Spatial Mismatch and Determinants of Foreign and Domestic Information and Communication Technology Firms in Urban China*

Yehua Dennis Wei
University of Utah

Feng Yuan
Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences

Haifeng Liao
University of Utah

Studies on foreign direct investment locations in China have been conducted mainly at interregional and interprovincial scales, and little attention has been paid to the intraurban scale where location decisions of foreign firms can differ from domestic firms. This article explores the intraurban locations of information and communication technology (ICT) firms in Suzhou, a city experiencing rapid globalization. We have found that the distribution of ICT firms in Suzhou exhibits distinctive spatial patterns characterized by a geographically based, institutionally created spatial mismatch between foreign and domestic firms. Foreign firms are concentrated in national-level development zones—China–Singapore Suzhou Industrial Park in the east and Suzhou New and Hi-Tech District in the west—whereas domestic firms tend to agglomerate in the inner city and the provincial-level development zone in the north. Poisson and negative binomial analyses further reveal that the locations of foreign firms are strongly correlated to development zones, and the agglomeration economies derived from the stock of foreign investment rather than domestic firms. The case of Suzhou highlights the challenges that Chinese cities face in industrial upgrading and technological development through embedding transnational corporations. **Key Words: China, industrial location, Poisson and negative binomial analysis, spatial mismatch, Suzhou.**

现有的有关中国外资企业区位的研究主要关注于区域和省这两个尺度，对于城市内部外资企业的区位及其与内资企业的差异关注较少。本文以苏州市区信息和通讯技术制造业企业为案例，主要探讨了全球化背景下中国外资企业和内资企业在城市内部的空间差异及其形成机制。我们发现在中国利用外资有关政策和制度的驱动下，苏州市区外资企业和内资企业在分布上呈现出"空间错位"的现象。外资企业倾向扎堆在以苏州市区东部中国-新加坡苏州工业园区和西部苏州高新区为代表的国家级开发区。然而，内资企业则主要集中在内城区和北部的省级开发区。泊松和负二项回归的结果进一步表明，外资企业在城市内部的区位选择主要受国家级开发区的位置，外资企业存量等因素的影响，但与内资企业的分布无显著关系。苏州的案例反映出全球化背景下，中国城市在提高外资企业的植根性，以及进行产业和技术升级过程中所遇到的挑战。**关键词：工业区位，空间错位，泊松和负二项回归，苏州，中国。**

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Los estudios sobre la localización de inversiones extranjeras directas en China se han realizado principalmente a escalas interregionales e interprovinciales, con muy poca atención dispensada a la escala intraurbana, donde las decisiones locacionales de las firmas extranjeras pueden diferir de las hechas por firmas domésticas. Este artículo explora las localizaciones intraurbanas de firmas de tecnologías de la información y las comunicaciones (TIC) en Suzhou, una ciudad que está experimentando rápida globalización. Hemos encontrado que la distribución de firmas de TIC en Suzhou exhibe patrones espaciales singulares caracterizados por un desfase espacial de base geográfica creado institucionalmente entre las firmas extranjeras y domésticas. Las firmas extranjeras están concentradas en zonas de desarrollo de nivel nacional—el Parque Industrial China–Singapur de Suzhou, al este, y la Nueva Suzhou y el Distrito Hi-Tech, al oeste—mientras que las firmas domésticas tienden a aglomerarse en las partes deprimidas de la ciudad y en la zona de desarrollo de nivel provincial, hacia el norte. Los análisis Poisson y binomial negativo revelan además que las localizaciones de firmas extranjeras están fuertemente correlacionadas con las zonas de desarrollo, y con las economías de aglomeración derivadas de las existencias de inversiones extranjeras más que de las firmas domésticas. El caso de Suzhou destaca los retos que enfrentan las ciudades chinas en términos de renovación industrial y desarrollo tecnológico a través de la inclusión de corporaciones transnacionales. **Palabras clave:China, localización industrial, análisis Poisson y binomial negativo, desfase espacial, Suzhou.**

Since the reforms initiated in the late 1970s, China has undergone a transition from a closed and plan-based system to an open and market-based economy, which can be conceptualized as a triple process of decentralization, marketization, and globalization (Wei 2000). Decentralization refers to the shift in power from the central government to local governments, empowering local governments in policy initiatives and economic development. Business activities have been increasingly based on the rule of markets instead of being regulated by government commands. Globalization highlights China's open door policies and the integration of China in the global economy, represented by the fact that China has become the largest recipient of foreign direct investment (FDI) in all developing countries. This triple transition also spatially varies, giving rise to the different development trajectories and models in China, especially the Sunan, Wenzhou, and Pearl River Delta (PRD) models (Ma and Fan 1994; Lu and Wei 2007; Wei 2007; Wei, Lu, and Chen 2009). FDI is more influential in coastal provinces such as Guangdong and Jiangsu, where it has become the most important driving force behind regional development, and local governments have also been actively involved in the cut-throat competition for FDI (Yang 2009).

Although there is a large body of literature on FDI locations in China, most of the existing research tends to focus on the uneven spatial distribution of FDI at the regional and provincial levels (e.g., Zhao and Zhang 2007), studies on intraurban location of FDI remain limited. Fortunately, the availability of data and the development of geographic information systems (GIS) have allowed researchers to remedy the inadequacy. Recent research has recognized the need for such studies, and the research on China has paid more attention to industrial locations at the intraurban level. They have found that FDI locations within Chinese cities are significantly impacted by development zones, accessibility to local transportation facilities, and the availability of industrial land (F. Wu 1999, 2000; J. Wu and Radbone 2005; Wei, Luo, and Zhou 2010).

Scholars are also increasingly concerned with the embeddedness and functions of transnational corporation (TNC) subsidiaries in China and Asia (Poon and Thompson 2003). They argue that in China's FDI-driven globalizing cities, such as Suzhou in the Yangtze River delta (YRD), foreign firms are branch, plant-like subsidiaries and few of them have established close linkages with local firms (Wei, Lu, and Chen 2009; Zhou et al. 2011), although such linkages are critical in the spillover of FDI and regional development (United Nations Conference on Trade and Development 2001; Williams 2005).

Wei (2010) conceptualizes the weak linkages between foreign and domestic firms in Suzhou as shaped by four types of mismatches: technological, structural, institutional, and spatial. His spatial mismatch thesis states that TNCs tend to locate in national-level development zones with preferential open door policies, whereas domestic firms are not well supported institutionally and spatially tend to locate in old city areas or suburban towns. This results in the

spatial mismatch in location that acts as a barrier to improve the linkages between TNCs and local firms. This thesis highlights the difference in location decisions between foreign and domestic firms. Because this finding is largely based on interviews and survey data, there is still room for a quantitative approach to explicitly test the spatial mismatch hypothesis.

