SCALE, AGGLOMERATION, AND REGIONAL INEQUALITY IN PROVINCIAL CHINA

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ABSTRACT
This study analyses regional development in provincial China through a case study of Jiangsu following the multi-scale and multi-mechanism framework. We have revealed a trend of increasing regional inequality and find it is mainly a result of the rapid development of Sunan (Southern Jiangsu), which also results in rising rural inter-county inequality. Subei (northern Jiangsu) faces more challenges due to the strong effects of self-reinforcing agglomeration and the constraints of geographical barriers. The spatial Markov chain analysis reveals that the development status of neighbouring counties has a strong influence on a county's development dynamics; a poor county neighbouring relatively richer counties has a higher possibility to move upwards, and vice versa. The geographically weighted regression analysis reveals that development mechanisms have strong local characteristics and the same mechanism affects regional development differently. Finally, our study confirms that the multi-scale and multi-mechanism framework helps the understanding of regional development in Jiangsu.

Key words: regional inequality, spatial Markov chains, geographically weighted regression, Jiangsu, China

INTRODUCTION

Regional inequality is an important issue in geographical research and regional development studies. It has received renewed interests since the late 1980s with concerns over the consequences of globalisation and liberalisation. The research has moved beyond orthodox neoclassical approaches by using more recently developed spatial analysis techniques.

China's market reform and economic growth have generated considerable attention on the issue of inequality and social justice (Wei 2002; Liu 2006; Pannell 2007; Wei & Ye 2009). While the majority of the studies raise concerns over rising regional gaps, others have revealed a complex landscape of regional inequality (Wei 2002). Aided by the rapid development of GIS and spatial analysis methods, recent studies have uncovered regional development patterns, dynamics and mechanisms in great details (Yu & Wei 2003, 2008).

Provincial China is the frontier of research on regional inequality given its diversity, dynamics and scale. Advances in GIS and spatial analysis have fulfilled the requirement of finer scale in the study of intraprovincial inequality. Recent work on provincial China has mainly dealt with Zhejiang (Ye & Wei

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2005; Wei & Ye 2009), Beijing (Yu 2006; Yu & Wei 2008), and to a lesser extent, Guangdong (Lu & Wei 2007). However, publications on Jiangsu, a province known for its north-south divide, mainly analysed regional inequality up to the mid-1990s (e.g. Wei & Fan 2000; Wei 2002), and changes since the mid-1990s have rarely been investigated.

This study examines changing patterns of regional inequality in Jiangsu and investigates the underlying mechanisms with spatial analysis methods based on the multi-scale and multi-mechanism framework (Wei & Fan 2000; Wei 2002). We start with investigating patterns of inequality at regional and county levels in Jiangsu, which includes 13 cities (or city districts) and 52 counties (including county-level cities), followed by an exploration of the underlying mechanisms. This research intends to fulfil three primary objectives. First, we examine patterns of regional inequality to determine the extent to which regional inequality has changed since 1978. Using Moran's I and spatial Markov chain analytical procedure, the analysis takes into account spatial autocorrelation to explicitly enhance our understanding of regional dynamics. The second objective is to analyse the mechanisms of regional inequality based on the triple transitions of globalisation, marketisation and decentralisation to address forces responsible for the change of regional inequality. The third objective is to provide a more detailed understanding of spatial dimensions of regional inequality, mainly through employing geographically weighted regression (GWR).

REGIONAL INEQUALITY: THEORETICAL AND CONTEXTUAL ISSUES

Since the 1950s, scholars have disagreed over trend and causes of regional inequality, and empirical findings have been conflicting. Orthodox regional inequality theories focus on the long-term trend of inequality and debate over evidences of regional convergence or divergence. Concerns over the effects of globalisation and liberalisation have generated renewed interests in regional inequality since the late 1980s. Reforms in former socialist countries have drawn even more attention to the effects of reforms on regional inequality (Petrakos 2001; Bradshaw & Prendergrast 2005). The neoclassical new convergence theory (e.g. Barro & Sala-I-Martin 1995), which has been criticised for its ignorance of space, scale, and time (Wei & Ye 2009), has drawn substantial attention. Alternatively, scholars have adopted institutional and evolutionary perspectives, and reiterated the significance of geography in the formation and evolution of regional inequality (e.g. Quah 1996; Gallup *et al.* 1999). Recent developments in spatial analysis techniques have enabled researchers to better understand the complexity of regional development by explicitly taking into account the role of geography (Rey 2001; Le Gallo 2004; Yu 2006; Wei & Ye 2009).

Regional inequality in China has attracted considerable interest due to its size, diversity, history and identity as a transitional, developing country (Wei 2007). Before the establishment of socialism in 1949, China's economy was spatially uneven, led by a more developed coastal region due to its geographical location and legacy of colonialism. During the initial stage of socialism, China was troubled by chaos, depression and huge inequalities, and Mao's new socialist regime faced a poor economy and a colonial legacy of imbalances. Some efforts were made to reduce regional inequality by introducing socialist institutions (such as the Danwei system), relocating industries to the interior and regional transfers of resources. The effects were heatedly debated and many found new sources of inequality and poor results of interior investment. Post-Mao reforms have intensified the debates over inequality, and evidences of both divergence and convergence have been presented (Zhang *et al.* 2001; Chai 1996; Wei & Kim 2002; Yu & Wei 2003). Supporters of uneven development policies argue that reforms have stimulated rapid growth without generating huge regional gaps, while the opposition contends that the state's favourable policies for the coastal region served as the basis for the region's massive FDI infusion, rising export, and rapid growth of private enterprises; social problems arising from reforms, including rising regional inequality, have brought social unrest and injustice to China.

With more readily available data, recent literature presents a rather complicated picture of regional inequality in China. Discrepancies can be ascribed to methodology, space, scale and data issues (e.g. Wei 2002), yet some consensus has been reached nonetheless. First, regarding patterns of regional inequality, scholars have found the intensification of the coastal-interior divide and the fluctuation of interprovincial inequality (Wei & Ye 2009). Second, scholars have revealed the pervasive force of spatial agglomeration, despite the fluctuation of regional inequality over time (e.g. Yu & Wei 2003), which seems in line with the broad literature on the power of geography and agglomeration in regional development (e.g. Scott & Storper 2003; He *et al.* 2007; Wei *et al.* 2009). Third, prosperous coastal provinces such as Guangdong, Jiangsu and Zhejiang received the most attention, where the effects of scale and agglomeration are evident. Research on Guangdong has highlighted the rising gap between the Pearl River Delta and the peripheral area of Guangdong, and the significance of external capital in regional polarisation, while others found evidences of regional convergence across cities and counties due to the rise of cities opening up as special economic zones (Weng 1998; Gu *et al.* 2001; Lu & Wei 2007). Recent studies on Zhejiang have uncovered the dynamics of regional development and spatial associations (Wei & Ye 2004, 2009; Ye & Wei 2005). They found that the traditional northeast-southwest divide of Zhejiang had been replaced by the coast-interior divide, and that regional inequality in Zhejiang, driven by the development of private enterprises in coastal Zhejiang, had been intensified at all scales of observation. Research on Jiangsu has consistently identified the rising north-south divide; overall inter-county inequality across county-level units rose and then declined with the slow growth of cities dominated by state-owned enterprises (SOEs), while rural inter-county inequality has been intensified (Wei 2002). However, recent change and spatial dimensions of regional inequality in Jiangsu have yet to be fully investigated.

Last, scholars have stressed the transitional nature of the Chinese economy and the effect of reforms on inequality. The multi-scale and multi-mechanism approach has emerged as a valuable framework to better understand regional inequality in China (Wei 2002, 2007; Yu & Wei 2008). Regional inequality will vary as it can be manifested as interregional (between-region), interprovincial (between-province) and intraprovincial (within-province) inequalities. Within a province, inequality can also be investigated through the scales of inter-regional, overall inter-county, and rural inter-county dimensions. This notion of multi-mechanism conceptualises China's transition as a triple process of decentralisation, marketisation, and globalisation, and argues for the articulation of global force, nation-states, and local factors in the understanding of regional development in China. Such processes have stimulated the development of coastal provinces based on the growth of non-state enterprises which challenged the traditionally leading provinces dominated by the SOEs (e.g. Masahisa & Hu 2001; Bao *et al.* 2002; Wei 2002; Yu & Wei 2003), acting as structural forces underlying the change of regional inequality at multiple scales.

