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Geographical FDI knowledge spillover and innovation of indigenous firms in China

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ABSTRACT

In recent decades, theoretical debate on firm innovation has considered particular forms of spatial clustering and foreign direct investment as almost mutually exclusive drivers. While cluster literature pays less attention to firm heterogeneity in ownership structure, FDI literature ignores the importance of geographical dimension in spillover effects. This study combines these two lines of theoretical inquiry to investigate regional FDI knowledge spillover effects on product innovation of China's indigenous electronic firms. It is found that localized innovative-related activities of foreign-invested firms significantly facilitate product innovation of domestic firms. However, FDI horizontal spillover is more important than vertical spillover and cross-sector rather than intra-sector knowledge is significant for indigenous innovation. FDI spillover effects can be reinforced by local innovative activities of domestic firms. This study highlights the significance of geographical proximity and relatively heterogeneous knowledge in FDI spillover effects on domestic innovation but questions the mutual trust relationship between foreign and domestic firms in a cluster.

1. Introduction

Theoretical discussions and debates on indigenous innovation of emerging economies have focused on the effects of foreign direct investment (FDI) and particular forms of spatial clustering of firms. While foreign investment has traditionally been viewed as exogenous sources of technology transfer, firm agglomeration or clustering has been considered as endogenously driving forces to firm innovation. Interesting enough, these two lines of theoretical inquire have seen each other as mutual exclusive driver without giving credits to the other (Menghinello, De Propris, & Driffield, 2010).

On the one hand, foreign direct investment and their effects on host economies have been a hot subject of documentation in the fields of economics and international business (Crespo & Fontoura, 2007; Havranek & Irsova, 2012). Scholars have been obsessive about whether or not and to what extent foreign-invested firms can produce knowledge spillover beneficial to local firms. Empirical analyses have generated competing interpretations, however (Aitken & Harrison, 1999; Javorcik, 2008; Smeets, 2008). These inconclusive findings are attributed to the disregard of the role played by geography in knowledge spillovers and innovation (Barrios, Görg, & Strobl, 2011; Driffield, 2006; László & Balázs, 2007).

On the other hand, the issue of spatial clustering or geographical proximity on firm innovation has never ceased to capture scholarly imagination of economic geographers. Since knowledge may decay with distance, geographical proximity plays a significant role in knowledge diffusion, assimilation, recombination and innovation (Wang, Lin, & Li, 2010). Meanwhile, geographical proximity is identified as an essential condition for firms to enjoy the benefits of externality and therefore brings trust, collaboration and interactions for knowledge flows and transfer (Boschma, 2005). However, this body of literature implies that knowledge spreads evenly among co-located firms without taking account into the heterogeneous characteristics of firms (Wang & Lin, 2013). Foreign-invested firms, for example, tend to be regarded as technological leaders compared to their counterparts in developing countries (Liefner, Wei, & Zeng, 2013). In recognition that the mechanism of knowledge flows and sharing identified in the cluster literature is based on equality and mutual benefits, the progress of knowledge spillover can be easily inhibited by the distinguished differences between local and foreign firms in technological capability, cognitive structure and management philosophy.

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Against the theoretical backdrop, this article attempts to combine these two lines of theoretical inquiry to investigate the geographical knowledge spillover effects of foreign-invested firms on product innovation of local firms in a cluster, with a case study on China's electronics industry. Thanks to the reform and open-up policy, China has been the largest recipient of foreign investment among the developing countries and even the world to warrant itself an interesting and significant case for a close investigation. The knowledge-intensive feature of the electronics industry means that there is an important role for FDI knowledge spillovers and flows to play in the process of innovation and hence a case that deserves our special attention. For example, Datang Telecom could not have developed China's own technical standards TD-SCDMA without technology transfer and knowledge spillovers from Siemens and Nokia. The NASDAQ-listed Chinese firm TechFaith was founded by people who used to work in Motorola (Du et al., 2009).

The rest of the article is structured as follows. It starts with a critical review of literature on geography, localized knowledge spillover, FDI spillover effects and innovation. It is then followed by a clarification of data and methodology adopted in this study. The third part introduces the evolution and spatial distribution of foreign-invested electronic firms during the period of 1998–2009. Attention is paid to the mechanism of geographical horizontal and vertical spillover effects of foreign-invested firms as well as the relative importance of intra- and inter-sector knowledge on product innovation of indigenous firms. The last part summarizes the main findings and discusses their implications.

2. Geographical knowledge spillover, FDI effects and innovation of domestic firms

2.1. Geographical proximity, knowledge spillover and innovation

When innovation studies in international business and management science lay much emphasis on micro-level strategies and behavior of firms at the expense of their meso-level geographical environment, the significant role played by geography in knowledge creation, spillover and flows has long been a concern of economic geographers. Since the early 1990s, professional attention has been turned to the study of clusters, industrial districts, innovation milieus, regional systems of innovation to highlight that geography or geographical proximity matters in the following ways (Markusen, 1996; Beugelsdijk, 2007). First of all, knowledge flows more easily and rapidly among co-located firms as spillover effects will decay with geography/distance (Simmie, 2004). In particular, knowledge is often divided into two forms: tacit knowledge and codified knowledge. In contrast to codified knowledge that can be easily understood and widely circulated, tacit knowledge involves know-how and requires a certain background to be put into full use, in which geographical proximity facilitates its process of transmission and absorption (Howells, 2002). Mariotti, Piscitello, and Elia (2010) illustrate that multinational enterprises in Italy tend to agglomerate with other multinational enterprises in order to enjoy localized knowledge inflows.

Second, firms' agglomeration in certain places can nurture a localized labor pool, which induces knowledge flows and circulation through the mobility of qualified labors in the cluster (Fan & Scott, 2003). An empirical research on Canadian manufacturing industries demonstrates that "being there" or "closeness" between users and producers is important for the successful dissemination and implementation of advanced knowledge and technologies (Gertler, 1995). Third, geographical proximity could forge trust relationship and innovative milieu between local agents by stimulating their interactions and linkages to intrigue collective learning and knowledge sharing (Gordon & McCann, 2000; Fu, Revilla, & Schiller, 2013). It is argued that the advantages of firms' co-presence do not really lies in the emergence of reciprocal actions to lowering transaction costs but in knowledge creation and diffusion through the horizontal and vertical dimensions of clusters (Maskell, 2001).

Horizontal dimension of a cluster consists of firms with similar goods and vertical dimension involves a complementary and interlinked network of suppliers and customers (Bathelt, 2005). Horizontal dimension provides opportunities for firms to continuously observe and monitor what local rival firms are doing and to compare to and imitate their competitors, whereas vertical dimension facilitates knowledge flows through input–output production linkages (Wolfe & Gertler, 2004). The sharing of a common set of values and norms in a cluster enhances formal and informal relations and hence strengthens local embeddedness, trust relationship and mutual learning among firms (Saxenian, 1994).

By stressing knowledge spillover within a sector, the existing literature pays much less attention to heterogeneous knowledge from other related sectors. It is argued that the most important knowledge transfers and spillover come from different industries (Glaeser, Kallal, Scheinkman, & Shleifer, 1992). There exists a debate over the importance between sectoral specialization and diversification in knowledge creation and innovation (Boschma & Iammarino, 2009). More recently, a few of scholars started to concern with technological relatedness and related variety in the process of firm innovation because knowledge will spill over from one sector to another only when these sectors shared related knowledge and competence (Frenken, Van Oort, & Verburg, 2007). It therefore requires more empirical studies to explore the relative importance of intra- and inter-sector knowledge sources.

This body of literature has traditionally taken clustering firms as undifferentiated entities with a low variance in business models, technological capability, ownership and size (Munari, Sobrero, & Malipiero, 2012). The heterogeneous and asymmetric distribution of knowledge base among co-located firms actually induces a highly selective and uneven way of knowledge spillover and diffusion in a cluster (Giuliani, 2007). Technological gatekeepers, i.e. those firms with a strong technological capability and intensive connections with firms outside the cluster tend to drive and dominate localized knowledge spillover (Giuliani, 2011). Foreign-invested enterprises (FIEs), with abundant resources and advanced technological knowledge, can be regarded as technological gatekeepers in a cluster, especially in the developing countries.

Nevertheless, the role played by FIEs in knowledge transfer and spillovers to boost localized technological capabilities remains controversial (Breschi & Malerba, 2001). On the one hand, geographical proximity can forge linkages between foreign-invested and domestic firms and encourage spillovers in a way of buyer–supplier interaction and labor mobility (Menghinello et al., 2010). With empirical evidences from Beijing, Zhou and Tong (2003) show that local firms' collaborations with foreign-invested firms in a cluster provide them with a vital technological training to improve their innovative capacity. It is also revealed that geographical proximity helps facilitate technological spillover from MNCs to local suppliers (Ivarsson & Alvstam, 2005).

