004. NEC then launched a joint venture with the Institute of Software, China Academy of Science to develop software for Japanese customers (Pei & Jing, 2006).

Many Chinese software firms have developed their capabilities by working with Western multinational enterprises that have entered the Chinese domestic market.<sup>5</sup> Initially, Chinese firms implemented the localization and testing of products

from Western enterprises. Later, they implemented application development and maintenance of these products (Niosi & Tschang, 2009).

Technology transfer through foreign direct investment (FDI) occurs in two primary ways. One is the "show how" of foreign investors displaying and spreading knowledge through their presence in the local economy. This presence gives local firms and personnel opportunities to learn through observation. The other way is through the technology flow within FDI firms, particularly in joint ventures (Lan, 1996). McManus et al. (2007) argue that FDI produces externalities in the form of spillovers in the software industry, including those related to productivity and market access.

Using regression analysis, Liu (2008) demonstrates that the technology spillovers from international firms outsourcing to China are substantial. IBM, Microsoft, and other multinationals established R&D centers for software development in China. These foreign R&D centers communicate with local firms and collaborate on new products. Through these relationships, local Chinese firms obtain new technology and information. Using correlation analysis, Yang (2011) shows that internal knowledge sharing and external knowledge acquisition are mutually correlated for Chinese software outsourcing vendors.

However, these studies barely explain the specific process of technology transfer involved in software development projects in China. The literature's analysis of technology transfer through offshore software development to China is also immature.<sup>6</sup> Most studies of offshore software development to China, such as Eltschinger's 2007 work, pay little attention to the effects of technology transfer. Indeed, Japanese firms that entrusted coding and testing to Chinese firms were concerned with the outflow of Japanese skills and knowledge to China (Takahashi & Takahashi, 2008). This concern, in and of itself,

4. In the late 1990s, approximately 20,000 Chinese commenced study abroad each year, and fewer than 10,000 returned. By the 2000s, a substantial increase occurred in both figures. In 2009, more than 229,000 Chinese commenced study abroad each year, and more than 108,000 returned to China (National Bureau, 2010).

5. Wu and Miyazaki (2006) have shown that some large Chinese software firms had strong business links to foreign IT firms, but only a few links to domestic firms. This phenomenon reflected the technology dependence of local firms on foreign multinational enterprises.

6. Offshoring software development to India was frequently analyzed at the organizational level (Krishna, Sahay, & Walsham, 2004; Nicholson & Sahay, 2004; Prashantham & Dhanaraj, 2010; Rivard & Aubert, 2008; Sahay, Nicholson, & Krishna, 2003; Walsham, 2001).

## UNINTENDED TECHNOLOGY TRANSFER TO CHINESE SOFTWARE FIRMS FROM JAPAN

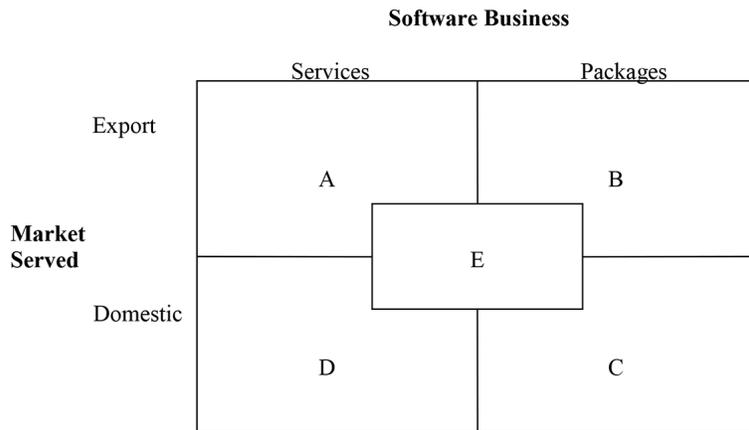


Figure 1. Strategic positioning for developing country software enterprises.

Source: Heeks (1999).

suggests that offshore development involves substantial technology transfer.

### 2.2 Strategies for Software Industries in Developing Countries

The previously described literature does not identify the strategic approaches that China should adopt for its future development. We now analyze some possible strategies for software industries in developing countries.

#### Export Strategies for Developing Countries

Correa (1996) described three strategies for promoting software exports in developing countries. Strategy 1 is the export of work that requires software engineers to work in developed countries for brief periods. These operations are primarily limited to programming, and the learning process with respect to design is not substantial.

Strategy 2 is the export of software development services, which, in the Chinese case, typically consists of software firms developing custom software in accordance with their clients' specifications or taking on part of the development process as subcontractors. Software engineers may participate in the design and implementation of systems, work which is likely to be higher value-added and more profitable than the activities mentioned in Strategy 1. The learning process is likely to be substantial.

Strategy 3 involves IT product exports. Applied to the Chinese case, this strategy requires the Chinese suppliers to develop or obtain access to a distribution network and ensure the provision of post-sales services. However, competition can be intense, and the advantage of low labor costs in a developing country loses its relative importance.

#### Firms' Strategies in Developing Countries

In contrast to Correa (1996), who did not analyze strategies for domestic markets, Heeks (1999) classified software firms' strategies into five positions in terms of

markets and business.<sup>7</sup>

Figure 1 depicts Heeks' five strategies. Position A represents the export of software services or off-shore development. In this position, developed countries entrust software firms in developing countries with either the entire software development or subsections thereof. Position B is the export of software packages. Position C is the production of packages for the domestic market. Position D is software development and the sale of software services to the domestic market. Finally, Position E represents supply for niche markets, including sector, application, and linguistic niches.

