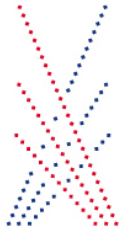


BRITISH ACADEMY
OF MANAGEMENT

BAM
CONFERENCE

3RD-5TH SEPTEMBER
ASTON UNIVERSITY BIRMINGHAM UNITED KINGDOM

This paper is from the BAM2019 Conference Proceedings

About BAM

The British Academy of Management (BAM) is the leading authority on the academic field of management in the UK, supporting and representing the community of scholars and engaging with international peers.

http://www.bam.ac.uk/

The congestion effect of Foreign Direct Investment's agglomeration on firm productivity in China: A spatial analysis

Author: Xiaolong Chen
University of Southampton

ARTICLE INFO

Keywords:
FDI agglomeration
productivity
spatial econometrics
geography
China
Asia

ABSTRACT

This paper expands the literature on industry agglomeration to explore the non-linear and spatial effects of horizontal, backward and forward foreign direct investment (FDI) agglomerations on domestic firms' productivity by employing a spatial econometric model with random effects based on the data of 12,240 firms covering the period 2010–2013 from China's Annual Industry Survey Database. In addition to the vital impact of firm characteristics (e.g. firm size and capital intensity) and geography characteristics (e.g. human capital and transport infrastructure), I also identify that the congestion (inverted U-shaped relationship) dominates the effect of the three types of FDI agglomerations on local firms' productivity, and a U-shaped relationship dominates the effect of their spatial agglomerations on neighbouring firms' productivity. I further capture that the interaction intensity of backward and forward FDI agglomerations with local and neighbouring firms are similar and much stronger than that of horizontal FDI agglomeration. The empirical findings provide some essential implications for region and industry policies.

1. Introduction

Since China's reform and opening in 1978, China's economy is becoming closer and closer to the rest of the world. The cross-border flow of FDI plays a vital role in the globalization process. According to UNCTAD (2018), the amount of FDI inflow rapidly increased at an average 19.853 per cent per year in developing countries and at an average 14.381 per cent per year in developed countries during the period 1970–2017. China as a developing country is the third largest economy for FDI receipt with US$136.320 billion in the world and the top economy for FDI receipt in developing countries in 2017 (UNCTAD, 2018). Moreover, eastern regions with the advantages of geography, endowments and preferential policies attracted a much larger amount of FDI than western, middle and north-eastern regions (Wei et al., 2009). The amount of FDI inflow to eastern regions accounted for roughly 78.153 per cent of total FDI inflow into China while the amount of FDI inflow to western, middle and north-eastern regions merely occupied about 8.111, 8.327 and 5.410 per cent, respectively in 2017 (NBS, 2018). In terms of the distribution of industries, the amount of FDI inflow into the top four industries (manufacturing; information transmission, software and information technology; real estate, leasing and business services; and wholesale and retail trades) consisted of 25.570, 15.964, 12.863 and 12.774 per cent, respectively of total FDI inflow into China while the amount of FDI inflow into other industries[1] was mostly far below 10 per cent of total FDI inflow into China in 2017 (NBS, 2018). The large uneven distributions of FDI in specific regions and industries can easily result in over agglomeration (congestion effect).

The literature of agglomeration economies traditionally focused on industry agglomeration with mixed domestic and foreign firms (Marshall, 1920; Krugman, 1991) and mainly identified two types of industry agglomerations namely localization and urbanization agglomerations. Localization (intra-industry agglomeration) economies that referred to the agglomeration of firms in the same industry arising knowledge spillover and labour pooling (Marshall, 1920)). Urbanization (inter-industry agglomeration) economies related to the variety and diversity of geographically proximate industries promoting productivity growth through sharing information and practices (Jacobs, 1969).

[1] According to the 2002 edition of China Industry Classification National Standard, other industries include wholesale and retail trades (8.760%), financial intermediation (6.045%), scientific research and technical services (5.223%), transport, storage and post (4.265%), production and supply of electricity, heat, gas and water (2.687%), construction (1.999%), mining (0.994%), agriculture, forestry, animal husbandry and fishery (0.820%), culture, sports and entertainment (0.533%), management of water conservancy, environment and public facilities (0.435%), services to households, repair and other services (0.433%), hotels and catering services (0.320%), health and social service (0.233%), education (0.059%) and public management, social security and social organization (0.023%). The values in the parentheses represent the amount of FDI inflow each industry to total FDI inflow into China in 2017.

I expand the literature and explore the interaction of the agglomeration of foreign firms with domestic firms. New foreign firms would face the liability of foreignness when they enter host countries (Johanson & Vahlne, 2009). Moreover, new foreign firms with comparative advantage expect a positive balance between inflow and outflow spillovers (Mariotti, et al., 2010). Therefore, new foreign firms are likely to agglomerate with prior foreign firms that have different backgrounds and encounter different operational difficulties from domestic competitors, where they can overcome the liability of foreignness and obtain a competitive advantage by accessing local knowledge especially local tacit knowledge from prior foreign firms through knowledge spillovers and information sharing (Shave et al., 1997; Barry et al., 2003; Mariotti, et al., 2010; Tan & Mayer, 2011; Lamin & Livanis, 2013). In fact, the study by He & Wang (2010) showed that foreign firms were obviously more agglomerated than domestic firms in China's firms. Simply considering overall FDI agglomeration may not explain well the interaction of FDI agglomeration with domestic firms. Thus, it is necessary to distinguish different types of FDI agglomerations including horizontal, backward and forward FDI agglomerations due to their different interaction mechanisms with domestic firms. In addition, horizontal FDI agglomeration relates to the agglomerated foreign firms in the same industries while vertical and forward FDI agglomerations refers to the agglomerated foreign firms in the upstream and downstream industries respectively.

There are no studies that have explored the non-linear and spatial effects of horizontal, backward and forward FDI agglomerations on domestic firms' productivity. This paper is original in three main respects. First, I use large firm-level data with 12,240 firms covering the period 2010–2013 to explore this topic by employing a spatial econometric model with attempting two different spatial matrices. Space dependence is a matter for exploring the spillover effect of foreign presence on firm productivity (Driffield, 2006; Coughlin & Segev, 2000; Van Oort, 2007; Ke, 2010). Second, I combine the ideas of revealed comparative advantage (RCA) index suggested by Balassa (1965) and horizontal and vertical (forward and backward) indices proposed by Javorcik (2004) to construct the new indices of horizontal, vertical and forward FDI agglomerations. These indices can capture well the different types of FDI agglomerations by reducing the impact of the large difference in the absolute economy scales of different regions in China. Third, I illustrate the different mechanisms of the interactions of horizontal, vertical and forward FDI agglomerations with domestic firms including the three main differences, namely, inter-firm relationship, the trade-off between benefits and costs, and interaction intensity.

This paper is structured as follows. After the introduction, Section 2 illustrates the relevant literature of agglomeration economies and develop hypotheses by interpreting the interactions of the agglomeration of foreign firms with domestic firms. Section 3 presents the econometric model, variable measurements, estimation techniques and study data details. Section 4 interprets empirical findings, and Section 5 gives the conclusions with policy implications.

2. Related literature review and hypotheses

The literature of agglomeration economies mainly identified two types of industry agglomerations, namely localization and urbanization agglomerations. The early seminal work of the effect of agglomeration on firm productivity can be traced to Marshall (1920) who identified localization (intra-industry agglomeration) economies that referred to the agglomeration of firms in the same industry arising knowledge spillover and labour pooling. In contrast, Jacobs (1969) discussed urbanization (inter-industry agglomeration) economies related to the variety and diversity of geographically proximate industries promoting productivity growth through sharing information and practices. Both localization and urbanization economies can be regarded as centripetal forces resulting in the spatial concentration of economic activities. The relevant empirical studies present inconclusive results. The empirical findings tend to support localization economies rather than urbanization economies when both are assessed together (Melo et al., 2009; Hu et al., 2015). Duranton and Puga (2004) summarized that a positive agglomeration effect on firm productivity generally originated from sharing, matching and learning mechanisms. The sharing mechanism refers to sharing indivisible goods and facilities, the gains from a wider variety of input and individual specialization, and risk. The matching mechanism relates to the efficient and effective matching between employers and employees in a large labour pooling. In addition, the learning mechanism involves knowledge creation, diffusion and accumulation enforced by proximate firms. The empirical studies such as Ciccone (2002), Dekle (2002), Fan & Scott (2003), Henderson (2003a), Cingano & Schivardi (2004), Brülhart & Mathys (2008), Graham (2009), Martin et al. (2011), Melo et al. (2017) and Klein & Crafts (2018) identified a positive effect of agglomeration on firm productivity. However, over-agglomeration can act as a centrifugal force to offset the benefits from agglomeration. This is because of the increased costs resulting from higher wages driven by competition among firms for skilled labour, higher rents due to increased demands for housing and commercial land and negative externalities such as congestion (Lall et al., 2004; Rizov et al., 2012). The empirical studies such as Batisse (2002), Frenken et al. (2007), Brülhart & Mathys (2008), Broersma & Oosterhaven (2009) and Azari et al. (2016) confirmed a negative effect of agglomeration on firm productivity. However, it is not necessary to assume that agglomeration economies or diseconomies are linearly dependent on the level of agglomeration. Agglomeration externalities of economies and diseconomies tend to experience a dynamic trade-off between benefits and costs and are likely to increase or decrease at different rates. Therefore, it is reasonable to capture the dynamic (non-

linear) effect of agglomeration economies or diseconomies on firm productivity. The empirical studies such as Henderson (2003b), Carlino et al. (2007), Lin et al. (2011) and Rizov et al. (2012) found an inverted U-shaped relationship (congestion effect) between agglomeration and firm productivity.