Through a case study of the information and communication technology (ICT) firms in Suzhou, this article advances the research on the intraurban locations of foreign and domestic firms to better understand the lack of TNC embeddedness in globalizing cities in developing countries. More specifically, this article attempts to fulfill three research objectives. First, we attempt to test the spatial mismatch thesis to better understand the role of state and development strategies (development zones) in shaping intraurban firm and FDI locations. Second, we aim to improve our understanding of the factors underlying the spatial patterns of foreign and domestic firms within Chinese cities, built on the triple transition framework of globalization, decentralization, and marketization, with an emphasis on the role of agglomeration, state institutions, and site characteristics. We argue that agglomeration economies have emerged as one of the advantages of the host city, playing an important role in the location decisions of both foreign and domestic firms. Third, and to a lesser extent, we argue that the spatial mismatch of foreign and domestic firms has important implications for the challenges of embedding TNCs and promoting regional development under globalization.

Located in the core area of the YRD, Suzhou is one of China's leaders in FDI and ICT industrial development. The city enjoys location advantages derived from its proximity to Shanghai and it is positioned as an important secondary city in the YRD, the leading emerging global city region in China. Since the late 1990s, the influx of foreign investment in the ICT sector, especially from Taiwan, has reshaped Suzhou as the largest laptop production region in the global ICT industry (Y. R. Yang and Hsia 2007; C. Yang 2009). In short, Suzhou is at the forefront of China's institutional reforms and opening up to the outside world and is an important city to study, as a good representation of the globalization and transformation of Chinese cities.

After the introduction, the theoretical and conceptual contexts are discussed, followed by data and methodology. Using GIS and exploratory point pattern analysis techniques, we examine the locations of foreign and domestic firms comparatively to identify their different patterns. This is followed by an analysis of the intraurban location determinants using Poisson and negative binomial regression methods. This article ends with a discussion of the challenges faced by globalizing cities in embedding TNCs and promoting regional development.

Research Background and Conceptual Framework

A wide range of factors, including transportation, land availability, labor cost, market size, and so on, are important to industrial locations. Neoclassical theories, adopting macro and quantitative approaches, tend to emphasize classic economic factors such as transportation and labor costs that can be traced back to Weber's industrial location theory. In contrast to traditional factors, scholars have also identified the impact of institutions and state policies on firm locations (e.g., Globerman and Shapiro 1999; Sit and Liu 2000). Work based on the social network model addresses the importance of interfirm trust, social embeddedness, or interpersonal relationships in making location decisions (e.g., Granovetter 1985; Gordon and McCann 2000). Different from the neo-classical school, highlighting comparative advantages and exogenous endowments, the new geography model states that firms can agglomerate to achieve specific mutual benefits, such as demand linkages that provide producers with incentives to locate close to buyers and cost linkages that drive customers to locate near suppliers (Krugman 1980, 1991; Ottaviano and Puga 1998). These kinds of local linkages are particularly important in TNC locations and the propensities of local sourcing of TNCs tend to be affected by a wide range of factors such as the strategic functions of subsidiaries and their entry modes (Williams 2005; Tavares and Young 2006). Recent literature on innovation and learning further hold that getting access to nontradable inputs and knowledge spillover also contributes to industrial concentration, especially for high-tech ICT firms (e.g., Bathelt,

Malmberg, and Maskell 2004; van Oort and Atzema 2004).

Spatial scale is an important perspective for examining industrial locations (Rosenthal and Strange 2003; He, Wei, and Pan 2007; He, Wei, and Xie 2008). At the global scale, industrial locations, especially the location of TNCs, are greatly sensitive to national characteristics, including economic growth rates, per capita income, government policies and efficiency, market size, institutional stability, and even the degree of economic freedom (e.g., Bengoa and Sanchez-Robles 2003). Different from country-level determinants, studies on industrial locations at the regional level tend to focus on the effect of clustering and agglomeration economies (e.g., Head, Ries, and Swenson 1995), the quality and capacity of infrastructure or transportation conditions (e.g., Friedman, Gerlowski, and Siberman 1992), government incentives, and industrial policies (e.g., Sit and Liu 2000).

Compared with a substantial body of empirical literature on industrial locations at the national or regional scale, increasing attention has been paid to industrial locations within the city (e.g., F. Wu 1999, 2000; Berkoz and Turk 2008; Óhuallacháin and Leslie 2009; Wei, Luo, and Zhou 2010). In a systematic study of the spatial pattern of industrial activities within the thirteen biggest Spanish cities, Arauzo-Carod and Viladecans-Marsal (2009) pointed out that there exists a negative relationship between the distance to the central city and the technological level of firms, indicating that new high-tech firms are more likely to be created in a central city with a high presence of well-qualified people. In short, at the intraurban scale, the factors of efficient transportation facilities, urban structures including suburban areas and central business districts (CBDs), land use regulations largely reflecting the effect of government policies and market forces, and to a lesser extent agglomeration economies, are identified as more important in the local decisions of firms, whereas factors like country political risks and regional labor cost differences might not apply.

In addition to spatial scale, firm heterogeneity is an important perspective on firm agglomeration behavior and productivity (Baldwin and Okubo 2006). This is of particular relevance in TNCs' business strategies and their spatial distribution. For instance, TNCs from different nationalities might have different corporate strategies and location decisions (Poon and Thompson 2004). In the case of TNCs' distribution in Italy, Mariotti, Piscitello, and Elia (2010) have identified the distinctive agglomeration behavior of foreign and domestic firms and found that foreign companies tend to agglomerate with their foreign counterparts instead of with domestic companies because of the information externalities and the balance between knowledge inflow and technology leakage. In this article, we follow the perspective of firm heterogeneity—referring to the distinction between foreign and domestic companies—in studying industrial locations in China.

In general, China's development over the past three decades can be conceptualized as a triple process of decentralization, marketization, and globalization (Wei 2007). Such a transition and the interaction between the state, local agents, and global capital have exerted profound impacts on industrial locations and regional development in China (He, Wei, and Pan 2007; He, Wei, and Xie 2008). We argue that the triple structural processes of transition in China—decentralization, marketization, and globalization—are also the most significant macro forces underlying intraurban industrial locations of foreign and domestic firms, which provides a conceptual framework for the study.

First, the decentralization has granted more authority to local governments in China to make their own decisions and take responsibility for local economic development. Decentralization has intensified the competition among Chinese cities in providing resources for economic growth and regional development. Such competition can be more explicitly and spatially represented by the establishment of development zones across the nation, entitled "development zone fever" (e.g., Y. R. Yang and Wang 2008; Wei and Gu 2010). Specifically, national-level development zones, in addition to well-planned industrial land and advantageous locations, are often coupled with more preconfigured benefits, including tax and tariff exemption, efficient customs service, state subsidies, and cheaper land, making these zones the most favorable places for foreign investors (Wei, Luo, and Zhou 2010).

Second, marketization in China has changed industrial locations by introducing market forces and developing land markets (He, Wei, and Pan 2007). As marketization often results in the reduction of trade barriers, industrial locations in China have exhibited a trend of increasing concentration, indicating that firms tend to agglomerate to achieve positive externalities (He, Wei, and Pan 2007; Mariotti, Piscitello, and Elia 2010). Marketization has also transformed the role of government in local economic development. Land resources and provision of efficient infrastructure become important for local governments to attract investment and achieve sustained economic growth (Wei, Luo, and Zhou 2010). Thereby, marketization and decentralization have made conventional accessibility indicators, land availability, and access to infrastructure more important when firms make intraurban location decisions.

