Production and R&D Networks of Foreign Ventures in China: Implications for Technological Dynamism and Regional Development

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Abstract

This paper analyzes the nature of FDI local networks in production and R&D activities in China and discusses their implications for technological dynamism and regional development. We investigate foreign ventures (or foreign-invested enterprises, FIEs) in the information and communication technology (ICT) industry, based on a large-scale survey of ICT firms conducted in three mega-city regions of China: Beijing, Shanghai-Suzhou, and Shenzhen-Dongguan. Our data show that FIEs in China are gradually localizing their production, but the extent of local embeddedness is contingent upon home country effects, local specific contexts and FDI-host region relationships. We have also found significant influence of industrial agglomeration on FDI location and network decisions. Beijing tends to have broader FDI sources and better integrated global-local networks, while in those regions dominated by FDI such as Suzhou and Dongguan, FIEs are thinly embedded with local economies and tend to establish global-local networks among themselves; local embeddedness is limited by a series of technological, institutional, spatial, and structural mismatches. Shanghai and Shenzhen are in between. More efforts are still needed to better integrate FDI with local economies and strengthen China's local innovative capacities.

Keywords: Foreign Investment, Production Networks, Embeddedness, Regional Development, China

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Introduction

Theories of hyper-globalization have been criticized for exaggerating the importance of labor costs in production and underestimating the complex process of foreign direct investment (FDI) decisions and the role of regions and institutions in global restructuring (Sayer 2004). While FDI has been a driving force of globalization, it has concentrated primarily in selected developing countries and globalizing city regions. For many geographers, the global economy is not a singular world economic system, but a regional world of production contested by localization, regionalization, and reterritorilization (Storper 1997). They highlight the localization of the global and the geographical embeddedness of multinational enterprises (MNEs). However, much of the debate is at the abstract level without concrete empirical evidence. The operation, strength and scope of FDI need to be scrutinized to better understand the nature of global-local networks, the extent of FDI local embeddedness and the effects of FDI on regional development.

As the largest recipient of FDI in the developing world, China provides a great opportunity for a nuanced analysis of the network structure of MNEs (including their subsidiaries), which are typically called foreign-invested enterprises (FIEs) in China or simply foreign ventures. Based on a large-scale survey of ICT firms conducted in three mega-city regions of China: Beijing, Shanghai-Suzhou, and Shenzhen-Dongguan, this paper examines network configurations of foreign ventures in the context of China's economic transition and marked regional differences, and discusses their impacts on technological progress and regional development. The particularly significant networks influencing regional development to be investigated are production (backward or supply, and forward or marketing/distribution) and R&D or innovation linkages (Young et al. 1994). While the focus of the paper is on FIEs-local networks, we will also study the location choice of FDI, which influences the structure of global-

local networks. We focus on the ICT industry because it is China's most globalized and dynamic industry. We follow the World Bank's definition of the ICT industry (2003) as consisting of hardware, software, networks, and media for collection, storage, processing, transmission, and presentation of information (voice, data, text, images).

Specifically, we ask the following research questions: What factors are of importance to FDI network and location decisions in Chinese cities? How locally embed are FIEs in terms of production and R&D activities? What are the implications of FDI networks on technological progress and regional development? We argue that FIEs in China are gradually localizing their production, but the extent of localization is contingent upon home country effects, local specific contexts, and host-MNE bargaining relationships. In certain locations MNEs tend to establish local networks among themselves, not necessarily with indigenous Chinese firms. Such local agglomeration has become increasingly important in the selection of FDI location and network formation. We highlight substantial regional differences in FDI networks and impacts on development. We believe that government policies are still needed to better integrate FDI with local economies, and strengthen China's local innovative capacities.

Theoretical and Contextual Issues

The institutional turn in economic geography has firmly placed institutions and networks as core factors in firm location and business organization (Phelps and Raines 2003). New geographic economics, as represented by Krugman, have also attempted to address the effects of institutions, agglomeration, and networks in FDI decisions and regional development (Boudier-Bensebaa 2005). A key concept is embeddedness, which has different directions (e.g., horizontal and vertical), types (e.g., social, cultural, structural, technological and political), and dimensions (societal, network, and territorial) (e.g., Hess 2004). We consider FDI local embeddedness as a

concept closely linked to FDI local networks, which can be described as the nature, depth and the extent of a foreign venture's ties into the local environment. Our focus is on economic geographic activities and FDI production and R&D networks.

FDI Production Networks and Local Embeddedness

While many scholars hold that geography matters in firm behaviors and business organization, they debate over the nature of the global-local network and the role of regions in the global economy. The New Regionalism literature highlights the significance of agglomeration and territory as sources of technological progress and regional development (e.g., Storper 1997; Cooke and Morgan 1998), which, however, has been criticized for over emphasizing local assets and contexts while ignoring the impacts of globalization, nation states and large firms (e.g., MacLeod 2001). There is a powerful voice in geography arguing for globalizing regional development (Coe et al. 2004), including the global production network (GPN) perspective. They point to the importance of external agents and relations in creating global-local networks and enhancing regional development (Bathelt, et al, 2004). The GPN perspective, however, has limitations as well, since it is largely based on the experiences of the most globalized countries/regions and sectors and tends to over emphasize global or extraregional processes in shaping regional development (Wei 2010).

We argue that neither the new regionalism nor the GPN perspectives are sufficient to interpret the nature of FDI networks and their effect on regional development in the Chinese context. We develop an integrated framework to bridge the regionalism and globalism perspectives for a better understanding of FDI decisions and networks. Our analytical framework maintains that the nature of global-local networks and the level of local embeddedness are

contingent upon three core factors; local context, FDI home country effects, and host-MNE relationship (Figure 1).

(Figure 1 about here)

The economic geography literature has firmly established that local context plays an important role in influencing firm behaviors and corporate geography (Dicken 2003; Gatrell et al. 2009; Storper 2009). The drives for localization have to do with the labor market conditions, the supply networks, local innovative capacity, and spatial organizations. To adapt to local institutions and labor market practices, MNEs may seek localization through the hiring of local people for key marketing and management positions. Cost reduction and agglomeration effects also influence FDI location decisions; the concentration of FIEs in regions such as the Yangtze River Delta (YRD) of China has made this region capable of providing high quality production components and parts, although many are made by FIEs located there (Wei et al. 2009). On the other hand, developing countries are engaged in competition for global capital through establishing FDI, export or development zones, which tend to be spatially segregated with domestic industrial zones (Grant and Nijman 2002; Wei et al. 2010), creating spatial mismatch between foreign and domestic firms. Local institutions' positions at the administrative hierarchy also influence their capacities to obtain top-down preferential policies and bargain with foreign investors.

Recent work has renewed scholarly interests in the role of home country effects on MNE behavior and knowledge transfer (Dicken 2003; Depner and Bathelt 2005; Lam 2007). In response to the claims that MNEs are placeless global corporations, Dicken (2003) argued that place and geography still matter fundamentally in firms behaviors, and that MNEs remain strongly enmeshed in their home country environments, or ownership-specific advantages

(Dunning 1993). FDI home countries tend to be technologically more advanced, and their technological advantages and structural characteristics are the basis for the formation of technological and structural mismatches between foreign and domestic firms. MNEs based in the United States with a more flexible and disintegrated business system tend to be better integrated with host economies, while MNEs based in Japan, South Korea and Taiwan have more vertically integrated global-local networks and more centralized corporate control, and tend to be slower in localization (e.g., Lam 2007). Taiwan firms have used relational guanxi assets, coupling with local states, and just-in-time logistics for their investment in China, leading to the formation of local/regional production networks and clusters, while Hong Kong investors tend to be more "merchants" and more embedded with the Chinese economy (Yang 2007; Yang and Hsia 2007).

Local context and home country effects serve as the basis for the nature of host-MNE relationships, which also influences network formation and local embeddedness (Yeung and Li 2002). The local state is a key component of both local context and host-MNE bargaining relationships, and is critical to institutional embeddedness. The state has increasingly recognized the significance of embedding MNEs and improving endogenous innovation capacities in economic development. To increase the multiplier and spillover effect of FDI, the state uses such policies as the development of infrastructure and supplies as usual measures. The ability of local states in bargaining and interacting with MNEs is crucial in shaping the structural or network characteristics of FDI (Kaminski and Smarzynska 2001). Given the state ownership of land and the potential in domestic markets, the Chinese state overall maintains strong bargaining power with MNEs, especially in key sectors such as automobile and production facilities requiring large land spaces (Sit and Liu 2000; Yeung and Li 2000). However, such bargaining power diminishes at the local level. Local states are more likely to engage in regional wars to lure foreign

investment and typically are not in any position to force localization of MNEs (Wei et al. 2008). Even the central governments are reluctant to place local content requirements, given global wars for capital and the drive to create pro-business environments. Despite the powerful interference of the Chinese state, MNEs localization decisions also take into account their strategic considerations, local supplies, and market conditions.

