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Regional inequality, spatial polarization and place mobility in provincial China: A case study of Jiangsu province

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ABSTRACT

This paper investigates regional inequality, spatial polarization, and places mobility in provincial China through a case study of Jiangsu province from a multi-scale and multi-dimensional framework. Based on policy changes and inequality indices, we divide the development trajectory of Jiangsu since the reform into three sub-periods: 1978–1993, 1994–2004, and 2004–2014. The analysis reveals that regional inequality and polarization have a similar pattern: fast growth during 1978–1993, fluctuating during 1994–2004, and stable decline after 2004. Place mobility stays low after 1994, mainly because of the growing accumulation of the developed area. After 2004 we can observe higher mobility, which, however, is not strong enough to change the core-periphery structure. The spatial measurements reflect the spatial agglomeration process, and the core-periphery structure has become clear and stable since 1994. Such findings are also confirmed by the clustering of self-organizing maps (SOM), which reveals local development trajectories in Jiangsu. This paper shows that a strong core-periphery structure increases spatial polarization and reduces place mobility, even though regional inequality does not intensify. More policies are needed to address the serious problems of spatial exclusion, the tremendous core-periphery gap, the persistent polarization among geographical regions and populations, and the decreasing place mobility. Our study calls for a more in-depth investigation of the multi-scale and multi-dimensional nature of spatial inequality and further analysis of the complexity of spatial inequality and the development of poorer regions.

1. Introduction

Inequality is a central topic because of its negative impacts on social cohesion, sustainable development, and political unity (Piketty, 2014; Stiglitz, 2012). The long debate on regional inequality has been renewed since the late 1980s due to concerns about the effects of globalization and liberalization (Barro & Sala-i-Martin, 1991). The uneven impact of the recent Global Financial Crisis has made it once again a burning topic (Boushey, DeLong, & Steinbaum, 2017; Wei, 2015).

Regional inequality in China has also attracted tremendous concern and scholarly attention. Since the launch of the economic reform in 1978, China has undergone a triple transition of decentralization, marketization, and globalization, which has reshaped regional development in China (Wei, 2000, 2002). While achieving an average annual growth rate of GDP at 9.7% from 1978 to 2014 (CSB, 2015), China also faces many challenges, including rising inequality, environmental problems and intensifying social injustice (Fan, Kanbur, & Zhang, 2011; Kanbur, Wang, & Zhang, 2017; Wei, 2007, 2017; Xie & Zhou, 2014; Xu, Pan, & Wang, 2018).

China has implemented several national programs, e.g., the Western Development Program, to stimulate economic growth in less developed western provinces (Fan & Sun, 2008; Li & Wei, 2010; Li & Fang, 2016). Given China's vast size, regional inequality not only exists across provinces but also within provinces (Wei, 2000; Wei & Fan, 2000). Scholars have scaled down research to intra-provincial inequality, with the availability of data and efforts of governments to reducing inequality (Dai, Ye, Wei, Ning, & Dai, 2018; Liao & Wei, 2012, 2015; Sun, Lin, Liang, & Li, 2016; Wei & Ye, 2004, 2009; Wei, Yu, & Chen, 2011; Yue, Zhang, Ye, Cheng, & Leipnik., 2014).

Spatial polarization is an important dimension of inequality and concerned about the clustering of income distributions. Polarization reflects the phenomena of "disappearing of the middle class" and

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"clustering around extremes," which are often masked by standard inequality measures (Foster & Wolfson, 1992). Intensifying regional polarization often indicates the worsening core-peripheral divide and the decline of upward mobility of poorer regions. However, such an important dimension of inequality, which draws huge concerns of citizens and governments, has been seriously under-investigated in the study of regional inequality, especially in China.