Third, globalization, especially the inflow of FDI, is regarded as the most important force shaping industrial locations in China (He, Wei, and Xie 2008). As a matter of fact, FDI is unevenly distributed in China and heavily concentrated in those emerging global city regions, which are endowed with advantageous locations, more connections with global and domestic markets, and better infrastructure facilities (Zhao and Zhang 2007). Furthermore, FDI location at the regional level is also greatly affected by the country of origin of FDI activity (He 2003) and such home country effects are also evident even at the intraurban scale (C. Yang and Liao 2010b).

Last, spatial clustering of FDI in different regions of China has given rise to varied forms of local production networks within different Chinese cities like Beijing, Shanghai, Suzhou, Shenzhen, and Dongguan, which are characterized by a distinctive relationship between foreign and domestic firms (Zhou et al. 2011). A case study of the auto industry in Shanghai found that the location choices of auto FDI from Germany were confined due to the requirement of local sourcing, driving the colocation of foreign and Sino-China joint ventures (Depner and Bathelt 2005). Kim and Zhang (2008) examined the development of the electronics industry in Qingdao and noted that the indigenous capability of the flagship domestic Chinese firms, such as Haier, successfully attracted foreign suppliers to locate in the same industrial park.

In this article, however, we question that such colocation patterns or substantial linkages between foreign and domestic firms are not a common phenomenon in China, especially in those export-oriented regions. In many cities with a large volume of FDI, the linkages between foreign and domestic firms are still thin (Wei, Lu, and Chen 2009). Even if linkages exist at the local level, these linkages are among foreign firms, forming TNCs' local networks, rather than TNCs' local networks with local Chinese firms (Wei 2010). Such cities, including Suzhou and Dongguan, are more likely satellite industrial districts serving TNCs (Wei, Lu, and Chen 2009; Zhou et al. 2011). Through the case of Kunshan city in Suzhou municipality, Wei (2010) conceptualized the relationship between foreign and domestic firms in these FDI-driven clusters into a series of spatial, technological, structural, and institutional mismatches. In particular, the spatial mismatch thesis argues that foreign firms tend to concentrate in national development zones with preferential FDI policies, leading to location "mismatch" between foreign and domestic firms; such a mismatch serves as the spatial barrier for FDI embeddedness. The spatial mismatch thesis was borrowed from the research on the job–housing relationship in the United States. It is argued that the spatial disconnection between the housing of blacks in the central city and availability of low-skilled jobs in suburban areas has resulted in high unemployment rates and low income of blacks, where employment opportunities of blacks have been reduced by their inability to follow jobs from the central city to the suburbs (Kain 1968, 2004).

Data and Methodology

We have compiled detailed firm-level data of ICT firms in Suzhou. We explicitly and quantitatively compare the intraurban location characteristics of foreign and domestic ICT firms. Our firm-level data on the ICT industry in the city were compiled from the first economic census of China, conducted at the end of 2004 by the National Bureau of Statistics of China. The database provides detailed information on all ICT firms in Suzhou, including the

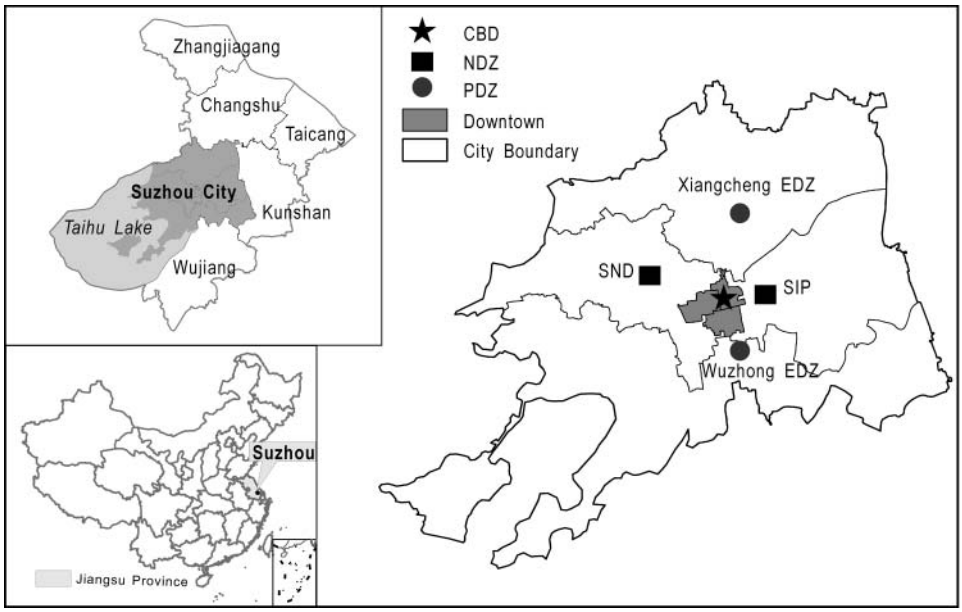

Figure 1 *Location and spatial organization of Suzhou city. Note: CBD = central business district; NDZ = national-level development zone; PDZ = provincial level development zone; SND = Suzhou New and Hi-Tech District; SIP = China–Singapore Suzhou Industrial Park; Xiangcheng EDZ = Xiangcheng Economic Development Zone; Wuzhong EDZ = Wuzhong Economic Development Zone.*

name, address (location), industry code, firm type, year of establishment, operating income, total assets, and number of employees at the end of 2004. In this article, the city of Suzhou refers to the city proper or the metropolitan area of Suzhou Municipality (Figure 1). It covers 1,650 km^2 of land area and includes seven districts. The two national-level development zones—the Suzhou New and Hi-Tech District; (SND) and the China–Singapore Suzhou Industrial Park (SIP)—are located in the west and east of the city, respectively.

We geocoded the ICT firms within the city with the aid of Google Earth and our ground knowledge. A total of 995 ICT firms were georeferenced on the map, accounting for 90 percent of the total number of ICT firms in the city. Most of the firms that were not geocoded are small firms lacking detailed address information.

Traditional methods used in assessing the distribution of industrial location or concentration include a series of indexes such as Herfindahl, Gini, or EG (Ellison and Glaeser) indexes (Duranton and Overman 2005). These methods all evaluate the heterogeneity of the spatial structure based on designated administrative boundaries such as city, ZIP code, and census tract. Spatial point pattern analysis and distance-based methods have been recently applied to the studies of industrial location (e.g., Marcon and Puech 2003; Duranton and Overman 2005). There are several advantages to using point pattern analysis. First, in contrast to studies with reference to administrative boundaries, point pattern analysis allows us to measure locations of firms based on same-size cell units or even the distances between points. Second, point pattern analysis can be further categorized into density-based methods such as quadrant analysis, kernel density estimation, and distance-based methods such as the *K*, *L*, and *M* functions (Bailey and Gatrell 1995; Marcon and Puech 2003). In this study, density-based methods (kernel density estimation and hotspot analysis using the Getis-Ord G_i^* statistic) are employed, which is explained in the related sections.