RESEARCH SETTING: JIANGSU PROVINCE

Jiangsu province lies in the centre of China's east coast with a population of 72.53 million in 2005 and covers 102,600 square kilometres, occupying 1.06 per cent of China's territory (Table 1). Jiangsu is one of the most developed provinces and has recorded rapid economic growth since the reform. It is divided geographically into three distinct regions: southern Jiangsu (Sunan), central Jiangsu (Suzhong,) and northern Jiangsu (Subei) (Figure 1), with distinctive development trajectories. In general, economic development follows a south-north gradient trend, with Sunan more developed than Subei. Suzhong ranks behind Sunan, yet Subei lags far behind.

Sunan is seated in the core of the Yangtze River Delta and is portrayed as "the Golden Triangle" region in Jiangsu for its advanced socioeconomic development and its close proximity to Shanghai. Sunan has traditionally been better developed than Subei, and served as an economic centre for China, where Suzhou is an ancient capital; its status in China, along with that of Hangzhou, was gradually replaced by Shanghai with the rise of colonial treaty ports.

Table 1. *Economic status of Jiangsu Province, 2005.*

	Jiangsu	As percentage of Jiangsu		
		Sunan	Suzhong	Subei
Population (million)	72.53	19.47	35.75	44.78
GDP (billion Yuan)	1824.50	44.59	35.62	19.79
FDI (billion US$)	19.07	58.99	34.69	6.32
Import and exports (billion Yuan)	308.88	81.67	16.20	2.14
Fixed assets investment (billion Yuan)	666.07	46.38	32.27	21.35

Source: Compiled from JSB (2006).

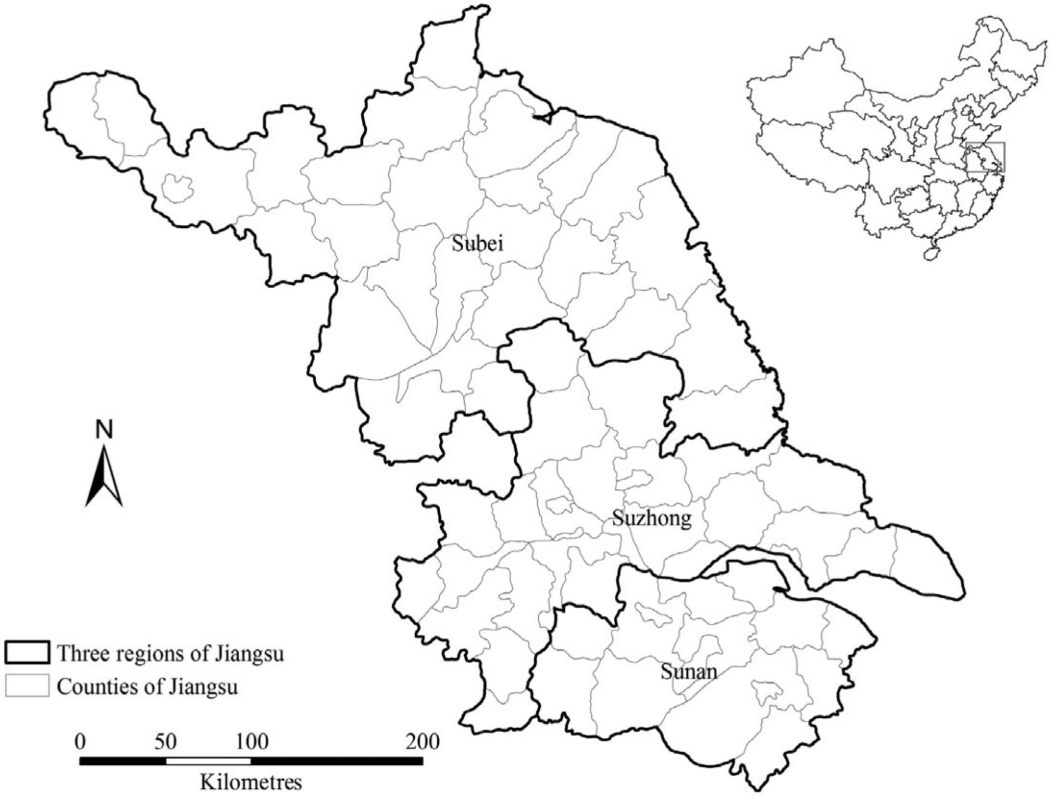

Figure 1. *Location of Jiangsu and regional divisions.*

During the first few years after the establishment of socialist China, regional inequality in Jiangsu was quite observable. In 1952, the ratio of gross value of industry and agriculture output per capita in Sunan and Subei was 2.1 to 1. In 2005, with a population of 14.29 million (about 19.7% of Jiangsu's total population), Sunan produced 44.6 per cent of Jiangsu's GDP, approximately 4.4 per cent of China's GDP. It also attracted 59 per cent of foreign direct investment (FDI) and dominated imports and exports in Jiangsu.

Suzhong experienced rapid industrialisation and growth during the early years of the young

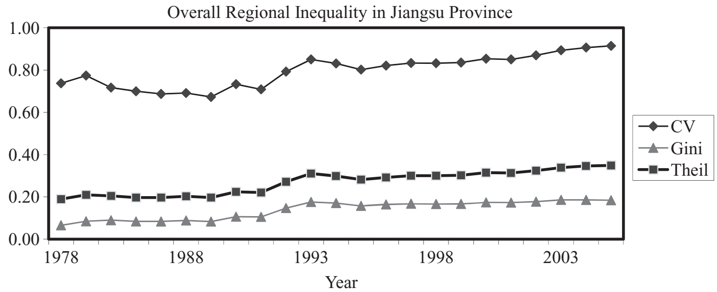

Figure 2. *Overall intercounty inequality in Jiangsu Province, 1978–2005.*

Republic due to the strong support for the provincial capital, Nanjing, received from both the central and provincial governments. The region experienced the difficulty in transforming its SOEs during the reform period. The relatively "remote" and geographically disadvantageous Subei, however, focused mainly on agriculture, with limited industrial development. By the end of the 1970s, the spatial division among Sunan, Suzhong and Subei was described as light industry, heavy industry and agriculture. The initiation of the reform enlarged the gap between industrialised Sunan and agriculture-focused "rural" Subei. By the end of 1993, Sunan produced 41 per cent of the province's GDP while Suzhong and Subei produced 37.2 per cent and 21.8 per cent, respectively. Such gaps have drawn intensified attention since the late 1990s, and the Sunan-Subei divide is one of the top policy issues in Jiangsu.

The majority of the data in this study are extracted or derived from Jiangsu and China's statistical yearbooks (e.g. JSB 2006). We have obtained systematic, comparable time-series data on counties in Jiangsu since 1978, which can hardly be found in other provinces. We use GDP per capita (GDPPC) in constant price as the indicator of regional inequality.

MULTISCALAR PATTERNS OF REGIONAL INEQUALITY

Studies of regional inequality often employ a variety of conventional inequality measurements, such as coefficient of variation (CV) (most commonly used), Theil's Index, and Gini Index. With the development of GIS and spatial data analysis, indexes explicitly taking into account spatial effects, such as Moran's I, Geary's C, and Getis and Ord's G, etc., have also been employed in recent studies (Yu & Wei 2003, 2008; Ye & Wei 2005). This research intends to use both sets of the complementary indexes for the investigation of inequality patterns. The first set is two non-spatial conventional indexes, the CV[1] and Theil's Index.[2] We also decompose Theil's Index to multiple scales with the consideration of the hierarchical structure of a province. Two scales are used here; one to decompose Jiangsu into inter-region and within-region inequality components to see changing inequality between and within regions (Sunan, Suzhong and Subei), which resembles the core-periphery structure of regions; another to decompose Jiangsu into cities and counties, the basic administrative/functional unit in China, to test the relationship between the urban (city) and rural (county) areas (city-county or urban-rural scale). In addition, we also investigate regional inequality by explicitly taking spatial autocorrelation into consideration. We will examine the Moran's I (both global and local) and employ the spatial Monte Carlo Markov chain (MCMC[3]) analysis to find the probability of regional convergence and divergence.

