Intra-metropolitan location of foreign direct investment in Wuhan, China: Institution, urban structure, and accessibility

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A B S T R A C T
Coastal cities have been at the forefront of China’s economic reform and open-door policy. However, regional differences in cost and income have prompted the government to encourage interior development since the late 1990s. Foreign direct investment (FDI) is one of the most mobile forms of capital and is a key agent of urban spatial transformation in China. This paper examines intra-metropolitan location of FDI location in interior China through a study of Wuhan, the largest metropolitan area in central China and the gateway to China’s north-south and east-west linkages. We find that FDI in Wuhan has become more concentrated over time and is centralized on the Wuhan Economic and Technological Development Zone, a national development zone. Combining the logistic model with geographically weighted regression, we examine the effects of institution and urban structure, in addition to the orthodox location factors (accessibility) on the FDI location. We find that FDI in Wuhan is a result of interaction among institution, urban structure, and accessibility. Also, easy access to road and the central business districts (CBDs) has positive impacts on the FDI location. Last, the importance of urban spatial structure is identified through the significance of the traditional auto industrial base, Hanyang, in the FDI location.

Introduction

Three decades of economic reforms and open door policies have made China the second largest (the largest in 2003) recipient of foreign direct investment (FDI) in the world (UNCTAD, 2013). As such, China’s FDI policies merit a closer look. China’s economic reform and openness to FDI has been a spatially varying process over the last three decades. Open door policies were firstly applied to special economic zones and coastal cities in the 1980s, and expanded to a few inland cities in the 1990s. The central government encouraged integrated regional development by initiating the Great Western Development Strategy in 1999, the Northeast China Revitalization in 2003, and the Rise of Central China Plan in 2004. At the same time, coastal development and rising demand have caused a shortage of natural resources and rising costs of production in coastal cities (Chibamba & Li, 2008). Such changes in both inland and coastal areas prompt the increasing attractiveness of interior cities to FDI. It is necessary and important to examine spatial patterns and determinants of FDI in inland cities.

Existing studies of FDI focus on coastal cities, and in terms of scale, interprovincial level and intercity level (Lin, Wang, Zhou, Sun, & Wei, 2011; Zhou, Sun, Wei, & Lin, 2011), paying little attention to FDI location at the intra-metropolitan level. Also, the effect of the urban spatial structure, which provides an important physical framework for foreign investment at an intra-metropolitan level, has rarely been studied. Moreover, few quantitative researches that do exist use aggregated data to explain individual firm behavior, not reflecting the heterogeneity of location choices of FDI. This study analyzes the characteristics and processes of FDI location in an inland area through a study of the Wuhan metropolitan area, China’s largest inland transportation hub and information center. Based on the 2008 economic census, this research uses spatial statistics and geographic information systems (GIS) to examine spatial-temporal patterns of FDI within Wuhan. It integrates a logistic model with geographically weighted regressions to investigate FDI locational determinants, paying special attention to the varying role of urban spatial structure and its interaction with agglomeration and institution. The objectives of this research are to map the shifts in patterns of FDI within Wuhan since 1990 and assess the effectiveness of relevant policies, to examine the influence of urban spatial structure and its interaction with agglomeration and institution in FDI, and to evaluate the effects of different accessibility.

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Analytical framework and research context

Location theories have been evolved over time. Neoclassical location theory advances a core-periphery pattern, focusing on the significance of accessibility to the central business district (CBD), transportation, and infrastructure in the investment costs (Alonso, 1964). New economic geography provides a new explanation on the concentration of firms through agglomeration effects of investment, emphasizing the positive externalities of increasing return (Krugman, 1991). In addition, the notion of polycentricity maintains that the urban spatial structure defines the characteristics of development sites and thus influences locational decisions of firms (Shukla & Waddell, 1991). Especially within a city with several centers, the traditional center has seen a declining attraction to new firms, while emerging new centers have increasingly attracted them. In recent years, institutional economics has discovered the significance of institution in FDI location (Dicken, 2007). These theories have influenced the policies and research on China's FDI, but they were developed primarily to explain FDI location in Western capitalist cities and therefore could be limited in explaining FDI location in Chinese cities, which have different urban spatial structure and are experiencing rapid urbanization and institutional transition to a market economy. The literature on FDI location within Chinese cities is very limited due to the limitation of data availability. This research is conducted under the framework of institution, urban structure, and accessibility in explaining FDI location.

Institution

New institutional economics focuses on the role of social and legal norms and rules in economic activity. It recognizes that transaction costs are a significant part of investment. Institutions matter for transaction costs in FDI (Coase, 1960). The internalization theory of FDI interprets how institutional market imperfections and market transaction costs may be internalized by multinational enterprises (MNEs) through FDI to minimize investment costs (Buckley & Casson, 1991; Rugman, 1980; Vernon, 1966). It is widely used in explaining the investment motives of firms.