On the basis of this approach, McManus et al. make the following argument:

[Position B] is almost non-existent in China's software industry. The majority of software programming in China is for the outsourcing and domestic services segment, which tends to be at the lower end of the software industry value chain. China currently lacks an entrepreneurial environment that fosters innovation. (2007, p. 131)

Li and Gao (2003) apply Heeks' (1999) model to China and argue that Positions A, B, and C are not good strategies for the country's particular circumstances. As a latecomer in the software export market, China faces insurmountable obstacles in Positions A and B for the immediate future. Worse

7. Heeks (1999) also clarified several factors crucial to successful software production, namely enterprise tactics, national strategy, and national vision. Heeks and Nicholson (2002) deduced the software export strategies from the experiences of six developing countries, comprising national vision, national strategy regarding markets, national tactics regarding infrastructure, and national tactics regarding international linkages and competitive clusters.

yet, these export-oriented approaches have a serious side effect: The advanced technology that firms acquire through the export of software services often fails to trickle down into the domestic market.<sup>8</sup> Position C is also inadvisable. For example, a Chinese software firm, KINGSOFT, developed the first word processing software package in simplified Chinese in 1988. However, 10 years later, Windows-based Microsoft Office took most of the market share.

In contrast, Positions D and E are suitable strategies for Chinese software firms. Position D is an appropriate starting point for several reasons. First, this segment is the easiest for new firms to enter. Second, this position can be a good starting point for progressing into exports. A sizable and demanding domestic market could be the springboard required to launch China into the export market, as a domestic market can provide a suitable base of relevant skills and experience and a strong record of accomplishment. Third, a sizable domestic market attracts a large number of IT multinationals. Collaboration with multinational firms can create export opportunities for local partners. In addition, Position E provides thriving market opportunities. Given China's high economic growth rate, an increasing number of large firms are operating across various industries, making Position E promising (Li & Gao, 2003, pp. 68–70).

Nonetheless, Li and Gao (ibid.) overlook the interaction between domestic and foreign firms through the export of software services. Contrary to their assumption, these exports have, in fact, led to technology transfer to domestic firms, as we show in the following sections.

In summary, Correa (1996) suggests that a substantial learning process would accompany the export of software development services. However, Li and Gao (2003) overlook this same effect. The following sections show how the export of software development services is playing an important role in the ongoing development of China's software industry.

### Marketing and Customer-Oriented Strategies

McManus et al. (2007) discuss marketing and customer-oriented strategies for Chinese and Indian software industries in light of the global software industry's structure and dynamics. The strategies include those for market positioning, demand gen-

eration, customer management, market influencing, and partnership leverage.

Overall, McManus et al. (2007) argue that, although the Chinese software industry had an inherent advantage of cost leadership, it also needed to implement these strategies to overcome its shortcomings. In addition, China needed to build trust and credibility with international clients, and to acquire the ability to remotely deliver large and complex projects.

### Technological Leapfrogging Strategies

Steinmueller (2001) examines the possibility of technological "leapfrogging" by developing countries. *Leapfrogging* means bypassing stages in capability building or investment that countries were previously required to pass. Steinmueller (ibid.) notes that developing countries need to address the following prerequisites for technological leapfrogging: 1) existence of absorptive capacities to produce or use IT, 2) access to the equipment and knowledge required to use the later stages of technological development productively, 3) complementary technological capabilities, and 4) downstream integration capabilities.

Overall, Steinmueller (ibid.) argues that it is possible for developing countries to address these prerequisites, due to the discontinuity brought about by technological change in electronics, the availability of knowledge about key technologies, and a broad and competitive market for producer and user tools. The following sections demonstrate that offshore development helps developing countries address these prerequisites.

## 3. Research Methodology

We use an inductive case study methodology to examine changes in the division of work in Japan and China. In keeping with the procedures of inductive case study research, we iterate continuously between the data and the emerging propositions (Eisenhardt, 1989; Yin, 2003). For this purpose, multiple case studies offer a more robust analysis than a single case study would.

Before describing our interview method, we need to explain the process of software development. When Japanese firms conduct offshore software development, they typically apply the waterfall model. Phases in this waterfall model include

8. Li and Gao (2003) referred to Arora and Athreye (2002), who explained how the technology that Indian software firms acquired through software exports failed to trickle down into the domestic market.

1) requirements definition, 2) external design, 3) internal design, 4) programming design, 5) coding, 6) unit tests, 7) join tests, 8) system tests, and 9) operations and maintenance. *Requirements definition* is the process of defining the product's requirements.<sup>9</sup> *External design* is product design that meets the defined requirements.<sup>10</sup> *Internal design* is the design of the implementation details that are invisible to users.<sup>11</sup> *Programming design* is the detailed specification and design of each program module. External and internal design require not only extensive technical knowledge and skills, but also business knowledge, which includes information regarding individual customer business styles, where and how the software will be used, and ideas about developing software that suits the business style of each customer.

In most offshore development projects in the 1990s, Japanese firms performed the requirements definition, design, and join and system tests. They entrusted Chinese firms with only the lowest value-added phases: coding and unit tests.

Now, however, we find that Japanese firms entrust a broader range of design phases to the Chinese. During 2007–2009, we interviewed 50 Chinese firms that received orders from Japan. These firms included local Chinese firms, joint ventures between Japanese and Chinese firms, and subsidiaries of Japanese firms.<sup>12</sup> Through this recent research, we discovered that more than half of these firms have been entrusted with external or internal design since the end of the 1990s, and substantial technology transfer involving design methods has occurred.

To investigate this more deeply, we re-interviewed some of the Chinese firms and the Japanese firms that traded with them. Based on the interview data, we analyzed the reasons for the changing outsourcing pattern, thereby formulating some propositions. We then re-interviewed the firms to confirm our propositions.

This process reveals that both the methods by

which and the reasons why Japanese firms entrusted design to Chinese firms were similar across the firms. Therefore, among the several dozen Chinese firms we interviewed, we chose four firms. We describe the results of our interviews with these firms<sup>13</sup> in the following sections. The description of the four sample firms encompasses the methods and reasons for entrusting design to many Chinese firms.

We designate the four Chinese firms as Firms A, B, C, and D. Firms A and D are local Chinese firms. Firms B and C are international joint ventures. Regarding their products, Firm A is a large IT vendor that provides software systems and packaged software. Firms B and D are also large IT vendors, but they provide software systems and embedded software. Firm C provides embedded software for its Japanese parent company. Thus, these four firms are representative of the various software development fields in China. Table A1 in the Appendix provides some general information about the sampled firms.