On the other hand, however, the mechanisms of mutual learning and knowledge spillover do not necessarily work out for a cluster co-presented by foreign and domestic firms, because of their different interests, cognitive structure and cultural background. It is argued that foreign-invested firms are reluctant to share their knowledge unless the host country forces them to do so (Wang & Lin, 2013). Liu and Dicken (2006) have coined a concept of obligated embeddedness to unravel that the foreign-invested firms in China have been forced by the government to make their procurement locally. The relationship based on obligation and

unwillingness may weaken the potential impacts of foreign-invested firms on innovation of domestic firms (Sun & Du, 2011).

Given the importance of geographical proximity and localized knowledge spillover in the relationship between FDI spillover and indigenous innovation, the empirical studies on the presence of foreign-invested enterprises and their geographical spillover effects in economic geography are surprisingly restricted (Ivarsson & Alvstam, 2005). This paper then resorts to the literature of FDI spillover effects to review the relationship between the presence of foreign-invested firms and performance of domestic firms.

2.2. FDI spillover effects and performance of domestic firms

A large number of studies have been conducted to explore FDI spillover effects on the performance of indigenous firms in developing countries from different perspectives (Crespo & Fontoura, 2007). Host countries are expected to potentially benefit from foreign direct investment in recognition of the advanced technology and knowledge embodied in FIEs. However, while some studies argue that FDI spillovers can occur and benefit to domestic firms through various channels, such as demonstration, worker mobility, forward or backward linkages as well as competition, others contest that foreign-invested firms may jeopardize the growth of domestic firms because of the market-stealing and skill-stealing effects (Aitken & Harrison, 1999; Görg & Strobl, 2001; Tian, 2006).

Empirical analyses on horizontal and vertical spillovers of FDI have also shown a great divergence. A large body of literature has reached a consensus on a positive vertical effect but a negative horizontal effect (Bwalya, 2006; Jeon, Park, & Ghauri, 2013; Jordaan, 2008; Kugler, 2006; Le & Pomfret, 2011; Liu, Wang, & Wei, 2009). The pattern of spillover effects has been reversed in other's research in which horizontal effects become significantly positive but vertical effects turn negative (Guo & Chen, 2011). More interestingly, some researchers observed that neither horizontal nor vertical spillover positively related to the productivity of domestic firms (Barbosa & Eiriz, 2009). This view is disputed, however, by others who identified a significant relationship between both horizontal and vertical spillover and firm productivity, (László & Balázs, 2007). These controversial findings need further explanations. First of all, a plethora of studies are based on industry-level analyses and rely upon cross-sectional data, which ignores the role of industrial heterogeneity in the relationship between FDI spillover and performance of domestic firms. For example, Hu and Jefferson (2002) discover that FDI spillover effects are varied by different industries in China. Suyanto, Bloch, and Salim (2012) reveal that FDI generates positive effects on the garment industry but negative effects on the electronics industry with a data from Indonesian manufacturing firms. Studies based on cross-sectional data also suffer from the endogeneity issue. That is, foreign-invested firms tend to chase high-productivity industries in which the high productivity may not be a result of FDI spillover effects but instead the nature of the industry per se or the fact that FDI inflows force less productive domestic firms to exit so as to increase their share in host countries (Javorcik, 2004).

Second, the existing literature does not pay enough attention to the role of geography played in FDI spillover effects on domestic firms. Studies on FDI spillovers without considering the geographical dimension may yield misleading results since positive effects from FDI only occur for local firms (Hamida, 2013). By introducing geography to their studies, a few of researchers draw a surprisingly consistent conclusion that regional FDI spillover improve the productivity of domestic firms (Barrios, Bertinelli, & Strobl, 2006; Crespo, Fontoura, & Proença, 2009; Del Bo, 2013; Driffield, 2006; Girma & Wakelin, 2007; Jordaan, 2005). However, this part of literature failed to control the spillover influence from other co-located domestic firms, which may produce upward aggregation bias to FDI spillover effects. As a matter of fact, geography or spatial clustering is pivotal not only for FDI spillover effects on domestic firms but also for their own development of foreign-invested firms. Research on FDI location choice highlights the significance of agglomeration economies and industrial clusters because FDI has favored to choose the region where related firms are located nearby to enjoy supportive facilitates, shared service centers and specialized factor inputs (Dunning, 2009). It is disclosed that foreign-invested enterprises in China have been inclined to concentrate on the eastern coast where industrial agglomerations are exposed (He, 2002).

Finally, there exists several methodological issues crippling the consistency of existing literature. For example, it is warned that studies using aggregate data that include foreign firms might exaggerate the positive effects of FDI given the fact that foreign-invested firms are more productive and innovative than domestic firms (Hale & Long, 2011). Horizontal and vertical spillover is measured by intra-industry linkages and inter-industry linkages respectively at a *two-digit* industrial level. This incurs a problem that intra-industry activities with this standard actually include not only horizontal dimensions but also supplier–buyer vertical linkages. Referring vertical spillover only to inter-industry linkages at the two-digit industrial level would miss the nuanced and potentially more concrete *firm-based* vertical relationship between foreign and domestic firms within an industry. Meanwhile, FDI knowledge or technology spillover is mainly measured by the share of foreign firms in employment, sales or output value (Del Bo, 2013). This article argues that this measurement can only reflect production activities of FIEs rather than innovation activities and knowledge spillover. Todo (2006) found a positive effect of foreign R&D stocks (not capital stocks) on the productivity of domestic firms, which suggests that knowledge spills over through foreign firms' R&D activities rather than production activities. It is also noted that the extant literature lays much emphasis on FDI spillover effects on productivity rather than innovation of domestic firms, although a couple of studies identified a positive relationship between FDI spillover and innovation of domestic firms (Cheung & Lin, 2004; Liu & Buck, 2007; Sun, 2010).

3. Data and method

To overcome problems identified above and to add to the limited literature, this study attempts to investigate *geographical* FDI spillover effects on product innovation of Chinese indigenous electronic firms. The purpose of this study is mainly twofold. The first is to investigate whether or not and how innovative activities of foreign-invested firms in a locality through horizontal and vertical dimensions can enhance product innovation of local indigenous firms. The second is to explore the relative importance of homogeneous and heterogeneous knowledge from FIEs in product innovation of domestic firms. In particular, this study examines the influence of four types of knowledge spillover, namely, intra-sector horizontal knowledge, intra-sector vertical knowledge, inter-sector horizontal knowledge and inter-sector vertical knowledge. More specifically, this studies attempts to answer the following questions. Do the localized innovative activities of foreign-invested firms facilitate innovation of Chinese indigenous firms? If they do, which dimension is more important, horizontal or vertical spillover? How does horizontal knowledge interact with vertical knowledge affecting innovation of domestic firms? Is knowledge from FIEs within the same sector more significant than that from related sectors?

Data in this study are from the Annual Industrial Survey Database that is conducted regularly by Chinese National Bureau of Statistics (CNBS). This database contains the most comprehensive,

accurate and internally consistent information of domestic and foreign firms since all firms in China are obligated to report their basic and financial information to the CNBS (Tian, 2006; Zhang, Li, Li, & Zhou, 2010). The basic information of firms includes their name, address, contact person, major products, year of founded, ownership etc. and the financial information includes employment, output value, sales, capital, new products, export and so on. The aggregation of firm-level information is published in the official China Statistics Yearbooks.

This study focuses on the electronics industry that covered 10,099 firms in 2009, including 5026 domestic firms and 5073 foreign-invested firms. This paper first analyzes the growth and spatial distribution of foreign-invested firms during the period of 1998–2009 at the aggregation level and conducts regression analyses at a disaggregation level with the newest data from the year of 2009[1]. According to the standard industrial classification (SIC), electronics industry in China contains eight three-digit sub-sectors, namely, telecommunications equipment (401), radar and related equipment (402), broadcasting and television equipment (403), electronic computers (404), electronic appliances (405), electronic components (406), household audio and video equipment (407) and other electronic equipment (409).

