SPATIAL-TEMPORAL PATTERNS AND DETERMINANTS OF FOREIGN DIRECT INVESTMENT IN CHINA

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With 11 figures and 6 tables
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Summary: This paper analyzes the location of foreign direct investment (FDI) in China, making special use of GIS to analyze the multi-scalar spatial-temporal distribution of FDI. The paper uses spatial statistics including Moran's *I* index, Getis and Ord's *G* statistics, and retrospective analysis, to detect spatial and temporal clusters. The paper also employs Geographically Weighted Regressions (GWR) to identify variant locational determinants of FDI across different regions and provinces. We have found that while new concentrations of FDI have formed in the interior, the eastern region still dominates FDI distribution. Moreover, the concentration of FDI moves among provinces within eastern China, from Guangdong toward the Pan-Yangtze River Delta (Pan-YRD) and Bohai Rim Region (BRR), especially metropolitan areas of Shanghai, Beijing, and Tianjin. Our modeling results show that institution, transportation, and agglomeration are major factors determining FDI location in China. However, Guangdong, the Pan-YRD and BRR have different dominating factors determining the concentration. Institution is the most influential to Guangdong, transportation is the most influential to the Pan-YRD, and agglomeration influences the most to the BRR.

Zusammenfassung: Dieser Beitrag analysiert und modelliert die räumliche Verteilung ausländischer Direktinvestitionen in China mit GIS. Die Analyse raum-zeitlicher Verteilungsmuster dient dem Aufdecken räumlicher und zeitlicher Cluster und erlaubt das Identifizieren von Determinanten der Standortwahl von Direktinvestitionen. Es zeigt sich, dass der Osten Chinas das Verteilungsmuster dominiert, trotz neu aufkommender Ballungen im Inland. Perlflussdelta, Jangtsedelta und Bohai-Region bilden die Schwerpunkte innerhalb des Ostens, vor allem aufgrund der Position der Metropolen Shanghai, Beijing und Tianjin. Generelle Ansiedlungsdeterminanten sind Marktgröße und Agglomerationsvorteile. Darüber hinaus variieren die räumlichen Verteilungsdeterminanten je nach Region.

Keywords: Foreign direct investment, spatial-temporal patterns, determinants, geographically weighted regression, GIS, China

1 Introduction

Attracting FDI is an important element in strategies of economic development in developing countries. FDI distribution is a spatially and temporally varying process. Locational determinants and dynamic process of FDI are important issues for policy makers, especially in developing economies. FDI can promote the growth of developing economies, as a source of finance, technologies, management advancement, labor skills, and competitiveness.

FDI has been one of the key elements of economic development in China since open-door policies began from four Special Economic Zones (SEZs) in 1978: Shenzhen, Zhuhai, Shantou, and Xiamen. Since the mid-1980s China's development policies have expanded from the fourteen coastal open cities to Guangdong, then to the Pan-Yangtze River Delta (Pan-YRD) (including Shanghai, Jiangsu, and Zhejiang), and the Bohai Rim Region (BRR). With the launch of the Western Development Strategy in 2000, the Reviving Northeastern Region Strategy in 2003, and the Central China Rising Strategy in 2004, FDI locations have expanded to a large range of central and western areas. China's preferential policies, inexpensive labor, increasing market size, improving transportation infrastructures and investment environment have made the country a favorite destination and the largest recipient of FDI among developing economies. In 2008, China absorbed a total of US$92.4 billion FDI, a 23.6% increase from 2007 (SSB 2009).

The geographical distribution of FDI in China has been very uneven and highly concentrated in the prosperous eastern/coastal provinces. This paper attempts to identify temporal and spatial clusters of FDI, and analyze important factors on FDI location in different regions. The purposes of this research

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are as follows: (1) to examine the temporal changes of spatial patterns of FDI distribution; (2) to evaluate potential effects of the national policies on FDI; (3) to identify variation of important factors determining FDI across different regions. The spatial data is analyzed with geographical information system (GIS) and spatial statistics, especially geographically weighted regression (GWR). The findings of this research could provide valuable information for policy-makers as well as researchers in the field.

2 Theoretical background: comparative advantage, agglomeration economies, and institutional analysis

Various theoretical concepts have been proposed to explain the determinants of locational patterns of FDI and the causal mechanisms behind these determinants. These theories explore comparative advantages, agglomeration economies, and institutional perspectives. Neoclassical location theories explain FDI activities in terms of conditions in locations where FDI activities operate (Santiago 1987). Traditionally location theory indicates the significance of accessibility to the central business district (CBD) (Alonso 1964). Location theory also shows the significance of transportation infrastructure, such as airports and highways (Knox and Taylor 1995; Guimera et al. 2005; Wu 1999).

Comparative advantage is based on cost comparison and profit maximization in terms of labor cost, transportation cost, and so on. Industrial organization theory pioneered by Hymer (1976) classified FDI into horizontal investment and vertical investment. The comparative advantage of a potential location for horizontal investment is determined by market access and competition. Compared to horizontal investment, the comparative advantage of vertical investment is access to low cost factors, such as labor markets, including the cost of labor and the level of productivity.

Agglomeration economies refer to the self-reinforcing phenomenon of FDI. The theoretical literature has identified and modeled four different mechanisms that lead to localization of industry: specialized labor (Audretsch and Feldman 1996), specialized intermediate suppliers of regional economies (Storper 2000), knowledge flows (Henderson 1997; Liefner and Zeng 2008), and scale economies. These factors can generate positive feedback loops (Storper 2000), which leads to the concentration of foreign ventures in particular locations (Krugman 1991). However, when a region or area's FDI concentration reaches a certain level, the region likely exhibits agglomeration diseconomies and lost comparative advantages due to serious problems, such as rising labor costs, congestion, pollution, transportation bottle necks, crime, and so on (Fan and Scott 2003). In such instances, firms' FDI move to regions with comparative advantages.

Institutional analysis focuses on institutional impacts on foreign investments, including transaction or internalization theory (Williamson 1973), and new regionalism (Ethier 1998). Transaction or internalization theory interprets how institutional market imperfection and transaction costs may be internalized by MNCs through FDI to minimize transaction costs, such as tariffs or subsidies, foreign exchange controls, import quotas, and income taxes (Rugman 1986; Hennart 1992). New regionalism (Ethier 1998) revealed the importance of regional integration schemes, such as the North American Free Trade Agreement, the European Union, and the Association of South East Asian Nations, which often combines a small, developing economy with one or more large developed economies. Developing economies can significantly increase their attractiveness to foreign investors by entering into agreements that share major features of the regional integration (Ethier 1998; Waldkirch 2003). More recent works on institutional theory have uncovered the significance of nation states (Dicken 2007; Liu and Dicken 2006; Wei et al. 2010) and policy incentives (Wei et al. 2010), often based on case studies and qualitative approaches (Leung 1993; Sit and Liu 2000; Yang 2006). These studies indicate that the institutions play an important role in tradeoff between comparative advantages and agglomeration. However, few efforts have been made to quantify non-traditional factors such as state policy, preferential policy treatment, and local promotion (Taylor and Thrift 1982; Wu and Radbone 2005; Wei et al. 2010).

To provide a framework for the analysis, the following specifically reviews more literature on FDI location to identify location factors. A number of studies have been conducted to investigate factors determining an MNE's location choice within a host country. Forces implied in these theories lead to quite different distribution patterns and dynamic processes of FDI. More specifically, the following factors are identified as important determinants: market size, labor cost, transportation, agglomeration, and institution.

Market Size: Numerous studies of FDI location have used a measure of economic size, showing that larger market size attracts more investment because there is more potential market demand. Coughlin

et al. (1990) uses a conditional logit model to find that states with higher per capita income attracted relatively more FDI. At the provincial level in China, GPP (Gross Provincial Product) is found to be a positive, statistically significant determinant through 1992 (Broadman and Sun 1997), from 1985 to 1995 (Cheng and Kwan 2000), and from 1990 to 2000 (Coughlin and Segev 2000).

Labor Cost: The cost of the labor market is a major factor affecting FDI. Higher wages deter foreign investment. By raising resource costs in a province, FDI may make the cost structure in neighboring provinces relatively more desirable (Coughlin and Segev 2000). At the state level, Luger and Shetty (1985), Coughlin et al. (1990), and Friedman et al. (1992) find wages to be a negative determinant of FDI in the United States. In China, at the provincial level, Coughlin and Segev (2000) find that wages exhibit a negative, statistically significant relationship. Chen (1997) uses nominal wages divided by average productivity as a wage measure and finds it is a negative, statistically significant determinant of FDI.