#### 4. Global Distribution of Tasks

Using the example of our four firms, this section describes changes in the division of work between Japan and China at the end of the 1990s. Figure 2 details the changes in the balance of tasks between Japanese firms and Chinese Firms A and B.

Firm A is a local Chinese firm founded in 1991. It was entrusted with programming design, coding, and unit tests by Japanese IT vendors in the 1990s. Firm A opened an office in Japan in 1999. Generally, Firm A's Chinese engineers have high levels of software development skills and Japanese language literacy. Therefore, they serve as mediators between Japanese IT vendors and the firm's main office in China. Around 2000, a Japanese IT vendor invited highly skilled Chinese engineers from Firm A to participate in internal design phases, which was a role previously assigned to Japanese engineers. The Chinese engineers gradually acquired internal design

9. This process includes determining features, cost and price, performance, safety, and regulatory factors.

10. These requirements include the definition of user interfaces (both command line and graphical); features; external interfaces to other programs or systems; a high-level architecture that shows the dependence on external components; and the response to cost, price, performance, safety, and regulatory requirements.

11. These details include the internal architecture of program modules, definitions for intermodule interfaces, and lists of key data structures and methods or functions associated with each module.

12. Of the 50 Chinese firms we interviewed, local Chinese firms comprise two-fifths, joint ventures between Japan and China comprise two-fifths, and subsidiaries of Japanese firms comprise one-fifth.

13. We interviewed each of the four firms three to four times.

	Requirements Definition	External Design	Internal Design	Programming Design	Coding	Unit Tests
1990s End of the 1990s 2000s	Japanese Firms			Chinese Firms A and B		

Figure 2. Changes in the division of work between Japanese firms and Chinese Firms A and B.

	Requirements Definition	External Design	Internal Design	Programming Design	Coding	Unit Tests
1990s Late 1990s 2000s	Japanese Firm			Chinese Firm C		

Figure 3. Changes in the division of work between a Japanese firm and Chinese Firm C.

skills and eventually equaled the expertise<sup>14</sup> of the Japanese engineers, and the Chinese began to conduct internal design by themselves. Presently, Firm A conducts external design jointly with the Japanese firm and internal design and other processes on its own.

Firm B is a joint venture between a Japanese IT vendor and a Chinese software firm. The Japanese IT vendor has entrusted programming design, coding, and unit tests to the Chinese firm for more than 10 years. When they established Firm B together in 1996, the Chinese parent company transferred skills and business knowledge to Firm B. Subsequently, the Japanese parent company invited engineers from Firm B to participate in the internal design phases. In 1998, the Japanese and Chinese engineers jointly commenced external design. Several years later, Firm B conducted external design on its own. Firm B's orders have been increasing since it established an office in Japan in 2001.

Firm C is a joint venture established by a Japanese machine manufacturer and a Chinese firm in 1991. Occasionally, engineers from Firm C worked at the Japanese parent company's offices and conducted external and internal design under the gui-

dance of Japanese engineers. In the late 1990s, Firm C's engineers began to conduct the external design phase by themselves. Currently, Firm C sometimes conducts its own requirements definitions. Figure 3 illustrates the changes in the division of work between the Japanese firm and Chinese Firm C.

In these three cases, Chinese firms conducted both external and internal design. The following case is one of a Chinese firm conducting only internal design. Figure 4 illustrates the changes in the division of work between a Japanese firm and Firm D.

Firm D is a local Chinese firm founded in 2000. A Japanese IT vendor invited highly skilled Chinese engineers from Firm D to Japan to participate in internal and programming design. In 2003, Firm D established a Japanese office staffed by Chinese engineers to increase sales to Japanese firms. Firm D now conducts its own internal design.

These examples show how changes in the division of work occurred in the software industry in Japan and China. First, Chinese engineers worked with Japanese engineers in the design phase. Once the Chinese engineers had acquired the necessary

14. As estimated by Firm A.

**UNINTENDED TECHNOLOGY TRANSFER TO CHINESE SOFTWARE FIRMS FROM JAPAN**

	Requirements Definition	External Design	Internal Design	Programming Design	Coding	Unit Tests
2000	Japanese Firm			Chinese Firm D		
Present	Japanese Firm			Chinese Firm D		

Figure 4. Changes in the division of work between a Japanese firm and Chinese Firm D.

skills and business knowledge, they began to conduct the design phase themselves.

To summarize, engineers in Chinese firms (i.e., suppliers) obtained skills and business knowledge by working with engineers in Japanese firms (i.e., outsourcers). Initially, the supplier engineers worked with the outsourcer engineers. However, once the former had acquired the necessary skills and business knowledge, they began to conduct the tasks on their own. Therefore, we arrive at the following proposition:

*Proposition 1:* Technology transfers of offshore software development arise through the collaboration of outsourcers and suppliers. Engineers in the supplier firm work with engineers in the outsourcer firm to acquire the necessary skills and business knowledge.

Furthermore, these examples show that the high absorptive capability of Chinese engineers was a key factor in technology transfer. For this reason, Chinese software firms made a point of assigning competent employees to their business activities with Japanese firms.

**5. Process of Technological Progress**

Next, we clarify the process by which Chinese firms acquire experience and skills relevant to the design phase. Offshore development differs from domestic development in three primary ways: the diversity of organizations and cultures, the nature of the work, and the process involved in the offshore relationship. Therefore, individuals, teams, and organizations have to manage the complex problem of embedded knowledge in offshore development (Nicholson & Sahay, 2004). We now describe how Chinese firms overcame difficulties in this area.

**5.1 Accumulation of Coding and Testing Skills**

In the 1990s, most Chinese engineers had little experience in offshore development. They needed to acquire experience and develop coding and testing skills, as well as Japanese-language literacy. This section explains how they accomplished these tasks.

**Acquisition of Coding and Testing Skills Working on Japanese Designs**

When Chinese firms received orders from Japan, the Chinese acquired coding and testing skills working on the designs sent by the Japanese. The four Chinese firms we interviewed had standardized their development methods and, thus, had improved coding and testing efficiency. One Chinese employee whom we interviewed said, “Japanese designs were very detailed. We followed them in conducting coding and testing. By repeating this, we overcame our deficiency in teamwork and established methods of organizing development teams.” In other words, Chinese firms followed the Japanese designs, and in so doing, learned the Japanese style of software development, organization of development teams, and other skills.