Selection of the year of 2009 needs justification since there is a five-year gap between what happened in 2009 and current situation. We therefore investigate the change of China's electronics industrial structure by comparing ownership (the role played by foreign-invested firms versus domestic firms), spatial and sectoral distribution in 2009 and 2013, with published statistical data from China's Electronics Industry Statistical Yearbook. First, as shown in Table 1, the ratio between foreign-invested firms and domestic firms did not change much in terms of firm number, sales value, export value and total profit from 2009 to 2013, although the absolute value in sales, export and total profit for both groups had increased during this period. Second, spatial distribution of this industry did not change much either with Pearl River Delta, Yangtze River Delta, Beijing, Tianjin as well as Sichuan and Chongqing dominating the growth (Ministry of Industry and Information Technology, 2010, 2014). Third, sub-sectors of telecommunications equipment, electronic computers and electronic components ranked top three among all not only in 2009 but also in 2013 (Ministry of Industry and Information Technology, 2010, 2014). In a word, the similar industrial structure of electronics industry in 2009 and 2013, judged by not only ownership but also spatial and sectoral distribution suggests that analyses based on data of 2009 are still valuable, robust and relevant to current situation.

Product innovation of domestic firms, the dependent variable in this study, is measured as the share of turnover generated by new products. It is believed that FDI presence is not enough to stimulate innovation of domestic firms but localized innovative-related activities of foreign-invested firms do. As it stands, this study uses output value share of new products to catch *FDI knowledge spillover*. To highlight the role of geography, we measure *geographical FDI knowledge spillover* as the aggregation of output value share of new products generated by foreign-invested firms in a *county-level* rather than provincial-level region.

[1] The large-scale firm-level database used in this paper is not publicly released. We obtained this database from Chinese National Bureau of Statistics via personal relationship. The database covers the information of all above-scale manufacturing firms from 1996 to 2009. China changed its standard for above-scale firms in 2011 among which above-scale firms refer to enterprises with their sales revenue above 20 million yuan, not 5 million yuan anymore. Therefore, the number of firms in this database after 2010 dramatically decreased. The database in 2009 includes as many enterprises as it can and is the best we could have obtained.

Table 1
Profile of China's electronics industry by ownership in 2009 and 2013.

	2009		2013	
	Foreign	Domestic	Foreign	Domestic
Firm number	8374	11,518	7088	10,878
%	42	58	40	60
Sales value (billion yuan)	3679.45	1340.80	6291.67	3097.47
%	73	27	67	33
Export value (billion yuan)	2602.16	291.08	4276.55	575.334
%	90	10	88	12
Total profit (billion yuan)	95.81	83.30	218.77	196.44
%	53	47	53	47

Data source: (Ministry of Industry and Information Technology (MIIT), 2010, 2014).

Following the study conducted by Motohashi and Yuan (2010), this paper divided all electronics firms into parts suppliers and assemblers according to the major products reported by each firm to investigate horizontal and vertical spillover effects. In other words, if a domestic firm is identified as a parts supplier, knowledge from local FDI parts suppliers is horizontal spillover and from assemblers is vertical spillover. *Horizontal* FDI knowledge spillover is calculated by output share of new products produced by foreign parts suppliers in a county-level region if the domestic firm is a parts supplier, or output share of new products generated by foreign assemblers if the domestic firm is an assembler. *Vertical* FDI knowledge spillover is measured by output share of new products produced by foreign assemblers in a county-level region if the domestic firm is a parts supplier, or output value share of new products by foreign parts suppliers if the domestic firm is an assembler.

This study further distinguished intra-sector from inter-sector knowledge spillover to examine their relative importance in product innovation of domestic firms. *FDI intra-sector knowledge spillover* is calculated by output share of new products generated by foreign-invested firms within the same three-digit sector in a county-level region while *FDI inter-sector knowledge spillover* is calculated by output share of new products generated by foreign-invested firms from other three-digit sectors in a county-level region. Therefore, knowledge spillover from foreign parts suppliers to domestic parts suppliers and from foreign assemblers to domestic assemblers is *intra-sector horizontal spillover* if knowledge flows are within the same three-digit sector and *inter-sector horizontal spillover* if knowledge flows are cross sectors. Similarly, knowledge spillover from foreign parts suppliers to domestic assemblers and from foreign assemblers to domestic parts suppliers is *intra-sector vertical spillover* if knowledge flows are within the same three-digit sector and *inter-sector vertical spillover* if they are based on cross-sectoral spillover (see Fig. 1).

Since firm characteristics such as age, size, ownership structure etc. may moderate FDI spillover effects, this study includes several control variables in the regression analyses. It controlled *firm age* as the years since the firm was founded and *firm employment* as a natural log of the total number of full-time employees in 2009. *Firm assets* are measured by a natural log of the total assets in 2009. A dummy variable is created to distinguish *state-owned enterprise (SOE)* from other domestic firms. If a domestic firm is SOE, the value for this dummy is 1, otherwise 0. Given the fact that domestic firms can enjoy localized knowledge spillover from both foreign and other domestic firms, it is necessary to exclude the impact of other domestic firms' innovative activities. *Geographical knowledge spillover from other domestic firms* is measured by output value share of new products generated by other domestic firms in a county-level region.

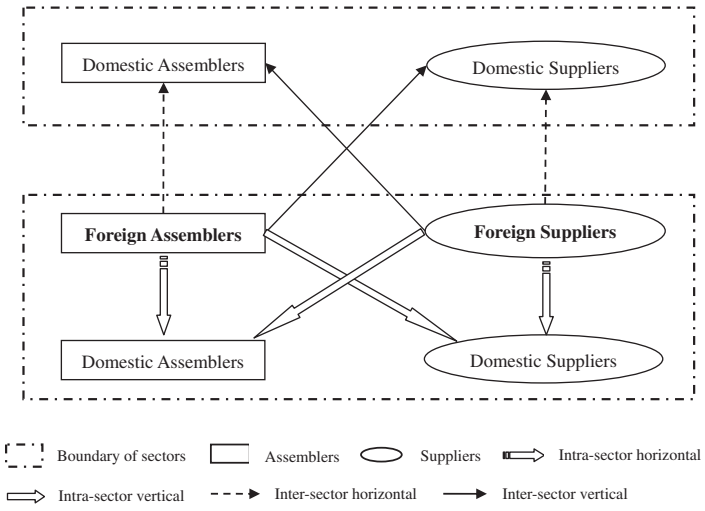

Fig. 1. FDI horizontal and vertical knowledge spillover at both intra- and inter-sector levels.

4. The role played by foreign-invested firms in China's electronics industry

China's electronics industry has experienced a rapid growth since 1990s when Chinese governments started to give it a high priority and global capital was shifted to China to chase a higher profit margin (Wang, 2013). Foreign direct investment has played a significant role in the growth of China's electronics industry. As shown in Fig. 2, foreign-invested firms had harbored 3.84 million persons and generated an output value of 2.79 billion yuan at the end of 2009, significantly higher than those in 1998. In particular, the year of 2003 witnessed a sharp growth in both employment and output value. The output value produced by foreign-invested firms in 2003 was 20 times higher than that of 2002. The expansion of foreign direct investment is believed to be a result of China's entry into WTO in 2001. During the period of 1998–2009, foreign-invested firms had increased their share of innovative activities and export (Fig. 3). Share of new products to total output value augmented from 10% in 1998 to 23% in 2009. Export accounted for 73% of total sales value in 2009, much higher than that of 1998.

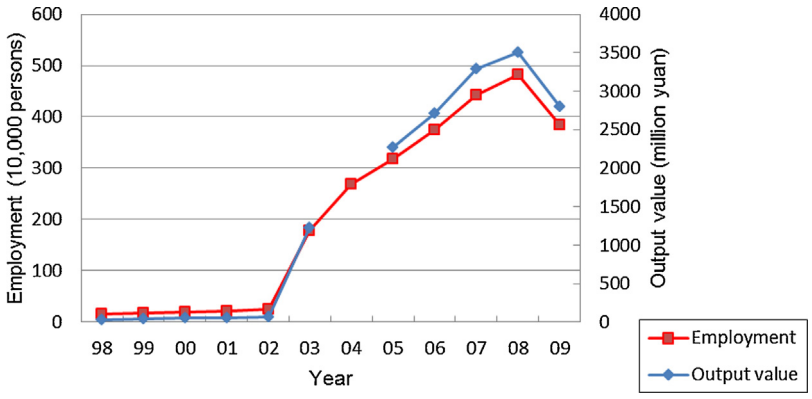

Fig. 2. Growth of above-scale foreign-invested firms in employment and output value, 1998–2009. *Source:* Our own calculation based on database from Chinese National Bureau of Statistics.