Figure 2 indicates similar regional development pattern by using different measurements. Overall inter-county inequality decreased gradually from the start of the reform to late 1980s with a focus on rural reforms, and then started to increase when reform shifted to urban and market reforms, with a slight drop around 1996. The inequality has steadily increased since the mid-1990s when reforms were deepened.

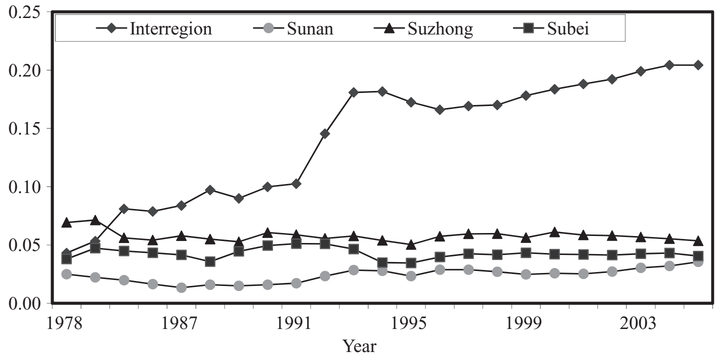

Figure 3. *Theil decomposition of overall intercounty inequality in Jiangsu province, 1978–2005.*

The decomposition of the Theil's index reveals that a significant increase in overall inequality is due primarily to a dramatic rise in the inter-region component (from 0.043 to 0.204) whilst the within region components did not change much (Figure 3). Interregional inequality dominates the development pattern. In addition, the decomposition of the Theil's index between urban and rural areas reveals an increasing inequality across rural counties as the primary contributor towards overall inequality. This suggests that rural inter-county inequality is the primary source of rising overall inter-county inequality.

These findings, however, might reflect the regional development process that dominates the coastal provinces in which rural industrialisation occurs at a much faster pace than the national average. Jiangsu in the post-Mao period could be further divided into three sub-periods separated by the mid-1980s and mid-1990s. In the early years of the reform, rural reform was focusing on rural areas and helped rural development in Subei. Consequently, from 1978 to the mid-1980s, rural inter-county inequality did not change much, as evidenced by the CV and Theil index. However, the urban reform since the mid-1980s favoured more industrialised counties and resulted in the boom of township-village-enterprises (TVEs) and a trend of rising rural inter-county inequality.

Radical market reforms in the early 1990s resulted in the rapid growth of foreign and private enterprises in Suzhong (Wei 2004). Consequently, the Theil's index experienced a rapid increase starting in 1990 and reaches the first peak in 1994 (0.225). After that, inequality indexes decreased somewhat with stable growth of FDI and the restructuring of SOEs and TVEs. Since the mid-1990s, Sunan embarked on a strategy to globalise its economy through attracting foreign investment symbolised by the establishment of the China-Singapore Suzhou Industrial Park (Wei *et al.* 2009), which resulted in a trend of rising inequality, showing no sign of convergence. This indicates an intensification of regional inequalities in Jiangsu, especially between Sunan, whose development is increasingly externally oriented, and Subei, which concentrated primarily on agriculture and endogenous industrialisation. In contrast, neither interurban nor urban-rural inequalities display much change (Figure 4). Urban-rural inequality actually declined somewhat due to problems of the traditionally richest cities, such as Wuxi, transforming their state sector on one hand, and the emergence of counties in Sunan which has been transformed from economies dominated by TVEs towards ones dominated by foreign and private enterprises on the other, including Kunshan, Wujiang and Jiangyin. These counties have been consistently ranked among the most developed counties in China. We found that the impact of SOEs on economic growth in central cities like Wuxi is less drastic compared to previous studies, which found a large drop of overall inter-county inequality (e.g. Wei & Fan 2000), due to more rapidly growing suburban counties, such as Wuxi county of Wuxi municipality, having been incorporated into central cities.

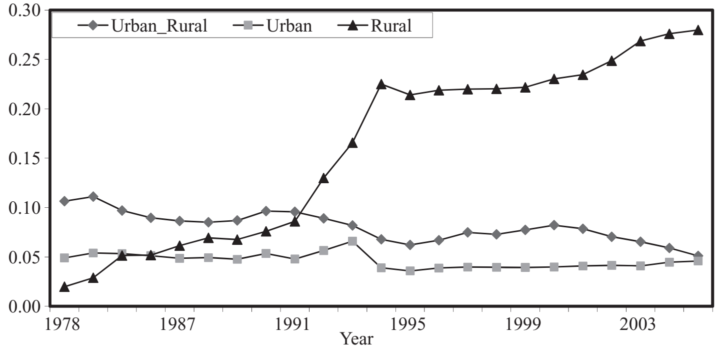

Figure 4. *Theil decomposition of overall intercounty inequality in Jiangsu Province, 1978–2005 (urban-rural).*

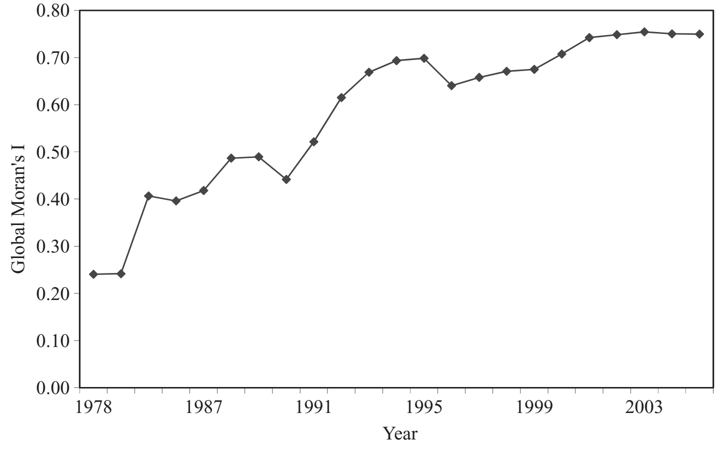

Figure 5. *Global Moran's I of GDP per capita in Jiangsu Province, 1978–2005.*

The above conventional inequality measurement index does not take into account spatial effects. For geographic data, it is almost inevitable that there is 'coincidence of attribute similarity with locational similarity', or spatial autocorrelation (Anselin 2001). Such autocorrelation, if ignored, could lead to biased or even misleading conclusions about regional development. We calculated global Moran's I as an index to measure spatial autocorrelation or spatial agglomeration (Figure 5). A rapidly increasing trend of the autocorrelation can be clearly observed from Figure 5. Global Moran's I rises from 0.24 in 1978 to 0.75 in 2005, all are significant at 95 per cent confidence level via the randomisation assumption. This finding clearly reveals a trend of rapid spatial concentration taking place in Jiangsu which has not been revealed by the conventional inequality indexes.

In our previous conventional analysis, we find that in the 1980s, the CV and Theil indices did not change much, depicting a relatively stable development pattern. However, global Moran's I reveals a trend of spatial concentration during the same period, which indicates geographic units (counties) that are close to each other start to become more alike. This hidden trend determines the later rapid increase of regional inequality as captured by the conventional indexes. Such clustering process increased rapidly in early 1990s when China implemented more radical reforms, further enlarging regional inequality in

Jiangsu. The clustering process dropped in 1996 similar to conventional indexes, but the upward trend continued after that, as represented by the increasing trend of Moran's I (Figure 5) and the conventional measuring indexes (Figure 2). The practice of employing spatial analysis techniques in addition to the conventional analysis provides a holistic picture of regional inequality in Jiangsu.

ANALYSING REGIONAL INEQUALITY WITH SPATIAL MARKOV CHAIN

The above analyses provide a general picture of regional development in Jiangsu. Detailed views of the dynamics with the spatial effects considered, however, will not be revealed through the "global" analysis. In addition, the analysis focuses on a static snapshot of regional development; the results are not necessarily reflecting the "dynamics" of the system. In this section, we intend to employ local analysis – a spatial Markov chain analysis technique (Rey 2001; Le Gallo 2004) to further the analysis of the dynamics of regional development.