Transportation: Another frequent consideration for FDI is the transport linkages. More extensive transportation infrastructures are associated with higher FDI. Head et al. (1995) and Shaver (1998) find the positive correlation between transportation and FDI in the United States. Interregional railroad connections are important in the foreign investors' locational choice in China (Chen 1996). Railroads are found to be the significant attractions for FDI at the provincial level of China (Sun et al. 2002).

Agglomeration: Because of neighboring effects, agglomeration may help increase the inflow of FDI into adjacent provinces through its spillover benefits. On the other hand, if agglomeration effects do not spill over, FDI may have a negative influence on location in neighboring provinces because the beneficial effects attract FDI to the initial province, but not to adjacent provinces (Coughlin and Segev 2000). At the state level, Coughlin et al. (1990) finds that states with higher densities of manufacturing activity attracted relatively more FDI in the United States. Cheng and Kwan (2000) use the FDI stock to investigate the determinants of FDI location in China from 1985 to 1995 and find a strong self-reinforcing effect of FDI at the provincial level. He et al. (2008) also shows that spatial autocorrelation has an advantage in attracting foreign investment in China. Head and Ries (1996) find that cities with this advantage are self-reinforcing. In their study, the number of existing foreign ventures, the total number of existing industrial enterprises, and the value of industrial output are measured to examine the effect of FDI stock on FDI.

Institution: The significance of the nation states and policy incentives in firm location and business organization has been emphasized in the recent literature. In general, good institutions exert positive influence on the location of FDI. Some efforts have been made to quantify non-traditional factors such as state policy (e.g., tax rate), and preferential policy treatment and local promotion (Taylor and Thrift 1982; Wu and Radbone 2005; Wei et al. 2010). Under the open door policy, China granted tax reductions and exemptions to foreign investment in designated cities. Local governments also offered local incentives to foreign investors including reduced administrative fees, lower land use fees, and flexible local regulations. Not only are there a multitude of incentives that change over time, there is a good deal of discretion by local authorities regarding the incentives they choose to offer. At the provincial level Broadman and Sun (1997) and Coughlin and Segev (2000) find a statistically significant preference for investing in coastal provinces. Wei et al. (2006, 2010) find the important roles of development zones in attracting FDI, respectively in Shanghai and Nanjing of China.

3 Methods and data source

3.1 Spatial and temporal indicators

We use Moran's *I* index, Getis and Ord's *G* statistics, and retrospective analysis to explore the spatial and temporal patterns of FDI distribution. Moran's *I* is commonly used to reveal spatial agglomeration by analyzing spatial autocorrelation among regions (Anselin 1988), which can detect the spatial clusters and agglomeration of FDI. Global Moran's *I* is to measure the degree of overall clustering tendency over the whole study area. Local Moran's *I* called Local Indicators of Spatial Association (LISA), assesses significant local spatial clustering around an individual location (Anselin 1995). In addition, Getis and Ord's *G* statistics is to measure globally or locally spatial concentration of high or low values (Getis and Ord 1992, 1996). Space-time scan statistics are used to test whether clusters existed over space and time for a predefined geographical region during a predetermined time period (Kulldorff et al. 1998). A space-time permutation model is applied to detect local concentrations over certain time periods (Kulldorff et al. 2005).

First, the study uses the global Moran's *I* index to analyze whether spatial autocorrelation exist in the patterns of FDI for China. The Moran's *I* index is used to summarize the degree to which FDI tends to locate near each other. It is used to test the clustering of similar value of FDI. An index close to 1 indicates clustering and an index close to 0 indicates randomness. Global Moran's *I* of each year is calculated in ArcGIS for the period between 1989 and 2007 so that the change of spatial distribution of FDI can be explored. Moreover, LISA (Local Indicators of Spatial Association) statistics, such as the local Moran's *I* is used to identify local spatial autocorrelation in provinces. This is because global Moran's *I* only detects spatial association averaged over the entire study area, it cannot identify localized occurrence of spatial autocorrelation. Local Moran's *I* statistic is used to identify local patterns of spatial autocorrelation. Local Moran's *I* of FDI in each year from 1989 to 2007 is mapped in ArcGIS.

Second, in order to detect concentrations of high or low values of FDI, the global and local Getis and Ord's *G* statistics are used to detect hot or cold spots of FDI. These hot or cold spots in each year are mapped in ArcGIS.

Third, retrospective analysis is applied to determine whether FDI distribution is close in space and also close in time. Spatial, temporal, and space-time scan statistics are used to detect clusters in spatial, temporal, and space-time dimensions. The normal model is used to find temporal and spatial clusters of FDI. This model is carried out in SaTScan.

3.2 Location determinants: regression model and geographically weighted regression

A regression model is used to examine which factors significantly affect locational decisions of FDI. GWR was developed to deal with non-stationary data by allowing regression model parameters to change over space (Fotheringham et al. 2002). We use it to examine the variance of the relative importance of factors determining FDI in different provinces, using FDI per capita (FDIPC) in a province as the dependent variable. Within the framework of GWR, the traditional linear model is expressed as

$$Y_i=\beta_0+\beta_1 X_i+\varepsilon_i \qquad \text{(Equation 1)}$$

where the subscript i represents specific geographical locations. Instead of being fixed, the values of β_0 and β_1 are now spatially varying. X_i consists of three groups of determinants of FDI: comparative advantage, agglomeration, and institution. Comparative advantage includes three variables that are usually used to measure a region's comparative advantages in attracting foreign investors. They are GDP per capita (GDPPC), average annual wage (WAGE), and railway length per square kilometer (RPSK). GDP per capita measures the relative strength of market demand of a province. Average annual wage indicates the cost of labor. Railway length per square kilometer measures the railway density, which indicates the extensiveness of transportation infrastructure. The FDI stock, the amount of existing FDI per capita (FDISTOCKPC), is measured as agglomeration. We measure the institution as the area percentage of national economic and technological development zones and high-tech development zones (DZPERCENT).

3.3 Data sources

Data acquired for this study include locational characteristics – socioeconomic data, and GIS spatial files (shapefiles). Locational socioeconomic data cover the following variables: FDI per capita, FDI, GDP per capita, GDP, average annual wage cost, railway length, and land area. GIS shapefiles refer to provincial boundary files of China. The national FDI data of China are from China Statistics Yearbook (SSB 2009), and provincial data are from China Data Online (http://chinadataonline.org/) with provincial socioeconomic data from 1989 to 2007. The shapefile source is China Data Center (http://chinadatacenter.org), from which the GIS boundaries for provinces are downloaded.

In our study, we analyzed determinants of FDI in 27 Chinese provinces and four municipalities between 1989 and 2007. In addition, in order to keep the consistency of the study area, Chongqing is integrated into Sichuan Province in the whole study period for calculating Moran's *I* and Getis and Ord's *G*, though this city has been separated from Sichuan Province since 1997. Hainan is also treated as a province in this study since it was separated from Guangdong after 1988.

The State Statistics Bureau has collected foreign investment data since 1985, representing a long history of FDI data, which makes data consistent and reliable in general. However, a small share of the FDI in China is due to "round-tripping" by mainland Chinese firms, who take advantage of tax incentives through phony FDI transactions (Henley et al. 1999). However, its effect on FDI patterns should be limited.

4 Results and interpretations

4.1 FDI growth and distribution in China

Since the launch of reforms in the late 1970s, China has dramatically restructured Mao's policy of self-reliance and has favored opening up its domestic economy to the outside world. FDI has since grown drastically in China, especially in the early and mid- 1990s when China deepened its economic reforms and in the early 2000s after China joined the WTO (Fig. 1). The primary sources of FDI in China are Greater China (Hong Kong and Taiwan), East Asia (Japan and South Korea), and the United States, followed by European countries.

Whereas all of the provinces in China have attracted foreign investment, the coastal region has captured the lion's share of FDI (Tab. 1 and Fig. 2). As figure 2 shows, a large amount of FDI has been located in China's eastern/coastal region, without any significant equalizing with the interior. China's eastern region generally attracted about 90% of the regional FDI. From 1983 to 2000, the central region's share of FDI increased from 1.1% to 9.1%, while the western region's share stagnated. In 2007, these two regions as a whole attracted only 21.7% of China's regional FDI. However, the FDI share in the eastern region decreased by 14% from 1985 to 2007 while the FDI share in the central region increased by 14%.