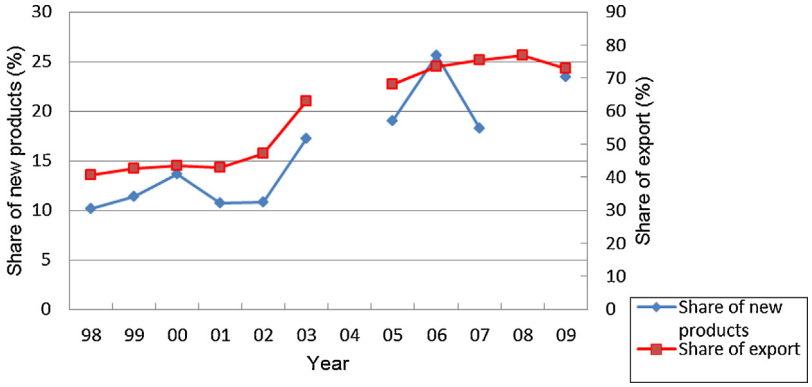

Fig. 3. Share of new products to total output value and share of export to total sales value of above-scale foreign-invested firms in the electronics industry, 1998–2009. *Note:* Data of new products in the years of 2004 and 2008 are not available. *Source:* Our own calculation based on database from Chinese National Bureau of Statistics.

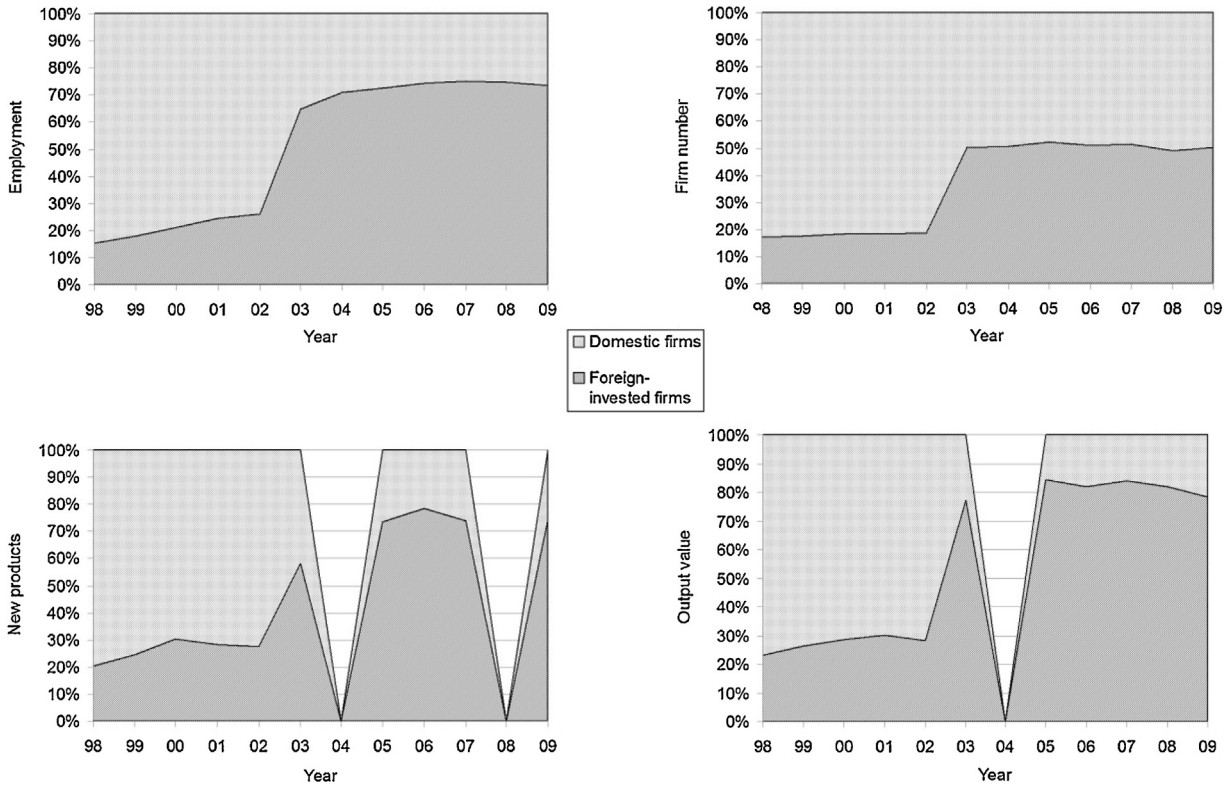

Fig. 4. Percentage of foreign-invested and domestic firms in firm number, employment, total output value and share of new products, 1998–2009. *Note:* Data of new products in the years of 2004 and 2008 and data of output value in 2004 are not available. *Source:* Our own calculation based on database from Chinese National Bureau of Statistics.

This study compared domestic firms and foreign-invested firms to disclose that the latter dominated China's electronic industry after 2003, by not only employment and total output value but also output value of new products. As shown in Fig. 4, foreign-invested firms had occupied less than 20% of firm number and less than 30% of employment, total output value and output value of new products before 2003. The situation had been reverse afterwards with domestic firms accounting for 30% of each indicator, expect for firm number. A set of *T*-test analysis based on 5026 domestic firms and 5073 foreign-invested firms in 2009 further revealed a significant difference in employment, total assets, output value, output value of new products, export and labor productivity. Foreign-invested firms significantly better performed in all economic indicators, suggesting that they are larger-sized, more innovative and export-oriented than domestic firms (Table 2).

Spatial evolution of foreign-invested firms by employment, output value and share of new products had presented the following features (Fig. 5). First, FDI has covered most of China's territory and at the same time foreign-invested firms have increasingly agglomerated in Guangdong and Jiangsu provinces. While Zhejiang province attracted more FDI than the national average (excluding those regions without FDI) measured by both employment and output value in 1998, it relatively lost its attraction to FDI in 2009. In contrast, Beijing and Fujian enjoyed a FDI output value higher than the national average in 2009 despite a disappointing performance of foreign-invested firms in these places in 1998.

Second, distribution of new products showed a spatial mismatch with that of employment and output value. Guangdong, as the most clustering region measured by employment and output value, failed to spark innovation-related activities of foreign-invested firms. Interesting enough, the western areas such as Guizhou, Sichuan, Chongqing harbored a higher ratio of innovative activities in 2009. A close examination unveils that Guizhou attracted only five foreign-invested firms in 2009, but two of them devoted a great attention to R&D investment and generated an innovative output high

Table 2
T-test results of economic indicators between foreign and domestic firms in 2009.

	Mean		*T*-value	*p*-Value
	Foreign firms	Domestic firms		
Employment (person)	757	275	10.238***	0.000
Total assets (billion yuan)	3.03	1.62	3.801***	0.000
Output value (billion yuan)	5.51	1.53	7.143***	0.000
Output value of new products (billion yuan)	1.29	0.45	2.730**	0.006
Export (billion yuan)	3.95	0.42	8.085***	0.000
Labor productivity (yuan/person)	6072	4821	3.111**	0.002

Source: Our own calculation based on database from Chinese National Bureau of Statistics.
*** *p* value is at 0.001 level; ** *p* value is at 0.01 level; labor productivity is calculated by output value generated by per worker.