The literature of agglomeration economies traditionally focuses on industry agglomeration with mixed domestic and foreign firms (Marshall, 1920; Krugman, 1991), whereas the interaction of agglomerations of foreign firms with domestic firms is not concerned. Foreign firms are generally different from purely domestic firms because they are larger, more intensive in capital, skilled labour and profitability, and pay higher wages to their employees (Haddad & Harrison, 1993; Aitken et al., 1997; Blomstrom & Sjoholm, 1999). The possession of these attributes makes foreign firms with a comparative advantage outperform domestic and foreign rivals in some dimensions in host countries especially developing countries where few domestic firms have a comparative advantage over foreign firms. New foreign firms with productivity advantage tend to choose relatively high production locations and expect a positive balance between inflow and outflow spillovers rather than one-way spillover to other firms in host countries (Shaver, 1998; Buckley et al., 2007; Graham & Kim, 2008; Mariotti et al., 2010). Moreover, prior foreign firms with different backgrounds encounter different operational difficulties from domestic competitors and their knowledge spillovers to new foreign firms tend to be more useful (Tan & Mayer, 2011; Lamin & Livanis, 2013). In other words, new foreign firms are willing to locate at the geography proximity with existing foreign firms in host countries because of demonstration effect and the alleviation of the liability of foreignness through knowledge spillovers and information sharing (Shaver et al., 1997; Barry et al., 2003; Mariotti et al., 2010). Therefore, accessing local knowledge is crucial for foreign firms when they enter the market in host countries for the first time. Moreover, knowledge can be simply classified into tacit knowledge (e.g., mental models, values and perceptions) and explicit knowledge (e.g., technical or academic data or information described in formal language) (Polanyi, 1966; Smith, 2001).Tacit local knowledge rather than explicit local knowledge is more difficult to transmit due to its tacit nature (Polanyi, 1966; Kogut & Zander, 1996; Lord & Ranft, 2000). Furthermore, the extent to which two organizations benefit from knowledge sharing depends largely on the quality of the relationship between them in host countries especially in emerging economies where institution avoid makes firms rely to a large extent on relational contracts rather than legal contracts and increases the difficulty of identifying the trajectory changes of the local environment (Simonin, 1999; Tan & Mayer, 2011; Lamin & Livanis, 2013). The concentration of economic activities facilitates the geography ties among firms. Under such an agglomeration context, a high level of trust between firms strengthens their emotional ties and promotes knowledge transfer, especially more valuable tacit and locally embedded knowledge (Dirks & Ferrin, 2001; Levin & Cross, 2004; Tallman & Chacar, 2011).

Simply considering overall FDI agglomeration may not explain well the interaction of FDI agglomeration with domestic firms. Therefore, it is necessary to distinguish horizontal, backward and forward FDI agglomerations due to their different interaction mechanisms with domestic firms. The interaction of horizontal FDI agglomeration with domestic firms refers to the competitive relationship between foreign firms and domestic firms. Technology diffusion through general horizontal effects works when imitation, competition or labour turnover occurs. Local firms in host countries can improve their productivity by simply copying some technology used by foreign firms, and the increased competitive pressure from the entrants of foreign firms forces them to upgrade their technology by using existing technology and resources more efficiently (Liu et al., 2000; Spencer, 2008). Furthermore, Wang & Blomström (1992) emphasized that the more competition the foreign firms faced from domestic firms, the more advanced technology it had to bring in to retain its competitive advantage, and then the larger potential it contributed to technology spillover. Finally, if local employees who receive training and absorb new technology in foreign firms would switch employers, they may transfer their knowledge from foreign firms to local firms (Javorcik & Spatareanu, 2008; Balsvik, 2011; Poole, 2013). Foreign firms that generally have a comparative advantage are unlikely to locate with domestic firm and tend to encounter a negative balance between inflow and outflow spillovers or even one-way outflow spillovers to domestic firms. Besides, in the interaction of horizontal FDI agglomeration with domestic firms, foreign firms keeping a competitive relationship with domestic firms are unlikely to locate closely with them. Thus, FDI agglomeration externalities of economies (sharing, matching and learning mechanisms) and FDI agglomeration externalities of diseconomies (such as higher wages for skilled labours and higher rents for housing and commercial lands) tend to have a weak impact on the productivity of domestic firms. However, in the context of the agglomeration of foreign firms, the clustering of economic activity can also facilitate the formation of business alliances and organizations to enhance their competitive advantages in the local market (Fan & Scott, 2003). Moreover, sharing knowledge among new and prior foreign firms can promote them to gain competitive advantages (Kogut & Zander, 1992; Tallman & Chacar, 2011). The nature of competition is unlikely to be locally bounded and can spread across the market. The increased competition from foreign firms may be detrimental to local firms and even crowd them out both of local product and labour markets in host countries (Aitken & Harrison, 1999; Spencer, 2008). To improve their productivity, they may force stricter or more cost-conscious management and motivate employees to work harder instead of imitating technology.

The interaction of backward or forward FDI agglomeration with domestic firms relates to the co-

operative relationship between foreign firms and suppliers or customers (domestic firms) operating between industries. Foreign firms can provide local suppliers with technical assistance or information to help improve the product or facilitate innovations to obtain the high-quality or low-price intermediate products that are delivered by local suppliers on time, and can also help local suppliers set up production facilities, provide training and help in management and organization (Javorcik, 2004; Kugler, 2006; Spencer, 2008). Customers can benefit from the improved performance by using intermediate goods provided by foreign firms in their production process (Javorcik & Spatareanu, 2008; Du et al., 2012). Foreign firms with large size and international operation are expected to have much more bargaining power than domestic firms, which the asymmetries in bargaining power might lead to negative spillovers to domestic firms (Girma et al., 2008). Furthermore, foreign firms generally choose the locations that are close to local suppliers or customers because they can easily purchase or supply intermediate goods from suppliers or to customers (Amiti & Javorcik, 2008). Therefore, FDI agglomeration externalities of economies and diseconomies both tend to have a strong impact on the productivity of domestic firms. Based on the discussion above, I summarize the comparisons of the interactions of horizontal, backward and forward FDI agglomerations with domestic firms in Table 1 and develop relevant hypotheses that are shown as follows:

	Horizontal FDI agglomeration	Backward FDI agglomeration	Forward FDI agglomeration
Inter-firm relationship	Competitive relationship between foreign firms and domestic firms. Coexistence of competitive and co-operative relationship between agglomerated foreign firms.	Co-operative relationship between foreign firms and local suppliers. Coexistence of competitive and co-operative relationship between agglomerated foreign firms.	Co-operative relationship. between foreign firms and local customers. Coexistence of competitive and co-operative relationship between agglomerated foreign firms.
Trade-off between benefits and costs	Horizontal effect through imitation, competition or labour turnover facilitates the increase of domestic firms' productivity. Whereas, over-competition from foreign firms would lead to the reduction of domestic firms' productivity. Additionally, FDI agglomeration externalities of economies and diseconomies have a weak impact on domestic firms' productivity.	Backward linkage promotes the increase of suppliers' productivity. Whereas, the asymmetries in bargaining power might lead to negative spillovers to suppliers. Additionally, FDI agglomeration externalities of economies and diseconomies have a strong impact on suppliers' productivity.	Forward linkage promotes the increase of customers' productivity. Whereas, the asymmetries in bargaining power might lead to negative spillovers to customers. Additionally, FDI agglomeration externalities of economies and diseconomies have a strong impact on customers' productivity.
Interaction intensity	Weak	Strong	Strong

Table 1
Comparisons of the interaction of horizontal, backward and forward FDI agglomerations with domestic firms.

Hypothesis 1: The increasing level of horizontal FDI agglomeration (foreign firms) tends to enhance domestic firms' productivity at the beginning and then reduce its productivity beyond its threshold value.

Hypothesis 2: The increasing level of backward FDI agglomeration (foreign firms) tends to enhance domestic firms' productivity at the beginning and then reduce its productivity beyond its threshold value.

Hypothesis 3: The increasing level of forward FDI agglomeration (foreign firms) tends to enhance domestic firms' productivity at the beginning and then reduce its productivity beyond its threshold value.

Hypothesis 4: The interaction intensity of both backward and forward FDI agglomerations (foreign firms) with domestic firms are relatively strong and similar while the interaction intensity of horizontal FDI agglomeration with domestic firms is much weaker than backward and forward FDI agglomerations based on the hypothesis 1, 2 and 3.

3. Econometric analysis

3.1. Model specification and estimation techniques

This paper mainly explores the non-linear and spatial effects of horizontal, backward and forward FDI agglomerations on firm productivity and develops a general spatial econometric

model by considering the suggestions of Anselin et al. (2008) and Elhost (2012)[2]. The model is described as follows:

$$\begin{aligned} productivity_{fr,t} = {} & \beta_0 + \beta_1 productivity_{fr,t-1} \\ & + \beta_2 \text{fdi\_agglomeration}_{fr,t} \\ & + \beta_3\, fdi\_agglomeration^2_{fr,t} \\ & + \beta_4 firm\_age_{\,fr,t} + \beta_5 firm\_size_{fr,t} \\ & + \beta_6 ownership_{fr,t} + \beta_7 export_{fr,t} \\ & + \beta_8 capital\_intensity_{fr,t} \\ & + \beta_9 human\_capital_{r,t} \\ & + \beta_{10} infrastructure_{r,t} \\ & + \beta_{11} W_1 \text{fdi\_agglomeration}_{fr,t} \\ & + \beta_{12} W_1\, fdi\_agglomeration^2_{fr,t} \\ & + \beta_{13} W_1 human\_capital_{r,t} \\ & + \beta_{14} W_1 infrastructure_{r,t} \\ & + \beta_{15} W_1 export_{fr,t} \\ & + \beta_{16} W_1 productivity_{fr,t} \\ & + \beta_i + \beta_r + \beta_t + \mu_{fr} + \nu_{fr,t} \end{aligned}$$

$$\upsilon_{fr,t} = \lambda W_1 \upsilon_{fr,t} + \xi_{fr,t}$$

Note: the footnotes 'f', 'i', 'r' and 't' of variables in the regression model represent firm, industry, region and time, respectively.