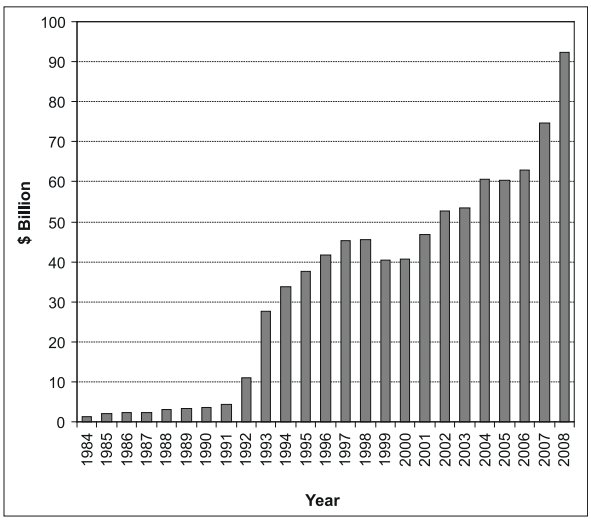

Fig. 1: The growth of FDI in China (1984–2008)

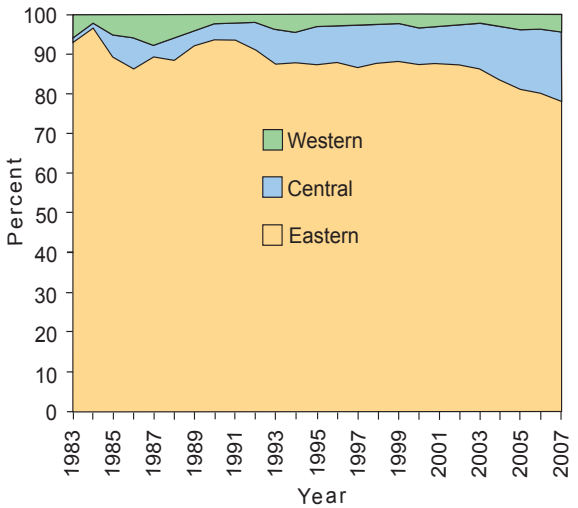

Fig. 2: Share of FDI in western, central, and eastern regions (1983–2007)

Among China's provinces, Guangdong attracted the earlier infusion of FDI, with the opening up of Special Economic Zones in south China (Tab. 2 and Fig. 3). In the 1980s, Guangdong captured about half of the FDI. With the opening up of the Pan-YRD, FDI in this region increased rapidly, which has become one of the largest hosts of FDI and emerging global city-regions in the world. Jiangsu gradually surpassed Guangdong to become the largest destination of FDI in China (Tab. 1 and Fig. 3). By 1995, although Guangdong remained dominant, the share of FDI in Guangdong declined to 27%, while shares of FDI in other southern and

Tab. 1: Regional distribution of FDI in China

	Eastern Region		Central Region		Western Region		Total	
	Total	Percent	Total	Percent	Total	Percent	Total	Percent
1985	827	92.4	36	4.0	32	3.6	895	100
1990	3045	94.2	111	3.4	76	2.4	3232	100
1995	32949	87.2	3380	8.9	1442	3.8	37771	100
2000	35412	87.6	3700	9.1	1330	3.3	40442	100
2007	96038	78.3	21664	17.7	4922	4.0	122624	100

Unit: US$ Million. Source: China Data Online

Tab. 2: Distribution of FDI in the BRR, Pan-YRD, and Guangdong

	1990		1995		2000		2007	
	FDI	Percent	FDI	Percent	FDI	Percent	FDI	Percent
Bohai Rim Region	**798**	**24.8**	**7716**	**20.4**	**8544**	**21.12**	**32869**	**26.8**
Beijing	277	8.6	1403	3.7	1684	4.2	5066	4.1
Tianjin	83	2.6	1521	4.0	1166	2.9	5278	4.3
Hebei	39	1.2	781	2.1	679	1.7	2416	2.0
Liaoning	248	7.7	1404	3.7	2044	5.1	9097	7.4
Shandong	151	4.7	2607	6.9	2971	7.3	11012	9.0
Pan-Yangtze River Delta	**366**	**11.4**	**9289**	**24.6**	**11199**	**27.7**	**40178**	**32.9**
Shanghai	177	5.5	3250	8.6	3160	7.8	7920	6.5
Jiangsu	141	4.4	4781	12.7	6426	15.9	21892	17.9
Zhejiang	48	1.5	1258	3.3	1613	4.0	10366	8.5
Guangdong	**1460**	**45.2**	**10180**	**27.0**	**11281**	**27.9**	**17126**	**14.0**

Unit: US$ Million. Source: China Data Online

eastern coastal provinces, including Jiangsu, Fujian, Shanghai and Shandong, increased. In 2007, Jiangsu had FDI of US$21.9 billion, larger than that of Guangdong (US$17.1 billion). In terms of FDI per capita, in 2007, centrally administrated municipalities of Tianjin, Shanghai, and Beijing were all among the top destinations of FDI, while Jiangsu led the nation's provinces (Figs. 4 and 5).

Within the eastern region, FDI in the BRR, Pan-YRD, and Guangdong are presented in table 2. FDI share in Guangdong drastically decreased from 45.2% to 14% over the period from 1990 to 2007. At the same time, FDI share in the Pan-YRD dramatically increased from 11.4% to 32.9%. Also FDI per capita in these three areas is presented in table 3. FDI per capita of the Pan-YRD dramatically increased from $3 to $276.3. Within the Pan-YRD, Shanghai's FDI per capita increased the most. From 1990 to 2007 FDI per capita also increased significantly in the BRR. Tianjin led the FDI per capita increase over the entire country in 2007.

Figure 6 shows the change of global Moran's *I* index for FDI per capita at the provincial level. It shows that global Moran's *I* for provincial FDI per capita has been greater than or equal to 0.15 and the Z-score for Moran's *I* has been greater than 1.96 since 2002. It indicates that at the provincial level FDI has shown the apparent pattern of positive spatial autocorrelation since 2002. Figure 7 shows similar changing patterns of the global Getis-Ord *G* index for provincial FDI per capita.

FDI in China is also unevenly distributed among cities. In general, cities in Guangdong and the Pan-YRD have dominated FDI. FDI tends to be concentrated in Special Economic Zones (SEZs), Open Coastal Cities (OCCs), other coastal cities, and provincial capitals. During the early 1980s, SEZs attracted half of the FDI. In 1984, when the 14 OCCs opened up, FDI in SEZs still accounted for 38.8% of the total, but the importance of OCCs increased as they attracted 25.4% of the FDI. The dominance of SEZs and OCCs in attracting FDI was not challenged during the 1980s, and only in the 1990s did the share of these cities' FDI decline somewhat, partially due to rising costs and the opening up of other areas for foreign investment. In 1990, SEZs and OCCs attracted US$1.55 billion FDI, which accounted for 47.7% of the regional FDI. In 2007, SEZs and OCCs attracted 5.0% and 26.6% of FDI respectively. Besides SEZs and OCCs, FDI has been attracted to several other coastal cities and provincial capitals. In 2007, the leading cities of FDI included Shanghai, Suzhou, Beijing, Tianjin, and Shenyang (Fig. 8).

Four major features can be summarized in terms of FDI location in China: (1) the coastal region dominated FDI; (2) the spread mainly took place from Guangdong to other coastal provinces; (3) the share of FDI in the interior region only increased slightly, with larger increases often taking place in provinces near the coastal region; (4) FDI tends to concentrate in Special Economic Zones, coastal cities, and provincial capitals.