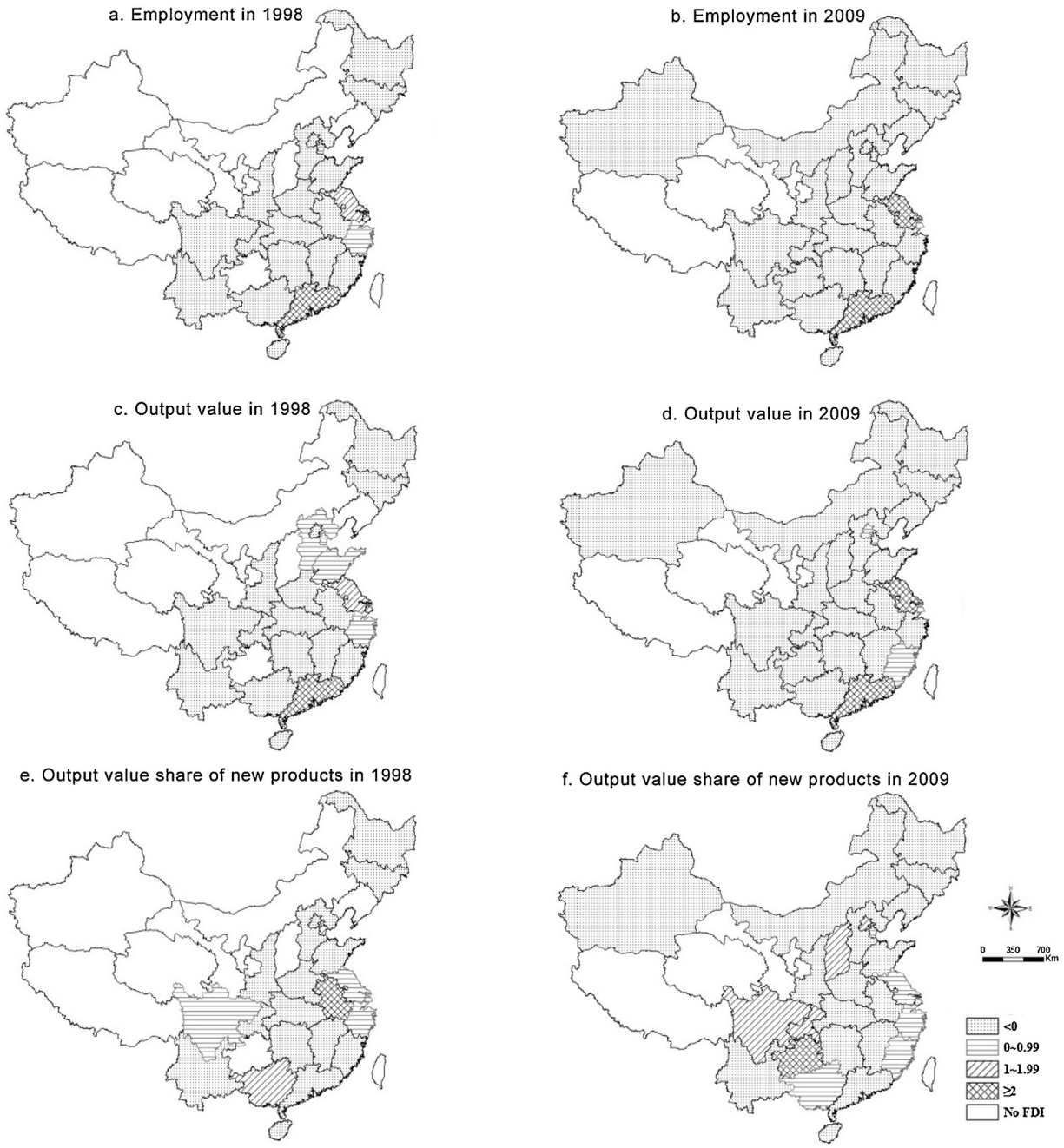

Fig. 5. Spatial distribution of foreign-invested firms by employment, output value and share of new products in selected years. *Source:* Our own calculation based on database from Chinese National Bureau of Statistics.

enough to make Guizhou ahead of others. Shanghai and Jiangsu suffered from a descending share of innovation activities during the period of 1998–2009 whereas foreign-invested firms in Beijing paid an increasing attention to product innovation.

This study further mapped out the location of foreign-invested firms in 1998 and 2009 as well as location of both foreign and domestic firms in 2009 (Fig. 6). It confirms that although foreign-invested firms had sprawled across western regions during the period of 1998–2009, Beijing, Tianjin, Yangtz River Delta and Pearl River Delta were still the most attractive locations to them. Meanwhile, FDI had favored to be agglomerated in the finer geographical scale in both eastern and western regions. Locational selection of domestic firms shows a convergence with that of FIEs at the national level.

5. Geographical FDI knowledge spillover and product innovation of domestic electronic firms

Although foreign and domestic electronic firms have shown a locational convergence, the issue about whether or not and how co-presence with foreign-invested firms can enhance product innovation of domestic firms remains unknown. We employ ordinary least squares regressions to address this issue. Table 3 reports the means and standard deviations of the dependent, independent, and control variables and their correlations. The correlation coefficients are low and the value of Variance Inflation Factor (VIF) is below 10, indicating that the multicollinearity is not a serious problem in this study.

We conduct five sets of regression analyses and the results are reported in Table 4. The adjusted R square is high enough in

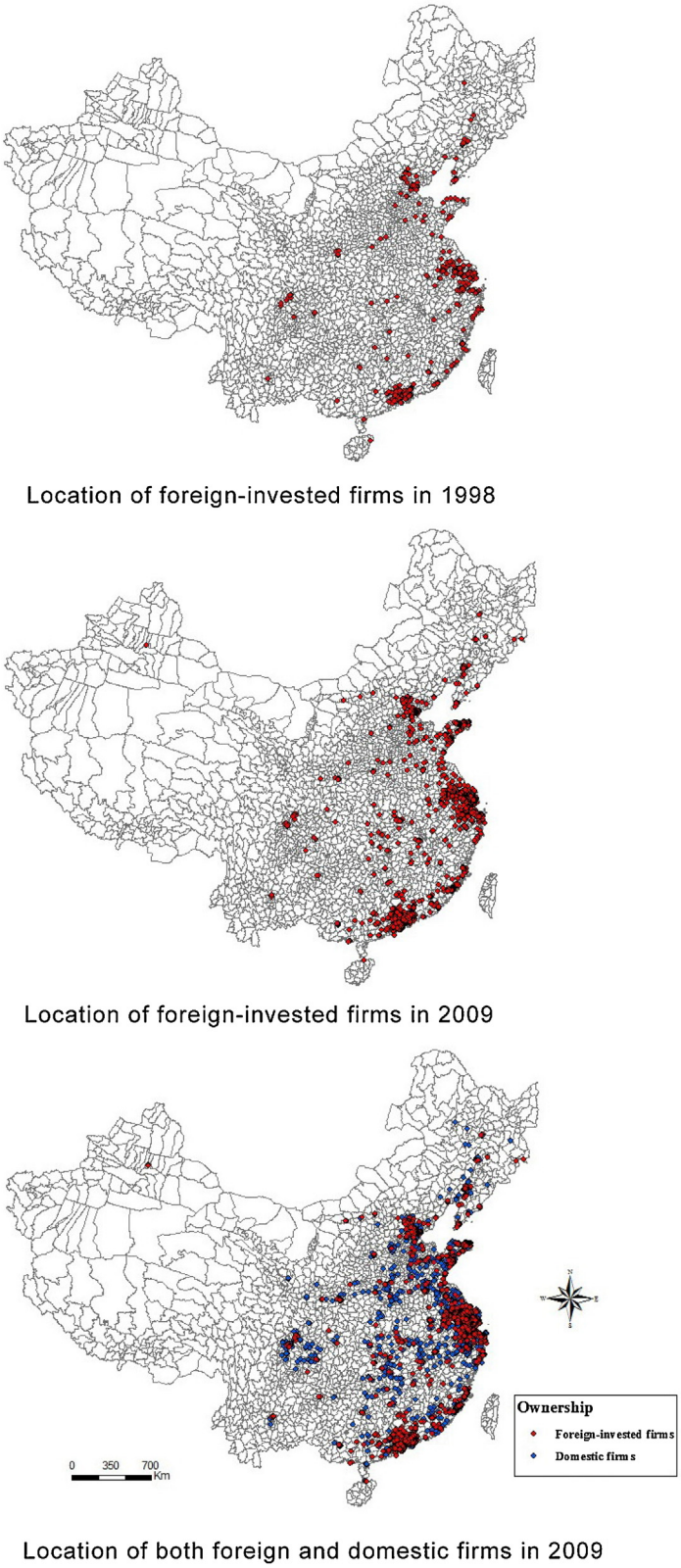

Fig. 6. Locations of foreign and domestic firms in 1998 and 2009. *Source:* Our own calculation based on database from Chinese National Bureau of Statistics.

each model to guarantee that our independent and control variables can well explain the product innovation of domestic firms. Model 1 presents the impact of all control variables, among which only firm assets and geographical spillover from other co-located domestic firms appear positively significant. It confirms that geographical proximity plays a significant role in knowledge spillover and diffusion. It also points to the importance of capital in innovation activities of firms because innovation requires both labor and capital investment. The positive impacts of firm assets and spillover from other domestic firms are robust even after the independent variables into the models (Models 2–5).

Table 3
Means, standard deviations and correlations.

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1. Product innovation	0.096	0.246											
2. Firm age	8.671	7.541	0.090***										
3. Firm assets	4.359	0.632	0.299***	0.295***									
4. Firm employees	2.034	0.486	0.156***	0.224***	0.685***								
5. SOE	0.029	0.169	0.070***	0.367***	0.203***	0.145***							
6. Regional knowledge spillover from *other domestic* firms	0.245	0.332	0.329***	0.062***	0.175***	−0.018	0.074***						
7. Regional FDI *vertical* knowledge spillover	0.172	0.228	0.251***	0.034*	0.078***	−0.046**	0.065***	0.334***					
8. Regional FDI *horizontal* knowledge spillover	0.171	0.235	0.196***	0.108***	0.011	−0.126***	0.012	0.297***	0.178***				
9. Regional FDI *intra-sector horizontal* knowledge spillover	0.237	0.332	0.216***	0.014	0.047**	−0.034	0.061**	0.250***	0.624***	0.189***			
10. Regional FDI *inter-sector horizontal* knowledge spillover	0.121	0.233	0.224***	0.031	0.071***	−0.047**	0.029	0.315***	0.901***	0.146***	0.232***		
11. Regional FDI *intra-sector vertical* knowledge spillover	0.182	0.253	0.287***	0.038	0.004	−0.167***	0.038	0.478***	0.375***	0.757***	0.186***	0.408***	
12. Regional FDI *inter-sector vertical* knowledge spillover	0.186	0.327	0.180***	0.103***	−0.007	−0.122***	0.007	0.248***	0.179***	0.955***	0.251***	0.107***	0.386***

Source: Our own calculation based on database from Chinese National Bureau of Statistics.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed).