$productivity_{fr,t}$ detonates firm's total factor productivity (TFP). I use the semiparametric approach suggested by Olley and Pakes (1996)[3] to estimate TFP. Moreover, I also consider ordinary least squares (OLS) with fixed effect to compute TFP as a robust test.

$fdi\_agglomeration_{fr,t}$ represents inflow FDI agglomeration. I combine the ideas of RCA index suggested by Balassa (1965) and horizontal and vertical (forward and backward) indices proposed by Javorcik (2004) to construct three new indices of horizontal, backward and forward FDI agglomerations. The economy scale and development level of different regions in China exhibit obvious unbalance. The new indices can capture well the three types of FDI agglomeration and overcome the measurement bias due to the difference in absolute economy scale of different regions in China. The three types of inflow FDI agglomerations include 1) Inflow FDI agglomeration within an industry (awi) $=(FC_{ri}/TC_{ri})/(FC_r/TC_r)$. FC_r and TC_r represent (inflow foreign capital/ equity) × output and total output in region r, respectively. FC_{ri} and TC_{ri} represent (inflow foreign capital/total equity) × output and total output, respectively in region r and industry i, respectively. 2) Inflow FDI agglomeration between backward industries (abi) = $a_o(FC_r/TC_r)$/(FC/TC). a_o denotes input index from China's 2012 input–output table[4]. FC and TC represent (total inflow foreign capital/total equity) × total output and total output, respectively. 3) Inflow FDI agglomeration between forward industries (afi) = $b_o\,(FC_{r-e}/TC_{r-e})/(FC_{-e}/TC_{-e})$. b_o denotes output index from China's 2012 input–output table. FC_{r-e} and TC_{r-e} represent [(inflow foreign capital/total equity) × output – export] and (total output – total export) in region r, respectively. FC_{-e} and TC_{-e} represent [(inflow foreign capital/total equity) × output-export] and (total output – total export), respectively.

Concerning independent variables, $firm\_age_{fr,t}$ is measured by the number of years since its incorporation. $firm\_size_{fr,t}$ is measured by the number of employees. $ownership_{fr,t}$ is measured by '1' if firms are state-owned and '0' otherwise. $export_{fr,t}$ is measured by '1' if firms conduct export and '0' otherwise. $capital\_intensity_{fr,t}$ is measured by fixed capital/the number of employees. $human\_capital_{r,t}$ is measured by the average number of education years. $infrastructure_{r,t}$ is measured by the total length of the region's roads/area. $W_1 human\_capital_{r,t}$, $W_1 infrastructure_{r,t}$, $W_1 productivity_{fr,t}$, $W_1 export_{fr,t}$, $W_1 fdi\_agglomeration_{r,t}$ and $W_1 \upsilon_{fr,t}$ represent the spatial lag of human capital, infrastructure, productivity, export, FDI agglomeration, and error term, respectively. In addition, β_0-β_{16} and λ represent corresponding coefficients. β_i, β_r and β_t represent industry-, region- and time-specific effects, respectively. μ_{fr} represents random effect. Finally, $\varepsilon_{fr,t}$ represents the error term.

I use the neighbouring spatial weight matrix in this paper and consider distance spatial weight matrices as a robustness test. 4) The neighbouring spatial weight matrix is equal to '1' if two regions are neighbouring and '0' otherwise. 5) The distance spatial weight matrix is equal to $1/d^2$ between two different regions and '0' otherwise. Besides, the both spatial weight matrices in regression models are row-standardized.

4)

$$w_{ab} = \begin{cases} 1 & if \text{ a and b are neighbouring adjacency} \\ 0 & if \text{ a and b are not neighbouring adjacency} \end{cases} \quad (a \neq b)$$

5)

$$w_{ab} = \begin{cases} \frac{1}{d^2} & if \text{ a} \neq \text{b} \\ 0 & if \text{ a = b} \end{cases}$$

d represents the distance between two capitals of regions

I also pay attention to two main econometric issues. Using simple OLS regression to estimate TFP would lead

[2] According to Anselin et al. (2008) and Elhost (2012), a most general spatial dynamic panel model is not identified and this unidentifiable issue can be solved by giving some restrictions. For instance, the coefficient of spatial $productivity_{fr,t-1}$, and the coefficients of spatial $firm\_size_{fr,t}$, $firm\_size_{fr,t}$, $ownership_{fr,t}$ and $capital\_intensity_{fr,t}$ are equal to zero in this paper, which excludes corresponding endogenous and exogenous interactive effects.

[3] There are several methods to estimate TFP such as the O–P method suggested by Olley & Pakes (1996), L–P method proposed by Levinsohm & Petrin (2003), OLS with fixed effect and GMM method suggested by Blundell & Bond (1998). However, the L–P method requires the data of intermediate input, and the GMM method needs data with enough long-time span to conduct lots of difference and lag processing to create a favourable instrument variable. Therefore, because of the lack of relevant data, I use the O–P method in this paper and consider OLS with fixed effect as a robust test.

[4] China's 2012 input–output table can be obtained from the website (http://data.stats.gov.cn/ifnormal.htm?u=/files/html/quickSearch/trcc/trcc01.html&h=740).

to some econometric problems especially the simultaneity bias of production decision and sample selection bias. Production decision makers can adjust production inputs based on currently observed firm productivity to maximize production outputs. Firms with a relatively large capital stock generally have a higher capability to deal with crisis and firms with a relatively small capital stock are likely to exit the market. Using the semiparametric approach proposed by Ollep & Pakes (1996) to estimate TFP can reduce the estimation bias caused by the selection issue and endogeneity problem. I also use OLS regression with fixed effect to estimate productivity as a robustness test and the results are consistent with the findings in this paper. Secondly, regarding simultaneity bias, inflow FDI might choose relatively high productive locations in host countries (Shaver, 1998; Buckley et al., 2007; Graham & Kim, 2008). I address this econometric issue by employing the test of Hausman (1978) with five instruments including export intensity (exports/ sales) at firm level, profitability (profits/sales) at firm level, the lag of inflow FDI at firm-level, the numbers of firms in each industry and market size (sales) in each industry. The test results show that there is no evidence of the simultaneity links of foreign presence to firm productivity, which is consistent findings with Buckley et al. (2002) and Buckley et al. (2007). Furthermore, Graham & Kim (2008) and Graham (2009) indicated that the overall evidence showed no substantial bias in agglomeration estimates if agglomeration did have an endogenous component based on the summary of previous studies that had checked the endogenous issue. Before running the regression estimation, I also conducted Moran's I test and the Hausman test. The results of Moran's I tests for each year (2010–2013) show the rejection of the null hypothesis at 1% significance, which means the existence of spatial dependence.

3.2. Data details

I use firm- and region-level data to explore the spatial effect of FDI agglomeration on domestic firms' productivity. Firm-level data are extracted from the Annual Industry Survey Database published by the National Bureau of Statistics of China (NBS) since 1998. The Annual Industry Survey Database classifies firms into 4-digit ISIC and includes firms with the annual sales that are at least 5 million RMB (roughly 0.806 million US$)[5]. This database is also frequently used to explore the relevant topics of international business and strategic management such as the studies of Chang & Xu (2008), Brandt (2012), Xiao et al. (2013) and Chang & Chung (2017). Region-level data are also obtained from NBS. After handling the data, there are no data of inflow FDI in the two regions including Hunan and Xizan, which leads to a total of 29 regions[6], which Figure 1 shows the number of neighbouring regions by the relevant region in China. Moreover, the economic development in these regions are large unbalance, and eastern regions are generally much higher than in other regions. For instance, the GDPs of Guangdong and Jiangsu located in eastern regions are 10,076.579 million US$ and 9,637.640 million US$, respectively while the GDPs of Ningxia and Qinghai located in western regions were merely 342.268 million US$ and 131.560 million US$, respectively in 2013 (NBS, 2013).The final data used in this paper involves 12,440 firms covering the period 2010–2013. In addition, Tables 2 and 3 show the descriptive statistics and correlation matrix of variables, respectively.

[5] I use the official exchange rate in 2013 (http://www.stats.gov.cn/tjsj/ndsj/2015/indexeh.htm). I also use it to exchange the value of the GDPs of Guangdong, Jiangsu, Ningxia and Qinghai from Chinese currency to the US dollar.

[6] Western regions include Nei Mongol Zizhiqu, Guangxi Zhuangzu Zizhiqu, Chongqing Shi, Sichuan Sheng, Guizhou Sheng, Yunnan Sheng, ShanXi Sheng, Gansu Sheng, Qinghai Sheng, Ningxia Huizu Zizhiqu and Xinjiang Uygur Zizhiqu. Northeastern regions include Liaoning Sheng, Jilin Sheng and Heilongjiang Sheng. Middle regions include Shanxi Sheng, Anhui Sheng, Jiangxi Sheng, Henan Sheng and Hubei Sheng. Finally, eastern regions include Beijing Shi, Tianjin Shi, Hebei Sheng, Shanghai Shi, Jiangsu Sheng, Zhejiang Sheng, Shandong Sheng, Fujian Sheng, Guangdong Sheng and Hainan Sheng.