**Training Programs**

The Chinese firms conducted training programs for their employees. Firms A and B invited Japanese engineers to China and sent their engineers to Japan. Through these training programs, Chinese engineers gained opportunities to experience software development processes in Japan. In addition, all four firms conducted Japanese-language training.

**Recruiting Engineers from Japan**

We found that Chinese firms hired engineers not only from China, but also from Japan. These firms recruited Japanese and Chinese software engineers working in Japan and asked their Japanese parent companies to transfer Japanese software engineers

to China. For example, Firm B's Japanese parent company sent a Japanese adviser to Firm B. In addition, certain Chinese firms secretly hired Japanese engineers as technical advisers.<sup>15</sup> Chinese engineers then acquired coding and testing skills from these foreign advisors. Through these measures, Chinese firms developed an understanding of foreign-based advanced technology. This period is regarded as a "chrysalis" stage in the design process.

### 5.2 Acquisition of Design Skills

Design skills are difficult to obtain through a team's own efforts. As previously described, in the 1990s, Chinese firms were accumulating experience in software development, but they lacked sufficient design skills. External design is particularly difficult, because it requires specific business knowledge. We now explain the process of offshore software development and clarify how Chinese firms acquired design skills. A representative case is the development process involving a Japanese IT vendor<sup>16</sup> and Chinese Firm A, described in the previous section.

Table 1 provides information from the interviews about the software development process. The Japanese IT vendor and Chinese Firm A jointly conducted external design. The Japanese IT vendor entrusted the later phases to Firm A and provided support. The vendor prepared the technical information, conducted training, checked each product, and corrected mistakes. Sometimes, Japanese engineers traveled to China to confirm the progress of the project and advise Chinese engineers.

Offshore development resulted in unintended technology transfer. In Phases 3 and 4, Firm A learned the process of developing software in accordance with the business style of each customer. In Phases 5–7, the Chinese firm acquired internal design skills. In Phases 10–12, it developed testing skills. In our interview, a manager at the Japanese IT vendor said, "Our firm did not implement technology transfer intentionally, but the above process resulted in technology transfer."

As previously stated, we interviewed dozens of Chinese firms entrusted with design, most of which acquired design skills and business knowledge in a

similar way—that is, Chinese firms acquired skills through training and repeated working experiences with their Japanese partners. In other words, entrusting design work to Chinese firms requires outsourcers' support, which leads to technology transfer. Thus, we arrive at the following proposition:

*Proposition 2:* Entrusting more difficult tasks necessitates outsourcers' support in the form of training, instruction, and periodic product checks. Entrusting work to others results in technology transfers to suppliers, even if the outsourcers do not intentionally implement such transfers.

Firm A is a local Chinese firm, not a subsidiary of the Japanese IT vendor. However, the Japanese vendor holds a positive attitude toward transferring technical instruction to Firm A; the same attitude is displayed toward Firms B and C by their Japanese parent firms. Firm A had been doing business with the Japanese IT vendor for about 10 years. In our interview, the Japanese IT vendor stated that it needed to produce high-quality products; thus, it unhesitatingly implemented technical instruction for its long-term partners.

From our interviews with dozens of Chinese software firms, we find that many Japanese firms conduct business in a similar way. Their attitude toward technical instruction of Chinese firms with which they have had lengthy (e.g., 10-year) business relationships differs greatly from their attitude toward Chinese firms with which they have had only short-term (e.g., 2-year) business relationships and is close to their attitude toward their own subsidiaries. Therefore, we suppose that little difference exists between the nature of technology transfer from Japanese firms to Japanese subsidiaries in China, and such transfer to local Chinese firms that are long-term partners.

## 6. Reasons for Changes in the Division of Work

This section discusses why Japanese firms changed the division of work between themselves and Chi-

15. For example, a Japanese engineer provided paid advice to a Chinese firm only on weekends. He did not notify his company of his activities.

16. This firm began offshore development in China in the late 1990s. Around 2000, the firm began to implement offshore operations on a large scale and entrust internal design to Chinese firms.

## UNINTENDED TECHNOLOGY TRANSFER TO CHINESE SOFTWARE FIRMS FROM JAPAN

Table 1. Software development process involving a Japanese IT vendor and Chinese Firm A.

Phase	Description
1	Japanese vendor conducts requirements definition.
2	Japanese and Chinese engineers jointly conduct external design.
3	Japanese vendor prepares technical information for developing software.
4	Chinese engineers undertake training in Japan (if necessary).
5	Japanese and Chinese engineers jointly develop an outline of the internal design using the Internet.
6	Chinese engineers arrange for Phases 7–12.
7	Chinese engineers conduct internal design based on the outline.*
8	Chinese engineers partition the content of internal design and place teams in charge of each component.*
9	Chinese engineers divide each component into subcomponents and select the person in charge of each subcomponent.* Chinese engineers then conduct coding.*
10	Chinese engineers conduct unit tests for quality verification.*
11	Chinese engineers conduct join tests for quality verification.*
12	Chinese engineers (or in some cases, Chinese and Japanese engineers together) conduct system tests for operation.*

\*Work checked by the Japanese IT vendor.

nese firms. We identify two primary reasons: quality control and cost reduction. In other words, Japanese firms entrusted the design phases to Chinese firms to improve product quality and to reduce development costs. We explain these reasons by analyzing the current software development circumstances in Japan.

### 6.1 Quality Control

One of the main problems in offshore software development is maintaining software quality. A survey<sup>17</sup> conducted by the Japanese government showed that 62.5% of Japanese firms are concerned about poor-quality software or have difficulty controlling quality. The most important reason appears to involve gaps in thinking about design changes and the level of quality. Although design changes often happen after the beginning of coding in Japan, they do not happen frequently in other countries. In addition, a large quality gap exists between Japanese firms and foreign firms (Ministry of Internal Affairs and Communications, 2007).