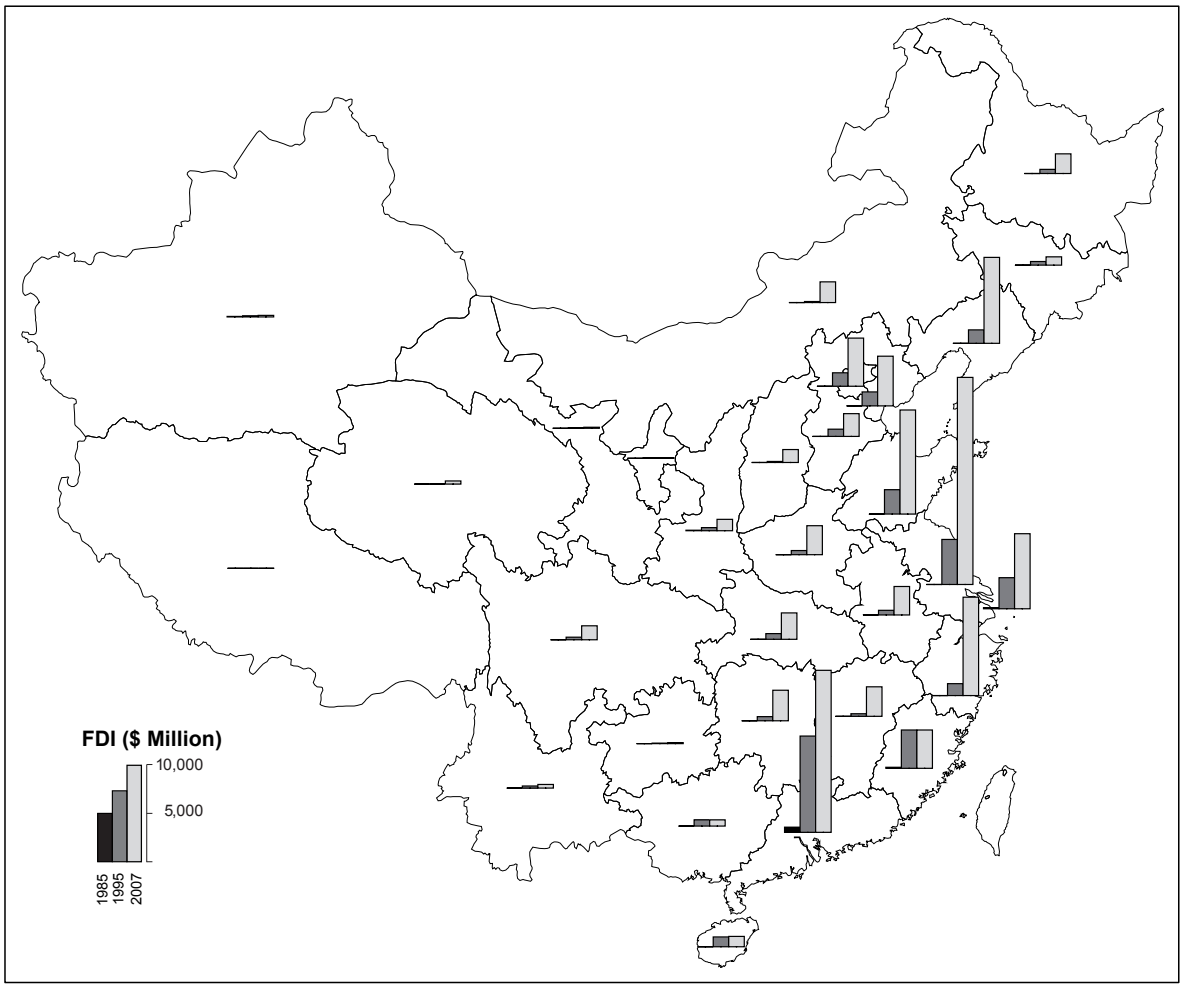

Fig. 3: Provincial distribution of FDI between 1985 and 2007

4.2 Regional clusters and dynamic processes of FDI

LISA results indicate that, at the provincial level between 1989 and 1997, except for 1991, there were not any local spatial autocorrelation of FDI. In 1991 only Hainan province showed the negative spatial autocorrelation of FDI at five percent significance level.

The FDI distribution has shown clustering tendency at both regional and provincial levels since 2002. Provincial patterns of spatial autocorrelation from 1989 to 2007 are presented in table 4. Among the BRR, Tianjin and Beijing have shown statistically significant positive spatial autocorrelation during the same period. The time periods are 1998, 1999, and from 2004 to 2007. Since 2006 new patterns of negative spatial autocorrelation have emerged in Hebei. In 2007 Liaoning showed a pattern of positive spatial autocorrelation. Among the Pan-YRD Shanghai, Jiangsu, and Zhejiang sequentially have shown statistically significant positive spatial autocorrelation since 1999, 2000, and 2003, respectively. In addition, within the central region Anhui showed a pattern of negative spatial autocorrelation, which indicates that Anhui had low FDI and was surrounded by provinces with high FDI. Within the western region Sichuan showed the pattern of positive spatial autocorrelation in 2006 and 2007, which indicates Sichuan and neighboring provinces, had similarly low FDI.

Hotspots maps of provincial FDI indicate that Shanghai has been a hot spot of FDI since 1992. During 1989 to 2001, except 1996 and 1997, Guangdong was a hot spot of FDI. However, after 2001 it was not a hot spot any more. Between 1995 and 2007, except 2003, Tianjin has been a hot spot of FDI. Beijing was found as a hot spot of FDI during the following periods: between 2005 and 2007,

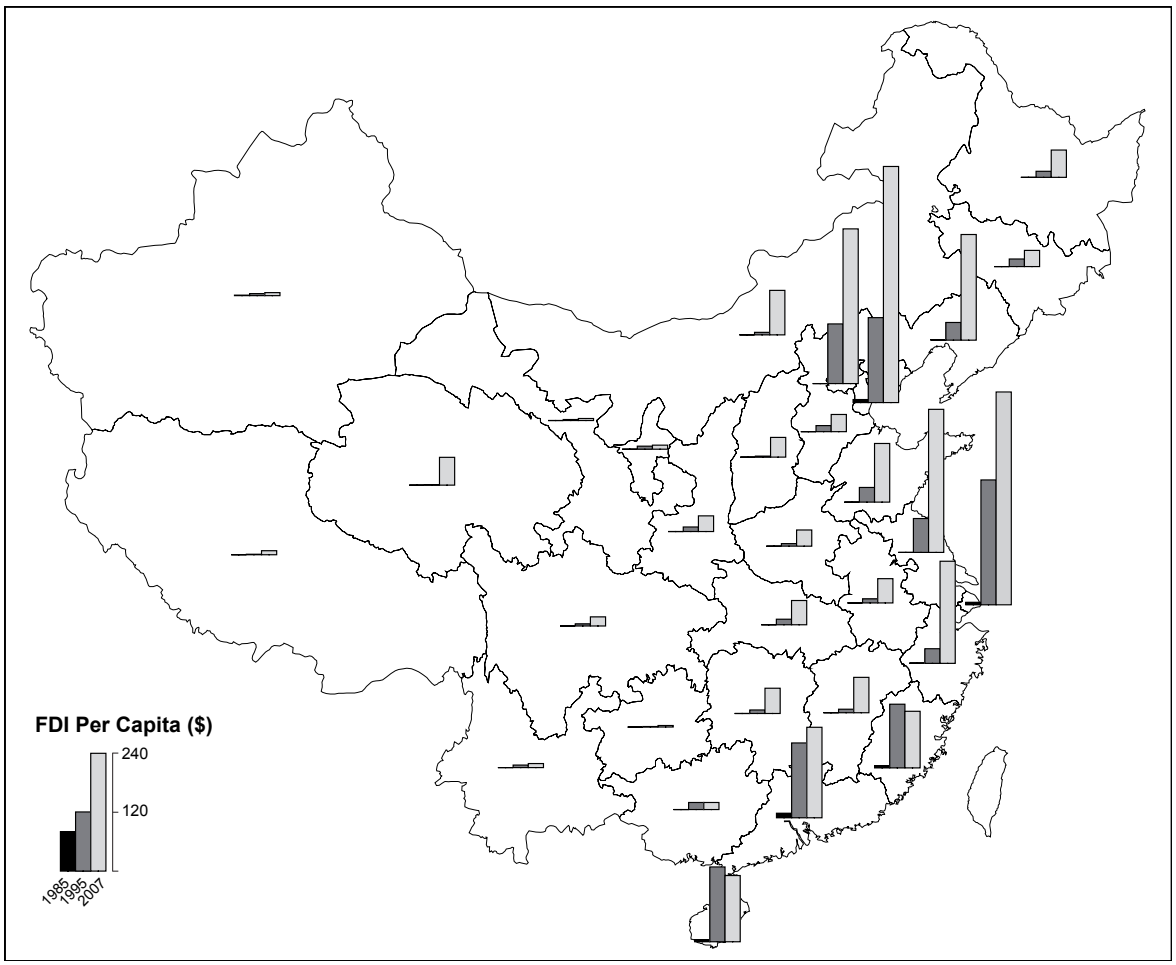

Fig. 4: Provincial distribution of FDI per capita between 1985 and 2007

Tab. 3: Distribution of FDI per capita in the BRR, Pan-YRD, and Guangdong

FDI Per Capita	1990	1995	2000	2005	2007
Bohai Rim Region	**3.9**	**36.0**	**38.3**	**93.1**	**140.7**
Beijing	25.5	112.1	121.8	229.3	310.2
Tianjin	9.4	161.5	116.5	319.2	473.3
Hebei	0.6	12.1	10.2	27.9	34.8
Liaoning	6.3	34.3	48.2	85.1	211.7
Shandong	1.8	30.0	33.0	97.0	117.6
Pan-Yangtze River Delta	**3.0**	**72.6**	**81.9**	**196.1**	**276.3**
Shanghai	13.3	229.7	188.8	385.3	426.3
Jiangsu	2.1	67.7	87.7	176.4	287.1
Zhejiang	1.1	29.1	34.5	157.6	204.9
Guangdong	**23.0**	**148.2**	**130.5**	**134.5**	**181.2**