Through the case study of Jiangsu province, this paper furthers our understanding of changing regional inequality in provincial China with an emphasis on spatial polarization and place mobility. Jiangsu is a well-developed province in China. Thus studying regional inequality, polarization, and place mobility there would provide insights into more developed coastal China and future development for undeveloped regions. It is also a region with deep concern of place mobility and polarization because of the historically rooted north-south divide. Furthermore, as Jiangsu is also a major component of the Yangtze River Delta integration; thus, its development trajectory also offers the experience of regional integration and the diffusion of development for other urban agglomerations.

2. Regional inequality, spatial polarization, and place mobility

Regional inequality has been a subject of intense debates among various schools of thought, especially convergence and divergence (Wei, 2015). The idea of long-term convergence is consistent with the growth pole theory and the inverted-U thesis, which state that regional inequality rises in the early stage of development and declines when the economy matures (Alonso, 1980; Martínez-Galarraga, Rosés, & Tirado, 2015; Williamson, 1965). However, empirical works find a lack of convergence and neo-Marxists regard the persistence of regional inequality as a necessary pre-condition and an inevitable consequence of capitalism (Smith, 1984; Soja, 1980). Globalization since the late 1980s has renewed the debates on regional inequality. The concept of convergence was further divided into σ-convergence, which holds that the overall degree of dispersion decreases in the long term, and the β-convergence, indicating the faster growth of poor regions than rich ones (Barro & Sala-i-Martin, 1991). Others argue that regional inequality increased in many countries (Martínez-Galarraga et al., 2015). New economic geography places increasing return to scale and agglomeration at the center of regional development (Fujita, Krugman, & Venables, 1999).

Geographical research on regional inequality pays particular attention to the multi-scalar nature, the agglomeration of economic activities, and more recently, spatial polarization (Li & Wei, 2010; Rey, 2001; Scott, 1998; Silva, Matyas, & Cunguara, 2015; Storper, 2018; Wei, 2015), challenging non-spatial views for their insensitivity to geographical scale, the nature of space and place, and the context of developing countries (Petrakos, Rodríguez-Pose, & Rovolis, 2005; Wei et al., 2011; Wei & Ye, 2009). Regional inequality is multi-scale in nature, and spatial agglomeration is an essential feature of geographical space. Nonetheless, spatial polarization and place mobility remain under-studied (Wei, 2015).

Geographers and planners have long been concerned about the core-peripheral structure and spatial polarization (Alonso, 1980; Friedmann, 1966; Smith, 1984; Storper & Walker, 1989). Polarization is the degree to which the population clusters around separate poles, while a traditional inequality index measures the spread of the income distribution (Zhang & Kanbur, 2001) and fails to distinguish between convergence to the global mean and clustering around local means (Esteban & Ray, 1994). Declining overall inequality can mask rising polarization, with related concepts of geographical concentration, club convergence, and poverty trap. Multiple mechanisms have been identified to account for spatial polarization, including factor mobility, urban bias, globalization, agglomeration economies, and knowledge spillover (e.g., Iammarino, Rodríguez-Pose, & Storper, 2018; Storper, 2018; Wei, 2015). More effective polarization indexes have been developed recently, such as the KZ index (Zhang & Kanbur, 2001; Federov, 1999), which are based on the core-peripheral structure.

Spatial polarization is often related to the lack of upward mobility of poorer regions, The decline of intergenerational mobility, the key to the American dream, has emerged as a hot spot of research (Chetty et al., 2014; Ewing, Hamidi, Grace, & Wei, 2016). While place mobility has also drawn renewed attention of geographers (Wei, 2015), our knowledge remains inadequate. Spatial Markov Chain is a traditional tool to measure place mobility (Hammond, 2004; He, Bayrak, & Lin, 2017; Le Gallo, 2004). However, it is still unable to illustrate regional trajectories directly, and more techniques are required.

3. Regional development and inequality in China

Interprovincial inequality in China declined from 1978 to 1990, increased in the 1990s and early 2000s, and decreased or stabilized during 2005–2010, although some researchers disagree (Fan & Sun, 2008; Li & Gibson, 2013; Li & Wei, 2010; Lu & Wang, 2002). A significant dimension of spatial inequality in China is the rising coast-interior gap due to the more rapid growth of coastal areas under globalization and liberalization (Li & Wei, 2010; Yu & Wei, 2003). Interior development has become a top agenda. Other divisions in China have also been used, such as urban-rural division (Xie & Zhou, 2014).