Adoption of the Markov chain in regional studies is a response to the criticism that traditional studies that focus on β or σ convergence fail to produce reliable inference of regional dynamics (Quah 1996; Fingleton 1999; Rey 2001). The basic approach of Markov chains is to classify different regions into various subcategories based on per capita GDP in a given year; a transition probability matrix can be established based on the data for each time period (Rey 2001; Le Gallo 2004). The matrix has a dimension of K by K, where K is the number of subcategories. A typical element of a transition probability matrix, m_{ijt}, describes the probability of a region that is in subcategory i at time t changes to subcategory j at the next time period. Normally, the transition matrix is assumed to be time-invariant. With this set-up, the dynamics of the system can be described as such:

$$R_{t+1} = R_t \times M$$

and

$$R_{t+p} = R_t \times M^p$$

where R_t is a K by 1 vector, representing the status of the system at time t; M is the transition probability matrix, and p the time interval.

Under the assumption of time-invariant transition matrix, the properties of this matrix could be further exploited to understand the dynamics of regional development. For instance, whether or not the transition matrix will converge, or achieve an ergodic state, indicates whether the regional system is converging or diverging. If it converges, the questions are what the ergodic state looks like and how long it takes for the transition matrix to achieve such a state.

In adopting the Markov chain in regional studies, scholars tend to argue that geography matters in determining the transition probability matrix. Quah's (1996) proposes a "conditioning" approach to study how closely the change of each region's GDP has followed that of certain groups of regions, which are expected to behave similarly. He considers a geographic conditioning and a national conditioning when studying the dynamics of Europe's economic development, and finds that the commonly defined geographic neighbours matter more than the macro national settings in a particular region's development.

Taking the essence of geographic conditioning to a further step and integrating recent developments in local spatial data analysis, Rey (2001) extends the Markov chain to a spatial Markov chain. Instead of using geographic neighbours to directly conditioning on the evolution of a particular region's development, the transition matrix was expanded in such a way that the transition probabilities of a region are conditioned on the GDP class of its spatial lag for the beginning of the year. In so doing, we obtain a so-called spatial transition matrix, which is a decomposition of the traditional K by K matrix into K conditional matrices of dimension (K, K) (This assumes that we categorise the spatial lags into the same number of categories as per capita GDP, K). Hence we have a K by K by K three-dimensional transitional matrix. The element of such a matrix, $m_{ijt}(k)$, represents the probability that a region in category i at time t will move to category j at the next time period if the region's spatial lag falls within category k at time t ($i, j, k = 1, \ldots, K$; $t = 1, \ldots, T$).

Once we have constructed such a spatial probability transition matrix, we can draw interesting conclusions based on the comparison between the elements of the spatial and non-spatial probability transition matrixes. If geography does not matter at all, then there will not be any difference between the spatial lag conditioned and the original transition probability, namely:

$$m_{ijt}(1) = m_{ijt}(2) = \cdots = m_{ijt}(K) = m_{ijt}$$

If, however, geography does matter, the comparison between $m_{ijt}(k)$ and m_{ijt} would hence point towards the direction and strength of how neighbours are influencing the dynamics of a particular region's development. As widely practiced (e.g. Le Gallo 2004), we subcategorised the development status of Jiangsu's counties into four initial groups based on their per capita GDP: (1) Poor counties (P) – less than 50 per cent of average GDP per capita; (2) Less-developed counties (L) – 50 to 100 per cent of Jiangsu's average GDP per capita; (3) Developed counties (D) – more than 100 per cent and less than 150 per cent; and (4) Rich counties (R) – more than 150 per cent. We use four groups instead of Le Gallo's five groups because we feel four groups correspond better with the geographical notion of core, semi-core, semi-periphery and periphery. If a county's per capita GDP is in the ith category and keeps constant in the next year, it is a stable process. If it changes to a higher category, it is an upward process. Otherwise, it is downward.

Once we have an initial distribution, we will then be able to build the spatial and non-spatial transition matrixes. Basically, the transition matrixes are built by counting the number of geographic units (and spatial lags) that either remain in one category or move to other categories during the entire study period. Percentages can be calculated and reported as a probability that one category can change to another during the same period.

Our previous analyses of spatial indexes indicate that Jiangsu experienced roughly two development stages of regional inequality and spatial agglomeration during the reform: the spatially concentrating yet relatively stable stage from 1985 to 1993 and the spatially concentrating but inequality enlarging stage from 1993 to 2005. To better understand Jiangsu's regional dynamics, we apply the spatial and non-spatial Markov chains analysis to these two periods separately. The results are reported in Tables 2–5.

Table 2. *Non-spatial Markov transitional matrix for GDP per capita in Jiangsu Province, 1985–1993.*

Category	P	L	D	R
P	0.959	0.041	0.000	0.000
L	0.082	0.909	0.009	0.000
D	0.000	0.024	0.833	0.143
R	0.000	0.000	0.024	0.976

Note: P: poor counties; L: less-developed counties; D: developed counties; R: rich counties.

Table 3. *Non-spatial Markov transitional matrix for GDP per capita in Jiangsu Province, 1993–2005.*

Category	P	L	D	R
P	0.972	0.028	0.000	0.000
L	0.031	0.957	0.012	0.000
D	0.000	0.121	0.758	0.121
R	0.000	0.000	0.015	0.985

Note: P: poor counties; L: less-developed counties; D: developed counties; R: rich counties.

The four tables give very interesting results. First, from the two non-spatial Markov chain tables, we found that all of the diagonal numbers are higher than the non-diagonal numbers, which means it is more likely for each category to remain in the current level for both study periods. The diagonal numbers range from 0.758 to 0.985, indicating that the lowest frequency for each unit to stay in the same category is about 75.8 per cent. The transitional frequency is very low. The highest transitional frequency is only 0.143, which indicates a relatively stable regional development system with gradual change. More detailed observation indicates a relatively strong upward movement during the first period of our analysis (1985–1993), as 19.3 per cent of the counties move upward, while only 13 per cent move downward. Yet in the second period (1993–2005), the upward mobility became less likely, as the possibility of moving up (16.1%) and moving down (16.7%) seems to be rather similar.

Second, the two non-spatial Markov chain transition matrixes clearly indicate that the transition process only happens between adja-

Table 4. *Spatial Markov transitional matrix for GDP per capita in Jiangsu Province, 1985–1993.*

Spatial lag	Category	Number	P	L	D	R
R	P	0	0	0	0	0
	L	0	0	0	0	0
	D	19	0	0.053	0.842	0.105
	R	89	0	0	0	1
D	P	0	0	0	0	0
	L	0	0	0	0	0
	D	21	0	0	0.81	0.19
	R	35	0	0	0.086	0.914
L	P	9	0.889	0.111	0	0
	L	43	0.07	0.884	0.047	0
	D	0	0	0	0	0
	R	0	0	0	0	0
P	P	113	0.965	0.035	0	0
	L	189	0.085	0.915	0	0
	D	2	0	0	1	0
	R	0	0	0	0	0

Note: P: poor counties; L: less-developed counties; D: developed counties; R: rich counties.

Table 5. *Spatial Markov transitional matrix for GDP per capita in Jiangsu Province, 1993–2005.*

Spatial lag	Category	Number	P	L	D	R
R	P	0	0	0	0	0
	L	0	0	0	0	0
	D	12	0	0.083	0.667	0.25
	R	147	0	0	0.02	0.98
D	P	0	0	0	0	0
	L	2	0	1	0	0
	D	18	0	0.111	0.833	0.056
	R	58	0	0	0	1
L	P	22	0.955	0.045	0	0
	L	63	0.016	0.968	0.016	0
	D	0	0	0	0	0
	R	0	0	0	0	0
P	P	266	0.974	0.026	0	0
	L	189	0.037	0.952	0.011	0
	D	3	0	0.333	0.667	0
	R	0	0	0	0	0

Note: P: poor counties; L: less-developed counties; D: developed counties; R: rich counties.

cent categories. Jumping from a lower category to a higher category while passing over an interval (or vice versa) proves to be impossible. This indicates regional transition tends to be gradual and smooth, rather than dramatic.