Unit: US$ per capita. Source: China Data Online

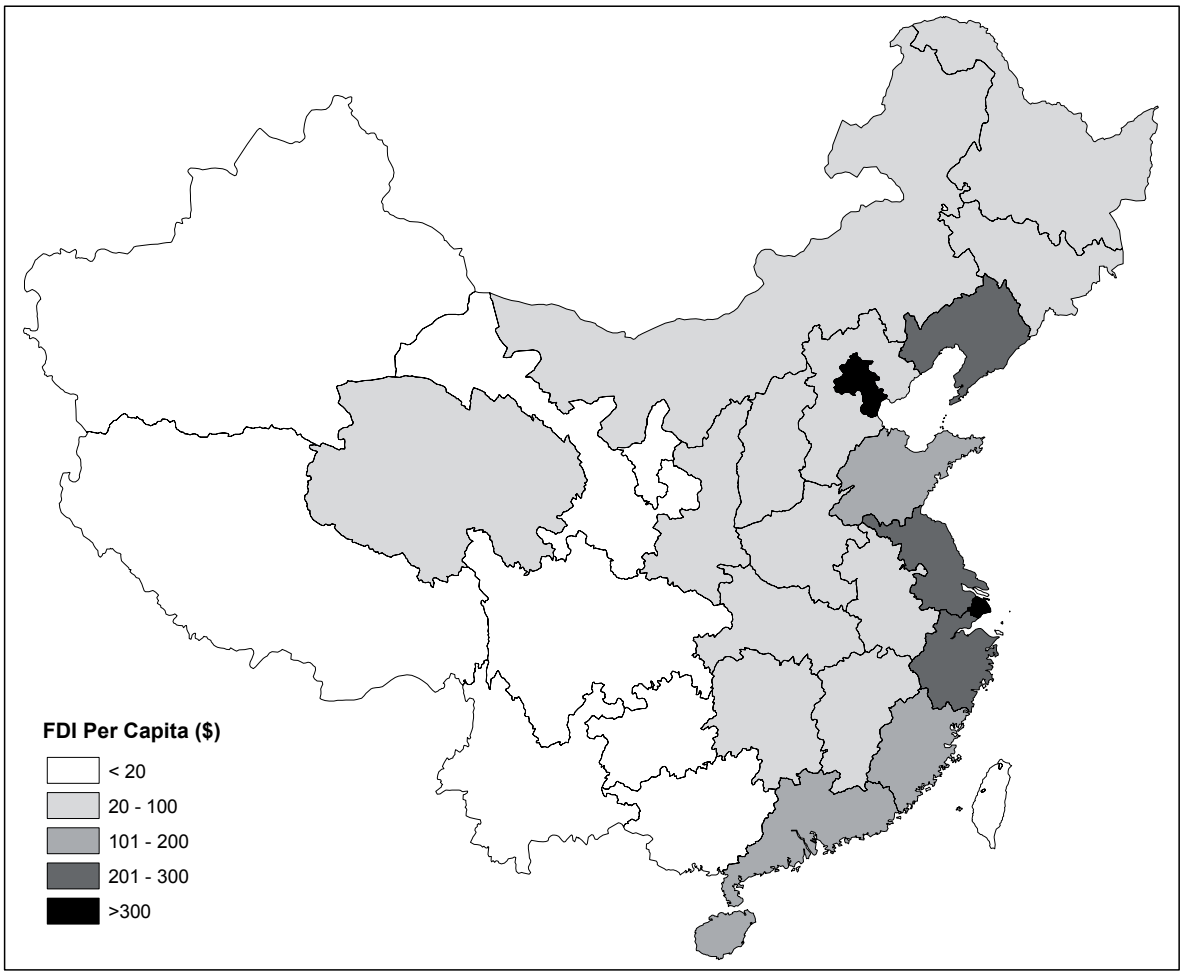

Fig. 5: Provincial FDI per capita in 2007

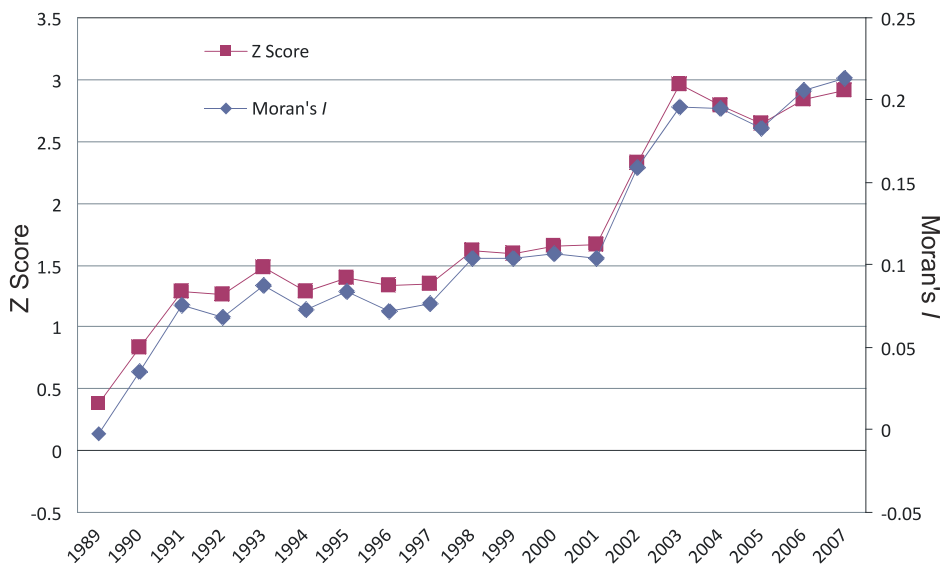

Fig. 6: Global Moran's *I* index for provincial FDI per capita

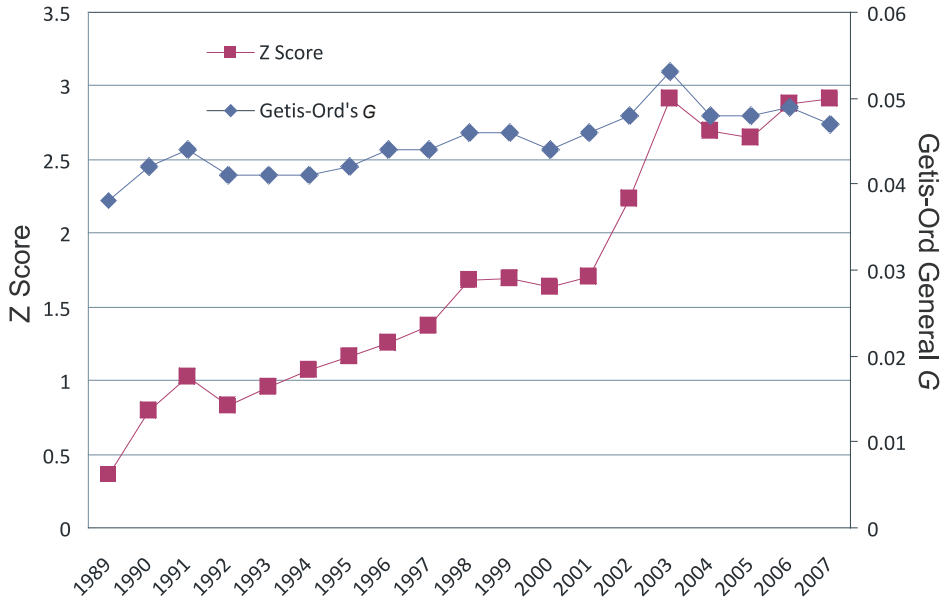

Fig. 7: Global Getis-Ord *G* index for provincial FDI per capita

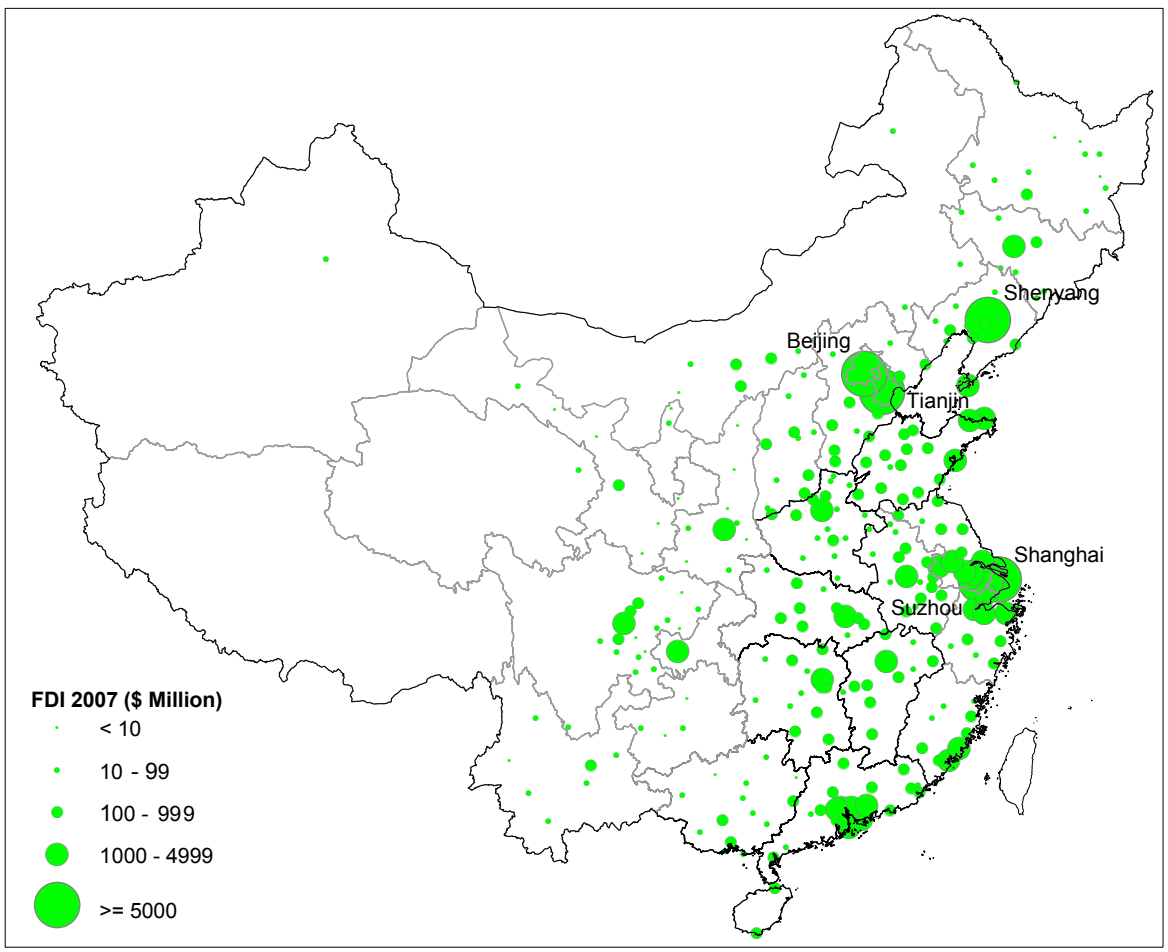

Fig. 8: FDI in China's major cities

Tab. 4: Provincial clusters of spatial autocorrelation and hot spots from 1989 to 2007

	Spatial Autocorrelation		Hot Spots	
Province	**Sign**	**Period**	**Sign**	**Period**
Beijing	Positive (HH)	1998–1999, 2004–2007	Hot	1989–1991, 1998–2000, 2005–2007
Tianjin	Positive (HH)	1998–1999, 2004–2007	Hot	1995–2002, 2004–2007
Liaoning	Positive (HH)	2007	–	–
Hebei	Negative (LH)	2006–2007	–	–
Shanghai	Positive (HH)	1999–2007	Hot	1989, 1992–2007
Jiangsu	Positive (HH)	2000–2007	–	-
Zhejiang	Positive (HH)	2003–2007	–	-
Guangdong	–	–	Hot	1989–1995, 1998–2001
Sichuan	Positive (LL)	2006–2007	–	–
Hainan	Positive (HH)	1991	Hot	1990–1993, 1995
Fujian	–	–	Hot	1991
Anhui	Negative (LH)	2004	–	–

between 1998 and 2000, between 1989 and 1991. Between 1990 and 1995, except 1994, Hainan has been a hot spot of FDI.

Local concentrations of FDI in the eastern region show a trend of movement from Guangdong to the Pan-YRD and BRR, especially after 2001. However, Guangdong, the Pan-YRD and BRR have different dynamics to attract FDI. Within the Pan-YRD, Shanghai first became a concentration of FDI in 1992. After that, Jiangsu and Zhejiang, centered around Shanghai, have shown as concentrations of FDI since 2000 and 2003, respectively. The temporal sequence of FDI clusters in Shanghai, Jiangsu, and Zhejiang implies the spread of concentrations from Shanghai to Jiangsu and Zhejiang among the Pan-YRD. It implies the notion that within the Pan-YRD beneficial effects spill over province borders and provinces benefit each other as an integrated area in regional development to compete against other regions. These beneficial effects help promote regional development and form a positive feedback cycle between economic growth and FDI. This positive cycle raises the purchasing power and causes a huge market, which currently becomes a major driver to FDI in the Pan-YRD. This demonstrates that the relation of firms with local and regional environments plays an important role in regional economic development, as mentioned in Oinas (1997).

Compared to the Pan-YRD, the BRR shows a different temporal and spatial pattern of FDI. Within the BRR, Tianjin and Beijing became concentrations of FDI in 1995 and 1998 sequentially. However, Hebei, centered around Tianjin and Beijing, didn't attract more FDI. The concentration of FDI didn't spread toward it. Conversely, Hebei has shown as a location of negative spatial autocorrelation in 2006 and 2007. The negative spatial autocorrelation implies a different regional development model from the positive spatial autocorrelation pattern. It implies these provinces compete with each other for foreign capitals and resources. So it is possible that Beijing and Tianjin deters FDI from coming into Hebei.