These gaps arise from the unique Japanese software development methodology. Typically, a Japanese firm does not first complete a design; rather, it adjusts and gradually optimizes the design during

the course of coding. Therefore, delays in determining the requirements definition and revisions of designs often occur. Moreover, Japanese firms pay attention to very detailed points of design. Chinese programmers who are unfamiliar with these practices cannot always understand why the designs are revised (Kitajima & Ban, 2006).

Japanese firms invited Chinese engineers to participate in internal design to control the software quality. In our interview, an executive of Firm A said the following:

The main purpose of offshore development in China is entrustment of coding and testing. However, when Japanese firms entrust only coding and testing, Chinese firms do not participate in design, so they cannot understand the properties of the software and make many mistakes in developing it. Therefore, the developed software has a large problem in quality. It takes significant time and money for Japanese firms to revise the software. The effects of cost reduction by offshore development are reduced.

In our interviews, Japanese firms said that the participation of Chinese engineers has several effects. First, Chinese engineers in charge of coding

17. The Japanese Ministry of Internal Affairs and Communications commissioned Mitsubishi UFJ Research and Consulting Co., Ltd. to conduct the survey. In 2007, questionnaires were mailed to 4,632 Japanese companies, 514 of which responded.

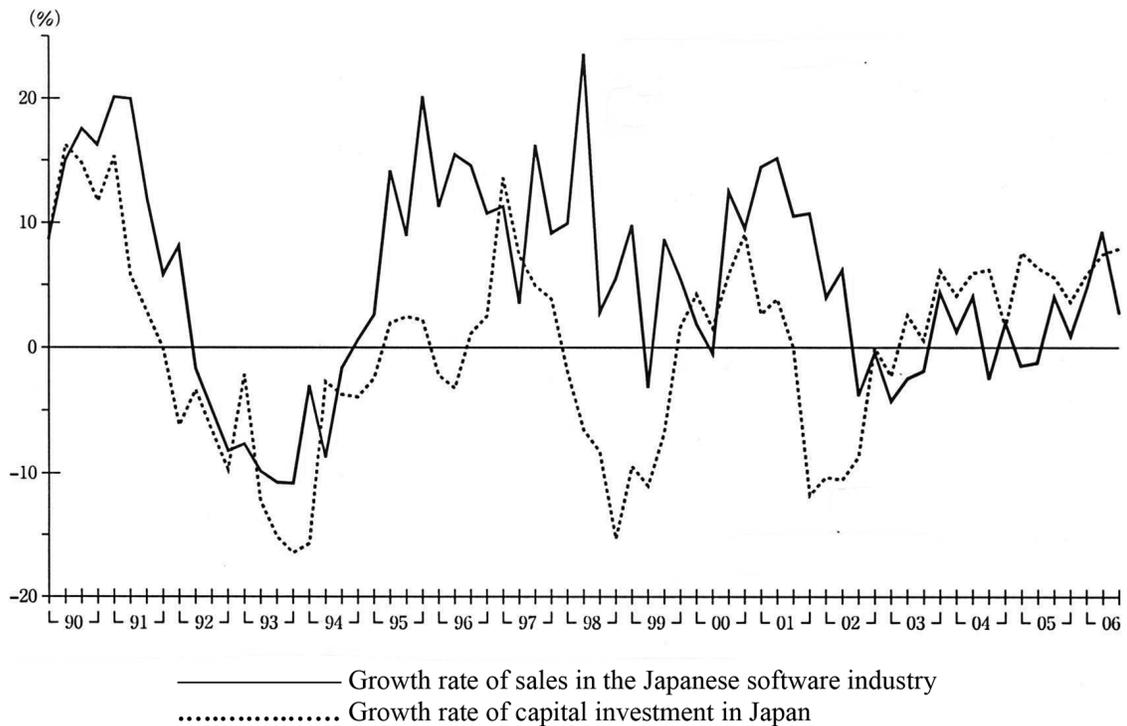


Figure 5. Growth rate of sales in the Japanese software industry (1990–2006).

Note: Growth rate is year over year.

Source: Murakami (2007).

and testing understand where and how the software is to be used. Second, Japanese firms can now explain design matters more easily to Chinese firms. Third, there is an improved understanding of design changes and reduced discrepancies in the level of quality between Japanese and Chinese firms.

## 6.2 Cost Reduction

The business environment of the Japanese software industry worsened at the end of the 1990s, promoting changes in the method of offshore development.

As Figure 5 shows, the growth rate of the Japanese software industry decreased at the end of the 1990s. To make matters worse, the unit price of software development in the Japanese market continued to decline during the 2000s.<sup>18</sup> In response, Japanese firms are looking for a new business model to maintain profits.

Japanese firms intended to reduce their development costs by entrusting design to Chinese firms. Our interviews show that the Japanese IT vendor that entrusted internal design to Firm A succeeded in reducing software development costs. The interviewee maintained that the personnel cost of the Chinese engineers who conducted the internal design of the same quality over the same period as the Japanese engineers was one-third that of their Japanese counterparts. Similarly, the Japanese IT vendor that entrusted design to Firm B achieved a cost reduction by entrusting external design to Chinese personnel.<sup>19</sup>

To summarize, quality and cost problems encountered by outsourcing firms in Japan led to changes in the division of work. In turn, these changes brought about additional technology transfers to

18. According to authors' calculation based on Bank of Japan Time-Series Data, the unit price of software development in Japan declined by 9.1% from April 2000 to April 2010.

19. This description is based on our interviews with the Japanese firms.

China. Therefore, we arrive at the following proposition:

*Proposition 3:* Outsourcers' problems, which include the need for quality control and the deterioration in the domestic business environment, result in changes to the division of work between outsourcers and suppliers. This change in the division of work leads to additional technology transfers.

## 7. Social Capital Dimensions of Technology Transfer

This section analyzes the previously described technology transfer from the viewpoint of social capital. As Inkpen and Tsang (2005) argue, concerted social interactions among organizational actors facilitate knowledge transfer. In other words, intensive exchange and trust encourage technology transfer. In addition, Sabherwal (2008) showed that social capital and intellectual capital affect the dynamics of management of outsourced information system development projects in India. Prashantham and Dhanaraj (2010) show that entrepreneurial Indian software firms that exploit the network learning opportunities presented by social capital achieve greater international growth. Therefore, we consider how Japanese and Chinese firms created a similar relationship. Using the framework developed by Nahapiet and Ghoshal (1998), we explore the development of this relationship across three social capital dimensions: structural, cognitive, and relational.