The important role of institutions in foreign investment is highlighted in Chinese context (Wei & Liefner, 2012; Zhou & Wei, 2011). Research on institutional effects mainly focuses on the significance of economic and technological development zones (ETDZs) in FDI location. Wei, Leung, Li, and Pan (2008) and Wei, Luo, and Zhou (2010) find that development zone authorities are a significant force influencing the intramunicipal location decisions of MNEs in Hangzhou and Nanjing, respectively. These development zones provide financial incentives, industrial infrastructures, and quality administration to modulate risks, support operations, and enhance investment environments (Wei et al., 2008). Similarly, Wu (1999) and Wu and Radbone (2005) find the positive impacts of ETDZs in Guangzhou and Shanghai, respectively. However, these existing studies did not assess and evaluate the effectiveness of certain national development strategies and policies in attracting FDI within a metropolitan area. Although there has been extensive research on the success of open policies in coastal cities, little is known about the effectiveness of national policies on FDI in inland cities when national policies toward these cities are changing.

The central government initiated the Rise of Central China Plan in 2004, which proposed the idea of the Greater Wuhan Megalopolis, consisting of Wuhan and eight surrounding cities, in order to create a competitive economic region in Central China. In 2005, Wuhan became a strategic pillar city and played a leading role in the Rise of Central China Plan, and specific policies were implemented later. In December 2005, the Ministry of Commerce issued Opinions Regarding Attracting Foreign Investment and Promoting the Rise of Central China. The following year, the State Council issued Opinions Regarding Promoting the Rise of Central China Plan, and in 2007, the General Office of the State Council issued a notice that 26 cities in Central China were given the same preferential policies as those implemented in the Great Western Development Strategy and the Northeast China Revitalization. Wuhan is one of these 26 cities. One of the aims of these opinions and notices is to strengthen modern equipment manufacturing bases, including auto and auto parts, and promote rapid development of development zones through the encouragement of investment by private enterprises and foreign enterprises. Incentives were provided to achieve this aim in terms of capital and land. They included fiscal and tax incentives, which increased the fiscal transfer payment to help undertake industrial transfer projects. Also, China Development Bank provided a discounted loan of 15 billion Yuan to basic infrastructure projects in national development zones in Central China. For encouraged projects in the categories of foreign investment, the imported equipment for their own use was duty free. There were also land incentives, which increased the quota of land for urban development and gave higher priority to land use in the industrial parks.

Wuhan has experienced a series of institutional changes since being opened as one of the five open cities along the Yangtze River by the central government in May 1992. Two national development zones, the Wuhan East Lake High-Tech Zone (Wuhan ELHTZ) and the Wuhan Economic and Technological Development Zone (Wuhan ETDZ) were established in 1988 and 1991, respectively. The Wuhan ELHTZ, referred to as ‘Optics Valley of China,’ focuses on the optical electronics, telecommunication, information, and biology sectors, while the Wuhan ETDZ is a manufacturing base for auto and auto parts. Additionally, each district in Wuhan established its own local development zone in the 1990s. Compared to the national development zones, these local development zones are considered to be local economic development tools and are more related to local interest within a metropolitan area. In 2010, the Wujiashan Economic and Technological Development Zone (Wujiashan ETDZ) was approved by the State Council to become the third national development zone in Wuhan, which is a food industry base. This research examines the effectiveness and influence of these specific policies on FDI location.

Urban structure

The notion of polycentricity identifies a polycentric urban structure in which a number of centers develop within the metropolis (Harris & Ullman, 1945). The important source of polycentric urban structure is increasingly identified as the significance of agglomeration economies (Krugman, 1991; Porter, 1990; Scott, 1988). Investment tends to cluster in several areas resulting from the tension between centripetal and centrifugal forces. The centripetal force is localized external economies in production (forward and backward linkages) while the centrifugal forces include urban land rent (Henderson, 1974). The theoretical work of polycentricity has been tested in a variety of empirical findings in Western capitalist cities (Blotevogel, 1998; Gordon, Richardson, & Wong, 1986; Waddell, Berry, & Hoch, 1993).

Chinese cities’ urban spatial structure is quite distinct from that of Western capitalist cities due to differences in their history, socioeconomic structure, and population, but its roles in FDI location have not been identified in Chinese cities yet. Further, the urban spatial structure of Chinese cities is experiencing significant changes resulting from rapid urbanization, industrialization, marketization, and decentralization. Rapid leapfrog developments in the suburbs and the emergence of multiple business and service areas in the city center are changing the current urban spatial
structure in Chinese cities and creating new ones (Ma & Wu, 2005). However, how this changing urban structure interacts with agglomeration and institution in FDI has rarely been explored.

Wuhan consists of thirteen districts: seven districts are in the city center, and another six districts are in the suburb. The suburb has more available land for FDI than the city center, while the suburb has a lower population than the city center. The suburb has a total area of 7606 square kilometers, more than eight times as much as the city center has. The suburb has a population of 3.34 million while the city center has a population of 5.76 million (Wuhan Statistics Yearbook, 2010). Wuhan is divided into three parts: Hankou, Hanyang, and Wuchang. In terms of urban functions and land use characteristics, Hankou is the commercial and financial center where the majority of commercial and financial land use is concentrated, Hanyang is the industrial center with the highest percentage of industrial land use, and Wuchang is the educational and cultural center where the majority of educational and cultural land use is concentrated. Each part has a long history of serving its function and has its own centers. Effects of different urban functions and landscapes are identified to examine the role of urban spatial structure in FDI location.