In addition to the point pattern analysis, the Poisson and negative binomial regression methods were used to model the locational factors underlying firm locations. As firm location is a process of selecting a preferable location from alternatives over a discrete space, the classic regression model could be problematic due to the violation of the normal distribution assumptions and too many zero value observations in point patterns (F. Wu 1999; Arauzo-Carod and Viladecans-Marsal 2009). Discrete choice models like the Poisson regression model are more powerful in modeling location decisions in a discrete urban space. Because the clustering of new establishments in specific areas can lead to an "overdispersion problem"—occurring when the variance is greater than the mean, which violates the assumption of the Poisson model, the negative binomial model can be used to solve this problem (Arauzo-Carod and Viladecans-Marsal 2009).

Moreover, we divided the study area with a grid using small-size cells. This helps us to efficiently model the intraurban point pattern in a more accurate manner because the number of the most disaggregated administrative units in Suzhou is only seven, which cannot be used as the unit for regression analysis. The cell size is determined by the size of the study area and the number of firms within the study area, as typically used in point pattern analysis (Wong and Lee 2005). The calculation formula is as follows:

$$Q = \frac{2A}{n} \tag{1}$$

where Q is the size of a single cell, A is the area for the study area, and n is the number of firm points in the study area. The size of a cell is $\sqrt{2A/n}$. The number of cells is $n/2$. So, the city proper of Suzhou is covered by 500 cells, and the size of each cell is a square 2 km in dimension.

Profile of the ICT Industry

The rise of Suzhou in the global ICT industry greatly benefits from the concentration of foreign manufacturing investment. The output value of Suzhou municipality's ICT manufacturing was 598.7 billion yuan (233.4 billion yuan for Suzhou city) in 2008, ranking first in Jiangsu Province and the YRD (even slightly higher than Shanghai; Shanghai Statistical Bureau [SHSB] 2009; Suzhou Statistical Bureau [SSB] 2009).[1] The ICT sector is the most important sector in Suzhou, accounting for 32.1 percent and 42.8 percent of total industrial output for the municipality and city, respectively. The ICT sector is also the major recipient of FDI and is dominated by TNCs. FDI in Suzhou municipality and city have risen dramatically since the early 1990s, reaching US$2.9 and US$1.2 billion in 2000, US$5.1 and US$2.5 billion in 2005, and US$8.1 and US$3.5 billion in 2008, respectively (SSB 2009). Foreign-invested enterprises had total exports and imports of US$174.9 billion in 2009, accounting for 86.8 percent of Suzhou municipality's total exports and imports, indicating the dominance of foreign investment and trade in the economy, making Suzhou the fourth largest export hub among Chinese cities in 2009, following Shanghai, Shenzhen, and Beijing (Suzhou Customs 2010). The municipality had 113 Fortune 500 TNCs such as AMD, Samsung, Siemens, Hitachi, Emerson, and so on ("113 Fortune 500 enterprises have invested in Suzhou" 2007).

Our firm-level data reflect the structure of the ICT industry in Suzhou city (Table 1). Foreign firms occupy over 96.8 percent of assets and 92.4 percent of the total employment. Most of the foreign ICT firms invested in the city after 2000 (76 percent). In terms of ownership, only 10.7 percent of foreign firms adopt the form of joint ventures and most domestic firms are private enterprises, reflecting the phase-out of Township and Village Enterprises in the Sunan model (Wei, Lu, and Chen 2009). Taiwan is the largest source of foreign ICT firms (218 firms), accounting for 45 percent of the total number of foreign firms, which is also double the second largest source (i.e., Japan). We also find that foreign ICT firms dominate the manufacture of computer equipment (77 out of 102) and also IC manufacturing (42 out of 58). This demonstrates that foreign firms play a dominant role in both key components and final assembly of computers, whereas a large number of domestic firms mainly specialize in the manufacture of low-end components. The number of employees in over 95 percent of domestic firms is also fewer than 200. In addition, the size distribution of foreign ICT firms is biased

Table 1 *Profile of information and communication technology firms in Suzhou City, 2004*

		# Cases (all)		# Foreign firms		# Domestic firms	
Attribute	**Category**	***n***	**%**	***n***	**%**	***n***	**%**
Year established	Before 1992	23	2.31	3	0.62	20	3.91
	1992–1995	65	6.53	27	5.58	38	7.44
	1996–2000	264	26.53	86	17.77	178	34.83
	After 2000	643	64.62	368	76.03	275	53.82
Type	Joint ventures	52	5.23	52	10.74	—	
	WFOEs	432	43.42	432	89.26	—	
	SOEs	21	2.11	—	—	21	4.11
	Private enterprises	490	49.25	—	—	490	95.89
Headquarter (FIEs)	Taiwan	218	21.91	218	45.04	—	—
	Japan	87	8.74	87	17.98	—	—
	United States	49	4.92	49	10.12	—	—
	Hong Kong	30	3.02	30	6.20	—	—
	Singapore	28	2.81	28	5.79	—	—
	South Korea	28	2.81	28	5.79	—	—
	Others	44	4.42	44	9.09	—	—
Sectors	Communication equipment	71	7.14	32	6.61	39	7.63
	Computer equipment	102	10.25	77	15.91	25	4.89
	Electronic parts/components	596	59.90	254	52.48	342	66.93
	Semiconductor wafer	45	4.52	25	5.17	20	3.91
	IC manufacturing	58	5.83	42	8.68	16	3.13
	Others	123	12.36	54	11.16	69	13.50
Asset ($ millions)	Less than 5	171	17.19	59	12.19	112	21.92
	5–10	104	10.45	4	0.83	100	19.57
	10–25	159	15.98	27	5.58	132	25.83
	Over 25	561	56.38	394	81.40	167	32.68
Total assets	($ millions, share %)	981,654 (100)		950,629 (96.84)		31,025 (3.16)	
Average assets	($ millions)		987	1,964		61	
Employee (persons)	Less than 100	712	71.56	241	49.79	471	92.17
	100–199	86	8.64	63	13.02	23	4.50
	200–499	107	10.75	94	19.42	13	2.54
	500–1,000	46	4.62	42	8.68	4	0.78
	Over 1,000	44	4.42	44	9.09	0	0.00
Total employee	(persons, share %)	247,303 (100)		228,499 (92.4)		18,804 (7.6)	

Note: WFOE = wholly foreign owned enterprise; SOE = state-owned enterprise; FIE = foreign invested enterprise.
Source: Firm level data set of Suzhou.

toward large-size firms. Over 80 percent of the foreign ICT firms in the city of Suzhou have investments over US$25 million. This bias is slightly different from the profile of ICT firms in Kunshan, a county-level ICT hub also in the municipality of Suzhou, in which the firm size distribution is characterized by a bipolar pattern (Wei 2010), which also shows the preference of large foreign ICT firms in Suzhou city. We can summarize that the ICT industry in Suzhou city is primarily occupied by large-scale foreign firms in both key component and system manufacturing, while domestic firms are weak.