Substantial regional differences exist in China in FDI basic profiles, localization, and R&D capacities. Scholars have found Beijing's advantage in corporation control functions and its local governance structure supportive of high-tech enterprises (Segal 2003, Zhou 2005, 2008). Local governments in Sunan (southern Jiangsu) including Suzhou tend to be more actively involved in economic development through local policy initiatives to shape the trajectories of regional development (Wei et al. 2009). Yet the research so far has rarely examined the differences in terms of FDI's local networks in different city regions.

This paper will investigate network configurations and local embeddedness of FIEs in China. Given that Suzhou and Dongguan's production is mainly for export, we hypothesize those regions have weak localization levels and that their local states' role in localization is limited due to the relative low position of these locals on Chinese administrative hierarchy. In contrast, the national level municipalities of Beijing and Shanghai and to a lesser extent Shenzhen, have more capacities for MNE localization and network development. We also expect the significant influence of local agglomeration on location decisions and network formation in China.

Effects of FDI on Regional Development and Technological Progress

Scholars also debate the effect of FDI networks on regional/local development. While some see local embeddedness and positive effects (e.g., Moran 200), others argue that developing

countries benefit little from production networks and knowledge transfer (e.g., Xu 2000). The relationship between foreign plants and domestic suppliers could be mutually beneficial when MNEs' competitiveness relies heavily on local suppliers (Moran 2001). Embeddedness and spillover effects in China are evidenced by the strong ability of local firms to drive the global-local networks in Qingdao (Kim and Zhang 2008), and the local content requirement and embeddedness in the automobile industry (Sit and Liu 1998), as exemplified by the development of Volkswagen's supply networks in Shanghai (Depner and Bathelt 2005).

However, in many developing countries global-local networks are thin and dependent on MNEs, especially when the industry is export driven, as evidenced by the Cathedrals-in-the-Desert phenomenon or satellite industrial platform in Central and Eastern Europe (e.g., Grabher 1994, Hardy 1998), the weak integration of local firms with MNEs' production networks existing widely in Latin America (e.g., Lowe and Kenney 1999), and the dominance of quiescent or branch plant-like subsidiaries, rather than developmental firms, in the Asia Pacific (Poon and Thompson 2003). The local effect may be limited and confined to internal network of FDI in the absence of necessary indigenous support capability (Leahy and Pavelin 2003). MNEs tend to network among themselves, forming global-local networks of MNEs (Jensen 2004). Integration with GPNs rarely exists, and the effects of MNEs on local economies are limited, mostly in the form of job opportunities, and to a lesser extent, tax contribution.

Scholars have also hotly debated the role of MNE networks in technological dynamism in developing countries. Similarly, while New Regionalism emphasizes local networks and structures, others argue for the role of extra-local connections and global production networks (Mackinnon et al. 2002; Coe et al. 2004). We maintain that the effectiveness of FDI on technological progress in developing countries also relies on local context, home country effects,

and global-local interactions. Their innovation activities primarily take place through enterprises learning to master, adapt and improve technologies that already exist in more advanced countries (UNCTAD 2007). The capacity of regions to support innovation and interaction with global capital is a key source of technological change. Moreover, great heterogeneity and different models of innovation systems exist among developing countries (Mani and Romijn, 2003), and among different regions in the same country, as evidenced by China's extraordinary diversity and local innovation systems (Miao et al. 2007). In terms of home country effect, scholars have reported that Japanese subsidiaries tend not to source locally and do not transfer much technology to local firms (e.g., Narayanan and Wah 2000)

Given the heterogeneity of local embeddedness of MNE behaviors, studies have documented both positive and negative aspects of global-local interactions on technological dynamism. Some argue that strong participation of MNEs in global-local networks tend to generate better results in innovation and technological progress (Moran 2001), such as the case of Bangalore, India with active participation of MNEs, in comparison with Bandung, Indonesia focusing on domestic actors and markets (Fromhold-Eisebith 2002). Export-led growth was also seen as integral to the success of East Asia NICs (Hobday 2000). Zhou and Tong (2003) argue that the success of the Zhongguancun Science Park in Beijing, considered China's Silicon Valley, relies on the interdependence between MNEs and local firms. The reliance of external technology does not necessarily diminish the importance of local networks and institutions in promoting technology change. So both the internal capacity and the interaction with MNEs are essential to fruitful innovation and technological progress.

However, there have been persistent questions on the role of MNEs in technological

progress since MNEs tend to spread low-end production to developing countries, while maintain basic research and highly innovative activities at home. It is well documented that MNEs strive to maintain technological advantages and are not willing to transfer core-technology to developing countries (Gertler 2003). The dependence of developing countries is on imported technology and foreign affiliates, which greatly diminishes their innovation activities and technological progress (Lowe and Kenney 1999). FIEs in China tend to engage in product and process developments for the Chinese market, while little improvement can be observed in basic R&D, and the effect of China's approach of market for technology is being questioned (Lemoine and Unal-Kesenci 2004, Sun 2002; Wei et al. 2009).

In this paper, we argue that the role of MNEs in technological progress in China is contingent upon the local R&D capacity, FDI home country effects, and the MNEs-host relationship (Figure 1). The capacity has to do with human resources, but also with the bargaining and strategic position of the region in relation to MNEs. Given weak indigenous production capacities in Suzhou and Dongguan, we expect weak linkages between FIEs and local firms in R&D activities and limited effect of FIEs on technological progress, while global-local linkages in national-level metropolitans of Beijing, Shanghai and Shenzhen might be stronger and more beneficial to their local economies.

Research Setting and Methodology

This research studies five core cities in the three globalizing city regions of China: Beijing and Shanghai-Suzhou of the YRD, and Shenzhen-Dongguan of the PRD (Figure 2). Beijing is China's national capital and center for research institutions and high-tech industry. The city has unparalleled advantages in government and human resources hosting the largest number of

premier universities and research institutes in China, which serve as the foundations for Zhongguancun (Zhou 2008). Beijing and Shanghai have been making aggressive efforts to transform themselves towards global cities. However, Beijing faces a shortage of water resources, has a much less developed manufacturing base, and is reputed to be bureaucratic.

(Figure 2 about here)

The PRD has a tradition of global trade and industrial development. Its institutional and locational advantages (one-step ahead in opening up and proximity to Hong Kong and Taiwan) have made it a major center of FDI, trade, and manufacturing. Since the mid-1990s, the region has diversified its FDI, which was originally dominated by Hong Kong's small-scale and labor-intensive manufacturing investment. The region, Shenzhen in particular, has been restructuring its development path from export processing towards the development of innovation and R&D capacity (Lu and Wei 2007; Wang and Lin 2008). Dongguan was a relatively less developed county in the PRD, and its development has been externally driven by overseas Chinese investment. Its rapidly growing ICT sector is characterized by labor-intensive assembly operations, mostly for export, and has the least access to China's domestic market.

The YRD has been China's traditional economic center, with Shanghai and southern Jiangsu and north Zhejiang provinces as the core. Shanghai has intensified its globalization efforts, aiming to become an engine of growth and a prosperous global city by shifting its focus from state-owned enterprises (SOEs) to capital and technology-intensive projects. The city is the largest economic center of China and hosts some of China's most technically advanced companies. Suzhou is an ancient city of China and during Mao's era, limited rural industries were established, which blossomed in southern Jiangsu (Sunan), known as the Sunan model of development. However, with intensifying competition and shrinking profits, township and village enterprises (TVEs) have been largely privatized, and globalizing Suzhou has become a

major pathway to industrialization and regional development, spearheaded by the China-Singapore Suzhou Industrial Park (Wei et al. 2009). Suzhou has quickly emerged as a major destination of FDI and a hot manufacturing center, especially as a hub of ICT industry, such as notebook computers and semiconductor manufacturing.