Accessibility

Location theory suggests that accessibility is an important determinant of industrial location. Classical industrial location models analyze the location of firms by minimizing the cost of access to different resources (Isard, 1956; Losch, 1959; Weber, 1929). Traditional studies of industrial locations indicate the significance of accessibility to the CBD and transportation infrastructure (Harrington & Warf, 2002; Knox & Taylor, 1995).

Different from the neoclassical location theory, accessibility has varied effects on the location of FDI within Chinese cities due to different urban spatial structure. Some scholars find the positive influence of proximity to the CBD, airports, and supporting services on FDI location in major coastal cities, such as Guangzhou (Wu, 1999) and Shanghai (Wu and Radbone, 2005), while Wei et al. (2010) find that proximity to the railway station is a negative factor for FDI in Nanjing. Thus, effects of accessibility on FDI location should be further studied. Current studies have shown, on one hand, that varied effects of accessibility may be due to the complexity of urban structure and local institutions. On the other hand, these studies are context-specific and fail to produce generalizable results because of unique regional and local contexts in coastal areas.

Wuhan has unique locational characteristics. Usually referred to as the ‘thoroughfare to nine provinces’, the Wuhan metropolitan area is China’s largest inland rail and road transportation hub. Wuhan is located within 1200 km of China’s six major metropolises—Beijing, Tianjin, Shanghai, Guangzhou, Xi’an, and Chongqing (See Fig. 1). China’s two transportation arteries, the Yangtze River that runs from west to east and the Jing-Guang Railway from north (Beijing) to south (Guangzhou), meet in Wuhan. In addition, the five major country-network railways all meet at Wuhan, forming a hub with spokes leading to northern, southwestern, mid-southern and eastern parts of China (Yangtze Council, 2008). Wuhan is a polycentric metropolitan area with one hub airport and two hub ports in Central China. Wuhan Tianhe International Airport is the busiest (and only) hub airport in Central China because of its geographically central location. Wuhan has two ports, Wuhan Port and Wuhan International Container Port. Wuhan Port is the largest inland hub port in Central China. Wuhan International Container Port is a deep water regional container hub port at the mid-stream of the Yangtze River. It plays a key role in the water transportation of Wuhan through connecting Wuhan with areas along the Yangtze River corridor, including the upstream areas of Chongqing and the downstream areas of Shanghai. This research examines effects of these transportation infrastructures in FDI location in terms of their accessibility.

Data and methodology

Data

Data for this study cover firm characteristics data from the 2008 economic census officially released by the National Bureau of Statistics and locational characteristics data from GIS spatial files. The firm level data do not include affiliates. Locational characteristics data includes distance to railways, distance to major roads, distance to the airport, distance to ports, distance to central business districts, density of firms, density of foreign firms.

Methodology

Spatial patterns of FDI: global and local statistics

Global statistics, global Moran’s I and global Getis-Ord G, are carried out to assess the degree to which the FDI distribution pattern deviates from the null hypothesis of spatial randomness. Global Moran’s I is calculated in ArcGIS between 1992 and 2008 to investigate the temporal change of spatial autocorrelation of FDI. Moran’s I index close to 1 indicates clustering and close to 0 indicates randomness. Local Moran’s I, LISA (Local Indicators of Spatial Association) statistics are used to indicate local spatial autocorrelation and identify local FDI clusters within Wuhan in 1995, 2000, and 2005–2008, respectively. In addition to examine the spatial autocorrelation of FDI, local Getis-Ord G statistics are used to identify hot or cold spot areas for FDI within Wuhan in 1995, 2000, and 2005–2008, respectively. ArcGIS is used to calculate and visualize results of LISA and local Getis-Ord G statistics.

Location determinants of FDI: logistic model and geographically weighted regression

In a discrete urban space, logistic models are usually used for predicting discrete outcomes, especially for firm-level data. It can reflect the heterogeneity of locational determinants of FDI by overcoming the assumption that the relationships between FDI and locational determinants are homogenous across all firms. Thus, a logistic model is appropriate to analyze the locational determinants of foreign investment at a firm level. However, due to limitation of data availability and appropriate models, the existing studies use aggregated data and ordinary least squares (OLS) linear regression to examine factors influencing FDI location. They assume normal distribution and ignore the heterogeneity of FDI location determinants, which may cause a downwards-biased estimate of the slope coefficient and an upwards-biased estimation of the intercept. Based on the 2008 economic census, our study uses firm-level data to establish the logistic model to examine locational determinants of FDI. We also develop the geographically weighted regressions (GWR) to examine the variation of the relative significance of factors determining FDI across the metropolitan area.