Location Patterns: Spatial Mismatch Between Foreign and Domestic Firms

This section uses firm density plots, kernel density estimation, and hotspot analysis to comparatively evaluate the spatial distribution of foreign and domestic firms. To explore the impact of internal urban structure, we plot the firm densities—defined as the number of firms in a square kilometer—against the distances to the CBD. Firm densities have greatly increased over time (Figure 2), indicating an increase in the number of establishments in Suzhou city. The firm densities of foreign firms and

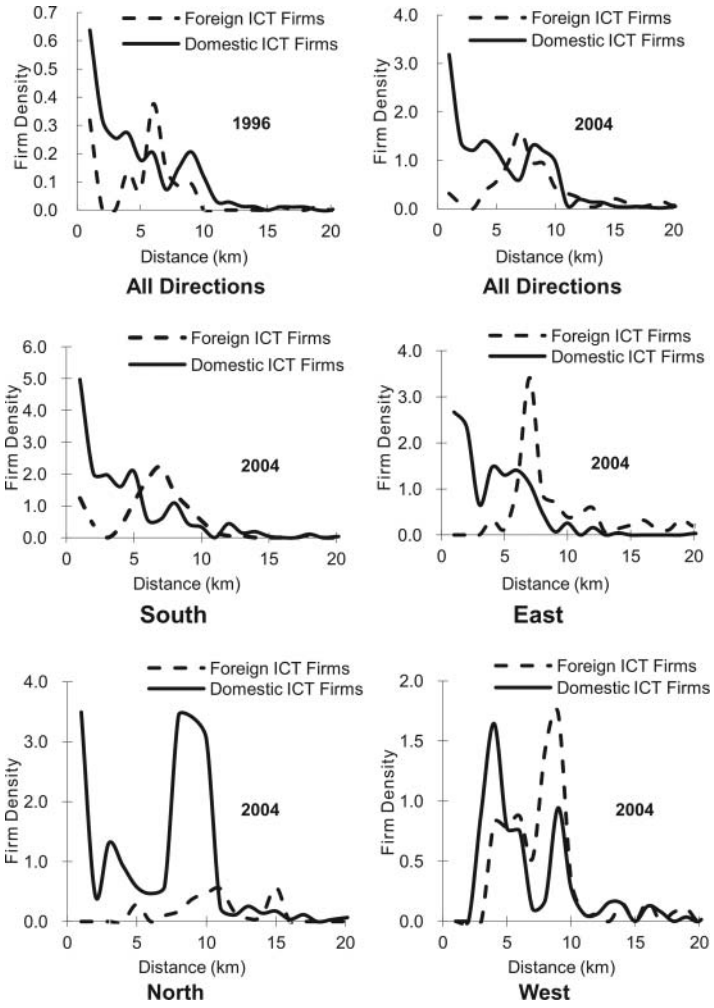

Figure 2 *Densities of firms and distances to the central business district in Suzhou City, 1996 and 2004. Note: ICT = information and communication technology. Source: Firm level data set of Suzhou.*

domestic firms have shown a pattern of spatial mismatch. The densities of domestic firms are much higher in the areas near the CBD. As the distance to the CBD increases, though, the densities of foreign firms rise and surpass that of domestic firms, indicating that firms located in the downtown or inner city of Suzhou are mostly domestic firms, whereas foreign ICT firms cluster in suburban areas, around 7 to 9 km from the CBD. Figure 2 also demonstrates that densities of foreign ICT firms are higher along the east and west directions, mainly because two national development zones, SIP and SND, are located in the east and west of Suzhou city, respectively. This shows that the locations near the CBD might not be attractive to foreign ICT firms due to land availability and their export nature, which is different from the research on industrial locations of ICT firms in Spain, where firms tend to locate as close as possible to the central city (Arauzo-Carod and Viladecans-Marsal 2009). By contrast, in addition to clustering in the inner city, the higher densities of domestic ICT firms in

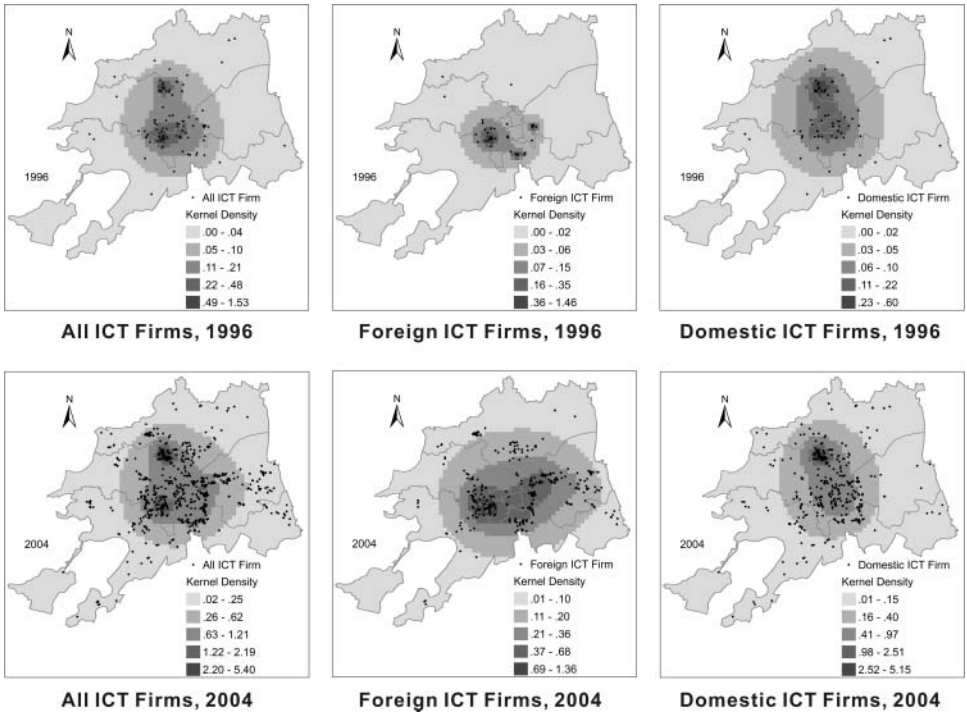

Figure 3 *Kernel density estimation of information and communication technology (ICT) firms in Suzhou City, 1996 and 2004. Source: Firm level data set of Suzhou.*

the northern suburban areas of Suzhou can be observed, partly resulting from the establishment of a provincial-level development zone, the Xiangcheng Economic Development Zone (XCEDZ) in Xiangcheng district in the north of the city, where a number of domestic ICT firms are concentrated (Xiangcheng Government 2010).