Besides official statistics and our years of experience with the study sites, the main data source is a large-scale survey of ICT firms conducted in 2006–2007 in these five cities. Our survey was conducted by a professional, national survey company affiliated with China National Bureau of Statistics (NBS). The ICTs surveyed were separated into hardware manufacturing including manufacturing of computer/communication equipment, semiconductors, electronic parts manufacturing and software. Our sample size was pre-determined with the target of representing 5% of the sample frame--the database from the 2004 economic census, which has a relatively complete list of the ICT firms. We also proportioned the sample size based on sector and regional information provided by the NBS's database. The survey followed a standard procedure, and was conducted through a mix of phone calls and on-site visits. The surveyors contacted senior executives, and each questionnaire usually took 1.5 hours to complete. 95% of those surveyed were contacted once again to verify the procedure, and our team members accompanied the surveyors on site to ensure quality. Altogether, 1,023 companies were surveyed, including 633 hardware companies that will be examined. The estimated response rates are between 10%-15%, which are in line with other studies in developing countries. Our statistical testing shows there were no significant statistical differences between the samples and the database in terms of foreign and domestic firms, except for slight oversampling of domestic firms in Shenzhen.

In 2006-2009, the research team conducted follow-up interviews with local government officials and selected surveyed companies that expressed willingness for interviews. The interviews, usually lasting one and a half to two hours, explored firms' development history, decision making process, organizational structure, performances, and network relations et al. Those interviews were helpful to understand firm decisions and networks, and answer our research questions, such as identifying weak local embeddedness. These data provide valuable information for our study of FIEs location decisions and network configurations in China.

FDI Characteristics and Regional Differences

We first present overall characteristics of FDI in the ICT industry in the study cities (Table 1). We find substantial regional difference among the surveyed FIEs in the five cities, indicating persistent regional divergence even among China's most developed regions. We first examine year of establishment, and find that, compared to Shanghai and Suzhou, Beijing and Shenzhen-Dongguan have more companies existing today that can be traced back to the 1980s. Shanghai and Suzhou clearly lag behind, indicating the early start of the ICT sector in Beijing and the earlier opening up of the PRD. Firms in Shanghai and Suzhou are much newer; Suzhou only had one FIE established before 1992. The ICT sector's growth started in the early 1990s with the deepening reform and accelerated in the late 1990s, especially for hardware manufacturing in the Yangtze River Delta.

(Table 1 about here)

In terms of ownership, during the early years of reforms, joint ventures (JVs) were the dominant form of FDI when wholly foreign-owned enterprises (WFOEs) were not permitted. With the release of investment control and the maturation of the investment environment,

WFOEs have become the dominant form of FDI. Most of the surveyed FIEs are WFOEs, especially Suzhou and Dongguan, while in Beijing, our sample has more JVs than WFOEs. Many of the JVs are headquartered in Beijing. The ownership patterns show the foreign dominance of FIEs in Suzhou and Dongguan, and to a lesser extent, Shenzhen and Shanghai, but in Beijing, many of the FIEs are JVs in which the Chinese parterners excert great influences.

The home countries of FIEs also differ among regions. Beijing has a diverse source of FIEs and half of the FIEs have headquarters there, although Shenzhen and Shanghai also host sizable FIEs headquarters. Shanghai has the strongest and most diverse presence of foreign affiliated firms and is favored by investment from the United States. The concentration of FIE headquarters in Beijing and Shanghai suggests that economic decision making in China is still highly centralized in the largest metropolitan areas. In the 1980s, Taiwanese investment was small but has become a major source of FDI in Suzhou since the mid-1990s (and in Dongguan as well), followed by Hong Kong, the United States, Japan, Singapore, Germany, the United Kingdom, and South Korea. We found that Suzhou is dominated by Asian capital, particularly from Taiwan (66.7%), followed by Japan (12.2%), making Suzhou a hub for Taiwanese ICT investment; none of the surveyed FIEs however have their headquarters located in Suzhou. While Japanese and Korean investments favor YRD, Hong Kong investment still heavily concentrated in the PRD. American and European investments spread among all three regions, though they slightly favor Shanghai.

With regard to sector composition, we can also find regional differentials. The national-level metropolitan locations (Beijing, Shanghai) are stronger in semiconductors and computer/communication equipment manufacturing than in electronic parts, which dominate Shenzhen, Dongguan and Suzhou. Beijing specializes in telecommunication equipment and IC

manufacturing, and Shanghai's major sectors are electronic parts and components, semiconductor wafers, IC manufacturing and telecommunication equipment. Suzhou, Shenzhen and Dongguan are more heavily involved in electronic parts and components, and computer equipment, which reflects the presence of FIEs based in Taiwan and Hong Kong. Moreover, Shanghai and Suzhou have more firms engaged in capital-intensive semiconductor manufacturing than do other places.

FIEs tend to be larger than domestic firms. Over half of the surveyed firms in Beijing and Shanghai had investment over US$25 million (58.8% and 56% respectively) (Table 1); they tend to be larger than firms in Suzhou, Shenzhen and Dongguan. In Suzhou and Shenzhen, a substantial proportion of the FIEs had investments between US$1-5 million, but a number of the FIEs had an investment size over US$25 million, which implies a bi-polar size distribution of FIEs. The evidence of the labor extensive nature of FIEs can also be identified, with half the firms having an employment of more than 500. Employment size in Beijing tends to be smaller, while Suzhou and Dongguan, dominated by manufacturing, tend to have more employment.

The surveyed firms in general were profitable during the study period and showed an ascending trend from 2004 to 2006, during which the proportion of loss-making FIEs decreased and profit margin increased; the proportion of loss-making FIEs in Suzhou decreased from 6.5% to 2.8% and that of FIEs with profit margin higher than 5% increased from 32.7% to 65.7%. It is also noticeable that a higher percentage of FIEs in Beijing and Shanghai enjoyed high profit margins. Beijing also has a larger share of FIEs with loss, implying the risk associated with the R&D orientation of FIEs in Beijing. Shenzhen and Dongguan's firms have similar profit margin distributions. Suzhou's firms tend to be less profitable, but fewer firms showed loss. Those indicators reveal the FIEs were general healthy, and their performance was improving during

2004-2006, the peak before the current financial crisis.

We have further analyzed characteristics of foreign and Chinese parent firms of surveyed FIEs (Table 2). An overwhelming percentages of FIEs have only one foreign parent firm. The main exception is Suzhou, which in avage had 1.3 foreign parent firms for each FIE. This reflects the dominance of Taiwanese firms in the city, and our interviews find that they tend to hold shares among each other, forming networked production relations, a phenomena studied by others as well (e.g., Yang 2007). Characteristics of primary foreign sources are quite similar to FIE headquarters. We find that major sources of JVs in Beijing are from Taiwan, Hong Kong and United States. Our interviews find that FIEs with capital from Taiwan and Hong Kong tend to seek political capital, technology, and mareting advantages in Beijing, while FIEs with capital from United States tend to be run by returnees. Beijing also has the highest average percentage of primary Chinese ownership (25%), followed by Shanghai (12.9) and Shenzhen (10.2%), considerablly smaller are Suzhou (3.7%) and Dongguan (2.9). Overall, foreign ownership in FIEs in Beijing does not have a dominant position, unlike the rest of the cities. FIEs in Suzhou and Dongguan are dominated by foreign ownership.

(Table 2 about here)

FIE Location Decisions and Intercity Competition

We also find significant differences in factors underlying FDI location decisions among the five cities (Table 3). Beijing and Shanghai share the importance of better local/regional market potential and better availability of skilled labor, reflecting their roles as central places of the Chinese market and their advantages in educated labor force. Shanghai enjoys better infrastructures, with greater proximity to major seaports/airports and locations of major

customers, while Beijing has advantages in better investment incentives and access to the central government. This is evidence of the formation of an ICT industrial cluster in the Yangtze River Delta, which has become an influential factor for the decisions of MNEs to invest in Suzhou.

(Table 3 about here)

Shenzhen and Dongguan share some common factors in FDI location, including better investment incentives, better infrastructures, better local/regional market potential, location of major customers, and agglomeration of similar enterprises. These findings indicate that while government incentives and conventional location factors remain important in location decisions, industrial agglomeration and closeness of major customers/supplies have also become important factors. Similar to Beijing and Shanghai, Shenzhen clearly has advantages in skilled labor and proximity to major seaports/airports. Dongguan, however, also attracts FDI because of its lower labor cost, better access to materials supplies, better government services and urban amenities (open spaces and cheaper housing et al.). We find the significant role played by labor and market access in the decision to invest in Suzhou, followed by infrastructure and investment incentives.