In Model 2, the impacts of geographical FDI vertical and horizontal spillover are compared. It turns out that both horizontal and vertical spillover exerted positive and significant influences on product innovation of domestic firms. However, the coefficient of horizontal spillover ($\beta = 0.161$, $p < 0.001$) is larger than that of vertical knowledge spillover ($\beta = 0.088$, $p < 0.01$). It implies that knowledge spillover from peers and competitors is more important than that from suppliers or buyers. This finding is contradictory to our understanding that firms generally learn from their foreign suppliers and buyers through productive linkages since the technological leaders (foreign firms) would force their domestic partners to upgrade their products to a high level, whereas foreign peers and competitors would keep domestic firms at arm's length to prevent knowledge leakage. There are two reasons behind this observation. First of all, lack of trust between foreign and domestic firms as well as the weak embeddedness of foreign firms impede production-based or vertical knowledge flows. Second, horizontal spillover effects are a little tricky in China. Chinese indigenous firms have presented a great divergence in their innovative capabilities in recent years. On one hand, there exist a majority of firms who engaged in a low degree of innovation. It is still possible for them to achieve new products by imitating their foreign peers and competitors under an institutional environment that lacks a protection of IP rights (Wang, 2013). On the other hand, however, for a few of indigenous firms who have caught up to conduct serious R&D investment, competition from foreign firms could stimulate their innovative activities and boost their innovation performance.

We also discover that there exists significantly interaction effects between geographical FDI horizontal and vertical knowledge spillover (Model 3). The coefficient of the interaction between horizontal and vertical spillover is significant and positive ($\beta = 0.123$, $p < 0.001$), suggesting a complementary and mutually reinforcing relationship between horizontal and vertical spillover. The impacts of knowledge from suppliers and buyers would be increasing if more foreign peers and rivalries are located nearby. The vertical spillover effects would be greatly reduced without the existence of horizontal spillover as well.

We further investigate the relative importance of geographical FDI intra-sector and inter-sector knowledge spillover (Model 4). It

Table 4
Regression results for product innovation of domestic firms.

DV: Product innovation	Model 1	Model 2	Model 3	Model 4	Model 5
(1) Firm age	0.007	0.006	0.007	0.021	0.003
(2) Firm assets	0.269***	0.250***	0.250***	0.173**	0.239***
(3) Firm employees	−0.044*	−0.064*	−0.074**	−0.036	−0.056*
(4) SOE	0.000	0.008	0.003	−0.013	0.001
(5) Geographical knowledge spillover from other *domestic* firms	0.294***	0.237***	0.207***	0.387***	0.183***
(6) Geographical FDI *horizontal* knowledge spillover		0.161***	0.076***		0.051*
(7) Geographical FDI *vertical* knowledge spillover		0.088**	0.139***		0.043*
(8) Geographical FDI *intra-sector horizontal* knowledge spillover				0.029	
(9) Geographical FDI *inter-sector horizontal* knowledge spillover				0.173***	
(10) Geographical FDI *intra-sector vertical* knowledge spillover				−0.002	
(11) Geographical FDI *inter-sector vertical* knowledge spillover				0.110*	
(6) Geographical FDI *horizontal* knowledge spillover × (7) Geographical FDI *vertical* knowledge spillover			0.123***		
(6) Geographical FDI *horizontal* knowledge spillover × (5) Geographical knowledge spillover from other *domestic* firms					0.154***
(7) Geographical FDI *vertical* knowledge spillover × (5) Geographical knowledge spillover from other *domestic* firms					0.122***
F	169.772***	103.349***	97.003***	30.194***	92.982***
R^2	0.176	0.226	0.239	0.352	0.253
Adj. R^2	0.175	0.224	0.236	0.340	0.250

Source: Our own calculation based on database from Chinese National Bureau of Statistics.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed).

is very interesting to find that FDI *inter-sector knowledge spillovers* from both horizontal and vertical sources are positive and significant but intra-sector knowledge sources appear insignificant for product innovation of domestic firms. Again, the coefficient of inter-sector horizontal knowledge spillover ($\beta = 0.173$, $p < 0.001$) is significantly higher than that of inter-sector vertical knowledge spillover ($\beta = 0.110$, $p < 0.05$). Two reasons are behind the observed pattern in which innovation of domestic firms significantly relies upon inter-sector, rather than intra-sector FDI knowledge spillover. First, inter-sector knowledge is related to heterogeneous knowledge which is more cognitively distant than the existing knowledge structure of domestic firms and therefore more valuable in the process of innovation. Second, being aware of the defective IP rights protection in China, foreign firms may be more vigilant about knowledge leakage when their Chinese counterparts are located nearby but be more slack on outward spillover when they are surrounded by firms from other sectors who will not be a threat to their business. This gives domestic firms more opportunities to learn from foreign firms in related sectors than in the same sector.

We model the interaction effects between domestic spillover and FDI spillover to investigate whether or not domestic spillover moderates FDI spillover effects (Model 5). Domestic spillover positively and significantly affects both FDI horizontal spillover ($\beta = 0.154$, $p < 0.001$) and vertical spillover ($\beta = 0.122$, $p < 0.001$). It suggests that FDI knowledge spillover would produce an even stronger influence if innovative activities of domestic firms are intensive and active in a cluster. This finding shows that the emergence of credible competition from local indigenous firms is a significant factor accelerating FDI knowledge spillover because FIEs would not increase their R&D investment and conduct innovative activities in China unless they realize that they may be risk of losing market share without doing so—an interesting point already made by Zhou, Sun, Wei, and Lin (2011).

6. Conclusion and discussion

In recent years, academic debate on firm innovation has considered particular forms of spatial clustering and FDI as almost mutually exclusive drivers of regional economic growth and innovation (Menghinello et al., 2010). While industrial districts and clusters literature views agglomeration as an endogenous form driven by local actors without taking into account the heterogeneous characteristics of clustering firms, the large stream of literature in international business concerned with the nation-level or industry-level impacts of FDI spillover but neglected the role of location, geography and agglomeration economies. This paper combines the two lines of theoretical inquiry to examine the mechanism of geographical FDI spillover effects on product innovation of domestic firms with a special focus on China's electronic industry.

During the period of 1998–2009, foreign-invested firms had experienced a rapid growth and played an important role in China's electronics industry. In particular, foreign firms dominated the electronics industry after 2003, measured by not only employment, total output value and export but also output value of new products. *T*-test analyses revealed a significant difference between foreign and domestic firms, with the former outperforming the latter in all economic indicators (employment, total assets, output value, new products, export and labor productivity). The spatial evolution of foreign-invested firms during 1998–2009 demonstrates that FDI had further concentrated in the eastern areas at the provincial level and simultaneously sprawled across the mid-western regions at the national level. However, the most concentrated region was not necessarily the most innovative region, which implies that many foreign-invested firms were not interested in innovative activities in China. Location strategies of foreign and domestic firms showed a convergence but domestic firms were more spatially dispersed compared to foreign-invested firms. A large number of foreign-invested firms choose to locate in the electronics industrial clusters of the eastern coastal regions.

The regression analyses based on 5026 domestic electronic firms in 2009 have generated some interesting findings. First, localized innovative activities of foreign firms exert positive and significant influences on product innovation of domestic firms. Second, geographical FDI horizontal spillover is more valuable than that of vertical spillover although both are significant. Moreover, FDI horizontal and vertical spillover reinforces each other to affect innovation of domestic firms. Third, inter-sector knowledge source is positive and significant but intra-sector spillover is illustrated insignificant. It advises that relatively heterogeneous knowledge from cross-sector sources is beneficial to product innovation of domestic firms. Finally, innovation of local domestic firms significantly stimulates and accelerates FDI knowledge spillover.

This paper contributes to the existing literature by combining both FDI spillover and industrial cluster theories to explain indigenous innovation in an emerging economy and generates new insights that can be valuable to both fields (Mayer & Sparrowe, 2013). First of all, this study accentuates that the role of geography or industrial cluster cannot be undervalued in the studies of FDI spillover effects because not only knowledge spillover may decay with distance but also labor mobility remains rather localized as skilled workers are likely to prefer new employment in the same region (Crespo et al., 2009).