The interesting part is that Liaoning, adjacent to Hebei, has become a concentration of FDI recently. It is probably the result of mixed influence of the BRR and 'Reviving Northeastern Region' policies. Broadly speaking, the BRR demonstrates a spreading process of FDI in leaps. In addition, Beijing and Tianjin have almost the same spatial and temporal patterns, which implies that they are almost in the same development stages and have same rhythms and steps in FDI. It is probably the result of implementing similar national policies in these two municipalities. They are hot spots, but recent years have witnessed the growth of Tianjin and decline of Beijing in FDI shares. It shows a potential that the Binhai New District of Tianjin, designated by the central government as a new experimental area for comprehensive reforms in 2006, has a positive effect on FDI, and therefore causes a new round of growth.

In the central region, Anhui had local negative spatial autocorrelation in 2004. It demonstrates that Anhui, with a low FDI level, was surrounded by provinces with high FDI levels. It shows a weak ability of Anhui to attract FDI, but it also shows opportunities: how to take advantage of good surrounding FDI environments to establish links between its own resources and outside environment through local industrial and FDI policies, and therefore potentially attracting more FDI. In the western region, a new concentration of

low value of FDI emerged in Sichuan and neighboring areas, which indicates that the western region still lacks attractions to FDI. Compared to other regions and corresponding policies, the Western Development Strategy has little effect in bringing more FDI to western China.

Finally, recently all three FDI hot spots are centrally administered municipalities – Beijing, Shanghai, and Tianjin. This indicates the important role of municipalities in attracting FDI in China. These cities are the centers of globalizing city regions, which is consistent with the notions in previous studies that FDI in developing countries is concentrated in globalizing city regions and these globalizing cities are emerging nodes of the global economy (Wei and Leung 2005).

4.3 Temporal clusters and changes of FDI

Space-time scan statistics find that the most likely cluster found in space-time model is Shanghai, Zhejiang, and Jiangsu from 2002 to 2008. The p-value for this cluster is 0.001. Shanghai, Zhejiang, and Jiangsu constitute the Pan-YRD, which implies the potential effects of China's entry in WTO on FDI in the Pan-YRD after 2001. It may mean that the Pan-YRD is most probably chosen as the region for FDI after WTO entry. The secondary cluster is found in the model is Inner Mongolia, Liaoning, Beijing, and Tianjin during the period between 2004 and 2008. The p-value for this cluster is 0.001. These four provinces constitute the Bohai Rim Region, implying the potential relationship with the comprehensive reform launched in this region in 2006. The reform may contribute to the concentration of FDI in this region during this period. The most likely cluster for the temporal model is during the period between 2004 and 2008.