Compared with previous studies on location decisions of FDI in China, we find two major changes in terms of location decisions. First, while a number of studies have identified the dominant role of state policies in FDI location decisions (e.g., Wei et al. 2008; Wei et al. 2009), we find that the role of state policies in location decisions has become less significant for the ICT firms. This is because China's investment policies have gradually been standardized across coastal cities, and institutional reforms and learning have reduced policy gaps across cities. Moreover, FDI in the ICT sector tends to focus more on human resources and access to markets. Local governments we interviewed also stressed the fact that their respective cities no longer have the advantages in land and incentives, and they must improve access, infrastructure,

supporting industries and government services. Second, industrial clustering/agglomeration have emerged as an important factor in location decisions, besides the influence of conventional factors of labor and market access. Such clustering has also been identified by other studies on related cities (e.g., Zhao and Zhang 2007). This is evident from high scores in the items of location of major customers, agglomeration of similar enterprises, and better access of material suppliers, particularly for FIEs in the YRD and Pearl River Delta (PRD), especially in Suzhou and Dongguan, which enjoy their competitive advantages through the clustering of firms. The locational advantage allows firms in secondary cities of Suzhou and Dongguan to use advanced business services provided by Shanghai and Shenzhen respectively.

FDI Production Networks and Local Embeddedness

Production linkage is the key component of network configurations. We find that import remains significant in total purchase, especially for Shanghai, Suzhou and Dongguan, while Beijing and Shenzhen rely more on domestic production (Table 4). While the surveyed FIEs have broad supply bases, the majority of supply linkages was with FIEs and localized within respective metropolitan areas, which once again is evidence of clustering among FIEs and within globalizing city regions; FIEs play a significant role in outsourcing. For Suzhou, among domestic purchase (44.4% of total purchase), the surveyed FIEs purchased their core materials or components mainly from other FIEs (62.3%) (51.5% for key components); only 30.5% of the equipment purchase in the past three years was domestic. We find that the foreign parents of the surveyed FIEs often dominate purchasing decisions due to strategic and quality considerations.

(Table 4 about here)

We further examin the spatial clustering of production within a driving distance of two hours. The importance of local is obvious in Shenzhen and Suzhou. National centers like Beijing and Shanghai, however, have broader supply bases. Beijing, as the national administrative center with weak local production capacities, shows smaller shares of supplies and purchases from local sources, indicaitng that its purchases and marketing are more diversified nationally. Shanghai, as the largest economic center in China, also has a diversified supply base, although Shanghai is more heavily dominated by purchases from the YRD. More firms are involved in outsourcing in Suzhou and Dongguan, which indicates the sector focus of Suzhou and Dongguan is on electronic parts and components. The local clustering of production in the YRD and PRD is also well reflected in outsourcing, while Beijing once again has a broader geographcial scope of outsourcing. Regarding the suppliers, more firms in Suzhou and Dongguan are suppliers, and again the local clustering of supply networks in the YRD and PRD are obvious. We find that in general FIEs dominate the production of equipment and key components, while Chinese firms mainly provide peripheral parts and materials. As will be elaborated in a later section, the relatively weak localization tendency with indigenous firms is associated with the multiple dimensions of mismatches between FIEs and local firms.

Home country effects are also evident from the survey. We find that MNEs based in the United States and Europe have broader supply bases and more localized production than other countries. Based on our interviews over the years, we find that they also tend to use Chinese personnel more frequently in key management positions, sometimes even as general managers. Human development has become one of the major contributions of MNEs to the development of high-tech industry in China. Japanese firms have also been learning from those countries and have increased their localization efforts in recent years. Similar trends can be observed among

firms based in South Korea. While Taiwanese firms are more embedded with local institutions and networks given their cultural proximity to China, their suppliers tend to network among themselves and domestic firms in Suzhou have very few linkages with them. FIEs in Suzhou are therefore structurally less embedded in the existing purchasing networks of domestic firms.

Table 5 shows the prominence of export and the significance of the United States as the destination country among FIEs, while FIEs are also increasingly penetrating the Chinese market with their products. Dongguan is the most export-oriented (72%), while Beijing is the least (32.2%) of all five city-regions. The proportions for FIEs involved in export are even higher. In Dongguan over 80 percent of companies engage in export, and in the YRD and Shenzhen about 60 percent of companies do. In Suzhou, 40.7% of surveyed FIEs had export rates higher than 50%, while 71.4% of non-FIEs had export rates lower than 10%. The United States is the leading country of export, except for Beijing (partly due to small sample size). Europe is an important destination, especially for the PRD. Export tends to be directed by foreign investors. Nevertheless, the Chinese market has become increasingly important. Beijing is more domestic-oriented. Shanghai and Shenzhen also have more domestic sales, while Suzhou and Dongguan are heavily export-oriented, indicating the rising domestic market in the forward linkage of FIEs in China. Our interviews in 2008 and 2009 reveal the increasing efforts of FIEs to expand their Chinese markets when export faced a difficult global environment.

(Table 5 about here)

FIEs linkages include a variety of local and non-local service firms (Table 6). We find that FIEs in Suzhou, Shenzhen and Dongguan were more likely use external services than firms in Beijing. They were also more likely to use local firms. Suzhou and Dongguan tend to use FIEs, many non-locals, more frequently. The PRD was also more likely to use consulting firms.

We find that more FIEs in cities of large size and national significance are involved in business associations. For Suzhou and the PRD, the most important associations were associations for Taiwanese businesses or investors, which is another evidence of the networking and clustering of Taiwanese firms in these regions. Smaller cities like Suzhou and Dongguan. These cities also rely on the primary cities, Shanghai and Shenzhen respectively, in their respective regions for business services, since their local markets are fragmented and local firms tend to be small.

(Table 6 about here)

Our survey shows that the role of imports in production had little change over the years, and FIEs did experience some significant increase in domestic purchase form domestic firms (Table 7). We notice some firms reported a significant increase in purchase from domestic firms and significant decline from FIEs. Outsourcing activities of FIEs also experienced some significant increase, and most of the outsourcing was once again with firms in their respective local areas.

(Table 7 about here)

To summarize, Beijing, Shanghai and Shenzhen, as top national metropolitan areas, had diverse supply and marketing linakges. Beijing had a particularly strong presences of domestic firms and domestic market orientations. Suzhou and Dongguang, as secondary mnuafcturing hubs of these cities, were more dependent on export and external production. The study also revealed the development of ICT clustering in the PRD and YRD, which maintain close linagkes with Beijing as well.

FDI R&D Activities and Networks

As MNEs tend to have their headquarters located in their home countries, headquarter and marketing functions are very limited among FIEs in China. Our

findings confirm that MNEs are more likely to place their regional administrative and R&D activities in major urban locations such as Shanghai and Beijing, rather than secondary cities like Suzhou and Dongguan.

Our analysis of the R&D resources and technological levels of FIEs shows that FIEs generally recognize the significance of R&D in productivity and competition (Table 8). Most of the surveyed FIEs had R&D facilities, although most of them were located in engineering or technical departments and only one was at the national level. The need to adapt to the increasingly sophisticated industrial and consumer markets in China was the major reason for undertaking such activities. However, serving as the basic R&D facility for the world market only accounted for small percentages of venture functions (3.3% of the functions in Suzhou).

(Table 8 about here)

We find Beijing led other cities in terms of R&D and marketing personal, with the highest percentage of employees with bachelor or advanced degrees, followed by Shanghai. Such characteristics are the basis for Beijing's significance in the ICT sector and the marketing linkages between Beijing and the PRD as well as the YRD. Suzhou and Dongguan, on the other hand, were mainly manufacturing bases, and had much smaller proportions of employment engaged in R&D and marketing activities. They also had much lower percentages of employees with bachelor or advanced degrees. It is surprising that Shenzhen had a low share of R&D personnel, although it had a reasonable share of management and marketing employment. Our fieldwork revealed that Suzhou was aggressive in recruiting R&D personnel, which has clearly contributed to the share of R&D employment in the city. Beijing

also had a larger share of local employment, followed by Shanghai. For Suzhou, Shenzhen and Dongguan, most of the firms had less than 25% of employment from local sources. The major metropolitan areas had higher income for R&D employees.