Scholars have also scaled down to study intra-provincial inequality especially in coastal provinces of Jiangsu, Zhejiang, and Guangdong and gradually in inland provinces such as Guizhou and Guangxi (Dai et al., 2018; Liao & Wei, 2012, 2015; Sun et al., 2016; Wei et al., 2011; Wei & Ye, 2004, 2009; Ye, Ma, Ye, Chen, & Xie, 2017; Yue, Zhang, Ye, Cheng, & Leipnik, 2014; Zhang, Tong, & Liang, 2018). They have identified complex landscapes of intraprovincial inequality. While intercounty inequality may have increased in some provinces (e.g., Jiangsu, Zhejiang, Guangdong, and Guangxi), it has declined in others (e.g., Guizhou and Chongqing). Most concerning is the existence, even intensification, of the core-peripheral structure in provincial China, such as the Sunan-Subei divide in Jiangsu, the gap between the Pearl River Delta and the rest of Guangdong, and the inequality between central Guizhou and the rest (Liao & Wei, 2012; Sun et al., 2016; Wei et al., 2011; Zhang et al., 2018). Such a structure is even strong in interior China (Shi, Cao, Shi, & Wang, 2020).

Geography matters in shaping the uneven economic landscape of China. Regional inequality in China is sensitive to scale, and cannot be simplified as convergence or divergence & Wei, 2012, 2015; Li & Wei, 2010; Liao; Wei et al., 2011; Wei & Ye, 2004, 2009; Yue et al., 2014). County-level inequality may have different trends compared to prefectural, provincial, and regional levels, especially after 2005 (He, Bayrak, & Lin, 2017; He, Fang, & Zhang, 2017).

While some factors influencing regional inequality in China are common worldwide, such as trade openness and human capital (Lessmann & Seidel, 2017), others are more China-specific. Government policies play as key roles in shaping regional inequality in China, such as the open-door policy in 1978, the tax reform in 1994, and entering the WTO in 2001 (He, Bayrak, & Lin, 2017). First, the triple processes of regional development in transitional China, namely decentralization, marketization, and globalization, are highly linked to regional inequality (Li & Fang, 2016; Liao & Wei, 2012; Wei, 2002). Second, structural transformation and industrial upgrading in China affect the inequality in industrial distribution, affecting regional inequality (Cheong & Wu, 2014; Li & Fang, 2014).

However, spatial polarization remains less examined. It is still less known how the trends of polarization and inequality differ across scales (e.g., Zhang et al., 2018). It is particularly important to know whether and how spatial polarization changed since the great financial crisis. Moreover, as place mobility is usually regarded as the underlying source of the dynamics of regional inequality and polarization, there is an insufficient understanding of how their patterns interact in the trajectory of regional development. Moreover, the linkages of these spatial

dimensions have rarely been investigated, which calls for a more thorough examination of these phenomena. More importantly, in the recent context of globalization and the global financial crisis, more studies are also needed to further the understanding of the new era.

4. Research setting and methodology

4.1. Research setting and data

Jiangsu is located in the center of China's east coast and neighbors Shanghai to the south (Fig. 1). With a population of 79.6 million in 2014 (similar to Germany, the second-largest country in Europe), Jiangsu is one of the most developed provinces and has experienced rapid economic growth since the late 1970s (CSB, 2009). GDP per capita in Jiangsu increased from 430 yuan in 1978 to 81,874 yuan in 2014. In 2014, Jiangsu produced 6508.8 billion yuan of GDP, second only to Guangdong Province (CSB, 2015). Its development experiences well represent the process of rapid growth and change in provincial China. To maintain consistency for analysis (He, Chung, Bayrak, & Wang, 2018), we use the administrative structure of Jiangsu in 2010, when there were 13 municipalities and 63 county-level spatial units, including 13 urban districts, 26 county-level-cities, and 24 counties.