The logistic model is specified in terms of the probability of the FDI location as follows:

\[ P = \exp(\beta_0 + \beta_1 X_i) / (1 + \exp(\beta_0 + \beta_1 X_i)) + f_i \]

where, as Table 1 shows, P is the probability of a firm investment, \( X_i \) is a vector describing the site characteristics. \( X_i \) consists of four groups of independent variables: accessibility, agglomeration, urban structure, and institution. Accessibility variables include DistanceCBD, DistanceAirport, DistanceRoad, DistanceRail, and DistancePort, representing distances to the CBDs, airport, major
roads, rails, and ports, respectively. Distances to the CBDs, airport, roads, major roads, rails, and ports indicate the accessibility to the CBDs and different transportation infrastructures. All distances are straight-line calculated in ArcGIS and do not consider accessible time based on road network. The positive effect of easy access to the CBD and transportation infrastructures is shown in the studies of industrial locations influenced by neoclassical economics (e.g., Harrington & Warf, 2002; Knox & Taylor, 1995). Agglomeration variables include FDIDensity and FirmDensity, respectively representing the density of foreign firms and density of firms

Fig. 1. Location, spatial organization, and districts of Wuhan metropolitan area. (a) Location and spatial organization of Wuhan metropolitan area. (b) Central city, suburb, and districts of Wuhan metropolitan area.
FDI in Wuhan: basic profile

The annual change in FDI amount reflects the combined effects of national policies and global forces in attracting FDI into Wuhan. FDI amount in Wuhan was little in 1990 and 1991. However, after Wuhan was approved as one of five open cities along the Yangtze River in 1992 and thereafter officially opened to foreign investors, it had a dramatic increase in FDI. Fig. 2 shows the annual change in FDI flows. From 1991 to 1995, FDI jumped from 15 million dollars to 592 million dollars. In 1992, the increase rate of FDI was 373%, the highest recorded rate of increase of FDI in history. In 1993, one year after the official open year, the increase rate of FDI was 314%. These remarkable increases after the official opening suggest the strong effects of national policies in attracting FDI into an inland city. In addition to national policies, the changing global economic environment was another consideration for FDI decisions. In 1996, a negative increase rate of FDI was shown after five consecutive years of rapid increase. Between 1996 and 1998, the negative or almost zero increase rate of FDI indicated the negative influence of the 1997 Asian financial crisis on foreign investment in Wuhan. Following an adjustment period in 1998–2001 and China’s entry into World Trade Organization (WTO) in 2001, Wuhan has experienced a continuous growth of FDI.

Sectors of foreign investment reveal how local socio-economic contexts and national economic strategies together influence FDI in Wuhan. Foreign firms invested in a variety of industries in Wuhan, but manufacturing, real estate, and wholesale and retail have been the three largest sectors of FDI. Based on the 2008 economic census, manufacturing, real estate, and wholesale and retail account for 39.2%, 17.6%, and 16.9% of the total FDI, respectively (Table 2). These three largest sectors of FDI reflect the characteristics of the economic structure of Wuhan, the largest industrial and commercial city of Central China. The largest share of FDI in the manufacturing sector implies the labor-intensive nature of FDI in Wuhan, the largest share of FDI in the real estate sector shows the strong influence of national policies on foreign investment because the central government had been pursuing an expansionary monetary policy and encouraged investments in the real estate industry for better part of the time since the late 1980s. The real estate sector has been the pillar industry in the economy of China.

National development zones played a leading role in attracting FDI in Wuhan. They accounted for 55.3 percent of the total foreign investment in 2008. They are located within the suburban districts along the boundary of central city. Each national development zone has a total area of around 200 square kilometers or more. Comparatively, provincial level development zones’ abilities to attract foreign investments were very limited. They only accounted for 1.4 percent of the total foreign investment in 2008. Compared to national development zones, these provincial level development zones have much smaller land areas. Each of them in the city center has a total area of less than 10 square kilometers, while each in the suburb has a total area of no more than 20.

### Table 1
Definitions of independent variables.

<table>
<thead>
<tr>
<th>Type</th>
<th>Independent variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>DistanceCBD</td>
<td>Distance to CBDs</td>
</tr>
<tr>
<td></td>
<td>DistanceAirport</td>
<td>Distance to Wuhan Tianhe International Airport</td>
</tr>
<tr>
<td></td>
<td>DistanceRoad</td>
<td>Distance to major roads</td>
</tr>
<tr>
<td></td>
<td>DistanceRail</td>
<td>Distance to railways</td>
</tr>
<tr>
<td></td>
<td>DistancePort</td>
<td>Distance to ports</td>
</tr>
<tr>
<td>Agglomeration</td>
<td>FirmDensity</td>
<td>Density of firms</td>
</tr>
<tr>
<td>Urban Structure</td>
<td>FDIDensity</td>
<td>Density of foreign firms</td>
</tr>
<tr>
<td></td>
<td>Suburb</td>
<td>Whether a foreign firm is located in the suburb area (dummy variable: 1 for Yes and 0 for No)</td>
</tr>
<tr>
<td></td>
<td>Hankou</td>
<td>Whether a foreign firm is located in Hankou (dummy variable: 1 for Yes and 0 for No)</td>
</tr>
<tr>
<td></td>
<td>Hanyang</td>
<td>Whether a foreign firm is located in Hanyang (dummy variable: 1 for Yes and 0 for No)</td>
</tr>
<tr>
<td>Institution</td>
<td>NationalETDZ</td>
<td>Whether a foreign firm is located in one of the national level ETDZs (dummy variable: 1 for Yes and 0 for No)</td>
</tr>
<tr>
<td></td>
<td>LocalETDZ</td>
<td>Whether a foreign firm is located in one of the provincial level ETDZs (dummy variable: 1 for Yes and 0 for No)</td>
</tr>
</tbody>
</table>

Fig. 2. The annual growth of FDI flows in Wuhan during 1990–2010.
Spatial patterns of FDI: global and local statistics

FDI distribution has been clustered since 2006 under the influence of the proposal of the Rise of Central China Plan in 2004 and the implementation of relevant specific policies thereafter. Fig. 3 highlights the changes of global Moran's I and global Getis-Ord G for FDI from 1992 to 2008. Global Moran's I has been positive and the Z score for global Moran's I has been greater than 2.58 since 2006. This indicates that FDI has shown the apparent clustering of high value at different significance levels since 2006. This suggests the effectiveness of a series of policies under the Rise of Central China Plan. After it was proposed in 2004, relevant specific policies were implemented thereafter, which were effective in improving inland cities’ attraction to foreign firms and bringing more FDI to cities in Central China.