Figure 3 further shows the distribution of ICT firms in Suzhou using kernel density estimation. In comparison to the normal density map of firm locations, kernel density estimation is useful in visualizing the intensity of events (locations of firms) by generating a smoothed estimation surface (Bailey and Gatrell 1995). The 3-km bandwidth was used based on the effect of visualization and smoothing because this bandwidth visualizes firm densities and smooths the data most effectively. In general, firm locations expanded from the inner city in 1996 to the suburban area in 2004 (see Figure 3). Before 1996, due to relatively convenient transportation and better productive service, the inner city was a better location for ICT firms, contributing to higher kernel density estimates of firms in Jinchang and Canglang districts, as well as SND in the west of the city. Moreover, as shown in Figure 3, foreign ICT firms expanded along the east–west axis in the city from 1996 to 2004, whereas domestic firms expanded in a north–south direction. Such change is highly consistent with the preceding analysis of firm density. In more detail, this result is also associated with the different development strategies and urban land use patterns in Suzhou city during the late 1990s and early 2000s. In this period, the most rigorous and visible measure that Suzhou undertook was developing the SIP in the east of the city, which consisted of mostly rural areas in the 1980s and early 1990s. SIP is also the largest development zone in Suzhou city jointly run by Chinese and Singaporean consortiums (Wei, Lu, and Chen 2009). Foreign investment flowing into the SIP increased from US$410 million in 1996 to US$1.58 billion in 2005, resulting

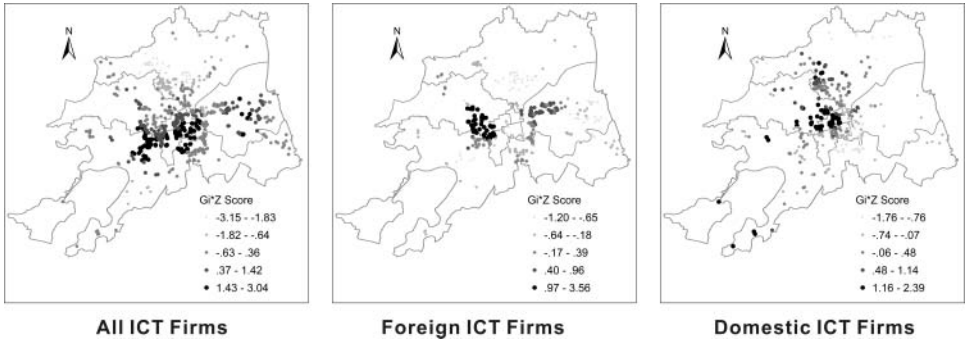

Figure 4 *Hotspot analysis of employment of information and communication technology (ICT) firms in Suzhou City, 2004. Source: Firm level data set of Suzhou.*

in increased kernel density estimates of foreign ICT firms in the eastern part of the city (Figure 3). So the national development zones including SIP and SND, to some extent, shaped the clustering of foreign ICT firms within the city, which also enabled Suzhou to scale up toward globalization (Wei, Lu, and Chen 2009).

Kernel density estimation mainly focuses on the point distribution but does not consider the impact of firm sizes on the clustering patterns. Based on the georeferenced firm data with employment in 2004, we conducted hotspot analysis using the Getis-Ord G_i^* statistic. The *G*-statistic indicates whether features with high values or those features with low values tend to cluster in a study area. If a firm's employment is high and employment of its neighboring firms is also high, it is part of a hotspot. The local sum of total employment for a firm and its nearby firms is compared proportionally to the sum of all firms. A *Z* score indicates whether there is a significant difference between the local sum and expected number of employees or a random distribution.

Figure 4 shows the results of hotspot analysis based on the employment of ICT firms in Suzhou in 2004. In contrast to the kernel density estimation map, hotspots of all firms are biased toward the hotspots of foreign ICT firms instead of domestic firms. This is reasonable because the number of employees of domestic firms is much smaller than foreign firms (Table 1). In addition, similar to the kernel density map, the hotspots of foreign firms are concentrated in SIP and SND, whereas hotspots of domestic firms are clustered in the inner city of Suzhou and the aforementioned XCEDZ in the north of the city—in contrast to other districts in Suzhou, domestic firms have contributed to 69 percent of the industrial output of Xiangcheng district (Xiangcheng Government 2010)—which confirms the spatial mismatch between foreign and domestic firms. In short, if the employment size of firms is considered, the clustering of ICT firms in Suzhou city is, to some extent, dominated by foreign ICT firms, especially those TNCs located in the national-level development zones of SND and SIP. The revealed spatial pattern of foreign ICT firms is also consistent with findings from a survey of ICT firms in Suzhou conducted in 2006, in which better industrial infrastructure and better investment incentives—two major characteristics of development zones—were ranked as the most important factors in making location decisions within the city (Wei, Lu, and Chen 2009).

Poisson and Negative Binomial Modeling of Intraurban Location Determinants

In this section, we further the preceding analysis of ICT firms in Suzhou city by exploring the location determinants for the year 2004. Using the number of firms in same-size cells in 2004 as the dependent variable, we use Poisson and negative binomial regression models

Table 2 *Factors underlying the location choice of information and communication technology firms*

Variable type	Variable	Variable definition	Unit	Expected sign
Agglomeration economies	Stock of firms	Firm density in 2000	Number/cell	+
Accessibility	Distance to highway exit	Distance between the centroid of the cell and the nearest Shanghai-Nanjing freeway exit	Km	–
	Distance to CBD	Distance between the centroid of the cell and Guanqian Street (CBD) in the downtown area	Km	–
Government policy	Development zone	The area of land that is used as development zones in the cell	Km^2	+
Land availability	Mountain area	The area of mountains in the cell	Km^2	–
	Lake area	The area of lakes in the cell	Km^2	–

Note: CBD = central business district.

to examine the determinants of the locations of foreign and domestic firms comparatively at the intraurban level.

As mentioned in the research background section, our analytical framework pays close attention to the significance of institutions, agglomeration, and place characteristics underlying location decisions of firms at the intraurban level. Given the intraurban level of analysis, location determinants at the national level (e.g., political risk and languages) or regional level (e.g., labor cost, market size) might not apply. This requires us to include variables that are tied to place characteristics (Wei, Luo, and Zhou 2010). Six variables were selected to explore the determinants of locations at the intraurban level (Table 2).

Government Policy

Research on China has revealed that government policy plays a critical role in firm locations, especially foreign-invested enterprises (Sit and Liu 2000; Wei, Luo, and Zhou 2010). To facilitate the development of high-tech industries, local governments in coastal China have provided more preferential policies for ICT firms that are relatively technologically advanced and capital intensive (C. Yang 2009). Government policy, especially in the YRD, can be represented by the establishment of development zones with preferential policies (Y. R. Yang and Wang 2008; Wei and Gu 2010). Specifically, regarding the location decisions at the intraurban level, as mentioned earlier, the land in development zones is relatively well planned and easy to develop. The development zones also offer a pleasant living environment and better industrial infrastructure, making them the most favorable places for ICT TNCs. In this study, the importance of development zones to firm locations is represented by the area of land that is used as development zones in each cell.