Third, the spatial Markov chains analysis clearly shows that neighbouring counties' development status has rather strong influence over a particular county's development dynamics. Richest counties have a 2.4 per cent (1985–1993) and 1.5 per cent (1993–2005) tendency of moving downward (Tables 2 and 3). If the richest counties are surrounded by relatively poorer counties (in our case, only the developed category is neighbouring the rich category), such possibility increases to 8.6 per cent during 1985–1993, though decreases to 0 per cent during 1993–2005. Again, resonating with the findings in the non-spatial Markov chains, changes in the second stage (1993–2005) are milder than in the early stage (1985–1993). On the other hand, poor counties in general have a 4.1 per cent (1985–1993) and 2.8 per cent (1993–2005) chance of moving upward (Tables 2 and 3). If the poor counties are surrounded by relatively richer counties (the developing category), however, such a tendency increases to 11.1 per cent (1985–1993) and 4.5 per cent (1993–2005) (Tables 4 and 5).

UNDERSTANDING THE MECHANISMS WITH AN EXPLICIT SPATIAL PERSPECTIVE

Understanding the mechanisms of regional development is necessary to decipher the sources and trends of regional inequality. Regression remains the most favoured method. Different from applying an ordinary least squared (OLS) regression analysis with easily defined dependent and independent variables, it is well known in the field of geographic research that one of the vital assumptions for OLS regression, namely, independent error term, may not hold. Our spatial Markov chain analysis indicates just as such in Jiangsu. Spatial autocorrelation which results from either spatial similarity or spatial heterogeneity often dominates the data set. To avoid the potential misleading estimation of the OLS method, we employ maximum-likelihood based spatial autoregressive analysis and geographically weighted regression (GWR) (Fotheringham *et al.* 2002) to explore development mechanisms in Jiangsu. GWR has the potential to reveal a non-stationary relationship in regional development, which provides crucial policy implications on the hypothesis that regional development is bounded within local conditions. It is possible that even if some of the local conditions are not observable, the GWR methodology can still capture their effects.

Western theories of regional inequality are subject to regional constraints, especially in China, since the orthodox neoclassical theory is mainly based on experiences of the developed Western economies with relatively free factor mobility. In China, although the government has initiated market reform, state policies and local agents still play an important role in regional development. Jiangsu's economy was particularly influenced by the national and local preferential policies. The status of regional development is usually represented by either a growth rate concept (e.g. Wei 2002) or an output concept (e.g. Yu 2006). Although previous studies on Jiangsu tend to use growth rates, this paper uses per capita GDP of each county as the proxy for regional development, which might generate new findings. Following previous studies, and the multi-mechanism framework which views the economic reform in China as a triple transition process of globalisation, marketisation and decentralisation, we have identified the following mechanisms of regional development that emphasise the roles of various agents and factors.

Foreign direct investment per capita (FDIPC) is often used as an indicator of globalisation, and is found to display significant contribution to regional development after the reform, especially in coastal areas (Fujita & Hu 2001; Yu & Wei 2008). We include this variable to represent the global force. We have to point out that FDI distribution in China is not totally driven by free markets, rather it is heavily influenced by the open door policy including the designation of development zones (mainly in Sunan) and related preferential policies.

Fixed asset investment per capita (FAIPC) is often chosen as a good representative of the effect of the state. This is mainly based on the nature of the Chinese economy. During the planned economy (before 1978), local investment was heavily drawn from the upper-level governments in the form of fixed asset investment. Even during the reform period, the state still used fixed asset investment as a key instrument to adjust the economy and balance regional development. We hence choose this variable to represent the effects of states.

After the reform, especially fiscal decentralisation reform during the 1980s, the decentralised financial system enabled the local governments to direct resources for their own development. Local financial expense per capita (LFEPC) reflects the financial potential local governments have over their own development. The increase of such expenses would be deemed a force of fiscal decentralisation as opposed to the fiscal system before the reform. In the studies of Greater Beijing in Yu (2006) and Yu and Wei (2008), the force of financial decentralisation was found to be contributing significantly to local development at both global and local levels. Per Jiangsu's development path as discussed previously, we anticipate the local financial power to be a boosting factor.

Another important mechanism often discussed in the literature is the percentage of industrial outputs of the SOEs. This variable, as pointed out in Yu and Wei (2003), represents the institutional structure and the importance of the economic efficiency of the state in regional development. Prior to the reform, enterprise ownership in China was fairly simple since most of the enterprises were owned by the state. The reform shattered such ownership structure, especially in the southeastern provinces that include Jiangsu. Multiple ownership structures including TVEs, and increasingly shareholding companies and foreign invested enterprises, have become the major ownership forms. The share of SOEs has been declining. Due largely to the relatively rigid institutional structure, lagging technological innovation, and ageing equipment, there is a consensus among scholars that SOEs usually pose a negative influence on regional development (Yu & Wei 2003).

Since we use per capita data, we think there is no need to use population as the control variable. Also since previous studies have found that education or human capital in general is insignificant as a mechanism of regional development in China, we decide not to include it in our model. Our preliminary exploratory analysis reveals that a log-linear relationship exists among per capita GDP and the above identified four mechanisms. We hence specify our models for regression as such:

$$Log\,(\mathrm{GDPPC}) = \beta_0 + \beta_1 * \mathrm{FDIPC} + \beta_2 * \mathrm{FAIPC} + \beta_3 * \mathrm{LFEPC} + \beta_4 * \mathrm{SOE}$$

The regression analyses are conducted in R (R Development Core Team 2009) with both SPDEP (Bivand 2009) and SPGWR (Bivand & Yu 2009) packages. Spatial regression (both lag and error models) and GWR are performed using the data for year 1996 and 2005. As Jiangsu's development moved into a rather stable status after the middle 1990s, the selection of the two years seems to be appropriate based on the data availability and satisfies the comparison purpose. Jiangsu was mainly opened in the early 1990s and FDI was limited in the 1980s. We therefore decided not to run a regression model for the 1980s. For comparison purposes, OLS regressions for both years are carried out as well.

After conducting the GWR analyses, the stationarity tests of the assumed non-stationary coefficients indicate that not all of the development mechanisms' coefficients are significantly varying over space. Based on such tests, we followed the suggestions in Fotheringham *et al.* (2002) and implemented the mixed GWR models. The results of the global regression analyses (OLS and spatial lag and error models) are reported in Table 6 (1996) and Table 7 (2005). The non-stationarity tests for GWR models are reported in Table 8 while Table 9 reports the results of the stationary parts of the mixed GWR models (Fotheringham *et al.* 2002). The non-stationary parts of the mixed GWR models are reported in Figures 6 and 7.

The goodness-of-fit statistics, such as the AICs and log-likelihoods, indicate that the data are better fit using spatial analysis techniques. For instance, in 1996, AIC for the OLS model is 86.609, while for the spatial regression models they are 76.084 and 60.528 respectively (Table 6); for the mixed GWR model AIC further decreases to 55.872 (Table 9). Similar results are observed from analyses using data of 2005 (Tables 7 and 9). This clearly points to the fact that ignoring the potential spatial effects in regression analyses could reduce model effectiveness. In addition, the AICs also indicate that local analysis (GWR) potentially provides a better fit for the data than global analyses (OLS and spatial regressions), even considering the decrease in the degrees of freedom. While in the global analyses, the robust Lagrange multiplier tests suggest a spatial lag instead of an error specification. The discussion henceforth focuses on the results presented by the spatial lag models at the global analytical level and the mixed GWR results at the local analytical level.