Jiangsu is divided into southern Jiangsu (Sunan), central Jiangsu (Suzhong), and northern Jiangsu (Subei). Following a south-north gradient, Sunan is the most developed area, and Subei the least developed while Suzhong is a transition zone. Sunan is also in the center of the Yangtze River Delta known for its historical development and proximity to Shanghai. In 2014, with a population of 27.39% of Jiangsu), Sunan produced 41.28% of the provincial GDP and dominated the exports and FDI in Jiangsu (Table 1).

Like other studies of regional inequality in provincial China, we use GDP per capita (GDPPC) as the major indicator of the overall regional development level in this research. The GDP data are adjusted to the constant value in 1978, and the majority of data are official statistics (CSB, 1986-2015). We use the de facto population, resident population (*changzhu renkou*), rather than the registered population (*huji renkou*), to calculate GDPPC. When official statistics were not available for the resident population, population data are interpolated using data from census years (He, Bayrak, & Lin, 2017).

Table 1
Major development indicators of Jiangsu Province, 1990–2014

Indicator	Jiangsu	% of China	% of Jiangsu		
			Southern	Central	Northern
1990					
Residential population (million)	67.67	5.92	19.72	36.89	43.39
Land area (sq. km)	102,600	1.06	17.37	29.16	53.47
GDP (billion yuan)	142	7.59	35.57	39.32	25.11
GDP per capita (yuan)	2042	126.40	180.39	106.60	57.86
FDI (billion US$)	0.1	4.04	40.03	45.32	14.64
Exports (billion US$)	2.9	4.74	43.16	52.22	4.63
Local fiscal revenue (billion yuan)	13.6	4.64	41.33	33.95	24.72
2014					
Residential Population (million)	79.6	5.8	27.39	34.92	37.69
Land area (sq. km)	102,600	1.06	17.37	29.16	53.47
GDP (billion yuan)	6509	10.23	42.07	37.47	20.45
GDP per capita (yuan)	81,874	175.59	153.63	107.29	54.27
FDI (billion US$)	28.2	23.5	47.63	32.69	19.68
Exports (billion US$)	337.7	14.4	73.16	21.06	5.78
Local fiscal revenue (billion yuan)	723.3	9.5	39.96	34.81	25.23

Source: CSB 2015.

4.2. Indices for regional inequality and polarization

We first use three statistical indices CV (coefficient of variation), Gini coefficient, and Theil index to measure regional inequality, and then decompose the inter-county Theil index by two divisions, the Sunan-Subei-Suzhong division and the urban (districts)-rural (county-level cities and counties) division to see the changing inequality between and within regions or groups.