The *structural dimension* of social capital represents the pattern of relationships among actors. This dimension involves network ties and network configuration. *Network ties* explain actor relationships and describe a fundamental aspect of social capital. *Network configuration* is the pattern of linkages among network members, representing hierarchy, density, and connectivity.

The *cognitive dimension* of social capital involves the resources for shared meaning and understanding among members. This dimension has two facets: shared goals and shared culture. The *relational dimension* of social capital refers to assets created and leveraged through relationships. Among the facets of this dimension, which include trust, norms, and identification, trust is a critical factor affecting inter-firm knowledge creation and transfer (Inkpen & Tsang, 2005).

### 7.1 Structural Dimension

#### Network Ties

Through offshore development, Japanese and Chinese engineers developed enduring interpersonal relationships. As described in section 4, Japanese firms began to entrust coding and unit tests to their Chinese partners in the early 1990s, and then gradually expanded the range of responsibilities entrusted to the Chinese engineers, thus transferring skills and business knowledge. During this time, Japanese and Chinese engineers maintained close contact with one another. In addition, they often worked together at Japanese firms' offices for several months when developing software. This collaboration facilitated the development of network ties between them.

#### Network Configuration

The relationship between Japanese and Chinese firms was that of principal contractors to subcontractors. Japanese firms wanted Chinese firms to develop high-quality software; therefore, Japanese firms transferred skills and knowledge. At the same time, Chinese firms eagerly absorbed these skills and knowledge, aiming to improve their own skills. This hierarchical relationship evolved into a close connection between the engineers of the two countries.

During the process of offshore software development, other Japanese firms entrusted only coding and unit tests to Chinese firms. Their main concern was that the technology transfer involved would assist Chinese firms in catching up and competing with them in those areas (Takahashi & Takahashi, 2008). On the other hand, the Japanese firms that outsourced design to Chinese Firms A, B, C, and D had few worries in this area. In the interviews, these Japanese firms stated that the skills and knowledge they transferred were obsolete, and that the transfer was the price of pursuing cost reductions. In addition, they stated that they would be able to develop new technologies to maintain their respective edges over Chinese firms.

### 7.2 Cognitive Dimension

#### Shared Goals

Entrusting the design duties to the Chinese encourages the formation of shared goals. As described in the previous section, Chinese engineers gained an understanding of the software properties by participating in the design process. This understanding

assisted Chinese and Japanese engineers in sharing goals related to the software under development. Furthermore, these engineers maintained close contact and visited one another regularly to discuss these shared goals.

### **Shared Culture**

Chinese engineers who worked with Japanese engineers learned the Japanese business culture, as well as relevant skills and knowledge. When these Chinese engineers first began working with Japanese engineers, they encountered a significant culture gap, and many arguments ensued. However, as they continued working together, Chinese engineers gradually came to understand the Japanese business culture. At the same time, Japanese engineers began to understand the Chinese way of thinking. As a result, both parties implemented their tasks more smoothly than before. In addition, training programs conducted by Chinese firms, as previously described, also contributed to their employees' understanding of Japanese business culture.

### **7.3 Relational Dimension**

#### **Trust**

Trust strengthened the ties between the Japanese and Chinese. Inkpen and Tsang note that "commercial transactions embedded in social ties instill into future exchanges expectations of trust and reciprocity. In turn, relationships based on trust and reciprocity are likely to promote the transfer of distinctive knowledge and resources" (2005, p. 159).

The ties between Japanese and Chinese engineers fostered trust in their mutually beneficial relationships. On the basis of these ties, Chinese engineers acquired skills and knowledge and gained experience. In turn, Japanese firms achieved cost reductions in their software development projects. As a result, Japanese firms transferred increasingly advanced technology, and Chinese engineers continued to gain knowledge from the process. This continuing exchange further strengthened their ties. A Japanese engineer we interviewed said, "Chinese engineers understand the Japanese business culture and their work meets our expectations. They are reliable. So we have continued working together and created a closer relationship."

To summarize, in these mutually beneficial relationships, outsourcers and suppliers foster trust through technology transfers. Developing trust con-

tributes to even more technology transfer. Therefore, we arrive at the following proposition:

*Proposition 4:* When the repeated technology transfers lead to mutually beneficial relationships and the development of trust between outsourcers and suppliers, the resultant relationships and trust promote still further technology transfers.

## **8. Concluding Remarks**

This article discussed technology transfer to Chinese firms from Japan through offshore software development. We investigated the process of technology transfer and the reasons for its implementation, then examined this process from the viewpoint of social capital. This case study analysis developed four propositions on technology transfer.

Our results revealed how technology transfer occurs. Engineers in supplier firms work with engineers in outsourcer firms, which allows the supplier firms to acquire new skills and business knowledge. The process of entrusting more difficult tasks to supplier firms necessitates the outsourcers' support in the form of training, instruction, and periodic product checks for quality. These practices result in technology transfers to suppliers, even when the outsourcers do not intentionally implement such transfers. Changes in the division of work lead to additional technology transfers. When repeated technology transfers lead to mutually beneficial relationships and the development of trust between outsourcers and suppliers, the relationships and the trust lead to even more technology transfers. These results indicate that offshore development brings substantial benefits to Japanese firms and enables significant technological progress in China's software industry.

Furthermore, the technology transferred through offshore development is employed in domestic software development in China. According to our interviews, the Chinese firms took advantage of the transferred skills for their own domestic projects. For instance, Firm A used these skills when developing a software system for subway management, while Firm D used them to develop the software to manage a tunnel. These cases show that acquired skills and knowledge allowed Chinese firms to catch up with firms from developed countries in certain areas of technology. We believe that technology transfer

## UNINTENDED TECHNOLOGY TRANSFER TO CHINESE SOFTWARE FIRMS FROM JAPAN

contributed significantly to the rapid development of the Chinese software industry.