Table 6. *Regression analyses in 1996.*

	Estimate	Standard error	t/z-value	Pr(>|t|)
OLS model				
(Intercept)	7.40e+00	1.75e−01	42.228	0.000
FAIPC96	1.35e−04	6.72e−05	2.006	0.049
FDIPC96	−2.73e−04	8.24e−04	−0.332	0.741
LFEPC96	1.69e−03	4.18e−04	4.045	0.000
SOEP96	−1.49e+00	4.80e−01	−3.108	0.003
Adjusted R-squared: 0.6831, F-statistic: 35.48 on 4 and 60 DF, p-value: 3.407e−15				
Spatial error model				
(Intercept)	7.34e+00	2.21e−01	33.278	0.000
FAIPC96	−2.73e−05	5.96e−05	−0.459	0.647
FDIPC96	1.89e−04	6.57e−04	0.288	0.774
LFEPC96	1.86e−03	3.61e−04	5.154	0.000
SOEP96	−5.95e−01	4.06e−01	−1.466	0.143
Lambda: 0.75194 LR test value: 12.525 p-value: 0.0004015, Log likelihood: -31.04210 for error model, AIC: 76.084, (AIC for OLS: 86.609) Robust Lagrange Multiplier test: 2.5571, on 1 DF, p-value: 0.1098				
Spatial lag model				
(Intercept)	3.0706e+00	6.4994e−01	4.7244	2.307e−06
FAIPC96	4.5077e−05	5.0726e−05	0.8886	0.3742
FDIPC96	−1.0009e−04	6.1104e−04	−0.1638	0.8699
LFEPC96	1.5956e−03	3.1174e−04	5.1183	3.083e−07
SOEP96	−5.4276e−01	3.8452e−01	−1.4115	0.1581
Rho: 0.5477 LR test value: 28.082 p-value: 1.1630e−07, Log likelihood: −23.26387 for lag model, AIC: 60.528, (AIC for OLS: 86.609) Robust Lagrange multiplier test: 21.093, on 1 DF, p-value = 4.375e−06				

The results show that the single most important development mechanism is per capita local financial expense. LFEPC is statistically significant in both years in the global analysis, and statistically significant and stationary in 1996, though exhibits varying relationships with per capita GDP in 2005 in local analysis. Such results are to be expected in Jiangsu, as after the economic reform, Jiangsu, along with other southeastern coastal provinces in China, has been leading the way of decentralisation and local fiscal system reforms. The increased financial freedom greatly stimulates local counties' development. Fiscal decentralisation has been considered the most important cause for the development of Sunan, which has even been conceptualised as local state corporatism. Such stimulation, however, decreased Sunan's importance during the recent years. It is only significantly related with per capita GDP in part of Subei (Figure 7b). This result might indicate the source of local development, especially that the source of local financial investment has been greatly diversified during recent years.

Second, fixed asset investment per capita, which was chosen as a proxy for the effect of the state, exhibits positive relationship with per capita GDP in both 1996 and 2005. Interestingly, the relationships turn negative in the most developed Sunan region (Figures 6b and 7a). This agrees with the economic structure and trajectory of Sunan's development that was dominated by TVEs, and more recently foreign investment with less government interference.

Table 7. *Regression analyses in 2005.*

OLS model	Estimate	Standard error	t-value	Pr(>|t|)
(Intercept)	8.99e+00	8.63e-02	104.234	0.000
FAIPC05	9.85e-06	1.89e-05	0.521	0.604
FDIPC05	3.04e-04	4.00e-04	0.760	0.450
LFEPC05	3.44e-04	1.09e-04	3.158	0.002
SOEP05	4.69e-01	4.02e-01	1.166	0.248

Adjusted R-squared: 0.7251, F-statistic: 43.2 on 4 and 60 DF, p-value: < 2.2e-16

Spatial error model

	Estimate	Standard error	z–value	Pr(>|t|)
(Intercept)	9.24e+00	1.64e–01	56.305	0.000
FAIPC05	9.95e–06	1.25e–05	0.797	0.425
FDIPC05	–1.47e–04	3.31e–04	–0.443	0.657
LFEPC05	2.49e–04	8.52e–05	2.918	0.004
SOEP05	5.15e–01	2.89e–01	1.782	0.075

Lambda: 0.7501 LR test value: 27.476 p-value: 1.5907e-07, Log likelihood: -20.34209 for error model, AIC: 54.684, (AIC for OLS: 80.16)
Robust Lagrange multiplier test: 2.404 on 1 DF, p-value: 0.1210

Spatial lag model

	Estimate	Standard error	z-value	Pr(>|t|)
(Intercept)	4.0790e+00	6.9200e–01	5.8945	3.758e–09
FAIPC05	1.9172e–05	1.3261e–05	1.4458	0.148238
FDIPC05	–1.8103e–04	2.8671e–04	–0.6314	0.527781
LFEPC05	2.0628e–04	7.8590e–05	2.6247	0.008672
SOEP05	5.7456e–01	2.8119e–01	2.0433	0.041022

Rho: 0.52992 LR test value: 36.762 p-value: 1.3346e-09, Log likelihood: -15.69890 for lag model, AIC: 45.398, (AIC for lm: 80.16)
Robust Lagrange multiplier test: 11.6657 on 1 DF, p-value: 0.0006366

On the contrary, Subei's development seems to rely much more heavily on the government's interference. This is even more so in 2005 (Figure 7a), for example, in the majority of Sunan and Suzhong FAIPC is significantly negatively related with per capita GDP, while in the core regions of Subei the relationships are significantly positive.

Third, the above result is supported by the varying coefficients of SOE in 1996 (Figure 6a) and a non-significant relationship in 2005 (Table 9), which is an agent for both industrial structure and government's roles in economic development. This confirms the fact that SOEs played a negative role in regional development during the mid-1990s, but no longer determined regional development in Jiangsu, given the economy is largely non-state in nature.

Last, the tables indicate the rather anti-intuitive statistical result, which is that per capita foreign direct investment does not seem to be significantly related to per capita GDP in both years, for either the global or local analysis. Such results might be caused by our choice of the proxy for global forces, not necessarily indicating that globalisation has no relationship with regional development. The findings point to the fact that after decades of the open

Table 8. *Non-stationarity test for the general GWR models.*

	(Intercept)	FAIPC96	FDIPC96	LFEPC96	SOEP96
Non-stationarity test of the general GWR model in 1996					
F statistic	11.010	3.273	1.505	0.684	2.832
Numerator DF	18.483	20.048	10.878	14.145	24.953
Denominator DF	60.147	60.147	60.147	60.147	60.147
p values	0.000	0.000	0.154	0.782	0.001
Non-stationarity test of the general GWR model in 2005					
F statistic	23.302	2.918	1.960	3.160	0.878
Numerator DF	21.272	10.028	4.585	8.972	22.438
Denominator DF	59.223	59.223	59.223	59.223	59.223
p values	0.000	0.005	0.104	0.004	0.623

Table 9. *Mixed GWR analysis.*

	Estimate	Standard error	t-value	Pr(>|t|)
Non-stationary part of the mixed model, 1996				
FDIPC96	0.0005692	0.0006418	0.887	0.378
LFEPC96	0.0013004	0.0002970	4.378	4.6e-05
AIC for mixed GWR model: 55.872 (for spatial lag model: 60.528, for OLS: 86.609)				
Non-stationary part of the mixed model, 2005				
FDIPC05	0.0003740	0.0003301	1.133	0.261
SOEP05	0.1382031	0.2429586	0.569	0.571
AIC for mixed GWR model: 14.478 (for spatial lag model: 45.398, for OLS: 80.160)				

door policy, FDI is increasingly embedded in regional development mechanisms.

CONCLUSION

Since the adoption of economic reforms and open door policies in the late 1970s, China has acknowledged the inevitable stage of uneven regional development. Preferential policies have allowed some regions to speed up economic growth and it is hoped that the benefits will trickle down to the lagging regions. The government has intensified the efforts to balance regional development since the late 1990s, but its effects are debatable. This paper uses newly developed spatial analysis techniques to study regional inequality in Jiangsu, building upon the recent efforts to understand China's regional development via a series of theoretical perspectives and methodological advances (Ying 2003; Wei 2007; Yu & Wei 2008).