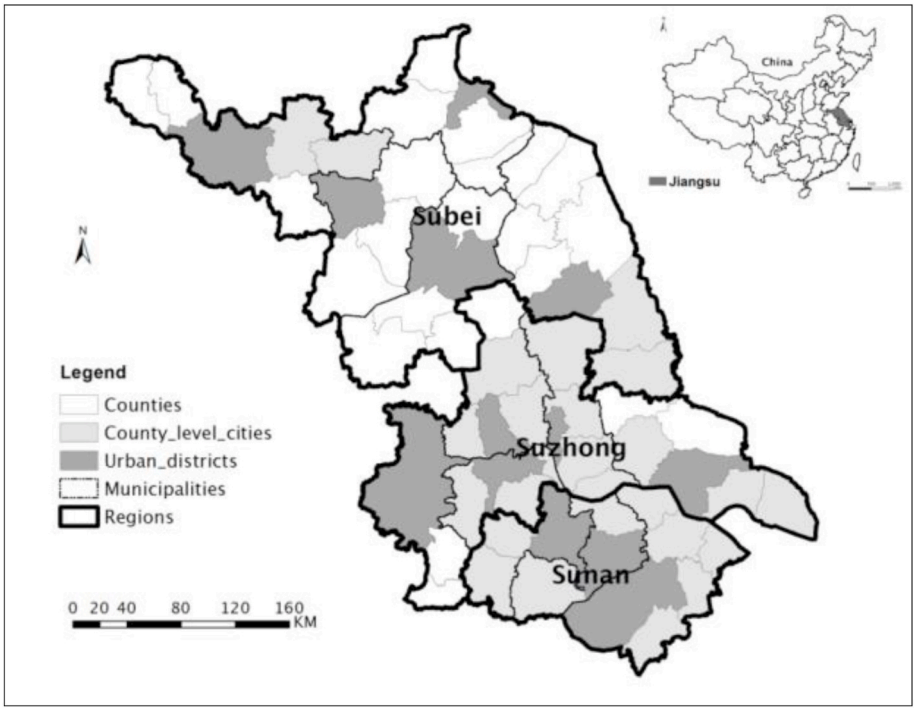


Fig. 1. Location and administrative divisions of Jiangsu province, 2010

Two widely used polarization measures, the Esteban and Ray index (1994) and Wolfson (1994) index, are first applied to the county-level GDPPC data. Following Federov (1999), we normalize the original value by the mean and multiply it by 100 to make the magnitude of ER comparable to the Gini coefficient. We then apply the Kanbur-Zhang index to understand the polarization condition between groups (Kanbur & Zhang, 2005). It is derived from the GE index (Zhang & Kanbur, 2001) and can be decomposed into within-group inequality and between-group inequality. The KZ index is the ratio of the between-group inequality to within-group inequality.

We analyze regional inequality by considering spatial effects. Specifically, global and local Moran's *I* are employed to explore the impact of spatial autocorrelation on regional development. We calculate global Moran's *I* to measure spatial agglomeration and local Moran's *I* to detect local spatial autocorrelation and identify clusters or outliers in regional development at the county-level.

4.3. Place mobility and Spatial Markov Chains

We apply several different techniques to capture place mobility. Here we divide the mobility measurements into two types. One is "accumulative mobility," which evaluates the mobility based on the historical development trajectory. The other one is "non-accumulative mobility" and reflects mobility by only local growth.

We employ Spearman's ρ rank correlation coefficient as an indicator of accumulative mobility. The coefficient shows how the previous rank of a county-level unit is related to its subsequent rank and how this relationship has changed over time. We further employ the non-spatial and spatial Markov chain to investigate the dynamics of regional development (Quah, 1996; Rey, 2001). The Markov chain approach classifies different spatial units into various categories based on their GDPPC in a certain year and investigates their probabilities of transition to another category for a given period. The transition probability matrix can be established based on data for each year. It has a dimension of K by K, in which K is the number of categories, and is supposed to be time-invariant.

Scholars have attempted to incorporate spatial dependence or spatial autocorrelation in determining the transition probability matrix (Rey, 2001). In which the traditional transition matrix is further expanded, and the transition probability of a region is conditioned on the GDPPC class of its spatial lag in the beginning year. Then we can obtain a spatial transition matrix and expand the traditional K by K matrix into K conditional matrices of dimension (KK), which means the spatial lags are categorized into the same number of groups of GDPPC. Lastly, a K by K by K three-dimensional transitional matrix will be constructed.

We categorize the GDPPC data into four groups (rich, developed, less developed, and poor) using the quantile method, corresponding with the geographical notion of the core, semi-core, semi-periphery, and periphery (Wei et al., 2011). The time interval of the Markov chain transition matrix is one year. If a county's GDPPC is in the *i* th category and remains the same in the following year, it is a stable process. If it climbs to a higher category, it is an upward process. If it declines to a lower category, it is a downward process. The Markov chain analysis is conducted in PySAl, an open-source library of spatial analysis functions written in Python (Rey & Anselin, 2010).