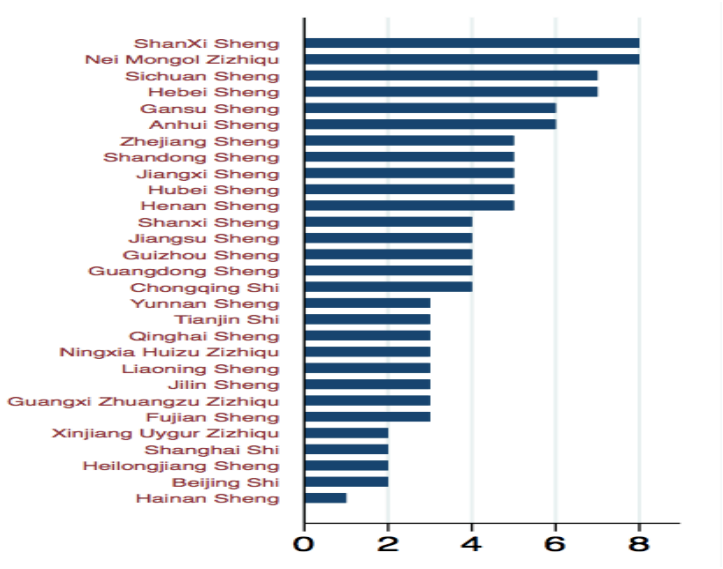


Fig. 1. The number of neighbouring regions by the relevant region in China

Table 2
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
productivity	49,760	7.036	0.969	0.798	12.568
productivity_lag	37,320	7.077	0.963	0.798	12.568
fdi_agglomeration (awi)	49,760	1.096	0.919	0	29.289
fdi_agglomeration (abi)	49,760	1.012	0.412	0	4.380
fdi_agglomeration (afi)	49,760	1.026	0.395	0	4.656
firm_age	49,760	11.740	6.618	0	186
firm_size*	49,760	5.871	1.026	0	11.667
ownership	49,760	0.049	0.215	0	1
export	49,760	0.677	0.468	0	1
capital_intensity*	49,760	4.046	1.564	-4.862	15.010
human_capital	49,760	9.374	0.791	6.764	12.028
infrastructure	49,760	1.295	0.347	0.086	2
W_productivity	49,760	7.070	0.131	6.342	7.787
W_agglomeration (awi)	49,760	1.169	0.229	0.930	3.371
W_fdi_agglomeration (abi)	49,760	1.079	0.266	0.225	2.382
W_fdi_agglomeration (afi)	49,760	1.127	0.256	0.213	2.075
W_infrastructure	49,760	1.242	0.314	0.212	1.565
W_human_capital	49,760	9.221	0.499	7.355	10.715

Note: * means log.

Table 3
Correlation matrix.

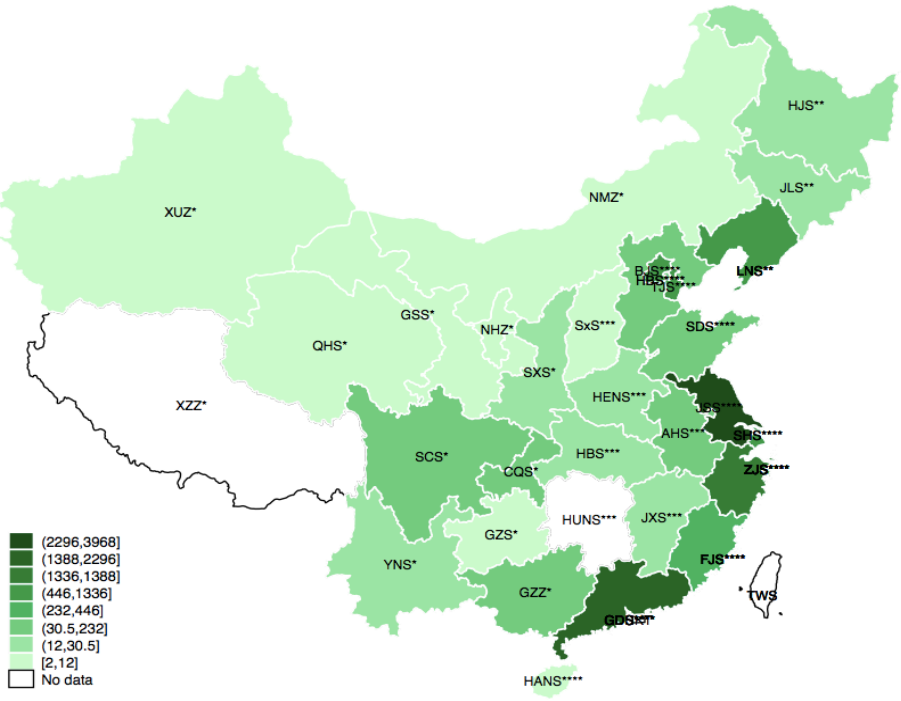
	1	2	3	4	5	6	7	8	9	10	11
1. productivity_lag	1										
2. fdi_agglomeration (awi)	-0.013	1									
3. fdi_agglomeration (abi)	-0.062	-0.05	1								

4. fdi_agglomeration (afi)	-0.07	-0.044	0.967	1							
5. firm_age	0.059	-0.004	0.019	0.046	1						
6. firm_size*	0.169	-0.014	0.038	0.039	0.196	1					
7. ownership	0.094	-0.018	-0.024	-0.026	0.154	0.086	1				
8. export	0.001	0.019	0.084	0.102	0.077	0.199	-0.05	1			
9. capital_intensity*	0.309	0.011	-0.06	-0.054	0.111	-0.08	0.096	-0.053	1		
10. human_capital	0.033	0.036	0.013	0.076	0.205	0.012	0.048	0.001	0.061	1	
11. infrastructure	0.087	-0.016	0.427	0.406	0.087	0.017	-0.017	0.075	0.005	0.379	1

* means log

4. Findings

Figure 2 shows the regional distribution of Chinese firms. It is obvious that the distribution of the study sample mainly concentrates on eastern regions. Wei et al. (2009) interpreted that eastern regions with the advantages of geography, endowments and preferential policies attracted a much larger amount of FDI than western, middle and north-eastern regions. Figure 3 shows the regional distribution of average Chinese firms' productivity during the period 2010–2013. The average Chinese firms' productivity in some of the eastern regions such as Jiangsu, Zhejiang and Fujian is relatively low. This may be the reason that a large number of low-level manufacturing firms in these regions, especially coastal regions, drag down its average firm productivity. In addition, Figures 4, 5 and 6 show the regional distributions of average horizontal, backward and forward FDI agglomerations during the period 2010–2013, respectively. The large difference in the agglomeration of foreign firms in China's different regions would easily lead to congestion effect.



Note: 1. Western regions(*): Nei Mongol Zizhiqu (NMZ), Guangxi Zhuangzu Zizhiqu (GZZ), Chongqing Shi (CQS), Sichuan Sheng (SCS), Guizhou Sheng (GZS), Yunnan Sheng (YNS), Xizang Zizhiqu (XZZ), ShanXi Sheng (SXS), Gansu Sheng (GSS), Qinghai Sheng (QHS), Ningxia Huizu Zizhiqu (NHZ) and Xinjiang Uygur Zizhiqu (XUZ); Northeastern regions(**): Liaoning Sheng (LNS), Jilin Sheng (JLS) and Heilongjiang Sheng (HJS); Middle regions(***): Shanxi Sheng (SxS), Anhui Sheng (AHS), Jiangxi Sheng (JXS), Henan Sheng (HENS), Hubei Sheng (HUBS) and Hunan Sheng (HUNS); Eastern regions(****): Beijing Shi (BJS), Tianjin Shi (TJS), Hebei Sheng (HEBS), Shanghai Shi (SHS), Jiangsu Sheng (JSS), Zhejiang Sheng (ZJS), Shandong Sheng (SDS), Fujian Sheng (FJS), Guangdong Sheng (GDS) and Hainan Sheng (HANS). 2. Taiwan Sheng (TWS) and Hong Kong Tebiexingzhengqu (HKT) are not classificated in this map.

Fig. 2. The regional distribution of Chinese firms.

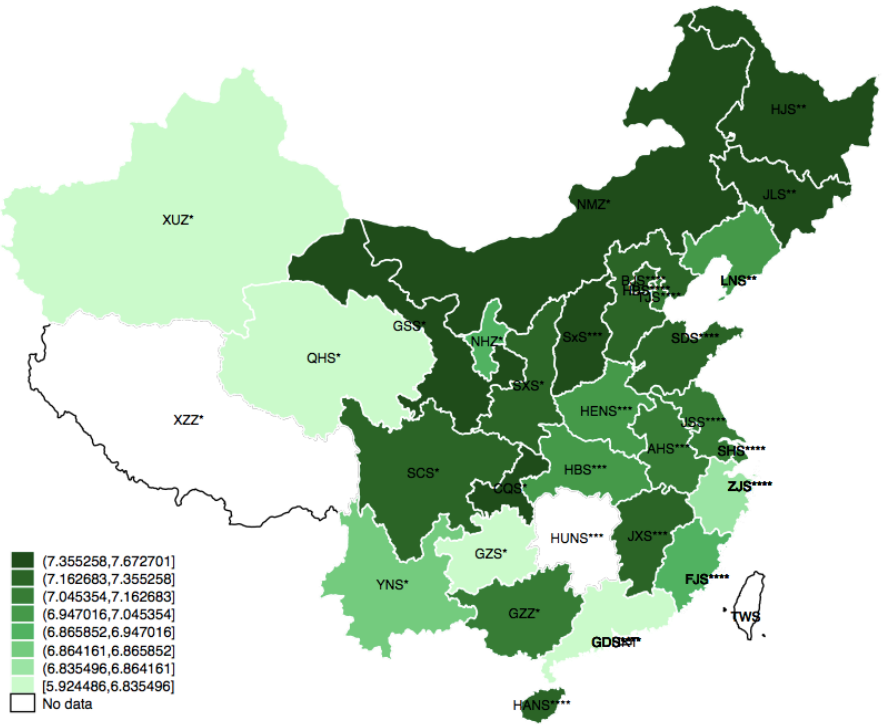


Fig. 3. The regional distribution of average Chinese firm's productivity during the period 2010–2013.