The multiscalar analyses using inequality indexes and decomposing techniques have yielded important findings. Traditionally, Jiangsu can be divided into the rich Sunan, moderately developed Suzhong, and poor Subei, and such a divide has been reinforced since the 1980s. The results reveal that overall inter-county inequality is mainly due to the dif-

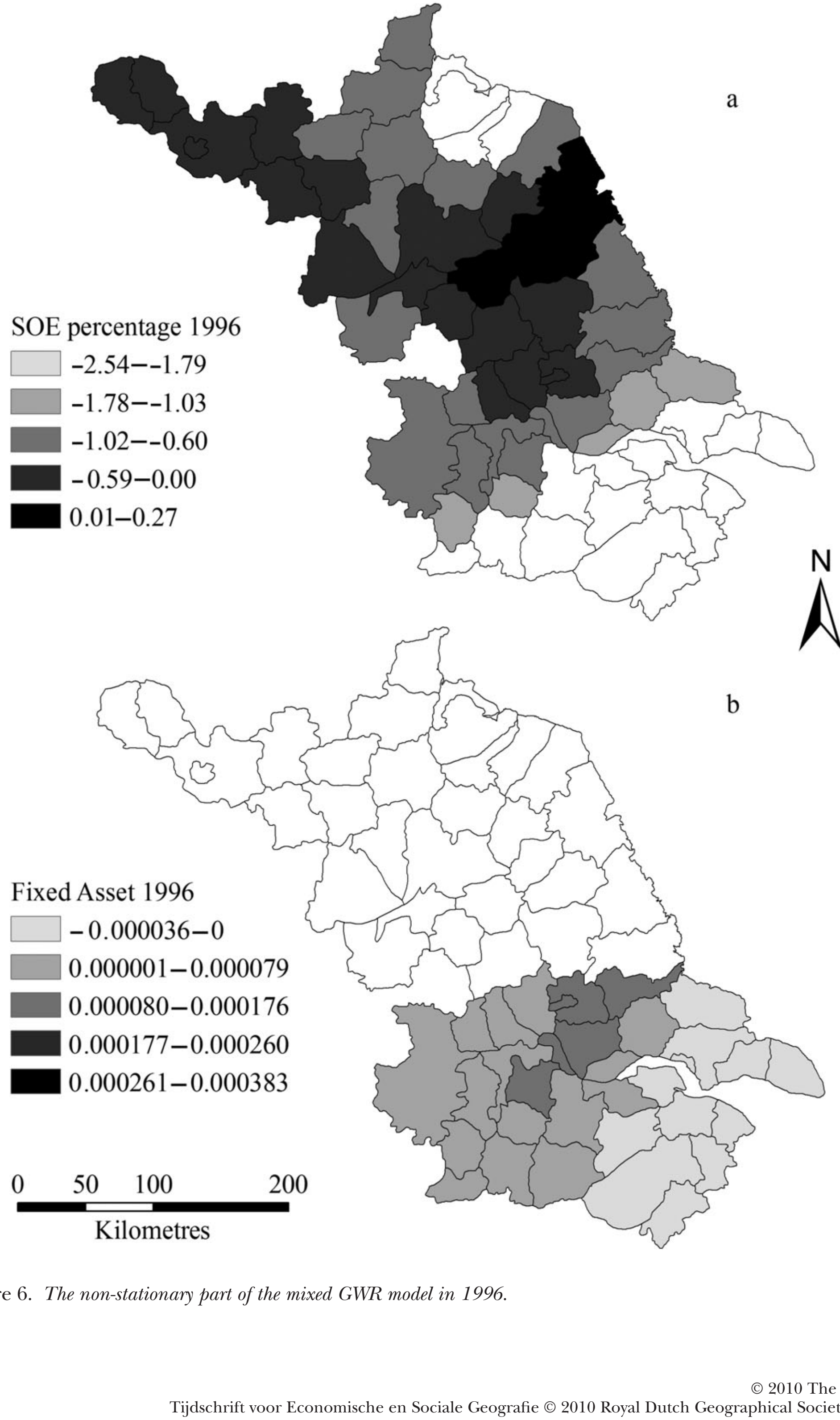

Figure 6. *The non-stationary part of the mixed GWR model in 1996.*

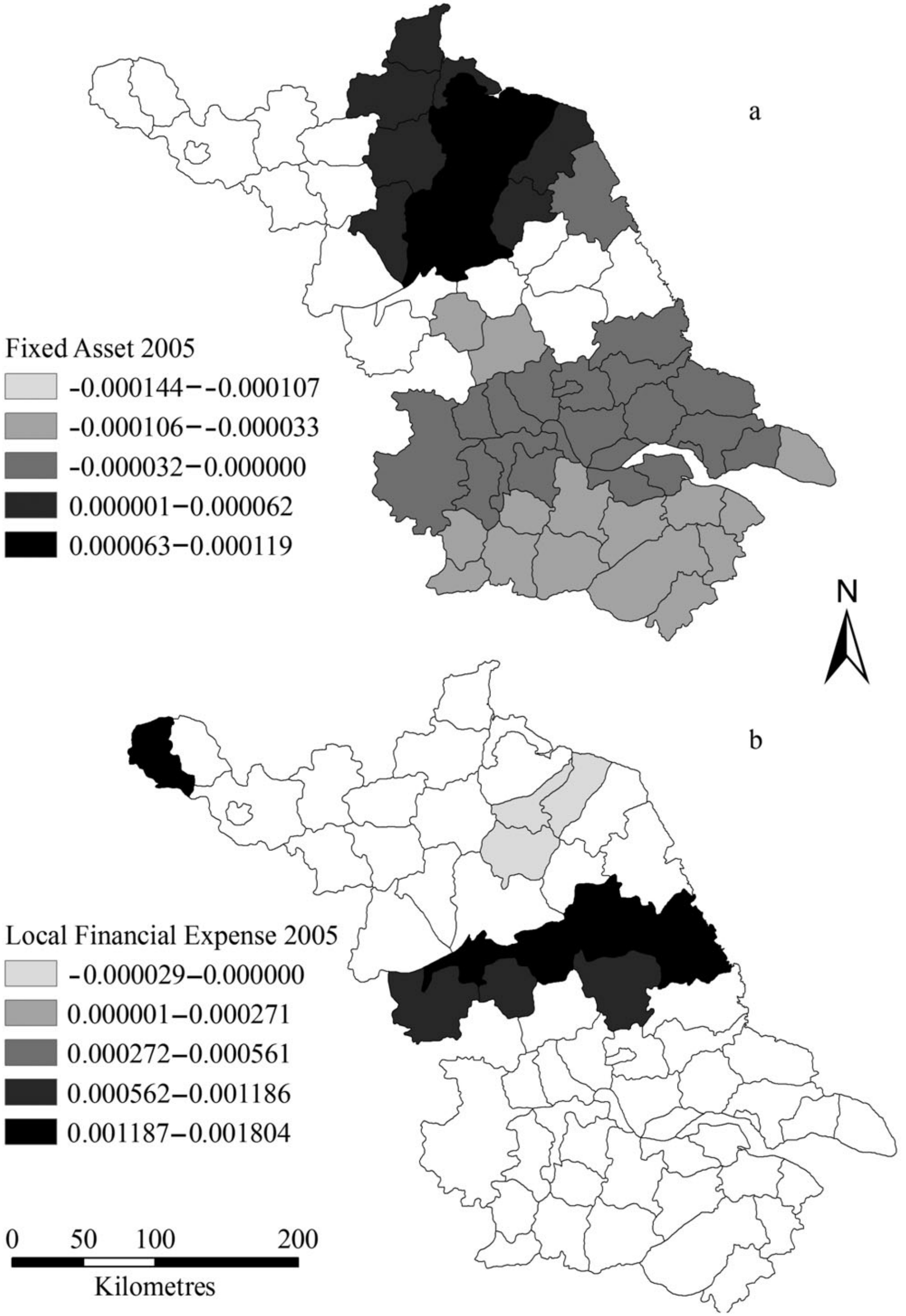

Figure 7. *The non-stationary part of the mixed GWR model in 2005.*

ference between Sunan, Suzhong and Subei, more specifically, due to the rapid growth of the counties in Sunan based on the development of TVEs and more recently, foreign and private enterprises. Intra-region inequality tends to be small. Urban-rural (city-county) inequality did not change much, but rural inter-county inequality intensified, which means that the major difference is among the rural counties. The findings suggest that Jiangsu's counties are not necessary poorer than its cities; they are in fact more dynamic and experienced faster growth than cities.

Combined with the spatial Markov chain model, the results reveal a significant spatial agglomeration process in Jiangsu from 1978 to 2005. Both spatial index and the dynamics process analysis reveal a trend of spatial agglomeration and that the north-south divide was fortified. This study confirms the general trend of increasing geographical concentration and agglomeration found in the studies of interprovincial (Yu & Wei 2003) and intra-provincial inequalities such as Zhejiang (Ye & Wei 2005) and Guangdong (Lu & Wei 2007). Therefore studies at both inter- and intra-provincial levels have found strong evidences of spatial agglomeration, which is consistent with the broad literature about the pervasive force of agglomeration operating at global and local scales.