Three parts of the metropolitan area mentioned above, Hanyang, Hankou, and Wuchang have very different spatial patterns of FDI, reflecting the centralized nature of FDI. Hanyang exerts a strong centralizing influence. Fig. 4 presents the results of local Getis-Ord G in 1995, 2000, 2005, and 2008, showing the strong contrast among Hanyang, Hankou, and Wuchang. In Hanyang lies a major concentration area of FDI; districts in Hankou adjacent to Hanyang are also concentration areas of FDI; no concentration areas of FDI are found in Wuchang. In 1995 and 2000, there were no obvious cold spot or hot spot patterns in Wuhan. In 2005, a very small number of hot spots emerged in suburban Hanan district and Caidian district of Hanyang, and also in the suburban Dongxihu district of Hankou, while a few cold spots emerged in the Qingshan district, Hongshan district, and the suburban Jiangxia district of Wuchang, and also in the suburban Xinzhou district and Huangpi district of Hankou.

In 2008, an increasing number of hot spots emerged and formed clusters in Hanyang, while an increasing number of cold spots emerged and formed clusters in Wuchang. At the same time, in Hankou, districts adjacent to Hanyang had small clusters of FDI hot spots while districts adjacent to Wuchang had small clusters of FDI cold spots. The strong centralizing influence of Hanyang manifests the benefits of localization economies to the FDI location. As a strong local auto industrial base, Hanyang is able to provide a diverse range of technological capabilities, abundant skilled laborers, and more-than-adequate production capacity to meet requirements from foreign investors. It, along with affinity to this area with the highest percentage of industrial land probably reflects the propensity of FDI to locate in predominantly industrial areas. The avoidance of Wuchang, which has high proportions of cultural and educational activities, suggests the avoidance of areas where little industrial linkages are occurring.

Two national development zones, the Wuhan ETZ of Hanyang and the Wujiaoshan ETZ of Hankou, are major agglomeration areas of FDI. Extremely large joint ventures are found to sustain a significant pull, showing the strong interaction among urban spatial structure, agglomeration, and institution. Fig. 5 presents the LISA results of FDI in 1995, 2000, 2005, and 2008, showing both negative and positive spatial autocorrelation. In 1995, there was only one cluster with negative spatial autocorrelation in the Wuhan ETZ. This cluster centered on the largest joint venture company with high level of FDI, Dongfeng Peugeot Citroen Automobile Company LTD, which is surrounded by firms with low level of FDI. In the same year, there were no clusters with positive spatial autocorrelation. In 2000, in addition to one existing cluster in the Wuhan ETZ, another two clusters with negative spatial autocorrelation were found in the Jiang'an district and the suburban Xinzhou district of Hankou. In the same year, there were no clusters with positive spatial autocorrelation. In 2005, in addition to three existing clusters, one more cluster with negative spatial autocorrelation was formed in the Wuhan ETZ. This cluster centered on another largest joint venture company with high level of FDI, Dongfeng Motor Company Limited. In the same year, there were still no clusters with positive spatial autocorrelation.

In 2006, all previous clusters with negative spatial autocorrelation in the Wuhan ETZ became clusters with positive spatial autocorrelation, forming the clusters of high FDI. Apparently, two extremely large joint ventures, Dongfeng Peugeot Citroen

### Table 2
Profile of foreign firms.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Category</th>
<th>Number of cases</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number</td>
<td>&lt;100</td>
<td>906</td>
<td>74.3</td>
</tr>
<tr>
<td>of employees</td>
<td>100–199</td>
<td>130</td>
<td>10.6</td>
</tr>
<tr>
<td></td>
<td>200–500</td>
<td>124</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>&gt;500</td>
<td>60</td>
<td>4.9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1220</td>
<td></td>
</tr>
</tbody>
</table>

Industry
- Agriculture, forest, livestock, and fishing: 0 cases
- Mining: 2 cases
- Manufacturing: 478 cases (39.2%)
- Electricity, gas, and water production: 7 cases
- Architecture: 44 cases (3.6%)
- Transportation, warehouse and postal services: 40 cases (3.3%)
- Information transmission, computer services, and software: 53 cases (4.3%)
- Wholesale and retail: 206 cases (16.9%)
- Hotel and restaurant: 65 cases (5.3%)
- Real estate: 215 cases (17.6%)
- Research, technical services, and geological survey: 48 cases (3.9%)
- Water, environment, and public facility management: 7 cases
- Neighborhood services and other services: 25 cases (2.0%)
- Education: 8 cases
- Health, social security, and social welfare: 2 cases
- Culture, sports, and entertainment: 16 cases (1.3%)
- Public administration and social organization: 4 cases
- International organization: 0 cases