4.4 Effects of transportation, agglomeration, and institution on FDI

The adjusted R square of the regression model is 0.921, indicating that about 92.1% of the variation of FDI per capita is explained by the explanatory variables (see Tab. 5). Three variables are statistically significant. The area percentage of national development zones has a positive effect on FDI at five percent significance level. Also, FDI stock per capita has a positive effect on FDI per capita at five percent significance level. The railway density has a positive effect on FDI at one percent significant level. The adjusted R square of the geographically weighted regression model is 0.979, indicating that about 97.9% of the variation of FDI pre capita is explained by railway density, FDI stock per capita, and the area percentage of national development zones. FDI stock, railway density, and the area percentage of national development zones have statistically significant effects on FDI. The factors of wage costs and market size are not statistically significant. Figures 9–11 show the surfaces of GWR coefficients for the area percentages of national development zone, FDI stock per capita, and railway density. It indicates that effects of the area percentage of national development zones, FDI stock per capita, and railway density on FDI per capita vary over space. GWR also shows that the area percentage of national development zones, FDI stock per capita, and railway density have positive relationships with FDI per capita. Coefficients for the national development zone area percentages, FDI stock per capita, and railway density are listed in table 6. Among three regions, the BRR has the highest coefficient for the FDI stock per capita, the Pan-YRD has the highest railway density coefficient, and Guangdong has the highest coefficient for the area percentage of national development zones.

Tab. 5: Regression model summary

	Coefficients	t-values	Sig	VIF
Constant	-8.497	-0.038	0.970	
FDISTOCKPC	0.045	2.313	0.029	8.098
WAGE	-0.005	-0.512	0.613	2.552
GDPPC	0.006	0.587	0.562	10.605
DZPERCENT	685.706	2.213	0.036	5.253
RPSK	0.740	3.457	0.002	5.444
Model Summary				
Adjusted R^2		0.921		

Tab. 6: Coefficients of geographically weighted regression in the BRR, Pan-YRD, and Guangdong

Region	Province	FDI Stock Per Capita	Railway Density	Development Zone Area%
	Beijing	0.0999	0.1064	26.1183
	Tianjin	0.0949	0.1104	30.6520
BRR	Hebei	0.0996	0.1063	26.6637
	Liaoning	0.0828	0.1203	40.5984
	Shandong	0.0634	0.1335	61.7360
	Shanghai	0.0249	0.1525	122.4825
Pan-YRD	Jiangsu	0.0364	0.1502	97.6947
	Zhejiang	0.0118	0.1477	163.5844
Guangdong	Guangdong	-0.0165	0.1364	280.2729

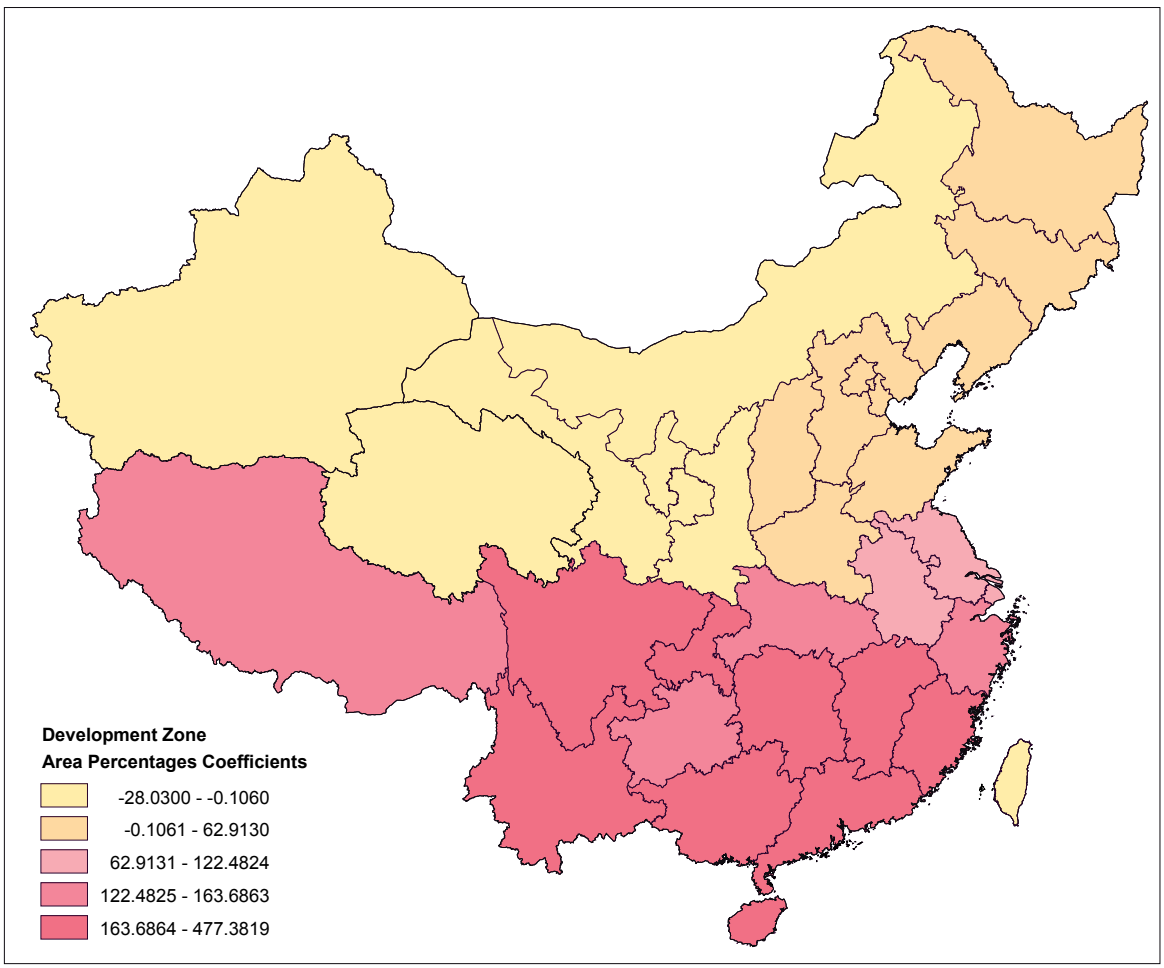

Fig. 9: Surface for geographically weighted regression coefficients of national development zone area percentages in 2007

5 Discussion and conclusion

Based on spatial statistics, GWR, and recent FDI data, this paper has studied the spatial and temporal patterns and determinants of FDI distribution. The FDI share in central China increased during the last two decades, but the eastern region still dominates. At the provincial level FDI has shown clusters of spatial autocorrelation and hot spots since 2002. After 1998 four hot spots, including Guangdong, Shanghai, Beijing, and Tianjin, emerged at different time periods. Before 2002 Guangdong had been a hot spot; however, it has not been a hot spot since then. Shanghai and Tianjin have been hot spots since