Our research results indicate a possible development strategy for China. Li and Gao (2003) insisted that the best strategy for China's software industry was to sell software services to the domestic market. However, as we have shown, exports contributed significantly to the domestic market expansion. Therefore, we recommend that the Chinese software industry intensify the export of software services, and that the government support these exports.<sup>20</sup> Hence, China should adopt strategies that focus on both domestic supply and export of software services.

Some Indian engineers working in Australia experience poor working conditions, and their situation in the labor market is in flux and uncertain (Biao, 2006). Conversely, Chinese engineers who work for Chinese firms and conduct design for Japanese projects receive higher salaries compared to their

domestic colleagues who do not work with the Japanese firms. In addition, implementing designs gives engineers greater satisfaction than coding and unit testing do. An engineer in Firm C who conducted requirements definition and design said, "I may be able to make more money if I work for another company. However, I enjoy my work creating new products. That's why I work for this company." This statement suggests that Chinese engineers obtain a sense of fulfillment by participating in requirements definition and design. These effects on labor conditions require further exploration, which remains a task for future research. ■

### Acknowledgment

We appreciate the helpful comments and suggestions from Dr. David Fraser at the University of California, Berkeley and anonymous referees. Any remaining errors are our own.

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20. The Chinese government has already implemented a number of policies to promote the export of products from its software industry. The 10th five-year plan (2001–2005) included tax reductions, subsidies, low-interest bank loans, and other preferential treatment. The 11th five-year plan (2006–2010) contained further promotional policies.

## Appendix

Table A1. Chinese firms entrusted with design from Japan.

	Outline of Firm	Products	Chinese Firms Lack	Phases Entrusted by Japan	What the Chinese Absorbed from Japan
Firm A	<ul style="list-style-type: none"> <li>• Founded in 1991</li> <li>• 780 workers</li> <li>• Local Chinese firm</li> </ul>	System development, packaged software	<ul style="list-style-type: none"> <li>• Business knowledge,</li> <li>• Skills in external design</li> <li>• Quality control</li> </ul>	<ul style="list-style-type: none"> <li>• From internal design to system test</li> <li>• Joint implementation of external design with Japan</li> </ul>	<ul style="list-style-type: none"> <li>• Business knowledge</li> <li>• Design skills</li> <li>• Quality control</li> </ul>
Firm B	<ul style="list-style-type: none"> <li>• Founded in 1996</li> <li>• 1,300 workers</li> <li>• Joint venture between Japan and China</li> </ul>	System development, embedded software	<ul style="list-style-type: none"> <li>• Business knowledge</li> <li>• Project management skills</li> </ul>	<ul style="list-style-type: none"> <li>• From external design to system test</li> </ul>	<ul style="list-style-type: none"> <li>• Business knowledge</li> <li>• Design skills</li> <li>• Quality control</li> <li>• Corporate philosophy</li> </ul>
Firm C	<ul style="list-style-type: none"> <li>• Founded in 1991</li> <li>• 430 workers</li> <li>• Joint venture between Japan and China</li> </ul>	Software for numerical control devices	<ul style="list-style-type: none"> <li>• Quality control skills</li> <li>• Corporate management skills</li> </ul>	<ul style="list-style-type: none"> <li>• From external design to system test</li> </ul>	<ul style="list-style-type: none"> <li>• Business knowledge</li> <li>• Requirements definition skills</li> <li>• Design skills</li> <li>• Quality control</li> </ul>
Firm D	<ul style="list-style-type: none"> <li>• Founded in 2000</li> <li>• 2,642 workers</li> <li>• Local Chinese firm</li> </ul>	System development, embedded software	<ul style="list-style-type: none"> <li>• Business knowledge</li> <li>• Experience</li> </ul>	<ul style="list-style-type: none"> <li>• From internal design to system test</li> </ul>	<ul style="list-style-type: none"> <li>• Organization of development teams</li> <li>• Business knowledge</li> <li>• Design skills</li> </ul>

Note: Interview place and time for Firms A, C, and D: Shanghai, June 2007; for Firm B: Shenyang, February 2007.

## References

- Arora, A., & Athreye, S. (2002). The software industry and India's economic development. *Information Economics and Policy*, 14(2), 253–273.
- Bianchi, P., Carnoy, M., & Castells, M. (1988). *Economic modernization and technology transfer in the People's Republic of China*. Stanford, CA: Stanford University, School of Education, CERAS.
- Biao, X. (2006). *Global "body shopping": An Indian labor system in the information technology industry*. Princeton, NJ: Princeton University Press.
- China Software Industry Development Research Report Editing Committee. (2005). *China software industry development research report*. [In Chinese]. Beijing, China: CSIDRREC.
- Correa, C. M. (1996). Strategies for software exports from developing countries. *World Development*, 24(1), 171–182.
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532–550.
- Eltschinger, C. (2007). *Source code China: The new global hub of IT outsourcing*. Hoboken, NJ: John Wiley & Sons.
- Farrell, D., & Grant, A. J. (2006). China's looming talent shortage. In D. Farrell (Ed.), *Offshoring: Understanding the emerging global labor market*. Cambridge, MA: Harvard University Press.
- Gregory, N., Nollen, S. D., & Tenev, S. (2009). *New industries from new places: The emergence of the hardware and software industries in China and India*. Washington, DC: World Bank.
- Heeks, R. (1999). *Software strategies in developing countries*. (Development Informatics Working Paper Series, 6). Manchester, UK: University of Manchester, Institute for Development Policy and Management.
- Heeks, R., & Nicholson, B. (2002). *Software export success factors and strategies in developing and transitional economies*. (Development Informatics Working Paper Series, 12). Manchester, UK: University of Manchester, Institute for Development Policy and Management.
- Huang, Y. (2011). Understanding the software industry in China: Export performance and regional development. *Journal of Emerging Knowledge on Emerging Markets*, 3, 289–307.
- Inkpen, A., & Tsang, E. (2005). Social capital networks and knowledge transfer. *Academy of Management Review*, 30(1), 146–165.
- International Development Research Centre (IDRC). (1997). *A decade of reform: Science and technology policy in China*. Ottawa, ON: Canada: IDRC.
- Ju, D. (2001). China's budding software industry. *IEEE Software*, 18(3), 92–95.
- Jui, S.-L. (2010). *Innovation in China: The Chinese software industry*. London, UK: Routledge.
- Kitajima, H., & Ban, J. (2006). Current status and enterprise strategy of Chinese offshore outsourcing: International labor division of software development. [In Japanese]. *The Annual Bulletin of the Institute of Policy and Cultural Studies, Chuo University*, 9, 163–181.
- Krishna, S., Sahay, S., & Walsham, G. (2004). Managing cross-cultural issues in global software outsourcing. *Communications of the ACM*, 47(4), 62–66.
- Lan, P. (1996). *Technology transfer to China through foreign direct investment*. Aldershot, UK: Avebury.
- Li, M., & Gao, M. (2003). Strategies for developing China's software industry. *Information Technologies & International Development*, 1(1), 61–73.
- Li, M., Lin, Z., & Xia, M. (2004). Leveraging the open source software movement for development of China's software industry. *Information Technologies & International Development*, 2(2), 45–63.
- Liu, S. (2008). Technology spillover effects by undertaking international software outsourcing in China. [In Chinese]. *Economic Research Journal*, 43(5), 105–115.
- McManus, J., Li, M., & Moitra, D. (2007). *China and India: Opportunities and threats for the global software industry*. Oxford, UK: Chandos Publishing.