Total: 1220

Source: 2008 Economic Census
Automobile Company LTD and Dongfeng Motor Company Limited, played important roles in forming these clusters of high FDI in the Wuhan ETDZ of Hanyang by strong intra-industry linkages. As the two largest foreign investments in Wuhan, both of them are automotive assembly plants attracting a large amount of foreign upstream suppliers surrounding them. These upstream suppliers are the manufacturers of auto parts and fittings. They range from individual parts and components to entire subassemblies, such as seating systems and integral automobile interiors. The Wuhan ETDZ has institutional advantages of national development zones and specific policies of the Rise of Central China Plan, which provides an array of preferential policies and superior infrastructure facilities and thus strengthens competitiveness of the Wuhan ETDZ for attracting those extremely large joint ventures into this zone at the initial stage. Hanyang, a strong auto industrial base with the highest percentage of industrial land, has a large amount of existing infrastructures, facilities, and skilled laborers, which provide the essential elements of firm operations. This thus sustains a significant pull of attracting foreign upstream suppliers surrounding those established extremely large joint ventures to form clusters of FDI at the following stage, generating agglomeration effects. Therefore, this spatial-temporal pattern of FDI in the Wuhan ETDZ is a consequence of the strong interaction among urban spatial structure, agglomeration, and institution.

In addition to the transformation of clusters with negative spatial autocorrelation into clusters with positive spatial autocorrelation, other new clusters with positive spatial autocorrelation emerged in the Wuhan ETDZ since the Wuhan ETDZ has established a good reputation in the quality investment environment toward FDI through years of efforts and experiences under the influence of the Rise of Central China Plan. In 2006, two clusters with positive spatial autocorrelation emerged in another national development zone, the Wujiashan ETDZ. Thus, agglomeration areas of FDI were basically formed in the Wuhan ETDZ and the Wujiashan ETDZ, indicating the effectiveness of implementation of its relevant specific policies after Wuhan became a strategic pillar city playing a leading role in the Rise of Central China Plan. In 2007 and 2008, respectively, one more cluster with positive spatial autocorrelation was added in the Wuhan ETDZ.

**Locational determinants of FDI in Wuhan**

As shown in Table 3, the Nagelkerke $R^2$ square for the logistic model is 0.781, indicating that 78 percent of the variation can be explained by these independent variables. Therefore, the logistic model is appropriate for examining the locational determinants of FDI in Wuhan. Table 4 shows that the adjusted $R^2$ square for the GWR is 0.681. This indicates that 68 percent of the variation can be explained. Also, the GWR results indicate that the relationships between FDI and influential factors are not invariant over space. The variant relationships show local effects that a global logistic regression model would not provide, although the global logistic regression model has a higher $R^2$ square.

**National development zones**

National development zones have the most significant positive impacts on the FDI location within Wuhan. A foreign investor is 4.8 times more likely to invest in a national development zone than
outside. Contrastively, we also find that provincial level development zones have no statistically significant effects on the FDI location in Wuhan due to very limited land area, as we mentioned in Section FDI in Wuhan: basic profile. Limited land area constrains provincial level development zones to attract more foreign investment since the largest percentage of foreign investment within Wuhan consists of manufacturing firms, which usually need a large amount of industrial land for their operation. On the other hand, it implies that each provincial level development zone should select appropriate industries to develop unique strategies to attract foreign investment in certain industries, in terms of its own historical, locational, and socio-economic advantages, in order to avoid aggravating competition and inefficient land use by expanding land area and lowering land price.

Fig. 6 shows the GWR parameter surface of national ETDZs. Hanyang has the highest coefficient for the national ETDZ while Wuchang has the lowest coefficient. In Hankou, the area adjacent to Hanyang has a higher coefficient than the area adjacent to Wuchang. Therefore, the Wuhan ETDZ in Hanyang has more positive impacts on FDI than the Wujiashan ETDZ in Hankou. And the Wujiashan ETDZ in Hankou has more positive impacts on FDI than the Wuhan ELHTZ in Wuchang. This further confirms the strong centralizing influence of Hanyang and significance of the Wuhan ETDZ located in Hanyang compared to another two national ETDZs.

### Urban structure

The location of Hanyang has positive influence on attracting FDI within Wuhan. A foreign firm is 2.2 times more likely to invest in Hanyang than outside. This finding endorses the observed cluster