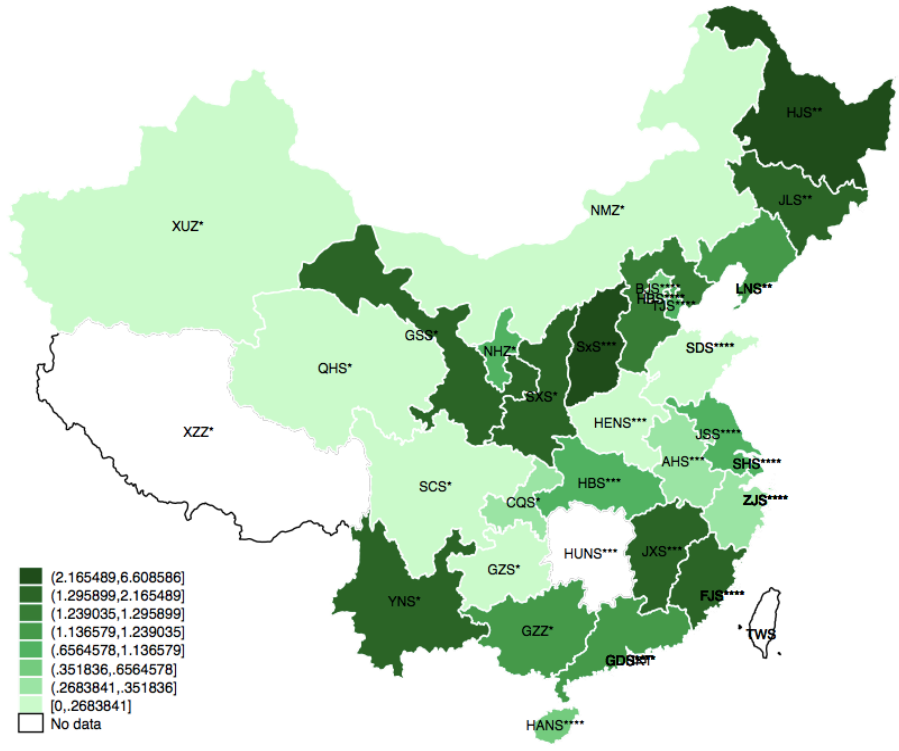


Fig. 4. The regional distribution of average horizontal FDI agglomeration during the period 2010–2013.

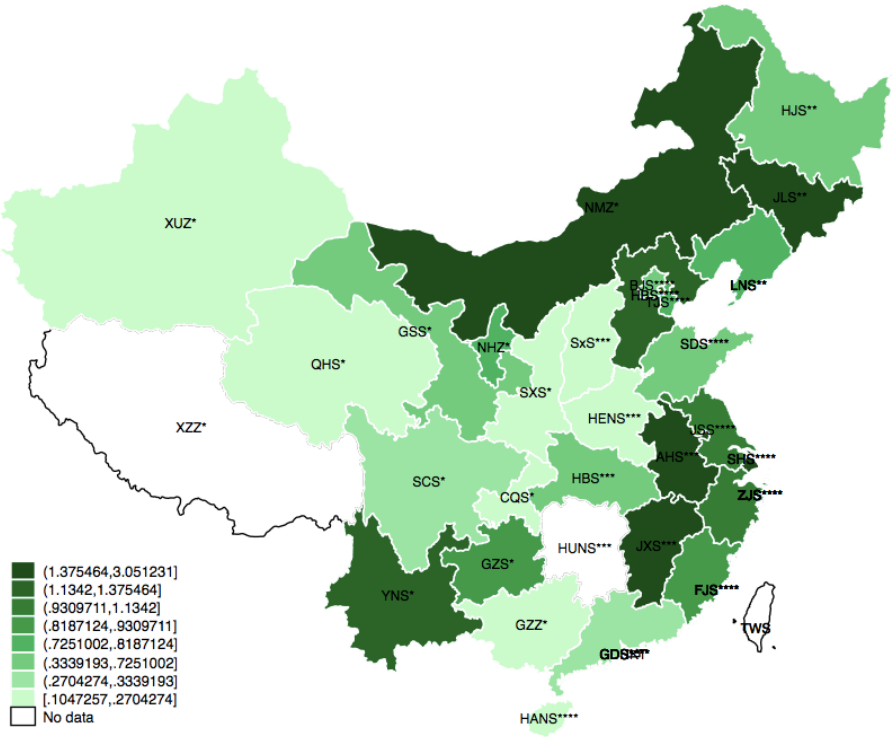


Fig. 5. The regional distribution of average backward FDI agglomeration during the period 2010–2013.

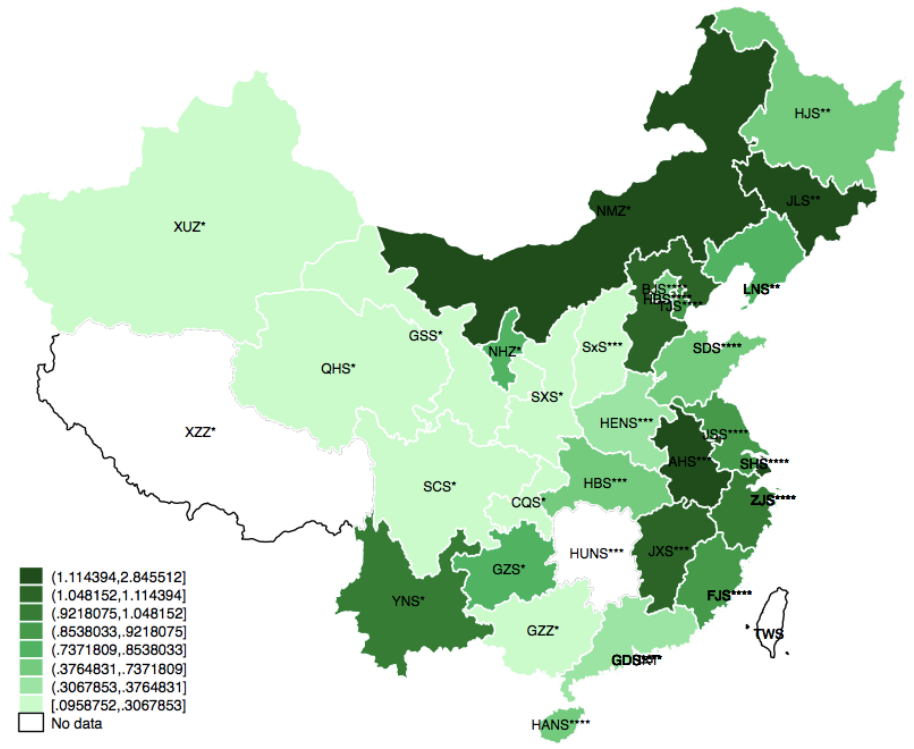


Fig. 6. The regional distribution of average forward FDI agglomeration during the period 2010–2013.

Table 3 shows the spatial regression results by employing. the neighbouring weight matrix. In model 4, the coefficient of horizontal FDI agglomeration is not statistically significant, and the coefficient of its squared term is negative and statistically significant. In model 6 and model 8, the coefficients of backward FDI agglomeration and its squared term, as well as the coefficients of forward FDI agglomeration and its squared term, are positive and negative with statistical significance, respectively. These results suggest an inverted U-shaped relationship between the three types of FDI agglomeration and local firms' productivity, which implies that any degree of horizontal FDI agglomeration would reduce local firms' productivity and the degree of backward and forward FDI agglomerations merely beyond its threshold value (the tipping point of the inverted U-shaped relationship) would lead to a decrease in local firms' productivity. The evidence partly supports hypothesis 1 and fully support hypotheses 2 and 3. In other words, the congestion dominates the effect of the three types of FDI agglomeration on local firms' productivity. In model 3, 5 and 7, the evidence shows that the spatial term of horizontal FDI agglomeration is negative with statistical insignificance and the spatial terms of vertical and forward FDI agglomerations are negative and statistically significant. Furthermore, the squared spatial terms of horizontal, backward and forward FDI agglomerations are positive with statistical significance. The evidence shows a U-shaped relationship between the three types of spatial FDI agglomerations and neighbouring firms' productivity, violating the general intuition that there is a simple linear or no relationship between them. In addition, this paper also obtains some co-products. Human capital and its spatial term show a positive relationship with local and neighbouring firms' productivity, respectively. Infrastructure and its spatial terms show negative linkage to local and neighbouring firms' productivity, respectively. Export from neighbouring regions is uncorrelated with local firms' productivity. Firm characteristics including firm age, ownership, capital intensity and export exert a positive impact on local firms' productivity except for firm size, which shows the opposite linkage.