Beijing led the cities in R&D activities. Beijing led other cities in % R&D spending and % firms with patents (Table 9). FIEs in Shanghai had more R&D facilities at the national or provincial levels, followed by Suzhou and Dongguan. Shenzhen and Shanghai had more FIEs experiencing significant increase in R&D spending, although most of the FIEs there had little change. The lack of R&D funding limits lower level cities' progress in technological upgrading and developing endogenous capacities, which is another major reason for the technological gap between FIEs and local indigenous firms. FIEs in Beijing are more involved with patents and new processes. While percentages of equipment after 2000 were similar among cities, the YRD and Dongguan had less shares of the equipment made domestically. The extent of R&D activities also differed across cities. FIEs in Beijing led other cities in terms of % of firms with patents, % sales income of new products over total sales, and % firms with new processes, indicating Beijing's superior innovation capacities over other cities (Table 8).

Regarding drivers and sources of innovation and technological change, we find that FIEs relied more heavily on internal self-development, followed by imports from abroad (Table 9). Suzhou had broader sources, with a substantial number of companies using domestic Chinese firms. However, domestic universities and institutions were rarely used as sources of core technology. Regarding specific information sources, customers were the most important for all study cities, followed by suppliers and cooperators. Relationships between FIEs are more important for FIEs in the YRD, but least important for Beijing. Foreign partners in general handled technological

imports, in most of technological development except for Beijing and Shenzhen, which have stronger internal development capacities. Suppliers and partners played less important roles in technological change.

(Table 9 about here)

We have also investigated the benefits of Chinese partners and the cooperation of FIEs with domestic firms in R&D activities. We find that Chinese partners can learn from foreign partners, but the extent of involvement differs across the cities. Chinese partners in Beijing, Shanghai and Dongguan were more positive over the learning from foreign partners, but the levels were much lower in Suzhou and Shenzhen. Both parties were concerned over the weak cooperation between foreign and domestic partners. Regarding the specific cooperation of FIEs with domestic firms in R&D, most of the cooperation was at lower levels such as technology advice, personal exchange, and information exchange. However, for the most important functions, mainly strategic alliance, cooperative R&D and technology transfer, most of the surveyed FIEs considered their cooperation with domestic firms not important or had no cooperation, which is a major reason for the lack of the cooperation between MNEs and domestic firms (Table 10). This finding affirms the view that the extent of technology transfer from FIEs to domestic firms in China is limited, despite the growing demand and sophistication of the market, MNEs are increasingly making Chinese cities attractive locations for strategic R&D activities (Sun 2003). Global experiences show that the technological activity of MNEs remains overwhelming centered in their home countries (Allen and Thompson 1997)--a challenging fact for Chinese cities, especially Suzhou and Dongguan.

(Table 10 about here)

Discussion and Conclusion

Chinese cities have come a long way from SOE dominated production centers towards globalizing cities and global manufacturing centers. Beijing and Shanghai have become emerging global cities, and Shenzhen has emerged miraculously from a small city to a metropolis of national significance. Suzhou has been transformed towards an externally driven globalizing city and high-tech center. Through years of globalization and development, FIEs are the main agents of development and production in Suzhou, Shenzhen and Dongguan, and many of them are in the highly competitive ICT sector. FIEs have re-shaped the trajectories of development in Chinese cities and become a key agent in the restructuring of the Sunan and PRD models. The location decision of MNEs was based on policies and services of local states, as well as labor conditions and locational advantages in access to markets and supplier networks, which implies that locational factors of FDI are a combination of conventional and institutional factors. We find the shrinking role of government policy and rising significance of local agglomeration in FDI location decisions.

This paper has investigated the network configurations and embeddedness of FIEs. We have found that in terms of supply networks, clustering of ICT firms in the YRD and PRD has provided opportunities for local purchase and subcontracting. However, the important external networks of FIEs are mainly formed among FIEs themselves. The linkages with domestic firms are thin, and no trend of significantly increasing global-local linkages can be detected. The weak global-local linkages can be further observed in the R&D and innovation activities. While we find a substantial number of FIEs with R&D facilities, most of them were used for process and product developments for the Chinese market. Technological progress is driven by customers, and the dependence on internal development and global sources is evident, with little usage of research institutions and endogenous firms in China. FIEs do not think cooperation with domestic firms necessary for R&D

and innovation activities, and there is no incentive for them to embed with local economies in R&D. Those features are particularly prominent in Suzhou and Dongguan, reflecting their dependency on external markets and the extent of external control.

A number of mismatches between FDI and study cities—technological, institutional, spatial, and structural--explain the weak FIE local linkages. Technological mismatch is a key reason for the weak embeddedness in these cities. The ICT sector is the most dynamic sector of the economy and requires a higher level of technological competence and just-in time logistics. The technological gaps between MNEs and local firms, especially those in Suzhou and Dongguan, have hindered the establishment of production networks between them. We find the weak embeddedness also has an institutional dimension or mismatch. The prefectural level and the lack of strategic industries in Suzhou and Dongguan have weaker bargaining power with foreign investors, which is quite different from the findings based on the auto industry in Shanghai, where the Shanghai government bargained with MNEs over local content requirements (Sit and Liu 1998). Closely related is the spatial mismatch in which development zones in most Chinese cities were developed in suburban or even rural areas with weak economic bases, which limits the potential for local companies to serve as suppliers for MNEs.

The structural features of FIEs, especially their sources, also affect the embeddedness. Most of the FIEs in the ICT sector in these cities are coming from Taiwan, whose investment is characterized by network-based cross-border production. Taiwanese firms, as subcontractors for globally leading manufacturing firms, tend to adopt the strategy of group investment and geographic clustering due to similar cultural background, existing business relations, and the common political risks they face. This clustering is also based on the production, credit, and social relations that were established among these firms in Taiwan before they relocated to

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mainland China (Yang 2007). The problem of intellectual property rights made Taiwanese investors concerned that internal promotion of Chinese citizens and external production with indigenous firms would leak key technologies to Chinese competitors. Effort in "innovated in China" has challenged Taiwanese firms' lead in innovation and technology.

We can identify a few areas where embeddedness can be observed. The deteriorating export market has forced FIEs to make greater efforts to penetrate the Chinese markets, and localization is one strategy FIEs are adopting. Our interviews find that a number of firms are improving linkages with firms in Beijing and Shanghai for their access to the domestic market and advantages in human resources, which have also scaled up the scope of geographical embeddedness. Embeddedness can also be found at broader geographical scales, such as interfirm networks within and between the YRD and the PRD, rather than at the metropolitan scale of Suzhou and Dongguan. Moreover, firms dealing in electronic parts and components likely have more production linkages with local firms. Lastly, FIEs that are small and located in peripheral areas of the regions also tend to seek localization more actively.

Our study suggests that the policy of globalizing regional development has the danger of promoting satellite districts, and that "holding down" the global is an important aspect of the globalization process to which localities must pay particular attention. While our overall assessment of Chinese pathways to industrialization and regional development is positive, cities might be better off had they given more weight to business services and private enterprises and had been more cautious with the selectivity and spillover effects of MNEs. The Chinese government has recognized the importance of FDI embeddedness and has implemented new policies to embed MNEs and promote endogenous innovation capacities. Such efforts, in the long run, should improve the embeddedness of FIEs, and enhance global-local networks.