---

**Table 3**

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Sig.</th>
<th>Exp (B)</th>
<th>95% CI for Exp (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>NationalETDZ</td>
<td>1.575</td>
<td>0.000</td>
<td>4.829</td>
<td>2.006 – 11.621</td>
</tr>
<tr>
<td>LocalETDZ</td>
<td>0.202</td>
<td>0.692</td>
<td>1.224</td>
<td>0.451 – 3.321</td>
</tr>
<tr>
<td>Hanyang</td>
<td>0.774</td>
<td>0.080</td>
<td>2.168</td>
<td>0.913 – 5.148</td>
</tr>
<tr>
<td>Hankou</td>
<td>0.417</td>
<td>0.309</td>
<td>1.517</td>
<td>0.680 – 3.384</td>
</tr>
<tr>
<td>FirmDensity</td>
<td>0.016</td>
<td>0.000</td>
<td>1.016</td>
<td>1.009 – 1.022</td>
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<tr>
<td>FDI Density</td>
<td>0.000</td>
<td>0.102</td>
<td>1.000</td>
<td>1.000 – 1.000</td>
</tr>
<tr>
<td>Suburb</td>
<td>0.245</td>
<td>0.554</td>
<td>1.277</td>
<td>0.568 – 2.873</td>
</tr>
<tr>
<td>DistanceAirport</td>
<td>−1.698</td>
<td>0.122</td>
<td>0.183</td>
<td>0.012 – 2.791</td>
</tr>
<tr>
<td>DistancePort</td>
<td>−2.383</td>
<td>0.360</td>
<td>0.092</td>
<td>0.001 – 15.220</td>
</tr>
<tr>
<td>DistanceCBD</td>
<td>−6.286</td>
<td>0.033</td>
<td>0.002</td>
<td>0.000 – 0.603</td>
</tr>
<tr>
<td>DistanceRoad</td>
<td>−38.595</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000 – 0.000</td>
</tr>
<tr>
<td>DistanceRail</td>
<td>−0.129</td>
<td>0.951</td>
<td>0.879</td>
<td>0.014 – 53.890</td>
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<tr>
<td>Constant</td>
<td>1.725</td>
<td>0.001</td>
<td>5.637</td>
<td></td>
</tr>
<tr>
<td>−2 Log</td>
<td>469.989</td>
<td>0.506</td>
<td>5.056</td>
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<tr>
<td>Cox &amp; Snell</td>
<td>0.781</td>
<td></td>
<td></td>
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<tr>
<td>Nagelkerke</td>
<td>0.781</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Square</td>
<td>0.781</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>adjusted R square</td>
<td>0.681</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Table 4**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual squares</td>
<td>57.817</td>
</tr>
<tr>
<td>Sigma</td>
<td>0.241</td>
</tr>
<tr>
<td>AICc</td>
<td>10.243</td>
</tr>
<tr>
<td>R Square</td>
<td>0.692</td>
</tr>
<tr>
<td>Adjusted R square</td>
<td>0.681</td>
</tr>
</tbody>
</table>
have increasingly attracted them (Shukla & Waddell, 1991). In other words, the attraction to new western countries that traditional centers have seen a declining infrastructure, comprehensive transportation and facilities, and other amenities. The significance of Hanyang shows the importance of traditional centers to foreign investors.

This finding is different from the tendency shown in cities of western countries that traditional centers have seen a declining attraction to new firms, while emerging new suburban centers have increasingly attracted them (Shukla & Waddell, 1991). In China, traditional centers still have increasing attractions to foreign investors because of their structural advantages, agglomeration effects, and investment incentives. The structural advantages of the traditional centers include easy access to infrastructure and industrial resources, closeness to both consumer and labor markets, and strong linkages to local firms (Liefner, Wei, & Zeng, 2013). The significance of Hanyang provides evidence for increasing attraction of traditional centers to foreign firms. However, this increasing attraction is exerting pressure on traditional centers because of very limited available land resources and congestion caused by increasing firm density there. Fig. 7 shows the GWR parameter surface of firm density. The suburb of Wuhan has a higher coefficient for firm density than the central city. It can be seen that the same amount of increase in firm density has larger effects on FDI in the suburb than that in the central city. It indicates that encouraging firms to locate in the suburb has the potential to produce more agglomeration effects and thus attract more FDI. Also, compared to the central city, the presence of more available land resources is another advantage that the suburb can provide.

FDI tends to locate in proximity to local firms, as evidenced by the significant coefficient for the FirmDensity variable, displaying strong industrial linkages with local firms. Two reasons may explain the result that foreign firms locate near other firms in general, but not locate near other foreign firms. First, for the joint venture firm, the location of Chinese partners has a great impact on FDI location and foreign firms tend to be close to their Chinese partners (Sun, Zhou, Lin, & Wei, 2013; Wei et al., 2008; Zhang, 2000). One survey study conducted by Zhang (2000) identified the location of Chinese partners as the most important factor in FDI location decisions. Second, not all local content requirements were eliminated and foreign firms were still required to achieve a certain degree of local content, although China enforced the provisions of the Trade-Related Investment Measures agreement after accession to the WTO. For example, in 2004, the National Development and Reform Commission formulated the new industrial policy in the auto industry. The policy still included provisions that discourage auto manufacturers from using imported auto parts (Branstetter & Lardy, 2008).