- Ministry of Commerce of the People's Republic of China. (2011). *China software export development report 2011*. Beijing, China: Ministry of Commerce.
- Ministry of Internal Affairs and Communications. (2007). *Research report of the progress of offshoring and its influence*. [In Japanese]. Tokyo, Japan: Ministry of Internal Affairs and Communications.
- Murakami, Y. (2007). New development of small software firms. [In Japanese]. *National Life Finance Cooperation Research Quarterly*, 80, 1–17.
- Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, 23, 242–266.
- National Bureau of Statistics of the People's Republic of China. (2010). *China statistical yearbook 2010*. [In Chinese]. Beijing, China: China Statistics Press.
- Nicholson, B., & Sahay, S. (2004). Embedded knowledge and offshore software development. *Information and Organization*, 14, 329–365.
- Niosi, J., & Tschang, F. T. (2009). The strategies of Chinese and Indian software multinationals: Implications for internationalization theory. *Industrial and Corporate Change*, 18(2), 269–294.
- Pei, C., & Jing, L. (2006). Japanese enterprises' investment in China's software industry. *China & World Economy*, 14(4), 93–104.
- Prashantham, S., & Dhanaraj, C. (2010). The dynamic influence of social capital on the international growth of new ventures. *Journal of Management Studies*, 47(6), 967–994.
- Rivard, S., & Aubert, B. A. (Eds.). (2008). *Information technology outsourcing*. Armonk, M. E. Sharpe.
- Sabherwal, R. (2008). Management of outsourced IS development project: The role of social capital and intellectual capital. In S. Rivard & B. A. Aubert (Eds.), *Information technology outsourcing*. Armonk, NY: M. E. Sharpe.
- Sahay, S., Nicholson, B., & Krishna, S. (2003). *Global IT outsourcing: Software development across borders*. Cambridge, UK: Cambridge University Press.
- Saxenian, A. (2003). *Government and guanxi: The Chinese software industry in transition*. (DRC Working Papers, 19). London, UK: Centre for New and Emerging Markets, London Business School.
- Saxenian, A. (2006). *The new argonauts: Regional advantage in a global economy*. Cambridge, MA: Harvard University Press.
- Steinmueller, W. E. (2001). ICTs and the possibilities for leapfrogging by developing countries. *International Labour Review*, 140(2), 193–210.
- Suttmeier, R. P., & Xiangkui, Y. (2004, May). *China's post-WTO technology policy: Standards, software, and the changing nature of technological nationalism*. (NBR Special Report no. 7). Seattle, WA: National Bureau of Asian Research.
- Takahashi, N., & Takahashi, M. (2008). Offshore software development from Japan to China and its effect on Japanese software firms. *The Business Review, Cambridge*, 11(2), 120–125.
- Tschang, T., & Xue, L. (2003, January 15). *The Chinese software industry: A strategy of creating products for the domestic market*. (ADB Institute Working Paper). Tokyo, Japan: Asian Development Bank Institute.
- Tschang, T., & Xue, L. (2005). The Chinese software industry. In A. Arora & A. Gambardella (Eds.), *From underdogs to tigers: The rise and growth of the software industry in Brazil, China, India, Ireland, and Israel*. New York, NY: Oxford University Press.
- Walsham, G. (2001). *Making a world of difference: IT in a global context*. New York, NY: John Wiley & Sons.
- Wilson, E. J., & Segal, A. (2005). Trends in China's transition toward a knowledge economy. *Asian Survey*, 45(6), 886–906.
- Wong, J., & Wong, C. K. (2004). China's software industry: Moving on the fast track. *Journal of Chinese Economic and Business Studies*, 2(1), 73–95.
- Wu, Q., & Miyazaki, K. (2006). Sectoral system of innovation in China—the case of software sector. *International Journal of Knowledge and Systems Science*, 3(2), 52–60.

## UNINTENDED TECHNOLOGY TRANSFER TO CHINESE SOFTWARE FIRMS FROM JAPAN

- Yang, D. (2011). The effect of knowledge management on product innovation—Evidence from the Chinese software outsourcing vendors. *iBusiness*, 3, 16–22.
- Yang, D., Ghauri, P., & Sonmez, M. (2005). Competitive analysis of the software industry in China. *International Journal of Technology Management*, 29(1/2), 64–91.
- Yin, R. K. (2003). *Case study research: Design and methods* (2nd ed.). London, UK: SAGE Publications.
- Zhang, Q.-G. (1999). *How to make Chinese Microsoft*. [In Chinese]. Beijing, China: Beijing Dang Dai Publisher.
- Zhang, X. Q., Fu, Z. T., & Liu, X. (2001). Factor analysis of preventing Chinese software industry from developing. [In Chinese]. *Chinese Tertiary Industry*, 6, 20–23.