The application of spatial regression analysis enables us to incorporate spatial dependence in analysing cross sectional data on geographical units. The utilisation of GWR makes it possible to detect the heterogeneous spatial structure. The results provide solid evidence that there exists significant heterogeneous spatial structure in Jiangsu. Decentralisation and location are two of the most important factors to understand regional inequality, while globalisation is embedded with those development mechanisms. Our results provide promising aspects of employing GIS and spatial data analysis techniques in understanding regional development processes.

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Notes

1. Coefficient of Variation (CV) is a measure of dispersion of a distribution. It is defined as the ratio of the standard deviation (σ) to the mean (μ). Sometimes the weight of population is taken into consideration. The larger the CV, the larger the disparity among regions.

$$CV = \frac{\sigma}{\mu}$$

2. Theil Index is a statistic technique used to measure economic inequality. One of the advantages of the Theil index is that it is the weighted sum of inequality within subgroups. We adopted the one stage Theil decomposition methods. Using the county as a basic regional unit, overall regional inequality is measured by the following Theil Index:

$$T_p = \sum_i \sum_j \left(\frac{Y_{ij}}{Y}\right) Log\left(\frac{Y_{ij}/Y}{N_{ij}/N}\right)$$

Y_{ij} is the income of unit j in region I; Y is the total income of all area. N_{ij} is the population of unit j in region I and N is the total population of all area.

3. Monte Carlo Markov chain (MCMC) is a discrete-time stochastic process. It is a class of algorithms for sampling from probability distributions based on constructing a Markov chain that has the desired distribution as its stationary distribution. The state of the chain after a large number of steps is then used as a sample from the desired distribution. Spatial Markov chain Monte Carlo analysis is a recently developed analytical technique (Rey 2001; Le Gallo 2004) to understand how the regional development pattern can be explained by the geographical relationships.

REFERENCES

Anselin, L. (2001), Spatial Econometrics. *In*: B. Baltagi, ed., *Companion to Econometrics*. Oxford: Blackwell.

Bao, S.M., G.H. Chang, J.D. Sachs & W.T. Woo (2002), Geographic Factors and China's Regional Development Under Market Reforms, 1978–1998. *China Economic Review* 13, pp. 89–111.

Barro, R. & X. Sala-I-Martin (1995), *Economic Growth*. New York: McGraw-Hill.

Bivand, R. (2009), SPDEP: Spatial Dependence: Weighting Schemes, Statistics and Models. Available at <http://cran.r-project.org/web/

packages/spdep/index.html>. Accessed October 2009.

Bivand R. & D. Yu (2009), SPGWR – An R package for Geographically Weighted Regression. Available at <http://cran.r-project.org/bin/windows/contrib/r-release/spgwr_0.5-4.zip>. Accessed October 2009.

Bradshaw, M. & J. Prendergrast (2005), The Russian Heartland Revisited: An Assessment of Russia's Transformation. *Eurasian Geography and Economics* 46, pp. 83–122.

Chai, J. (1996), Divergent Development and Regional Income Gap in China. *Journal of Contemporary Asia* 26, pp. 46–58.

Fingleton, B. (1999), Estimates of Time to Economic Convergence. *International Regional Science Review* 22**,** pp. 5–34.

Fotheringham, A.S., C. Brunsdon & M. Charlton (2002), *Geographically Weighted Regression*. Chichester: John Wiley & Sons.

Fujita, M. & D. Hu (2001), Regional Disparity in China 1985–1994. *The Annals of Regional Science* 35, pp. 3–37.

Gallup, J.L., J.D. Sachs & A.D. Mellinger (1999), Geography and Economic Development. *International Regional Science Review* 22, pp. 179–232.

Gu, C.L., J.F. Shen, K.Y. Wong & F. Zhen (2001), Regional Polarisation Under the Socialist-market System Since 1978. *Environment and Planning A* 33, pp. 97–119.

He, C., Y.H.D. Wei & F. Pan (2007), Geographical Concentration of Manufacturing Industries in China. *Eurasian Geography and Economics* 49, 603–625.

JSB (Jiangsu Statistical Bureau) (2006), *Jiangsu Tongji Nianjian (Jiangsu Statistical Yearbook)*. Beijing: China Statistics Press.

Le Gallo, J. (2004), Space-time Analysis of GDP Disparities among European Regions. *International Regional Science Review* 27**,** pp. 138–163.

Liu, H. (2006) Changing Regional Rural Inequality in China, 1980–2002. *Area* 38, pp. 377–389.

Lu, L.C., & Y.H.D. Wei (2007), Domesticating Globalisation, New Economic Spaces and Regional Polarisation in Guangdong Province, China. *Tijdschrift voor Economische en Sociale Geografie* 98, pp. 225–244.

Masahisa, F. & D. Hu (2001), Regional Disparity in China 1985–1994. *The Annals of Regional Science* 35, pp. 3–37.

Pannell, C.W. (2007), The China Challenge: Observations on the Outlook for the 21st Century. *Eurasian Geography and Economics* 48, pp. 3–15.

Petrakos, G. (2001), Patterns of Regional Inequality in Transition Economies. *European Planning Studies* 9, pp. 359–383.

Quah, D. (1996), Regional Convergence Clusters across Europe. *European Economic Review* 40, pp. 951–958.

R Development Core Team (2009), R: A Language and Environment for Statistical Computing. Available at <http://www.R-project.org>. Accessed October 2009.

Rey, S.J. (2001), Spatial empirics for economic growth and convergence. *Geographical Analysis* 33, 195–214.

Scott, A.J. & M. Storper (2003), Regions, Globalisation, and Development. *Regional Studies* 37, pp. 579–593.

Wei, Y.H.D. (2002), Multiscale and Multimechanisms of Regional Inequality in China. *Journal of Contemporary China* 11, 109–124.

Wei, Y.H.D. (2004), Trajectories of Ownership Transformation in China. *Eurasian Geography and Economics* 45, pp. 90–113.

Wei, Y.H.D. (2007), Regional Development in China: Transitional Institutions, Embedded Globalisation, and Hybrid Economies. *Eurasian Geography and Economics* 48, pp. 1–21.

Wei, Y.H.D. & S. Kim (2002), Widening Inter-county Inequality in Jiangsu Province, China, 1950–95. *Journal of Development Studies* 38, pp. 142–164.

Wei, Y.H.D. & C.C. Fan (2000), Regional Inequality in China: A Case Study of Jiangsu Province. *Professional Geographer* 52, pp. 455–469.

Wei, Y.H.D., Y.Q. Lu & W. Chen (2009), Globalising Regional Development in Sunan, China. *Regional Studies* 43, pp. 409–427.

Wei, Y.H.D. & X.Y. Ye (2004), Regional Inequality in China: A Case Study of Zhejiang Province. *Tijdschrift voor Economische en Sociale Geografie* 95, pp. 44–60.

Wei, Y.H.D. & X.Y. Ye (2009), Beyond Convergence: Space, Scale, and Regional Inequality in China. *Tijdschrift voor Economische en Sociale Geografie* 100, pp. 59–80.

Weng, Q.H. (1998), Local Impacts of the Post-Mao Development Strategy: The Case of the Zhujiang Delta, Southern China. *International Journal of Urban and Regional Research* 22, pp. 425–442.

Ye, X.Y. & Y.H.D. Wei (2005), Geospatial Analysis of Regional Development in China: The Case of Zhejiang Province and the Wenzhou Model. *Eurasian Geography and Economics* 46**,** pp. 445–464.

Ying, L.G. (2003), Understanding China's Recent Growth Experience. *Annals of Regional Science* 37, 613–628.

Yu, D.L. (2006), Spatial Varying Development Mechanisms in the Great Beijing Area. *The Annals of Regional Science* 40, pp. 173–190.

Yu, D.L. & Y.H.D. Wei (2003), Analysing Regional Inequality in Post-Mao China in a GIS Environment. *Eurasian Geography and Economics* 55, pp. 514–534.

Yu, D.L. & Y.H.D. Wei (2008), Spatial Data Analysis of Regional Development in Greater Beijing, China, in a GIS Environment. *Papers in Regional Science* 87, pp. 97–117.

Zhang, Z., A. Liu & S. Yao (2001), Convergence of China's Regional Incomes 1952–1997. *China Economic Review* 12, pp. 243–258.