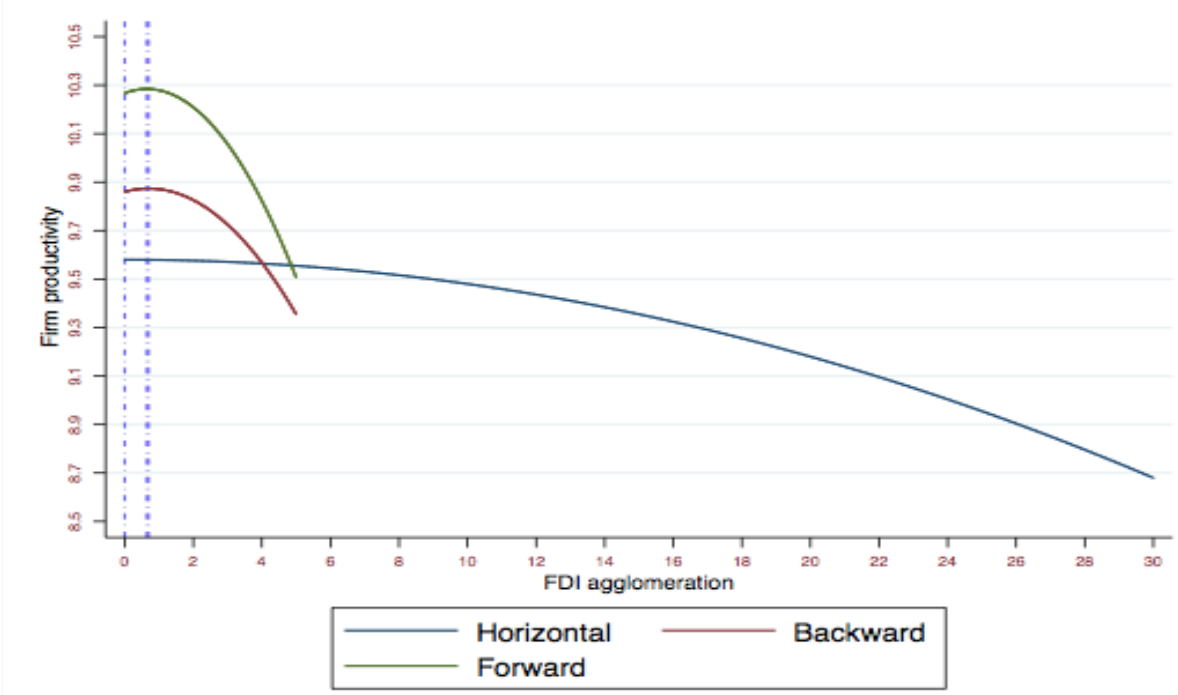
Based on the regression results in Table 4, I further draw the inverted U-shaped relationship between the three types of FDI agglomerations and local firms' productivity, which is shown in Figure 7. The marginal elasticities (the sensitivity to local firms' productivity along with the change of FDI agglomeration's level) between horizontal, backward and forward FDI agglomerations and local firms' productivity are about 0.002, 0.056 and 0.082, respectively, which supports hypothesis 4. Moreover, the threshold values of horizontal, backward and forward FDI agglomerations are roughly 0, 0.694 and 0.646, respectively. Foreign firms in horizontal agglomeration are competitive relationship with local firms in the same industry, which makes local firms are geographically alienated to foreign firms. Foreign firms in forward and backward agglomerations are co-operative relationship with local upstream and downstream firms, which makes local upstream and downstream firms be geographically close to foreign firms. Furthermore, the interaction intensity of agglomerated foreign firms with domestic firms is constrained by the geographical distance. Average 3.949 per cent of total backward FDI agglomerations and 3.971 per cent of total forward FDI agglomerations during the 2010–2013 period are beyond its threshold value in this study sample. Hence, horizontal FDI agglomeration should be not encouraged, and backward and forward FDI agglomerations should retain a reasonable degree for reaping more benefits from FDI.

I also draw the U-shaped relationship between the three types of spatial FDI agglomerations and neighbouring firms' productivity, which is shown in Figure 8. The marginal elasticities between spatial horizontal, backward and forward FDI agglomerations and neighbouring firms' productivity are about 0.032, 0.386 and 0.368, respectively. Furthermore, the threshold values of horizontal, backward and forward FDI agglomerations are roughly 0, 0.205 and 0.234, respectively. In addition, I employ the distance spatial weight matrix to conduct spatial econometric estimation as a robust test, which the results shown in Table 5 are consistent with the findings by using the neighbouring spatial weight matrix (Table 4). Nevertheless, I prefer the results using the neighbouring spatial weight matrix.

Table 4
Regression results by using neighbouring weight matrix.

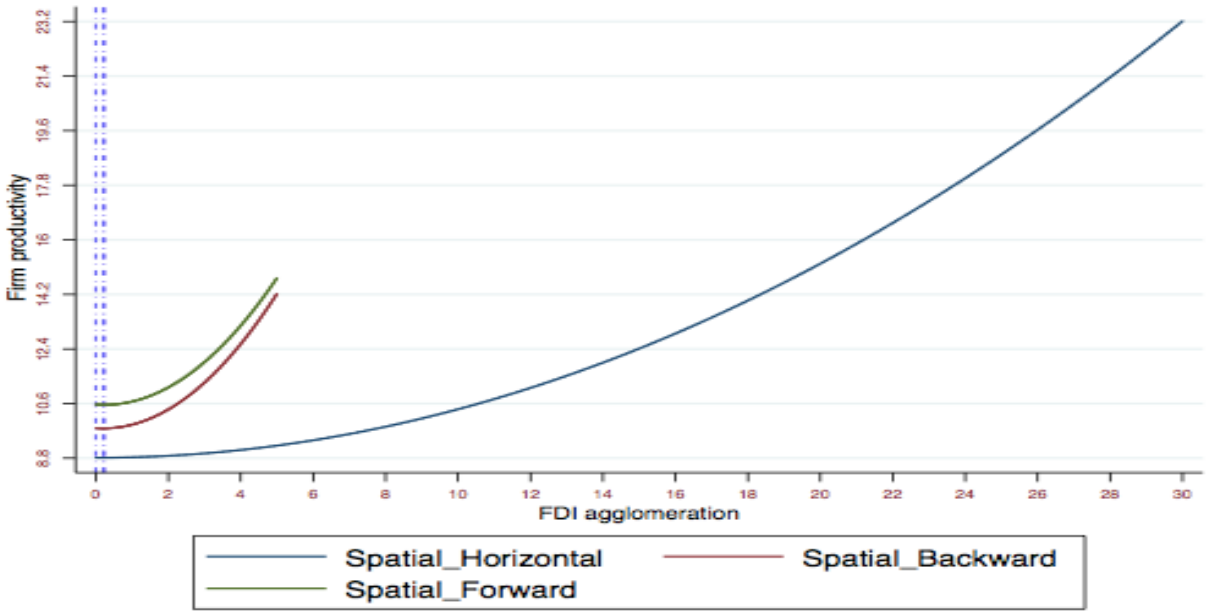
	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8
productivity_lag	0.232***	0.281***	0.286***	0.284***	0.300***	0.288***	0.301***	0.289***
firm_age	0.006***	0.006***	0.006***	0.006***	0.007***	0.006***	0.006***	0.006***
firm_size	-0.110***	-0.101***	-0.098***	-0.099***	-0.095***	-0.098***	-0.095***	-0.098***
ownership	0.200***	0.203***	0.205***	0.201***	0.195***	0.202***	0.195***	0.201***
export	0.023***	0.030***	0.032***	0.032***	0.031***	0.032***	0.032***	0.032***
capital_intensity	0.087***	0.090***	0.093***	0.092***	0.092***	0.092***	0.092***	0.092***
human_capital	0.084***	0.095***	0.077***	0.096***	0.081***	0.092***	0.075***	0.088***
infrastructure	-0.147***	-0.209***	-0.130***	-0.190***	-0.235***	-0.197***	-0.256***	-0.212***
fdi_agglomeration (awi)				-0.002				
fdi_agglomeration (awi)_2				-0.001**				
fdi_agglomeration (abi)						0.039***		
fdi_agglomeration (abi)_2						-0.028***		
fdi_agglomeration (afi)								0.053***
fdi_agglomeration (afi)_2								-0.041***
W_infrastructure		-1.129***	-1.118***	-1.133***	-1.155***	-1.105***	-1.299***	-1.178***
W_human_capital		0.340***	0.375***	0.347***	0.270***	0.326***	0.272***	0.323***
W_export		0.011	-0.041	0.016	-0.016	0.012	-0.002	0.018
W_productivity		-1.000***	-0.908***	-0.992***	-0.924***	-1.004***	-0.998***	-1.025***
W_υ		0.915***	0.867***	0.906***	1.131***	0.918***	1.151***	0.959***
W_fdi_agglomeration (awi)			-0.038					
W_fdi_agglomeration (awi)_2			0.016***					
W_fdi_agglomeration (abi)					-0.079***			
W_fdi_agglomeration (abi)_2					0.193***			
W_fdi_agglomeration (afi)							-0.086***	
W_fdi_agglomeration (afi)_2							0.184***	
Time_dummmy	YES	YES	YES	YES	YES	YES	YES	YES
Industry_dummy	YES	YES	NO	NO	NO	NO	NO	NO
Region_dummy	YES	NO	NO	NO	NO	NO	NO	NO
Constant	5.013***	9.728***	8.814***	9.580***	9.791***	9.860***	10.569***	10.267***
Observations	37,320	37,320	37,320	37,320	37,320	37,320	37,320	37,320
Pseudo R-square	0.469	0.434	0.468	0.441	0.445	0.448	0.425	0.4099
Log-pseudolikelihood	-27,860	-27,550	27,550	-27,570	-27,500	-27,560	-27,500	-27,550
Wald chi-square	5,375.53	5,639.03	5,524.96	5,546.91	5,710.24	5,555.27	5,762.21	5,598.14
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: Standard errors are not report and parentheses are p value. *p<=0.1, **p<=0.05, ***p<=0.01.



Note: This paper puts the three Inverted U-shaped pictures together to compare their elasticities. However, the Inverted U-shaped relationship is more obvious if this paper draws them separately by changing the scale of firm productivity and FDI agglomeration.

Fig. 7. Inverted U-shaped relationship between different types of FDI agglomerations and local firms' productivity.



Note: This paper puts the three U-shaped pictures together to compare their elasticities. However, the U-shaped relationship is more obvious if this paper draws them separately by changing the scale of firm productivity and FDI agglomeration.

Fig. 8. U-shaped relationship between different types of spatial FDI agglomerations and neighbouring firms' productivity.

Table 5
Regression results using spatial distance weight matrix.