It is also argued that innovation of domestic firms can only be facilitated by localized innovation-related activities of FIEs rather than the simple FDI presence or involved business network. Giuliani (2007) has observed that the structure of knowledge network differs from that of business network. In other words, business-based linkages with foreign firms do not necessarily lead to innovation-related knowledge diffusions in a cluster. Rather, co-presence with *innovative* foreign firms enables domestic firms to learn spilled knowledge and benefit from inward mobility of well-trained labors.

Second, this study criticizes the emergence of "new regionalism" in economic geography which regarded firms as homogenous entities to overemphasize their unity and collaboration. It especially casts doubts over the trust relationship and embeddedness in a cluster. The economic globalization brings a hybrid of firm structure to a cluster in which firms show significant differences in social background, modes of thinking as well as cognitive and management styles. This is very different from traditional industrial districts that are comprised of genuinely "local" firms with a deep social and geographical embeddedness. The "obligated embeddedness" of foreign firms in China does not only exist in automobile industry as identified by Liu and Dicken (2006), but also in the electronics industry as revealed by this study. In that case, although foreign firms are forced to engage in production relations with indigenous firms, they are discreet about their knowledge and technology. However, we find that the presence of competitive indigenous firms is a no less important leverage than government regulations to propel knowledge spillover and transfer of foreign firms. Competition outweighs collaboration to facilitate innovation in a cluster with a hybrid firm structure. Therefore, an interactionist approach that links regional assets proposed by new economic geography with firm-level attributes should be taken to draw a complete picture of firm innovation and regional development (Beugelsdijk, 2007).

The divergence or heterogeneity in technological capability among domestic firms further complicated knowledge flows in a

cluster. It is not unusual for Chinese indigenous electronic firms to conduct "reverse engineering", which can be done by horizontal observation and imitation. A questionnaire survey in Shenzhen's ICT firms alerts that about 11% of sampled firms confessed that reversed engineering was an important source of core technology (Wang, 2013, 171). While intra-sector spillover can well serve the purpose of "reverse engineering", this paper highlights the importance of inter-sector heterogeneous knowledge from both horizontal and vertical sources to those indigenous firms who devoted themselves to R&D activities and radical innovation in which related but heterogeneous knowledge plays a vital role. Hence, the relative importance of intra- and inter-knowledge depends upon the technological capability of clustering firms and the nature of innovation in a cluster.

Finally, our study reveals that despite the risk in knowledge leakage and imitation, a majority of FIEs prefers to be located in the existing industrial clusters where has already harbored many domestic firms. This suggests a beneficial relationship between FDI and firm clustering, which has been illustrated by Menghinello et al. (2010) and Hilber and Voicu (2010). Again, the attraction or advantage of a cluster with a diversified ownership structure or various sources of capital lies not so much in mutual trust and social embeddedness but rather in supportive infrastructure, institutional environment, high-qualified labors and local market potential. However, our study also identifies that not all foreign firms are interested in clusters but a few isolated themselves from others. This could be explained by the concept of global cluster network, proposed by Bathelt and Li (2014) to claim that foreign firms originating from clusters are more likely to set up inside the existing clusters of host countries whereas those from non-clusters choose to locate in somewhere without spatial agglomeration.

This study has practical implications. In a globalizing world where labor and capital are spatially mobile, how to attract and retain the footloose production factors to be a "sticky" place is a big concern perplexing local governments everywhere. In the case of China's electronics industry, geographical FDI knowledge spillover is largely inhibited due to the lack of mutual trust not only between foreign and domestic firms but also among indigenous firms. Therefore, the Chinese governments should wait no longer to build an institutional environment under which IP rights are well protected so that firms can share their knowledge without worrying about knowledge stealing. For domestic firms, strengthening their own innovative capability is an effective, if not the only way, to stimulate and benefit from FDI knowledge spillover and to survive and succeed in the increasingly fierce competition.

Several limitations in this paper should not be overlooked. Methodologically, there is no easy task to measure inter-sector/heterogeneous knowledge spillover. Which digit level, two-digit or three-digit, should be selected to set apart homogeneous knowledge from heterogeneous one? Knowledge from other two-digit industrial sectors may be too heterogeneous but from three-digit sectors is not heterogeneous enough. Boschma and Iammarino (2009, 292) argue that knowledge will spill over only when two sectors are related and "it is unclear what a pig farmer can learn from a microchip company even though they are neighbors". We therefore define that knowledge from other three-digit industrial sector is heterogeneous but this classification is not beyond dispute. Furthermore, the data used in this study is a bit old. Since CNBS has not publicly released this dataset, data in the year of 2009 is the best we could have obtained. Although we believe our main findings are still robust and relevant in current China, we look forward to similar studies based on a updated dataset to judge the applicability of this study.

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References

Aitken, B. J., & Harrison, A. E. (1999). Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. *The American Economic Review, 89*(3), 605–618.
Barbosa, N., & Eiriz, V. (2009). Linking corporate productivity to foreign direct investment: An empirical assessment. *International Business Review, 18*(1), 1–13.
Barrios, S., Bertinelli, L., & Strobl, E. (2006). Coagglomeration and spillovers. *Regional Science and Urban Economics, 36*(4), 467–481.
Barrios, S., Görg, H., & Strobl, E. (2011). Spillovers through backward linkages from multinationals: Measurement matters! *European Economic Review, 55*(6), 862–875.
Bathelt, H. (2005). Geographies of production: Growth regimes in spatial perspective (II)—Knowledge creation and growth in clusters. *Progress in Human Geography, 29*(2), 204–216.
Bathelt, H., & Li, P.-F. (2014). Global cluster networks—Foreign direct investment flows from Canada to China. *Journal of Economic Geography, 14*(1), 45–71.
Beugelsdijk, S. (2007). The regional environment and a firm's innovative performance: A plea for a multilevel interactionist approach. *Economic Geography, 83*(2), 181–199.
Boschma, R. (2005). Proximity and innovation: A critical assessment. *Regional Studies, 39*(1), 61–74.
Boschma, R., & Iammarino, S. (2009). Related variety, trade linkages, and regional growth in Italy. *Economic Geography, 85*(3), 289–311.
Breschi, S., & Malerba, F. (2001). The geography of innovation and economic clustering: Some introductory notes. *Industrial and Corporate Change, 10*(4), 817–833.
Bwalya, S. M. (2006). Foreign direct investment and technology spillovers: Evidence from panel data analysis of manufacturing firms in Zambia. *Journal of Development Economics, 81*(2), 514–526.
Cheung, K.-y., & Lin, P. (2004). Spillover effects of FDI on innovation in China: Evidence from the provincial data. *China Economic Review, 15*(1), 25–44.
Crespo, N., & Fontoura, M. P. (2007). Determinant factors of FDI spillovers—What do we really know? *World Development, 35*(3), 410–425.
Crespo, N., Fontoura, M. P., & Proença, I. (2009). FDI spillovers at regional level: Evidence from Portugal. *Papers in Regional Science, 88*(3), 591–607.
Del Bo, C. F. (2013). FDI spillovers at different levels of industrial and spatial aggregation: Evidence from the electricity sector. *Energy Policy, 61*(0), 1490–1502.
Driffield, N. (2006). On the search for spillovers from foreign direct investment (FDI) with spatial dependency. *Regional Studies, 40*(1), 107–119.
Du, D. (2009). *Research and development of multinational corportations in China: Growth, influences and policy suggestions*. Beijing: Science Press (in Chinese).
Dunning, J. (2009). Location and the multinational enterprise: A neglected factor? *Journal of International Business Studies, 40*(1), 5–19.
Fan, C. C., & Scott, A. J. (2003). Industrial agglomeration and development: A survey of spatial economic issues in East Asia and a statistical analysis of Chinese regions. *Economic Geography, 79*(3), 295–319.
Frenken, K., Van Oort, F., & Verburg, T. (2007). Related variety, unrelated variety and regional economic growth. *Regional Studies, 41*(5), 685–697.
Fu, W., Revilla Diez, J., & Schiller, D. (2013). Interactive learning, informal networks and innovation: Evidence fromelectronics firm survey in the Pearl River Delta, China. *Research Policy, 42*(3), 635–646.
Gertler, M. S. (1995). "Being there": Proximity, organization, and culture in the development and adoption of advanced manufacturing technologies. *Economic Geography, 71*(1), 1–26.
Görg, H., & Strobl, E. (2001). Multinational companies and productivity spillovers: A meta-analysis. *The Economic Journal, 111*(475), F723–F739.
Girma, S., & Wakelin, K. (2007). Local productivity spillovers from foreign direct investment in the U.K. electronics industry. *Regional Science and Urban Economics, 37*(3), 399–412.
Giuliani, E. (2007). The selective nature of knowledge networks in clusters: Evidence from the wine industry. *Journal of Economic Geography, 7*(2), 139–168.
Giuliani, E. (2011). Role of technological gatekeepers in the growth of industrial clusters: Evidence from Chile. *Regional Studies, 45*(10), 1329–1348.
Glaeser, E. L., Kallal, H. D., Scheinkman, J. A., & Shleifer, A. (1992). Growth in cities. *The Journal of Political Economy, 100*(6), 1126–1152.
Gordon, I. R., & McCann, P. (2000). Industrial clusters: Complexes, agglomeration and/or social networks? *Urban Studies, 37*(3), 513–532.
Guo, B., & Chen, X. (2011). How does FDI influence industry-level knowledge production efficiency in China? *Asian Journal of Technology Innovation, 19*(2), 263–277.