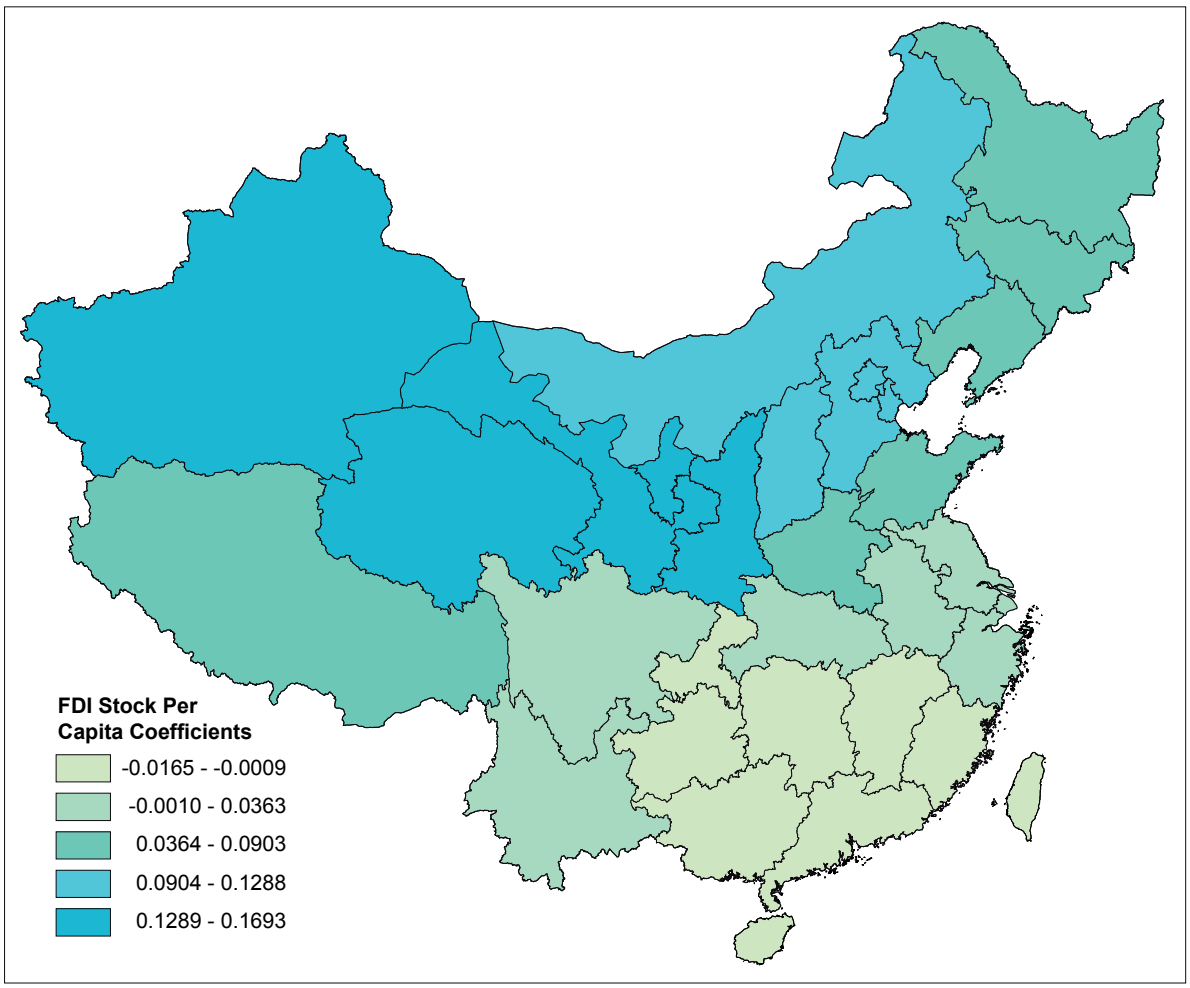

Fig. 10: Surface for geographically weighted regression coefficients of FDI stock per capita in 2007

1992 and 1995, respectively. Beijing was a hot spot before 1992 and after 1997.

The majority of local patterns of spatial autocorrelation are located in the eastern region. Among the eastern region, both the BRR and Pan-YRD have apparent local concentrations of spatial autocorrelations since 1998, but within each region the time periods for clusters of each province are different. Within the BRR, Beijing and Tianjin have completely the same time periods for clusters of spatial autocorrelation. All happened during the following periods: 1998, 1999, and between 2004 and 2007. Liaoning was a concentration of positive spatial autocorrelation in 2006 and 2007. However, within the Pan-YRD, Shanghai, Jiangsu, and Zhejiang became clusters sequentially in 1999, 2000, and 2003. A few concentrations have also emerged in the central and western regions. Anhui, in the central region, had a cluster of negative spatial autocorrelation in 2004, which indicates a low FDI level compared to neighboring provinces. In addition, in 2006 and 2007 positive spatial autocorrelation of low FDI emerged in Sichuan of the western region, showing low FDI in this province and its neighbors.

Institution, transportation, and agglomeration factors have positive effects on FDI. However, effects of these factors vary in different regions. Among three regions, institution had the most influential to Guangdong, transportation had the most influence on FDI in Pan-YRD, and agglomeration had the most influence on FDI in BRR.

Our research shows the significance of certain policies designated by the central government. Comparison of spatial and temporal changes of FDI in Guangdong, the Pan-YRD and BRR suggests the significance of national government incentives, especially at the initial stage. The comparison among regions further indicates that the relation of firms with local and regional environments, and transportation

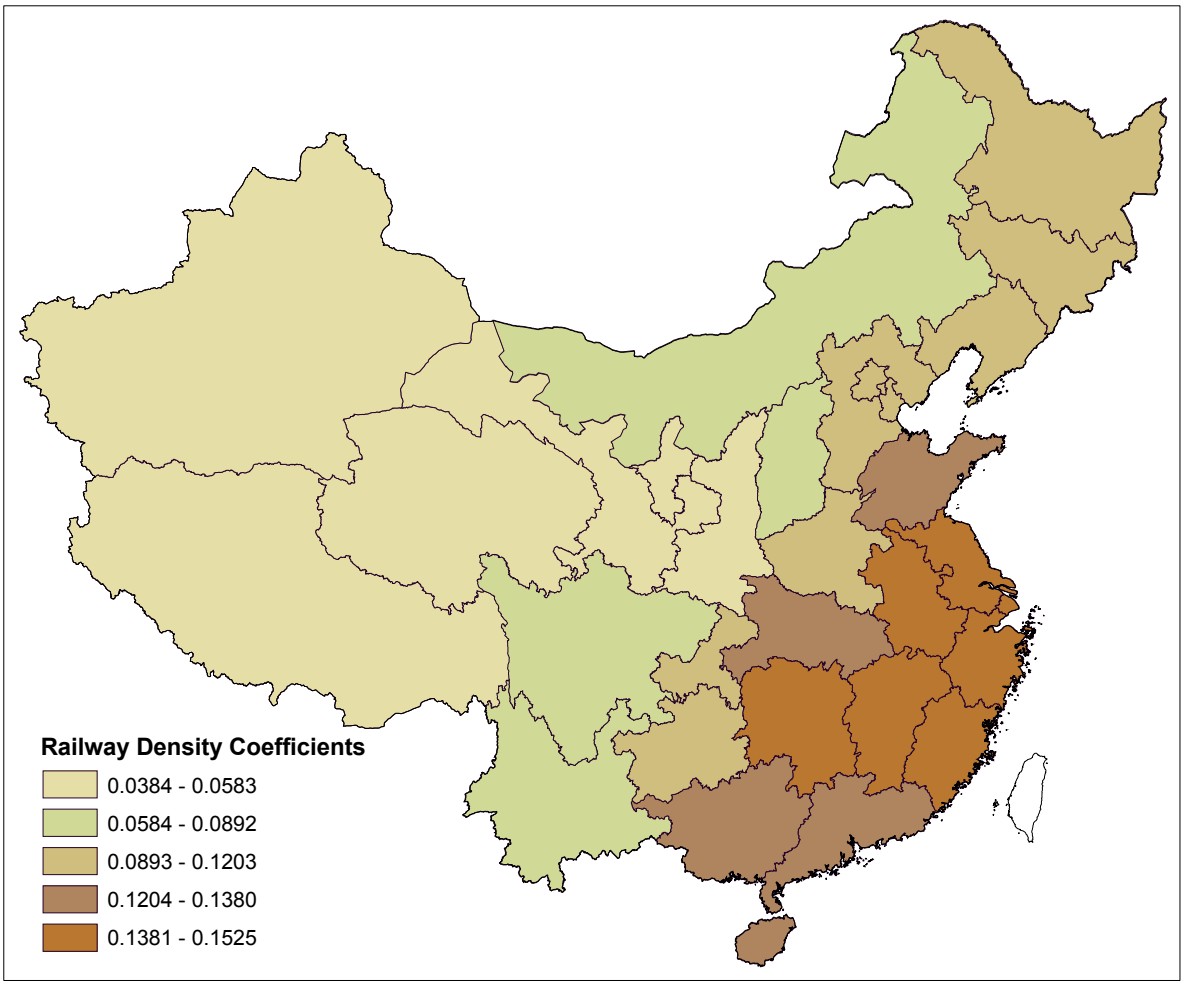

Fig. 11: Surface for geographically weighted regression coefficients of railway density in 2007

infrastructure play important roles in the later stage of regional economic development, as mentioned in Oinas (1997) and Wei et al. (2010). A positive linkage between FDI and local economies becomes a major sustainable driver for FDI inflows.

The significant performance of three centrally administered municipalities – Beijing, Shanghai, and Tianjin, indicates the important role of municipalities in attracting FDI in China. It also indicates the competitive advantages of these cities as the centers of globalizing city regions, which is consistent with the notion that FDI in developing countries is concentrated in globalizing city regions (Wei and Leung 2005; Wei et al. 2010). This further confirms the importance of emerging global cities in global capital flow and spatial restructuring (Scott 2001). More research on the different hierarchy of cities is needed to further understand the locations, processes, networks, and embeddedness of FDI in China's urban areas.

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