Agglomeration Economies

In the ICT industry, the spatial agglomeration of similar or related firms is one of the most important benefits for colocation (Arauzo-Carod and Viladecans-Marsal 2009). Also, the colocation of ICT firms strengthens the information spillovers at the interfirm level and enhances interfirm transactions via the formation of just-in-time production and specific supply chain governance (zero-stock; Y. R. Yang and Hsia 2007). The agglomeration or clustering of firms can also result in the concentration of external producer services, such as business, finance, and intermediaries. These agglomeration economies, in turn, provide incentives for the clustering of ICT firms. In the model, the firm density in the cells in 2000 (stock of firms) is used to represent the effects of agglomeration economies.

Accessibility

Accessibility is another crucial factor when firms make location decisions within cities, and previous studies of industrial locations also indicated the significance of accessibility to the

Table 3 *Estimation of industrial locations of ICT firms in Suzhou*

Dependent variable	Number of foreign ICT firms			Number of domestic ICT firms		
Independent variables	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Constant coefficient	0.1240	–0.2275	0.1978	–0.8702**	–0.0023	–1.6418***
Stock of all firms	0.1077			0.3572***		
Stock of foreign firms		0.9540***			0.8167**	
Stock of domestic firms			–0.0380			0.8498***
Distances to CBD	–0.0172*	–0.0157*		–0.0181*	–0.0406***	
Distances to highway exits			–0.0176*			–0.0037***
Government policy (development zone)	0.2803**		0.3859***	0.1995*		0.1486
Mountain area	–1.7742**	–1.8203***	–1.9774***	–0.4458	–0.3015	–0.4719
Lake area	–1.0527***	–0.9815***	–0.9999***	–0.5709***	–0.4526**	–0.4858**
Sample	351	351	351	351	351	351
α	3.6598***	2.8937***	3.9826***	2.1652***	7.6123***	2.4264***
LR statistics	926.72	771.78	982.32	583.70	1, 425.83	660.98
Probability (LR stat)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Log likelihood	–293.53	–289.02	–295.88	–248.98	–280.19	–248.21
Pseudo-R^2	0.6122	0.5718	0.6240	0.5396	0.7179	0.5711

Note: Densities refer to kernel density estimates. ICT = information communication and technology; CBD = central business district; LR = likelihood ratio.
*Significant at 0.1.
**Significant at 0.05.
***Significant at 0.01.

CBD and transportation infrastructure (F. Wu 2000; Wei, Luo, and Zhou 2010). We employ distances to the CBD to indicate the accessibility of a cell or a specific location to the central city (downtown) where command and service functions are relatively concentrated. Moreover, distances to the nearest highway exits are used to measure the accessibility to transportation infrastructure. In particular, products in the ICT industry are characterized as small in size and also high in value, and a firm's location cannot simply be interpreted by the logic of minimizing cost brought by interfirm material linkages as accessibility plays an important role in achieving just-in-time production (Y. R. Yang and Hsia 2007). Therefore, most of these products are delivered by cargo trucks through highway systems (Targa, Clifton, and Mahmassani 2006). We consider that distances to the nearest highway exits can well represent how close or convenient it is for the ICT producers to deliver their products.

Land Availability

We also expect that the availability of industrial land is crucial to ICT firms when they select sites within cities. Those areas including mountains and lakes are believed to be more difficult for building factories. In addition, urban planning in China has put more emphasis on environmental protection. Local governments have also restricted the transformation of land use from mountains or lakes to industrial land (Xie et al. 2006). The availability of industrial land therefore can be negatively associated with the area of mountains and lakes in specific locations or cells.

To avoid the problem of multicollinearity, correlation coefficients of all explanatory variables were calculated and we identified that the distances to the CBD and the distances to the nearest freeway exits were highly correlated and the correlation coefficient between stock of foreign firms and development zones was also significant. We therefore put these variables into three sets of Poisson and negative binomial regression models, aiming to eliminate multicollinearity. To examine the impact of agglomeration economies on the locations of domestic and foreign firms in a comparative way, the stocks of foreign firms, domestic firms, and all ICT firms were also involved in the specific models, respectively. The results of

Poisson and negative binomial regression analyses are shown in Table 3.

First, development zones are significantly related to the location decisions of foreign ICT firms, but they are insignificant to domestic firms. This suggests that development zones in Suzhou are mostly built to attract foreign investors instead of domestic firms. It also echoes the previous literature on Suzhou, highlighting that to compete with other regions, particularly the PRD, local governments in Suzhou have adopted a more explicit spatial strategy, namely, establishing development zones or industrial parks that are endowed with well-planned and low-priced industrial land to lure foreign firms from Taiwan (Y. R. Yang and Wang 2008).

Second, we have found that agglomeration economies have varied effects on the locations of foreign and domestic ICT firms in the city of Suzhou. As demonstrated by the study of TNCs' location behavior in Italy (Mariotti, Piscitello, and Elia 2010), locations of foreign ICT firms in Suzhou are also associated with existing foreign firms, but the effect of existing domestic firms is very weak. This result is likely to be related to the thin embeddedness of foreign ICT firms and the nature of their exclusive network (Wei 2010). This finding is also consistent with the survey in Suzhou in 2006, showing that locations of major customers, agglomeration of similar enterprises, and better access to material suppliers are the three most important factors when foreign firms make location decisions within Suzhou (Wei, Lu, and Chen 2009). Further, our regression models also show that the locations of domestic firms are significantly affected by the stock of previous firms, especially domestic firms and, to a lesser extent, foreign firms as well. This indicates that domestic ICT firms, which are mostly small in size, tend to cluster with other domestic firms. In terms of foreign firms, smaller firms' location patterns show similarity with domestic firms, whereas large foreign firms tend to cluster in development zones, as we have found in previous sections. The spatial mismatch has been reduced somewhat with the expansion of FDI beyond national-level development zones, as evidenced by Figure 3 as well. The aforementioned survey also highlighted that 18.3 percent of foreign firms have increased their local sourcing from domestic firms during the period from 2004 to 2006, even though such purchases are mainly for the supplies of peripheral parts and low-end components.

Third, accessibility indicators have more significant influence on the location of domestic firms than foreign firms, as evidenced by the fact that the regression coefficients for foreign firms are marginally significant at the level of 0.1. This is because given their export orientation, foreign firms rely less on the CBD in Suzhou city and tend to locate in large-scale development zones in suburban areas, which occupy more land and connect expressways more efficiently. By contrast, domestic firms are smaller and closer to urban areas, and therefore the distances to highway exits or the CBD have a greater effect on their locations within the city. This finding is consistent with the earlier research on the FDI locations in Nanjing (Wei, Luo, and Zhou 2010). So, in China, the negative relationship between the distance to the central city and the higher technological level of firms—found in the case of Spain (Arauzo-Carod and Viladecans-Marsal 2009) and higher rates of new ICT firm formation in central core locations identified in The Netherlands (van Oort and Atzema 2004)—might not apply because foreign ICT firms labeled as high-tech enterprises mostly take the secondary cities in China, including Suzhou and Dongguan, as their export-oriented manufacturing or assembly centers.