**Accessibility**

Among five accessibility variables, only CBDs and road access are valued, while airport, ports, and railways access are not valued. This reflects the distinction in effects of accessibility on FDI location between the inter-metropolitan level and the intra-metropolitan level. Ports, airports, and railways are used to connect with networks outside a metropolitan area, and are thus important transportation infrastructures for FDI location at the inter-metropolitan level. When a foreign firm compares Wuhan with other metropolitan areas to make an investment decision, it may place higher importance on access to airports, ports, and railways. But when it has already chosen Wuhan as its destination area and made a decision on investing in Wuhan, access to airports, ports, and railways might not be emphasized. Proximity to roads has a positive influence on the FDI location within Wuhan. This implies the significance of intra-metropolitan transportation infrastructure networks in FDI location since roads are major infrastructures connected with resources within a metropolitan area. Fig. 8 shows the GWR parameter surface of distance to major roads. Proximity to major roads in Hankou and Wuchang has larger positive effects on FDI than in Hanyang. It suggests that, considering the relatively comprehensive infrastructure in Hanyang, road infrastructure investments in Hankou and Wuchang can have more positive impacts on FDI than those in Hanyang.

FDI is centralized around the CBDs, evidenced by the significant coefficient for the DistanceCBD variable. FDI seems to enjoy
substantial urbanization economies. As mentioned in Section FDI in Wuhan: basic profile, real estate and wholesale and retail have a major presence in the FDI of Wuhan. The positive impact of CBDs on the FDI location also indicates the significance of traditional commercial and business centers to foreign investors. This further confirms the advantages of the traditional centers and their increasing attraction to foreign firms due to easy access to infrastructure and commercial resources, and proximity to both consumer and labor markets. Fig. 9 shows the GWR parameter surface of distance to CBDs. The distance to CBDs has a stronger influence in the suburb than that in the central city, which suggests that CBDs tend to have global influence on FDI across the whole area.

**Conclusion**

This paper investigates the spatial-temporal pattern and determinants of FDI in Wuhan, a hub metropolitan area of Central China, during the last two decades. We find that the shifts in patterns of FDI in Wuhan reflect the combined effects of local socio-economic contexts, national policies, and global forces. FDI increased dramatically between 1992 and 1995 after Wuhan was officially opened to foreign investors in 1992. Between 1996 and 1998, FDI had declined under the influence of the 1997 Asian financial crisis. Since China joined the WTO in 2001, FDI has recorded years of continuous growth. Major FDI sectors were manufacturing, real-estate, and wholesale and retail, which reveals the effects of local industrial and commercial history, and national economic policies. More than half of the FDI was located in national development zones, showing the significant role of national development zones in FDI location.

Institution, urban structure, and accessibility were three significant factors determining FDI location. They interacted with each other to shape patterns and influence locational decisions of foreign investment. First, under the influence of the proposal of the Rise of Central China Plan in 2004 and the ensuing implementation of relevant policies, FDI patterns started to exhibit geographical clustering within Wuhan in 2006. Therefore, our results provide evidence for the effectiveness of the Rise of Central China Plan in attracting more FDI and forming clusters within Wuhan, a strategic pillar city of this plan. Second, FDI has shown an overwhelmingly centralized nature since 2006. They are centralized on the Wuhan ETDZ due to the interaction among institutional advantages of national development zones, the agglomeration effects of extremely large foreign investment, and the transformation of traditional industrial areas. With the support of national and local preferential policies, extremely large foreign investment played important roles in generating agglomeration effects of FDI in the traditional industrial core through attracting other foreign upstream firms close to them. Third, urban structure has significant impacts on FDI location. Traditional centers in the metropolitan area still have an increasing attraction to foreign firms. Hanyang, as an old industrial base and center, is the major area of foreign investment, especially for manufacturing industries, due to strong technological and production capacity, easy access to infrastructure and industrial resources, and abundant skilled labors. In addition, access to roads and CBDs are important for the FDI location within Wuhan, further confirming the increasing attraction of traditional centers to FDI.

The above findings have the following three theoretical and policy implications. First, the great effectiveness of the Rise of Central China Plan in 2004 provides a striking contrast to the ineffectiveness of the Great Western Development Strategy in 2000 (Huang & Wei, 2011). The positive externalities from agglomeration effects of coastal areas may explain the effectiveness of the Rise of Central China Plan because Central China is adjacent to the coastal areas. Thus, if the central government gives higher priority to Central China, it may more effectively and efficiently promote national economic growth through rapid economic increase of the central areas. And the economic increase of the central areas may provide positive externalities to the western areas adjacent to them. Second, large foreign investment firms played key roles in agglomeration effects of national development zones. This implies that targeting industries and selecting large foreign firms is important for development zones to develop strategies to attract foreign investment. Since the competition for large foreign
investment firms is always highly intense, development zones need to integrate local historical, socio-economic, institutional, and locational advantages to develop strategies to target industries and firms. Suitable selection of targeting industries and large foreign investment can put limited resources together to increase the chances of success in attracting these large foreign investments, and can therefore bring more relevant foreign investments into development zones through positive agglomeration effects of these large foreign investments. Third, the increasing attraction of traditional centers to foreign firms within Wuhan contributes to the literature on location theory by providing evidence in Chinese context. At the same time, the assessment of national policies on FDI in inland cities contributes to the literature on institutional economics by identifying and evaluating the role of institutional evolution and change in the economic behavior of firms.

In conclusion, this paper has documented the patterns and determinants of FDI at an intra-metropolitan level in China and demonstrated the influence of the Rise of Central China Plan. We have also identified the significance of national development zones, urban structure, and accessibility in FDI location. Our research has shown that different theoretical perspectives on FDI are complementary, and integrating them might be more effective in achieving a more thorough understanding of FDI theories.

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References