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Figure 1. A Schematic Framework for Analyzing FDI Networks

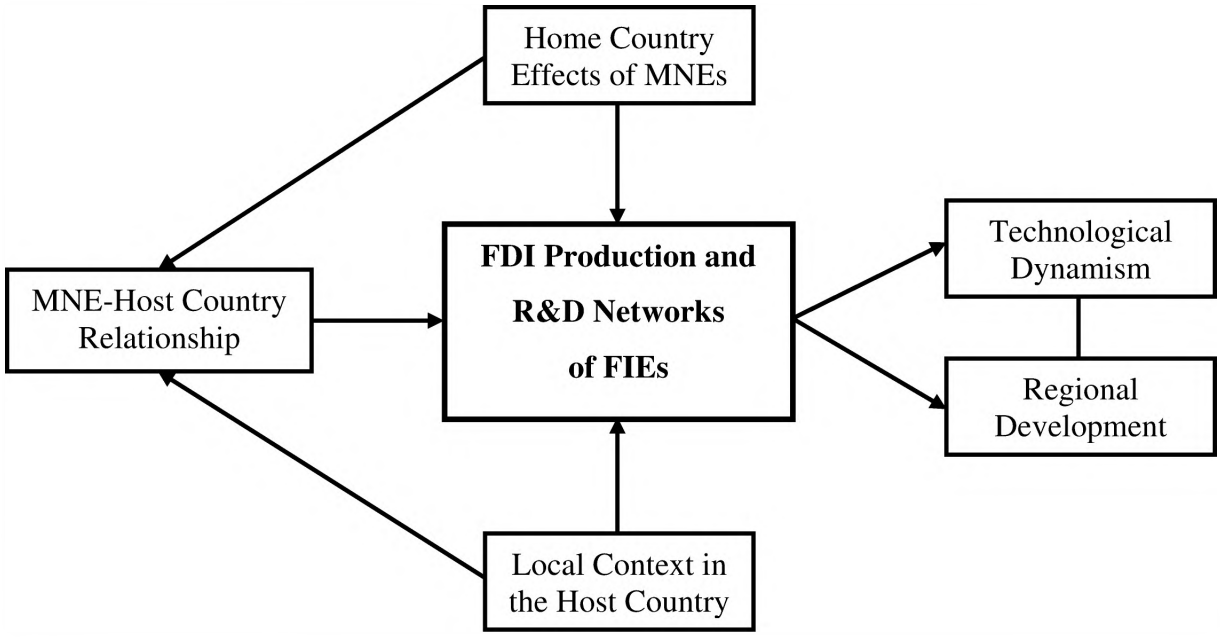

Figure 2. Research Settings: The ICT Sector and Primary FDI Source Countries

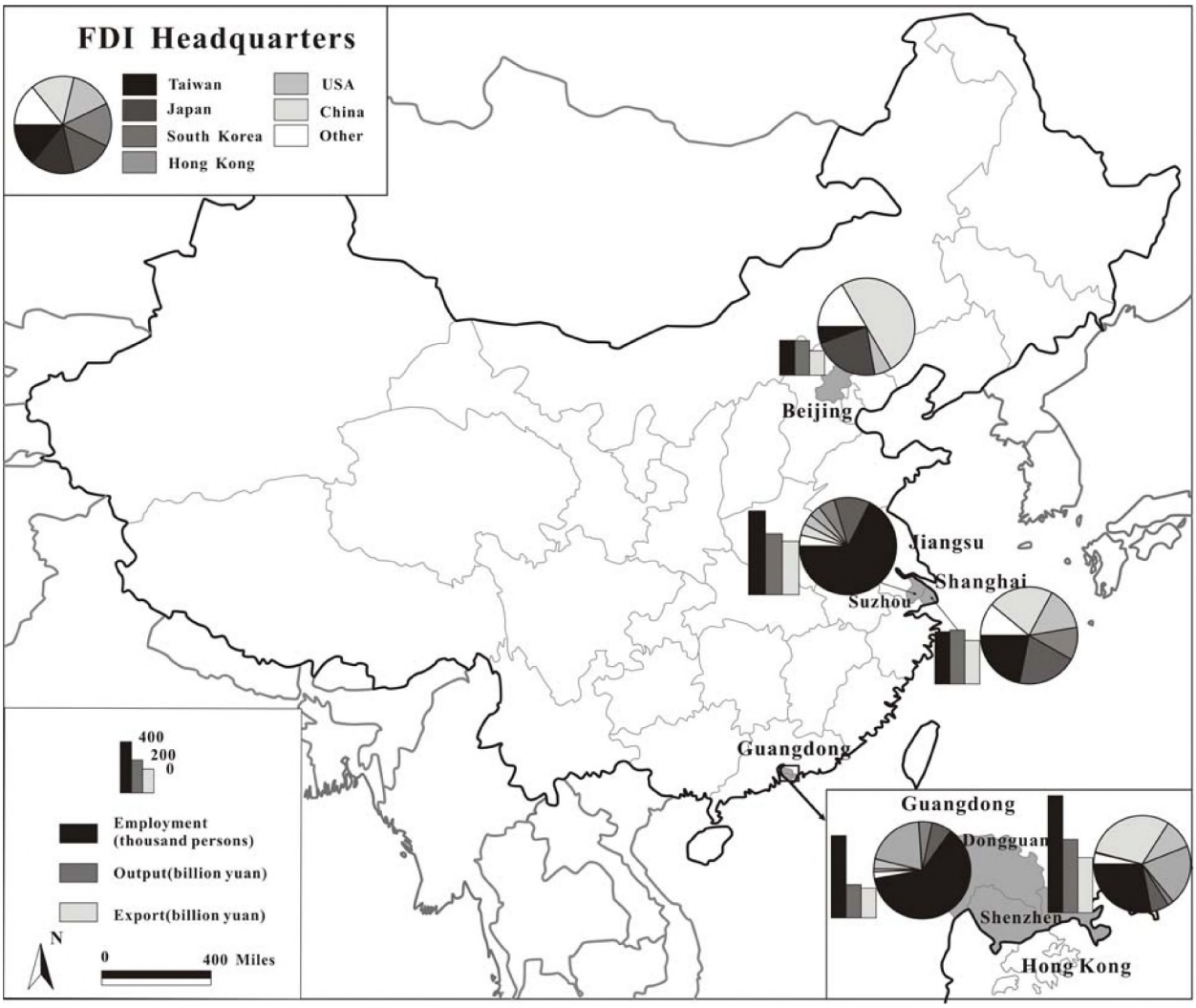

Table 1. Profile of the Surveyed FIEs: Establishments (Proportion)

Attribute	Category	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Year	Before 1992	3 (16.7)	5 (9.1)	1 (0.9)	5 (10.2)	12 (13.5)
Established	1992-1995	3 (16.7)	12 (21.8)	11(10.2)	12 (24.5)	21 (23.6)
	1996-2000	6 (33.3)	10 (18.2)	19 (17.6)	14 (28.6)	32 (36)
	After 2000	6 (33.3)	28 (50.9)	77 (71.3)	18 (36.7)	24 (27)
Ownership	Joint Venture	10 (55.6)	18 (32.7)	6 (5.6)	13 (26)	9 (10)
Form	WFOEs	8 (44.4)	37 (67.3)	102 (94.4)	37 (74)	81 (90)
Headquarters	Taiwan	1 (5.6)	12 (21.8)	73 (67.6)	14 (28)	56 (62.2)
	Japan	4 (22.2)	11 (20)	13 (12)	3 (6)	6 (6.7)
	South Korea	0 (0)	6 (10.9)	6 (5.6)	1 (2)	4 (4.4)
	Hong Kong	0 (0)	0 (0)	4 (3.7)	10 (20)	18 (20)
	USA	1 (5.6)	8 (14.5)	4 (3.7)	5 (10)	3 (3.3)
	China	9 (50)	12 (21.8)	4 (3.7)	15 (30)	1 (1.1)
	Other	3 (16.7)	6 (11)	4 (3.7)	2 (4)	2 (2.2)
Sector	Telecom Equipment	7 (38.9)	8 (14.5)	5 (4.6)	6 (12)	9 (10)
	Computer Equipment	1 (5.6)	3 (5.5)	29 (26.9)	12 (24)	24 (26.7)
	Electronic Parts/Comp	3 (16.7)	25 (45.5)	50 (46.3)	32 (64)	57 (63.3)
	Semiconductor Wafer	3 (16.7)	11 (20)	8 (7.4)	0 (0)	0 (0)
	IC Manufacturing	4 (22.1)	8 (14.5)	16 (14.8)	0 (0)	0 (0)
Asset	< 1	0 (0)	2 (4)	13 (12)	1 (2.3)	4 (6.7)
($ Million)	1 to 5	6 (35.3)	7 (14)	42 (38.9)	19 (44.2)	10 (16.7)
	5 to 10	1 (5.9)	7 (14)	18 (16.7)	8 (18.6)	16 (26.7)
	10 to 25	0 (0)	6 (12)	10 (9.3)	2 (4.7)	12 (20)
	Over 25	10 (58.8)	28 (56)	25 (23.1)	13 (30.2)	18 (30)
Employee	< 100	12 (66.7)	18 (32.7)	17 (15.7)	7 (14)	6 (6.7)
(Persons)	100 to 199	0 (0)	12 (21.8)	13 (12)	9 (18)	13 (14.4)
	200 to 499	3 (16.7)	13 (23.6)	30 (27.8)	15 (30)	31 (34.4)
	500 to 1,000	1 (5.6)	8 (14.5)	26 (24.1)	11 (22)	20 (22.2)
	Over 1,000	2 (11.1)	4 (7.3)	22 (20.4)	8 (16)	20 (22.2)
Profit Margin	> 10	9 (50)	28 (54.9)	24 (22.2)	21 (40.4)	37 (42.5)
(%)	5 – 10	3 (16.7)	11 (21.6)	47 (43.5)	11 (21.2)	29 (33.3)
	1 - 5	4 (22.2)	9 (17.6)	34 (31.5)	16 (34.6)	18 (20.7)
	<= 0	2 (16.1)	3 (5.9)	3 (2.8)	2 (3.8)	3 (3.4)

Source: The ICT survey.