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8
productivity_lag	0.232***	0.256***	0.273***	0.258***	0.265***	0.263***	0.265***	0.258***
firm_age	0.006***	0.006***	0.005***	0.005***	0.006***	0.006***	0.005***	0.006***
firm_size	-0.110***	-0.102***	-0.093***	-0.100***	-0.097***	-0.098***	-0.097***	-0.099***
ownership	0.200***	0.227***	0.216***	0.226***	0.225***	0.227***	0.225***	0.224***
export	0.023***	0.025***	0.029***	0.027***	0.029***	0.027***	0.028***	0.032***
capital_intensity	0.087***	0.091***	0.097***	0.093***	0.095***	0.093***	0.095***	0.095***
human_capital	0.084***	0.137***	0.067***	0.140***	0.114***	0.155***	0.114***	0.117***
infrastructure	-0.147***	-0.168***	0.01	-0.156***	-0.073***	-0.184***	-0.077***	-0.072**
fdi_agglomeration (awi)				0.002				
fdi_agglomeration (awi)_2				-0.001*				
fdi_agglomeration (abi)						0.053***		
fdi_agglomeration (abi)_2						-0.011*		
fdi_agglomeration (afi)								0.155***
fdi_agglomeration (afi)_2								-0.037***
W_infrastructure		-0.515***	-0.983***	-0.525***	-0.560***	-0.584***	-0.652***	-0.685***
W_human_capital		0.283***	0.171***	0.287***	0.116***	0.299***	0.158***	-0.029
W_export		0.004	1.524***	0.011	0.533***	0.103	0.388***	1.614***
W_productivity		-2.986***	0.422*	-3.038***	-1.846***	-2.297***	-1.954***	0.585
W_υ		1.182***	-1.058***	1.181***	1.073***	1.191***	1.110***	-1.047***
W_fdi_agglomeration (awi)			-1.697***					
W_fdi_agglomeration (awi)_2			0.147***					
W_fdi_agglomeration (abi)					0.015			
W_fdi_agglomeration (abi)_2					0.493***			
W_fdi_agglomeration (afi)							0.073***	
W_fdi_agglomeration (afi)_2							0.389***	
Time_dummmy	YES	YES	YES	YES	YES	YES	YES	YES
Industry_dummy	YES	YES	NO	NO	NO	NO	NO	NO
Region_dummy	YES	NO	NO	NO	NO	NO	NO	NO
Constant	5.013***	22.791***	0.048	23.112***	15.912***	17.698***	16.653***	0.158
Observation	37,320	37,320	37,320	37,320	37,320	37,320	37,320	37,320
Pseudo R-square	0.469	0.449	0.537	0.448	0.47	0.483	0.492	0.519
Log-pseudolikelihood	-27,860	-27,750	-27,720	-27,780	-27,750	-27,770	-27,760	-27,780
Wald chi-square	5,375.51	5,017.39	7,399.37	4,903.72	4,861.62	4,926.37	4,871.64	7,529.31
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: Standard errors are not report and parentheses are p value. *p<=0.1, **p<=0.05, ***p<=0.01

5. Conclusions

This paper expands the literature of industry agglomeration to explore the non-linear and spatial effects of the horizontal, backward and forward FDI agglomerations on domestic firms' productivity based on firm-level data by employing a spatial econometric model with random effect. I also illustrate the three types of interaction mechanisms including the main differences in terms of inter-firm relationship, the trade-off between benefits and costs, and interaction intensity. The findings in this paper provide some meaningful evidence to trigger ongoing dialogue between economists, business analysts and government officers.

I find that the congestion dominates the three types of FDI agglomerations on local firms' productivity. Furthermore, local firms' productivity is relatively strong sensitivity to the change of the level of backward and forward FDI agglomerations while weak sensitivity to that of horizontal FDI agglomeration. To reap more benefits from FDI, horizontal FDI agglomeration is not encouraged (its threshold value is equal to zero) and backward and forward FDI agglomerations should retain a reasonable degree that is not beyond its threshold value (0.694 and 0.646, respectively) in the local region. Although backward and forward FDI over-agglomerations merely show an average 3.949 per cent and 3.971 per cent of corresponding total FDI agglomerations during the four years in this study sample and the congestion effect seems to have not yet extensively spread, the over-agglomerations are possible to become more and more severe without reasonable intervention. Consequently, it would largely impede the benefits of FDI agglomerations and even injure domestic firms.

In addition to the congestion effect, I have also drawn special attention to the spatial effect. The empirical evidence displays a U-shaped relationship between spatial horizontal, backward and forward agglomeration of foreign firms and neighbouring firms' productivity, which challenges our general intuition of the existence of a simple linear or no relationship between them. Furthermore, neighbouring firms' productivity is relatively strong sensitivity to the change of the level of spatial backward and forward FDI agglomerations while weak sensitivity to that of horizontal FDI agglomeration. Besides, I also obtain some co-products. Human capital both in the local region and neighbouring regions are positively associated with local firms' productivity. In contrast, infrastructure both in the local region and neighbouring regions have a negative effect on local firms' productivity. Export in neighbouring regions does not show evidence of linkage to local firms' productivity. Firm characteristics including firm age, ownership, capital intensity and export exert a positive impact on local firms' productivity except for firm size, which shows the opposite linkage.

The empirical evidence in this paper provides some credible signals for the implications of region and industry policies that promote firm productivity and economic growth. To reap as much benefit from FDI as possible, local governments should reasonably induce different types of FDI agglomeration because of the difference in their interaction mechanisms with domestic firms. Local governments should moderately disperse FDI in some regions and industries with FDI over-agglomeration, and local governments in middle and western regions should implement preferential policies such as duty exemptions and subsidized industry infrastructure to attract FDI. Furthermore, in China, local governments in different regions generally separately attract FDI and compete with each other. However, it seems to be better for local governments in different regions to co-operate by developing an integrated policy to promote the positive interactions of FDI agglomeration with domestic firms both in local and neighbouring regions. In addition, local governments, especially in less-developed regions, should also pay attention to socioeconomic conditions such as human capital and transport infrastructure because these factor endowments are essential determinants of firm productivity both in local and neighbouring regions.

Appendix A. Relevant indices

Revealed comparative advantage (RCA) suggested by Balassa (1965):

$$RCA_{ij} = (X_{ij}/\sum_j X_{ij})/(\sum_i X_{ij}/\sum_{ij} X_{ij})$$

Where X_{ij} denotes exports in sector i from country j. The numerator and denominator denote the percentage share of a given sector i in national exports and the percentage share of the same sector in the world exports respectively.

Horizontal and vertical indices proposed by Javorcik (2004):

$$Horizontal_{jt} = \frac{\sum_{i\in j} Foreign\ share_{it} \times Y_{it}}{\sum_{i\in j} Y_{it}}$$

Where $Foreign\ share_{it}$ represents the share of firm i's total equity owned by foreign investors. Y_{it} represents the output of firm i in industry j.

$$Backward_{jt} = \sum_{k\neq j} \theta_{jk}\, Horizontal_{kt}$$

Where θ_{jk} represents the percentage of industry j's total intermediate use that is purchased by industry k.

$$Forward_{jt} = \sum_{m\neq j} \rho_{jm} \frac{\sum_{i\in m} Foreign\ share_{it} \times (Y_{it} - EX_{it})}{\sum_{i\in m}(Y_{it} - EX_{it})}$$

Where ρ_{jm} represents the percentage of industry j's total intermediate input that is supplied by industry m. EX_{it} represents the exports of each firm i in industry m.

References

Aitken, B. J., Harrison, A. E. (1999). Do domestic. Firms. benefit from direct foreign investment? Evidence from Venezuela. *American Economic Review*, *89*(3), 605-618.

Aitken, B., Hanson, G. H., Harrison, A. E. (1997). Spillovers, foreign investment, and export behavior. *Journal of International Economics*, *43*(1-2), 103-132.

Amiti, M., Javorcik, B. S. (2008). Trade costs and. location of foreign firms in China. *Journal of Development Economics*, *85*(1-2) 129-149.

Anselin, L., Le Gallo, J., Jayet, H. (2008). Spatial panel econometrics. In *The econometrics of panel data* (pp. 625-660). Berlin: Springer.

Azari, M., Kim, H., Kim, J. Y., Ryu, D. (2016). The. effect of agglomeration on the productivity of urban manufacturing sectors in a leading emerging economy. *Economic Systems*, *40*(3), 422-432.

Balassa, B. (1965). Trade liberalization and revealed comparative advantage . *The Manchester School*, *33*(2), 99-123.

Balsvik, R. (2011). Is labor mobility a channel for spillovers from multinationals? Evidence from Norwegian manufacturing. *The Review of Economics and Statistics*, *93*(1), 285-297.

Barry, F., Görg, H., Strobl, E. (2003). Foreign direct investment, agglomerations, and demonstration effects: an empirical investigation. *Review of World Economics*, *139*(4), 583-600.

Batisse, C. (2002). Dynamic externalities and local growth: A panel data analysis applied to Chinese provinces. *China Economic Review*, *13*(2-3), 231-251.

Blomström, M., Sjöholm, F. (1999). Technology transfer and spillovers: Does local participation with multinationals matter? 1. *European Economic Review*, *43(*4-6), 915-923.

Blundell, R., Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115-143.

Brandt, L., Van Biesebroeck, J., Zhang, Y. (2012). Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing. *Journal of Development Economics*, *97*(2), 339-351.

Broersma, L., Oosterhaven, J. (2009). Regional labor productivity in the Netherlands: Evidence of agglomeration and congestion effects. *Journal of Regional Science*, *49*(3), 483-511.

Brülhart, M., Mathys, N. A. (2008). Sectoral. agglomeration economies in a panel of European regions. *Regional Science and Urban Economics*, *38*(4), 348-362.