Fourth, firm locations are also affected by the site characteristics of available industrial land. Regardless of domestic or foreign firms, lake areas are negatively related to firm densities. This is of particular importance when compared with other cities such as Dongguan in south China where foreign ICT firms are also concentrated. In Dongguan, industrial development has resulted in severe environmental degradation and massive loss of water bodies (Hu et al. 2005). The Suzhou government has made more efforts to conserve water bodies (Xie et al. 2006) to achieve long-term environmental sustainability. In addition, we also show that mountain areas are significant to foreign ICT firms and the coefficient sign is negative. This is also understandable because large foreign ICT firms located in development zones are more likely to have well-planned flat industrial land.

Discussion and Conclusion

This article analyzes the intraurban locations of ICT firms in Suzhou with an emphasis on the differences between foreign and domestic firms. First, this study provides strong evidence for the perceived notion of a "spatial mismatch" between foreign and domestic firms that is highly associated with the establishment of development zones—SND and SIP—in the east and west of Suzhou city. Using Poisson and negative binomial regression models, it also shows that the industrial location in China can be explained by a triple transition of globalization, decentralization, and marketization, further proving the effectiveness of this analytical framework.

This study has also more specifically demonstrated that at the intraurban scale, development zones, agglomeration economies, land availability, and urban structure have significant influences on firm locations. We find that foreign ICT firms only take the stock of foreign investment into consideration but are not concerned with the distribution of domestic firms in location decisions. Moreover, foreign ICT firms are also more sensitive to the urban landscape and the availability of industrial land, which is also an important reason why national-level development zones are the most favorable places for TNCs.

Second, this study has found that TNCs tend to concentrate in national development zones, essential to the problem of spatial mismatch between foreign and domestic firms. Such a pattern of TNC location is geographically based and institutionally created through China's open door policies, providing preferential policies to foreign firms in national development zones unavailable to domestic firms. Consequently, the development of Suzhou's companies highly focused on FDI-led manufacturing and TNCs have formed their own exclusive network in the city. We cannot identify a strong mutual relationship between the locations of foreign ICT firms and the proximity to the central city common to ICT firm locations in Europe. The relationship between TNCs' locations and development zones in Suzhou reflects the location process between locality and TNCs under China's transition. The industrialization in the PRD is more characterized by a bottom-up process, where most industrial districts were constructed by local villages and township governments. The resulting industrial landscape is fragmented due to the construction of small-size industrial districts without coordination at the city level and detailed guidance planning (Yeh and Li 1999). Suzhou has implemented a "top-down" strategy to FDI, represented by the establishment of national-level development zones. This strategy is helpful for the YRD or Suzhou in particular to compete for FDI and the relocation of Taiwanese ICT firms since the late 1990s (C. Yang 2009). Such a strategy is critical to the spatial mismatch between foreign and domestic firms, however, indicating the institutional creation of the mismatch and the function of local states in China. Decentralization in China has been associated with the reform of the evaluation system of local states, in which economic indicators such as gross domestic product (GDP) have become the most important indicator in the promotion of local cadres within the Chinese government (Y. R. Yang and Wang 2008). This triggers local governments to make every effort, such as establishing national-level development zones, to entice large TNCs because they could exert significant influence on GDP and tax revenue in a short time. Insufficient attention has been paid, however, to the long-term indigenous development and supporting domestic firms to enter these zones. Therefore, the geographical phenomenon of spatial mismatch is not purely a consequence of "rational" location decisions of firms but also rooted in China's institutional system.

Third, this spatial mismatch serves as the basis for the weak linkages between foreign and domestic firms in Suzhou. The challenges facing Suzhou in embedding TNCs are not unique. In many other cities in developing countries, supply linkages between TNCs and local firms are contingent on a wide range of factors such as entry modes, culture affinities, and sector characteristics, and the general embeddedness of TNCs tends to be weak (Williams 2005; Yang and Liao 2010a; Wei, Liefner, and Miao 2011). The spatial mismatch between foreign and domestic firms is also related to the fact that most of the foreign ICT firms in Suzhou are from Taiwan. Taiwanese ICT firms tend to adopt the strategy of "network-based relocation," which in turn

limits the collaboration between foreign and domestic firms (Hsu 2006). In addition, in the face of the fierce competition for FDI, local governments in Suzhou are weak in bargaining with TNCs, and they also believe that they should let TNCs organize their local production networks by themselves based on the market. So although the inflow of FDI has enabled Suzhou to become the largest laptop production region in the global ICT industry, the district is more representative of a satellite manufacturing floor instead of a neo-Marshallian district with global–local synergy (Wei, Lu, and Chen 2009).

Fourth, the spatial mismatch between foreign and domestic firms has imposed more challenges on the future development of Suzhou. Our overall assessment of Suzhou's development, based on the clustering of foreign ICT firms in the city, is positive for economic development and we also notice that a few domestic ICT firms have successfully established linkages with globally led firms and developed indigenous innovation capabilities. As a matter of fact, local governments in Suzhou are well aware of the importance of embedding foreign ICT firms in local economic development and fostering indigenous innovation capabilities. More recently, the Suzhou government has launched a series of policies to help domestic firms and provide support for local innovation activities (Wei, Liefner, and Miao 2011). Nevertheless, spatial mismatch, coupled with structural and technological mismatches, provides a strong barrier to the embeddedness of TNCs and requires more effort from local governments to overcome spatial barriers to foreign and domestic firm linkages.

Lastly, some research limitations in the case of Suzhou deserve attention. Due to the dominance of Taiwanese ICT firms in Suzhou, the resulting spatial pattern of TNCs in Suzhou is greatly influenced by the characteristics of Taiwanese TNCs. Additionally, because the varied forms of local production networks in different globalizing city-regions in China have been identified (Zhou et al. 2011), more research on other cities in China, such as inland cities with a smaller amount of FDI that are of great potential, is likely to enrich our knowledge about the geographical differentials of dynamic relationship—either match or mismatch—between foreign and domestic firms. ■

Note

[1] The numbers here only count enterprises with sales revenue over 5 million yuan (for details about changes in industrial statistics in China, see He, Wei, and Xie 2008).

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YEHUA DENNIS WEI is a full professor in the Department of Geography and Institute of Public and International Affairs at University of Utah, Salt Lake City, UT 84102. E-mail: wei@geog.utah.edu. His research focuses on China's economic and urban geography, regional and urban development, and globalization.

FENG YUAN is an assistant professor in Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, China, 210008. E-mail: fyuan@niglas.ac.cn. His research interests include industrial agglomeration, spatial analysis, and China's regional and urban development and planning.

HAIFENG LIAO is a PhD Candidate in the Department of Geography at the University of Utah, Salt Lake City, UT 84102. E-mail: haifeng.liao@utah.edu. His research focuses on GIS spatial statistics, industrial location, and regional and urban development and planning, with a regional focus on China.