Table 2. Profiles of Foreign and Chinese Parent Firms of the Surveyed FIEs

Attribute	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Average # of Foreign Parent Firms	1	1	1.3	1	1
Average % of Foreign Ownership	74.9	85.4	94.5	90.2	97.1
Average % of Primary Foreign Ownership	74.9	85.3	91.4	87.8	97.3
Primary Foreign Source: # (%)					
Taiwan	3 (16.7)	15 (27.3)	72 (66.7)	19 (38)	58 (64.4)
Japan	4 (10)	11 (20)	13 (12)	3 (6)	6 (6.7)
South Korea	0 (0)	3 (5.5)	7 (64.8)	1 (2)	4 (4.4)
Hong Kong	2 (4.3)	5 (9.1)	5 (4.6)	19 (38)	17 (18.9)
USA	3 (6.8)	11 (20)	5 (4.6)	5 (10)	3 (3.3)
Others	6 (14.6)	10 (18.2)	6 (5.6)	3 (6)	2 (2.2)
Average % of Primary Chinese Ownership	25.1	12.9	3.7	10.2	2.9
Home Cities of Primary Chinese Firms: # (%)					
Beijing	10 (100)	1 (5.6)	0	1 (7.1)	0
Shanghai	0	17 (94.4)	0	0	0
Suzhou	0	0	4 (66.7)	0	0
Shenzhen	0	0	0	13 (92.9)	0
Dongguan	0	0	0	0	9 (100)
Others	0	0	2 (33.3)	0	0

Source: The ICT survey.

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Table 3. Location Decision Factor Scores of the Surveyed FIEs

Location Factors	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Local States/Infrastructure					
Better Investment Incentives	0.50	0.22	0.19	0.54	0.56
Better Attitude Toward FDI	0.06	0.25	0.03	0.04	0.38
Better Infrastructures	0.28	1.56	0.27	0.46	0.56
Better Urban Amenities	0.06	0.18	0.01	0.08	0.43
Professional Service	0.00	0.33	0.05	0.12	0.43
University& Research Institutions	0.11	0.09	0.02	0.08	0.22
Labor and Supplies					
Lower Labor Cost	0.33	0.09	1.01	0.36	0.63
Better Availability of Skilled Labor	0.94	1.13	0.71	0.9	0.28
Better Access to Material Supplies	0.00	0.15	0.6	0.26	0.61
Location and Market Access					
Better Local/Regional Market Potential	1.50	1.35	0.68	0.5	0.44
Closer to Major Seaports/Airports	0.00	0.76	0.86	1.34	0.23
Location of Major Customers	0.44	0.58	0.91	0.62	0.53
Agglomeration of Similar Enterprises	0.17	0.18	0.68	0.48	0.41
Other	0.50	0	0	0.1	0.49

Note: FIEs were asked to identify and rank three most important location factors, which were given scores of 3, 2, 1; the higher the total score, the more important the factor. The score for each factor is the average of the total scores for all surveyed FIEs in a given city (standardized for comparison among cities).

Source: The ICT survey.

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Table 4. Production Networks of the Surveyed FIEs

	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Imports as % of total purchase	41.3	63	51.9	39.8	50.1
% domestic purchase	58.7	35.2	44.4	60.2	47.3
% local purchase (within two hour driving distance)	37	30.5	49	50.6	37.8
As Suppliers: # (%)	3 (16.7)	17 (30.9)	49 (45.4)	20 (40.0)	42 (46.7)
Supplies as % Sale	7.2	8.9	18.7	17.3	24.4
% From FIEs	0	15.6	23	13.4	30.6
% From Local (within two hour driving distance)	33.3	46	54.3	47.3	49.2
Outsourcing: # (%)	5 (27.8)	17 (30.9)	47 (43.5)	14 (28.0)	38 (42.2)
Outsourcing as %	47.8	32.6	24.7	18.1	14.1
Expenditure Outsourcing to the local (within two hour driving distance)	28	50.9	60.1	65.3	65.9

Source: The ICT survey.

Table 5. Marketing Activities of the Surveyed FIEs

	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Median Annual Sales (million yuan)	6.9	20	30	20	50
% Export	32.2	52.1	43.5	57.9	72.3
Leading Destination: # (%)					
U.S.A.	2 (16.7)	16 (36.4)	24 (28.9)	19 (45.2)	32 (40.5)
Japan	4 (33.3)	11 (25)	18 (21.7)	4 (9.5)	13 (16.5)
Europe	1 (8.3)	7 (15.9)	6 (7.2)	9 (21.4)	18 (22.8)
% Export directed by: # (%)					
Foreign investors	8 (66.7)	35 (79.5)	48 (57.8)	28 (66.7)	60 (71.4)
Firm self	4 (33.3)	9 (20.5)	35 (42.2)	14 (33.3)	24 (28.6)
% Domestic sales: Among which					
% Consumers	2.5	10.3	17.6	3.8	1.8
% Domestic firms	76.4	52.4	28.6	50.9	29.7
% FIEs	6.1	34.6	51.8	40.0	68.4
% Government and Related enterprises	15	2.7	2	5.3	0.1

Source: The ICT survey.

Table 6. External Business Services of the Surveyed FIEs

	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Using Advertising Services: # (%)	2 (11.1)	8 (14.5)	17 (15.7)	17 (34.0)	12 (13.3)
FIEs	1 (50.0)	1 (12.5)	8 (47.1)	2 (11.8)	4 (33.3)
Local Firms	1 (50.0)	7 (87.5)	8 (47.1)	15 (88.2)	6 (50)
Non-local Firms	0 (0.0)	0 (0.0)	1 (5.8)	0 (0.0)	2 (16.7)
Using Consulting Services: # (%)	1 (5.6)	10 (18.2)	20 (18.5)	18 (36.0)	21 (23.3)
FIEs	0 (0.0)	-	7 (35.0)	1 (5.6)	8 (38.1)
Local Firms	1 (100)	-	13 (65.0)	17 (94.4)	8 (38.1)
Non-local Firms	0 (0)	-	0 (0.0)	0 (0.0)	5 (23.8)
Using Human Resource Services: # (%)	2 (11.1)	16 (29.1)	65 (60.2)	24 (48.0)	44 (48.9)
FIEs	0 (0.0)	1 (6.3)	2 (3.1)	2 (8.3)	1 (2.3)
Local Firms	2 (100.0)	15 (93.7)	62 (95.4)	22 (91.7)	38 (88.4)
Non-local Firms	0 (0.0)	0 (0.0)	1 (1.5)	0 (0.0)	5 (9.3)
Belong to Business Associations: # (%)	12 (66.7)	18 (33.3)	22 (20.4)	14 (28.0)	23 (25.6)
Most Important Associations	N/A	Shanghai Semiconductor Association	Taiwan Business Association	Taiwan Business Association	Taiwan Investors Association
Most Lacking Business Services	N/A	Human Resource Service (30.2)	Advertisement (35.3)	Advertisement (28.9)	Advertisement (31.6)

Source: The ICT survey.

Table 7. Change of FIEs's External Linkages in last three years (2004-2006)

	Significant Increase		Significant Decrease		Not Much Change	
	#	%	#	%	#	%
% Imports	45	14.3	35	11.2	234	74.5
Domestic Purchase	69	22.0	22	7.0	223	71.0
% From Domestic Firms	58	18.3	22	6.9	237	74.8
% From FIEs	25	7.9	54	17.1	237	75.0
Key Component Purchase						
% Purchase from FIEs	44	13.8	20	6.3	254	79.9
% Subcontracting from FIEs	32	24.6	7	5.4	91	70.0
% Outsourcing	25	20.9	4	3.3	91	75.8
% Outsourcing to the Local (within two hour driving distance)	19	15.7	6	5.0	96	79.3

Source: The ICT Survey.