Hale, G., & Long, C. (2011). Are there productivity spillovers from foreign direct investment in China? *Pacific Economic Review, 16*(2), 135–153.
Hamida, L. B. (2013). Are there regional spillovers from FDI in the Swiss manufacturing industry? *International Business Review, 22*(4), 754–769.
Havranek, T., & Irsova, Z. (2012). Survey article: Publication bias in the literature on foreign direct investment spillovers. *Journal of Development Studies, 48*(10), 1375–1396.
He, C. (2002). Information costs, agglomeration economies and the location of foreign direct investment in China. *Regional Studies, 36*(9), 1029–1036.
Hilber, C. A. L., & Voicu, I. (2010). Agglomeration economies and the location of foreign direct investment: Empirical evidence from Romania. *Regional Studies, 44*(3), 355–371.
Howells, J. R. L. (2002). Tacit knowledge, innovation and economic geography. *Urban Studies, 39*(5/6), 871–884.
Hu, A. G. Z., & Jefferson, G. H. (2002). FDI impact and spillover: Evidence from China's electronic and textile industries. *World Economy, 25*(8), 1063–1076.
Ivarsson, I., & Alvstam, C. G. (2005). The effect of spatial proximity on technology transfer from TNCs to local suppliers in developing countries: The case of AB Volvo in Asia and Latin America. *Economic Geography, 81*(1), 83–111.
Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *The American Economic Review, 94*, 605–627.
Javorcik, B. S. (2008). Can survey evidence shed light on spillovers from foreign direct investment? *The World Bank Research Observer, 23*(2), 139–159.
Jeon, Y., Park, B. I., & Ghauri, P. N. (2013). Foreign direct investment spillover effects in China: Are they different across industries with different technological levels? *China Economic Review, 26*, 105–117.
Jordaan, J. A. (2005). Determinants of FDI-induced externalities: New empirical evidence for Mexican manufacturing industries. *World Development, 33*(12), 2103–2118.
Jordaan, J. A. (2008). Intra- and inter-industry externalities from foreign direct investment in the Mexican manufacturing sector: New evidence from Mexican Regions. *World Development, 36*(12), 2838–2854.
Kugler, M. (2006). Spillovers from foreign direct investment: Within or between industries? *Journal of Development Economics, 80*(2), 444–477.
László, H., & Balázs, M. (2007). Does distance matter in spillover. *Economics of Transition, 15*(4), 781–805.
Le, H. Q., & Pomfret, R. (2011). Technology spillovers from foreign direct investment in Vietnam: Horizontal or vertical spillovers? *Journal of the Asia Pacific Economy, 16*(2), 183–201.
Liefner, I., Wei, Y. H. D., & Zeng, G. (2013). The innovativeness and heteroeneity of foreign-invested high-tech companies in Shanghai. *Growth and Change, 44*(3), 522–549.
Liu, W., & Dicken, P. (2006). Transnational corporations and "obligated embeddedness": Foreign direct investment in China's automobile industry. *Environment and Planning A, 38*(7), 1229–1247.
Liu, X., & Buck, T. (2007). Innovation performance and channels for international technology spillovers: Evidence from Chinese high-tech industries. *Research Policy, 36*(3), 355–366.
Liu, X., Wang, C., & Wei, Y. (2009). Do local manufacturing firms benefit from transactional linkages with multinational enterprises in China? *Journal of International Business Studies, 40*(7), 1113–1130.
Mariotti, S., Piscitello, L., & Elia, S. (2010). Spatial agglomeration of multinational enterprises: The role of information externalities and knowledge spillovers. *Journal of Economic Geography, 10*, 519–538.
Markusen, A. (1996). Sticky places in slippery space: A typology of industrial districts. *Economic Geography, 72*(3), 293–313.
Maskell, P. (2001). Towards a knowledge-based theory of the geographical cluster. *Industrial and Corporate Change, 10*(4), 921–943.
Mayer, K. J., & Sparrowe, R. T. (2013). Integrating theories in AMJ articles. *Academy of Management Journal, 56*(4), 917–922.
Menghinello, S., De Propris, L., & Driffield, N. (2010). Industrial districts, inward foreign investment and regional development. *Journal of Economic Geography, 10*(4), 539–558.
Ministry of Industry and Information Technology (MIIT) (2010). *China's electronics industry statistical yearbook 2009*. Beijing: Electronics Industry Press Electronic version.
Ministry of Industry and Information Technology (MIIT) (2014). *China's electronics industry statistical yearbook 2013*. Beijing: Electronics Industry Press (Electronic version).
Motohashi, K., & Yuan, Y. (2010). Productivity impact of technology spillover from multinationals to local firms: Comparing China's automobile and electronics industries. *Research Policy, 39*(6), 790–798.
Munari, F., Sobrero, M., & Malipiero, A. (2012). Absorptive capacity and localized spillovers: Focal firms as technological gatekeepers in industrial districts. *Industrial and Corporate Change, 21*(2), 429–462.
Saxenian, A. (1994). *Regional advantage: Culture and competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.
Simmie, J. (2004). Innovation and clustering in the globalised international economy. *Urban Studies, 41*(5/6), 1095–1112.
Smeets, R. (2008). Collecting the pieces of the FDI knowledge spillovers puzzle. *The World Bank Research Observer, 23*(2), 107–138.
Sun, Y. (2010). What matters for industrial innovation in China, R&D, technology transfer or spillover impacts from foreign investment? *International Journal of Business and Systems Research, 4*(5/6), 621–647.
Sun, Y., & Du, D. (2011). Domestic firm innovation and networking with foreign firms in China's ICT industry. *Environment and Planning A, 43*(4), 786–809.
Suyanto, Bloch, H., & Salim, R. A. (2012). Foreign direct investment spillovers and productivity growth in Indonesian garment and electronics manufacturing. *Journal of Development Studies, 48*(10), 1397–1411.
Tian, X. (2006). Accounting for sources of FDI technology spillovers: Evidence from China. *Journal of International Business Studies, 38*(1), 147–159.
Todo, Y. (2006). Knowledge spillovers from foreign direct investment in R&D: Evidence from Japanese firm-level data. *Journal of Asian Economics, 17*(6), 996–1013.
Wang, C. C. (2013). *Upgrading China's information and communication technology industry: State-firm strategic coordination and the geography of technological innovation*. Hangzhou and Singapore: Zhejiang University Press and World Scientific.
Wang, C. C., Lin, C. S. G., & Li, G. C. (2010). Industrial clustering and technological innovation in China: New evidence from the ICT Industry in Shenzhen. *Environment and Planning A, 42*, 1987–2010.
Wang, C. C., & Lin, G. C. S. (2013). Dynamics of innovation in a globalizing china: Regional environment, inter-firm relations and firm attributes. *Journal of Economic Geography, 13*(3), 397–418.
Wolfe, D. A., & Gertler, M. S. (2004). Clusters from the inside and out: Local dynamics and global linkages. *Urban Studies, 41*(5/6), 1071–1093.
Zhang, Y., Li, H., Li, Y., & Zhou, L.-A. (2010). FDI spillovers in an emerging market: The role of foreign firms' country origin diversity and domestic firms' absorptive capacity. *Strategic Management Journal, 31*(9), 969–989.
Zhou, Y., & Tong, X. (2003). An innovative region in china: Interaction between multinational corporations and local firms in a high-tech cluster in Beijing. *Economic Geography, 79*(2), 129–152.
Zhou, Y., Sun, Y. F., Wei, D. Y. H., & Lin, G. C. S. (2011). De-centering "spatial fix"—Patterns of territorialization and regional technological dynamism of ICT hubs in China. *Journal of Economic Geography, 11*, 119–150.