Buckley, P. J., Clegg, J., Wang, C. (2002). The impact. of inward FDI on the performance of Chinese manufacturing firms. *Journal of International Business Studies*, *33*(4), 637-655.

Buckley, P. J., Clegg, J., Wang, C. (2007). Is the relationship. between inward FDI and spillover effects linear? An empirical examination of the case of China. *Journal of International Business Studies, 38*(3), 447–59.

Carlino, G. A., Chatterjee, S., Hunt, R. M. (2007). Urban density and the rate of invention. *Journal of Urban Economics*, *61*(3), 389-419.

Chang, S. J., Chung, J. (2017). A quasi-experimental. approach to the multinationality-Performance relationship: An application to learning-by-exporting. *Global Strategy Journal*, *7*(3), 257-285.

Chang, S. J., Xu, D. (2008). Spillovers and competition among foreign and local firms in China. *Strategic Management Journal*, *29*(5), 495-518.

Ciccone, A. (2002). Agglomeration effects in. Europe. *European Economic Review*, *46*(2), 213-227.

Cingano, F., Schivardi, F. (2004). Identifying the sources of local productivity growth. *Journal of the European Economic Association*, *2*(4),720-744.

Coughlin, C. C., Segev, E. (2000). Foreign direct investment in China: a spatial econometric study. *World Economy*, *23*(1), 1-23.

Dekle, R. (2002). Industrial concentration and regional. growth: evidence from the prefectures. *Review of Economics and Statistics*, *84*(2), 310-315.

Dirks, K. T., Ferrin, D. L. (2001). The role of trust in organizational settings. *Organization Science*, *12*(4), 450-467.

Driffield, N. (2006). On the search for spillovers from foreign direct investment (FDI) with spatial dependency. *Regional Studies*, *40*(1), 107-119.

Du, L., Harrison, A., Jefferson, G. H. (2012). Testing for horizontal and vertical foreign Investment spillovers in China, 1998–2007. *Journal of Asian Economics*, *23*(3), 234- 243.

Duranton, G., Puga, D. (2004). Micro-foundations of urban agglomeration economies. In *Handbook of regional and urban economics* (Vol.4, pp. 2063-2117). Elsevier, Amsterdam.

Elhorst, J. P. (2012). Dynamic spatial panels: Models, methods, and inferences. *Journal of Geographical Systems*, *14*(1), 5–28.

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.

Girma, S., Görg, H., Pisu, M. (2008). Exporting, linkages and productivity spillovers from foreign direct investment. *Canadian Journal of Economics*, *41*(1), 320-340.

Graham, D. J. (2009). Identifying urbanization and localization externalities in manufacturing and service industries. *Papers in Regional Science*, *88*(1), 63-84.

Graham, D. J., Kim, H. Y. (2008). An empirical analytical framework for agglomeration economies. *The Annals of Regional Science*, *42*(2), 267-289.

Haddad, M., Harrison, A. (1993). Are there positive spillovers from direct foreign investment?: Evidence from panel data for Morocco. *Journal of Development Economics*, *42*(1), 51-74.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of The Econometric Society*, 1251-1271.

He, C., Wang, J. (2010). Geographical agglomeration and co-agglomeration of foreign and domestic enterprises: a case study of Chinese manufacturing industries. *Post Communist Economies*, *22*(3), 323-343.

Henderson, J. V. (2003a). Marshall's scale economies. *Journal of Urban Economics*, *53*(1), 1-28.

Henderson, J. V. (2003b). The urbanization process and economic growth: The so-what question. *Journal of Economic Growth*, *8*(1), 47-71.

Hu, C., Xu, Z., Yashiro, N. (2015). Agglomeration and. productivity in China: Firm level evidence. *China Economic Review*, *33*, 50-66.

Jacobs, J. (1969). The economy of cities. Random House, New York.

Javorcik, B. S. (2004). Does foreign direct investment. increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review*, *94*(3), 605-627.

Javorcik, B. S., Spatareanu, M. (2008). To share or not to share: Does local participation matter for spillovers from foreign direct investment?. *Journal of Development Economics*, *85*(1-2), 194-217.

Johanson, J., Vahlne, J. E. (2009). The Uppsala internationalization process model revisited: From liability of foreignness to liability of outsidership. *Journal of International Business Studies*, *40*(9), 1411-1431.

Ke, S. (2010). Agglomeration, productivity, and spatial spillovers across Chinese cities. *The Annals of Regional Science*, *45*(1), 157-179.

Klein, A., Crafts, N. (2018). Agglomeration externalities. and productivity growth: US cities, 1880–1930. *The Economic History Review*. 1-24.

Kogut, B., Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the Replication of technology. *Organization Science*, *3*(3), 383-397.

Kogut, B., Zander, U. (1996). What firms do? Coordination, identity, and learning. *Organization Science*, *7*(5), 502-518.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, *99*(3), 483-499.

Kugler, M. (2006). Spillovers from foreign direct investment: within or between industries?. *Journal of Development Economics*, *80*(2), 444-477.

Lall, S., Deichmann, U., Shalizi, Z.(2004). Agglomeration economies and productivity in Indian industry. *Journal of Development Economics*, *73*(3), 643-673.

Lamin, A., Livanis, G. (2013). Agglomeration, catch-up and the liability of foreignness in emerging economies. *Journal of International Business Studies*, *44*(6), 579-606.

Levinsohn, J., Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*, *70*(2), 317-341.

Levin, D. Z., Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management Science*, *50*(11), 1477-1490.

Lin, H. L., Li, H. Y., Yang, C. H. (2011). Agglomeration and productivity: Firm-level evidence from China's textile industry. *China Economic Review*, *22*(3), 313-329.

Liu, X., Siler, P., Wang, C., Wei, Y. (2000). Productivity spillovers from foreign direct investment: evidence from UK industry level panel data. *Journal of International Business Studies*, *31*(3), 407-425.

Lord, M. D., Ranft, A. L. (2000). Organizational learning about new international markets: Exploring the internal transfer of local market knowledge. *Journal of International Business Studies*, *31*(4), 573-589.

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*(4), 519-538.

Marshall, A. (1920). Industry and Trade, third ed, London. Macmillan.

Martin, P., Mayer, T., Mayneris, F. (2011). Spatial. concentration and plant-level productivity in France. *Journal of Urban Economics*, *69*(2), 182-195.

Melo, P. C., Graham, D. J., Noland, R. B. (2009). A. meta-analysis of estimates of urban agglomeration economies. *Regional Science and Urban Economics*, *39*(3), 332-342.

Melo, P. C., Graham, D. J., Levinson, D., Aarabi, S. (2017). Agglomeration, accessibility and productivity: Evidence for large metropolitan areas in the US. *Urban Studies*, *54*(1), 179-195.

National Bureau of Statistics of China (2013). GDP by Province.http://data.stats.gov.cn/english/easyquery.htm?cn=E0103 (accessed 8 January. 2019).

National Bureau of Statistics of China (2018). China Statistic Yearbook 2018. http://www.stats.gov.cn/tjsj/ndsj/2018/indexeh.htm (accessed 8 January 2019).

Olley, G. S., Pakes, A. (1996). *The dynamics of. productivity in the telecommunications equipment industry* (No. w3977). National Bureau of Economic Research.

Polanyi, M. (1966). The tacit dimension. Garden City, New York.

Poole, J. P. (2013). Knowledge transfers from multinational to domestic firms: Evidence from worker mobility. *Review of Economics and Statistics*, *95*(2), 393-406.

Rizov, M., Oskam, A., Walsh, P. (2012). Is there a limit. to agglomeration? Evidence from productivity of Dutch firms. *Regional Science and Urban Economics*, *42*(4), 595-606.

Smith, E. A. (2001). The role of tacit and explicit knowledge in the workplace. *Journal of Knowledge Management*, *5*(4), 311-321.

Shaver, J. M. (1998). Accounting for endogeneity when.assessing strategy performance: does entry mode choice affect FDI survival?. Management Science, *44*(4), 571-585.

Shaver, J. M., Mitchell, W., Yeung, B. (1997). The effect of own-firm and other-firm experience on foreign direct investment survival in the United States, 1987-92. *Strategic Management Journal*, *18*(10), 811-824.

Simonin, B. L. (1999). Ambiguity and the process of. knowledge transfer in strategic alliances. *Strategic Management Journal*, *20*(7), 595-623.

Spencer, J. W. (2008). The impact of multinational. enterprise strategy on indigenous enterprises: Horizontal spillovers and crowding out in developing countries. *Academy of Management Review*, *33*(2), 341-361.

Tallman, S., Chacar, A. S. (2011). Knowledge accumulation. and dissemination in MNEs: a practice-based framework. *Journal of Management Studies*, *48*(2), 278-304.

Tan, D., Meyer, K. E. (2011). Country-of-origin and industry FDI agglomeration of foreign investors in an emerging economy. *Journal of International Business Studies*, *42*(4), 504-520.

UNCTADSTAT (2018). FDI inflow and outward flows and stock. https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx (accessed 1 January, 2019).

Van Oort, F. G. (2007). Spatial and sectoral composition effects of agglomeration economies in the Netherlands. *Papers in Regional Science*, *86*(1), 5-30.

Wang, J. Y., Blomström, M. (1992). Foreign investment and technology transfer: A simple model. *European Economic Review*, *36*(1), 137-155.

Wei, K., Yao, S., Liu, A. (2009). Foreign direct investment and regional inequality in China. *Review of Development Economics*, *13*(4), 778-791.

Xiao, S. S., Jeong, I., Moon, J. J., Chung, C. C., Chung, J. (2013). Internationalization and performance of firms in China: Moderating effects of governance structure and the degree of centralized control. *Journal of International Management*, 19(2), 118-137.