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Table 8. Employment Structure and R&D Activities of the Surveyed FIEs

	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Employment Structure (%)					
R&D	28.4	12.9	7.5	4.3	2.7
Medium and High Level Management	15.8	17.6	11.4	15.4	11.5
Marketing	18.7	11.1	3.0	9.7	3.5
Bachelor or Higher Degree	66.4	36.1	9.7	16.5	8.9
Local Employment: # (%)					
< 25%	4 (22.2)	32 (58.2)	77 (71.3)	37 (74.0)	63 (70.0)
26% - 50%	0 (0.0)	7 (12.7)	13 (12.0)	7 (14.0)	7 (7.8)
51% - 75%	1 (5.6)	6 (10.9)	4 (3.7)	3 (6.0)	3 (3.3)
> 75%	13 (72.2)	10 (18.2)	14 (13.0)	3 (6.0)	17 (18.9)
R&D Employee					
Average Persons	13	28	52	19	17
Average Income (yuan)	4813	4081	2766	4326	3873
Self Trained (%)	12.1	23.3	44.1	24.5	27.7
Recruited Domestically (%)	82.6	71.5	54.1	72	67.1
Recruited Abroad (%)	5.3	5.2	1.8	3.5	5.2
Having R&D Facility: # (%)	16 (88.9)	35 (63.6)	60 (55.6)	39 (78.0)	49 (54.4)
National Level	0 (0.0)	2 (5.9)	1 (1.7)	0 (0.0)	1 (2.0)
Provincial Level	0 (0.0)	3 (8.8)	5 (8.5)	1 (2.6)	3 (6.1)
% R&D Spending	31.0	18.0	6.9	13.6	6.6
Change in R&D Spending, 2004-06: # (%)					
Increase Significantly	4 (22.2)	16 (29.1)	23 (21.3)	20 (40.0)	16 (18.2)
Decrease Significantly	1 (5.6)	2 (3.6)	5 (4.6)	0 (0.0)	2 (2.3)
Little Change	13 (72.2)	37 (67.3)	80 (74.1)	30 (60.0)	70 (79.5)
Equipment after 2000: # (%)	13 (72.2)	39 (70.9)	76 (70.4)	34 (68.0)	61 (67.8)
% Domestic Equipment Value	48.3	26.9	32.8	44.6	25.8
Firms with Patents: # (%)	7 (38.9)	12 (24.0)	30 (27.8)	10 (20.0)	16 (17.8)
# Domestic patents per firm	3.4	14.2	28.0	9.1	34.3
# Foreign Patens per firm	4.3	2.5	15.7	0.4	32.7
# Domestic Patents per firm, 2004-06	2.7	7.7	11.3	2.5	15.9
# Foreign patents per firm, 2004-06	4.3	1.3	6.9	0.2	9.3
# of New Products, 2005-06	6.1	23.2	52.2	10.6	17.9
Sales income of New Products (as % of total sales)	53.1	14.0	29.2	33.4	33.1
Firms with New Processes, 2005-06: # (%)	13 (72.2)	29 (52.7)	55 (50.9)	21 (42.0)	44 (48.9)

Source: The ICT survey.

Table 9. Drivers and Sources of Innovation and Technological Change of the Surveyed FIEs

	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Source of Core technology: # (%)					
Internal Development	15 (62.5)	35 (53.0)	57 (38.0)	35 (61.4)	62 (60.8)
Companies in China	1 (4.1)	3 (4.6)	24 (16.0)	0 (0.0)	6 (5.9)
Imported Abroad	4 (16.7)	18 (27.3)	40 (26.7)	12 (21.1)	12 (11.8)
Abroad & Internal	4 (16.7)	9 (13.6)	26 (17.3)	8 (14.0)	22 (21.5)
Domestic Univ./Institution	0 (0.0)	0 (0.0)	2 (1.3)	2 (3.5)	0 (0.0)
Other	0 (0.0)	1 (1.5)	1 (0.7)	0 (0.0)	0 (0.0)
Important/Very Important Information Sources for Innovation/Upgrading: # (%)					
Customers	16 (30.1)	53 (31.5)	103 (39.6)	47 (34.1)	82 (31.0)
Among Which, FIEs	3 (18.8)	27 (50.9)	75 (72.8)	13 (27.7)	39 (47.6)
Suppliers	11 (20.8)	43 (25.6)	74 (28.4)	36 (26.1)	58 (22.0)
Among Which, FIEs	2 (18.2)	25 (58.1)	50 (67.6)	5 (13.9)	1 (1.7)
Cooperators	11 (20.8)	42 (25.0)	48 (18.5)	41 (29.7)	57 (21.6)
Among Which, FIEs	1 (9.1)	22 (52.4)	29 (60.4)	4 (9.8)	5 (8.8)
Colleagues	15 (28.3)	30 (17.9)	35 (13.5)	14 (10.1)	67 (25.4)
Among Which, FIEs	3 (20.0)	14 (46.7)	24 (68.6)	2 (14.3)	3 (4.5)
% Foreign Partners Handling Technological Imports	66.7	67.3	75.0	59.2	71.6
% Foreign Partners Handling Technological Development	38.9	61.8	63.9	44.7	63.2
Learning by Chinese Partners (%)					
Ideas for New Technology	71.4	76.5	34.8	40.0	80.4
Learning Foreign Conditions	100.0	76.5	56.5	40.0	85.5
Knowing more Collaborators	100.0	70.6	34.8	25.0	60.0
Improving R&D Management	71.4	76.5	24.6	20.0	74.5
Training Technicians	71.4	55.9	49.3	40.0	78.2

Table 10. Cooperation of FIEs with Domestic Firms in R&D.

	Beijing	Shanghai	Suzhou	Shenzhen	Dongguan
Cooperation with Domestic Firms					
Importance of Alliance					
Non & Not Important	15 (83.3)	32 (58.2)	92 (85.2)	43 (86.0)	80 (88.9)
Average	0 (0.0)	4 (7.3)	9 (8.3)	3 (6.0)	2 (2.2)
Important & Very Important	3 (16.7)	19 (34.5)	7 (6.5)	4 (8.0)	8 (8.9)
Importance of Cooperative R&D					
Non & Not Important	14 (77.8)	30 (54.5)	88 (81.5)	46 (92.0)	75 (83.3)
Average	2 (11.1)	8 (14.5)	10 (9.3)	0 (0.0)	5 (5.6)
Important & Very Important	2 (11.1)	17 (30.9)	10 (9.3)	4 (8.0)	10 (11.1)
Importance of Technology Transfer					
Non & Not Important	16 (88.9)	40 (72.7)	92 (85.2)	50 (100.0)	82 (91.1)
Average	2 (11.1)	12 (21.8)	14 (13.0)	0 (0.0)	8 (8.9)
Important & Very Important	0 (0.0)	3 (5.5)	2 (1.9)	0 (0.0)	0 (0.0)
Importance of Technology Advice					
Non & Not Important	11 (61.1)	35 (63.6)	82 (75.9)	45 (90.0)	71 (78.9)
Average	5 (27.8)	13 (23.6)	22 (20.4)	4 (8.0)	15 (16.7)
Important & Very Important	2 (11.1)	7 (12.7)	4 (3.7)	1 (2.0)	4 (4.4)
Importance of Personal Exchange					
Non & Not Important	9 (50.0)	34 (61.8)	75 (69.4)	44 (89.8)	71 (79.8)
Average	7 (38.9)	14 (25.5)	25 (23.1)	2 (4.1)	13 (14.6)
Important & Very Important	2 (11.1)	7 (12.7)	8 (7.4)	3 (6.1)	5 (5.6)
Importance of Information Exchange					
Non & Not Important	9 (50.0)	32 (58.2)	76 (70.4)	46 (92.0)	83 (92.2)
Average	6 (33.3)	15 (27.3)	18 (16.7)	3 (6.0)	3 (3.3)
Important & Very Important	3 (16.7)	8 (14.5)	14 (13.0)	1 (2.0)	4 (4.4)

Source: The ICT Survey.

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