To explore potential future mobility, we also employ intergenerational income elasticity (IGE). It is a widely-applied measurement for intergeneration mobility, which is the regression coefficient of linear regression (Solon, 2004). The regression is based on the log-transformed measure of the GDPPC of the current year and previous year. The index is aimed to find out how the existing economic condition affects growth potential. In intergeneration mobility studies, the index is usually between 0 and 1, but the relationship of GDPPC between two years is much closer than intergenerational earnings. Thus, the index is expected to be around 1. If the index is higher than 1, then the existing economic condition makes the income gap larger, as the richer regionals may have a higher growth rate than poorer. If the index is lower than 1, then the existing economic condition does not bring advantages to richer regionals, representing a higher "non-accumulative" place mobility.

To better explain the role of space, we further develop a spatial measurement of the IGE. As it is the regression coefficient of linear regression, the result may be biased as spatial autocorrelation among residuals is not considered. Thus, we replace the simple OLS regression with a spatial error regression to consider the spatial autocorrelation and compare the new spatial IGE to the original one. The larger the difference between the two indices, the higher the spatial clustering in place mobility.

4.4. Clustering of self-organizing map (SOM)

To have a comprehensive view of the development trajectories and dynamics of each county in different development stages, we apply a clustering analysis to explore the different development patterns. To reflect the development trajectory and mobility at the same time, we use both GDPPC and growth rate as clustering variables.

A proper clustering method is a critical issue in this study. We demand a method that is friendly to visualize and compare different dimensions, as we want to classify different groups based on two aspects (GDPPC and growth rate) with multiple dimensions (each year) at the same time. Many traditional clustering methods are superb in doing the clustering job, but the results are hard to interpret. Based on this need, we select the Self-Organizing Map (SOM) as our primary clustering method, which is an artificial neural network that can project high-dimensional data onto prototypes of lower-dimensional output space (Kohonen, 1990). It is an advanced methodology to visualize data similarity and cluster observations. We adopt a two-stage procedure proposed by Vesanto and Alhoniemi (2000), first using SOM to produce the prototypes which then will be clustered in the second stage, to classify the diverse trajectories of regional development patterns in Jiangsu. The two-stage procedure is found to perform better than the direct clustering of the data (Vesanto & Alhoniemi, 2000). In this study, we use the agglomerative hierarchical clustering method to cluster the SOM.

5. Multi-scale patterns of regional inequality and polarization in Jiangsu

5.1. Multi-scale patterns of regional inequality

We first examine the trends of regional inequality at the inter-county, inter-municipal, and interregional levels by using Gini, CV, and Theil. As shown in Fig. 2, the three groups of average numbers of inter-county inequality, inter-municipal inequality, and interregional inequality show similar trends. They are respectively, 0.35, 0.28, 0.24 (Gini), 0.65, 0.52, and 0.44 (CV) and 0.20, 0.13, and 0.10 (Theil), which indicates that regional inequality is more significant at smaller spatial units. Regional inequality increased slightly from 1978 to 1980, gradually decreased between 1981 and 1983 and then registered fast growth in 1984 and 1985. From 1986 to 1991, regional inequality fluctuated slightly but maintained a gradual rising trend. The general rising trend of regional inequality in the 1980s was related to the reform of urban industrial sectors in the mid-1980s, during which time urban districts in Sunan and Suzhong and county-level cities (e.g., Jiangyin, Kunshan, and Zhangjiagang) in Sunan benefited disproportionately (Wei & Fan, 2000).

From 1991 to 1993, regional inequality in Jiangsu experienced a dramatic increase, which was closely related to Deng Xiaoping's Southern Tour and the establishment of the Pudong New Area in Shanghai in 1992. Deng's tour called for a deepening of economic reform and stimulated a new round of socialist marketization. Jiangsu, especially the Sunan region, benefited greatly from its geographical proximity to Shanghai. Regional inequality decreased slightly from 1993 to 1995, maintained at a relatively stable level from 1996 to 2004.

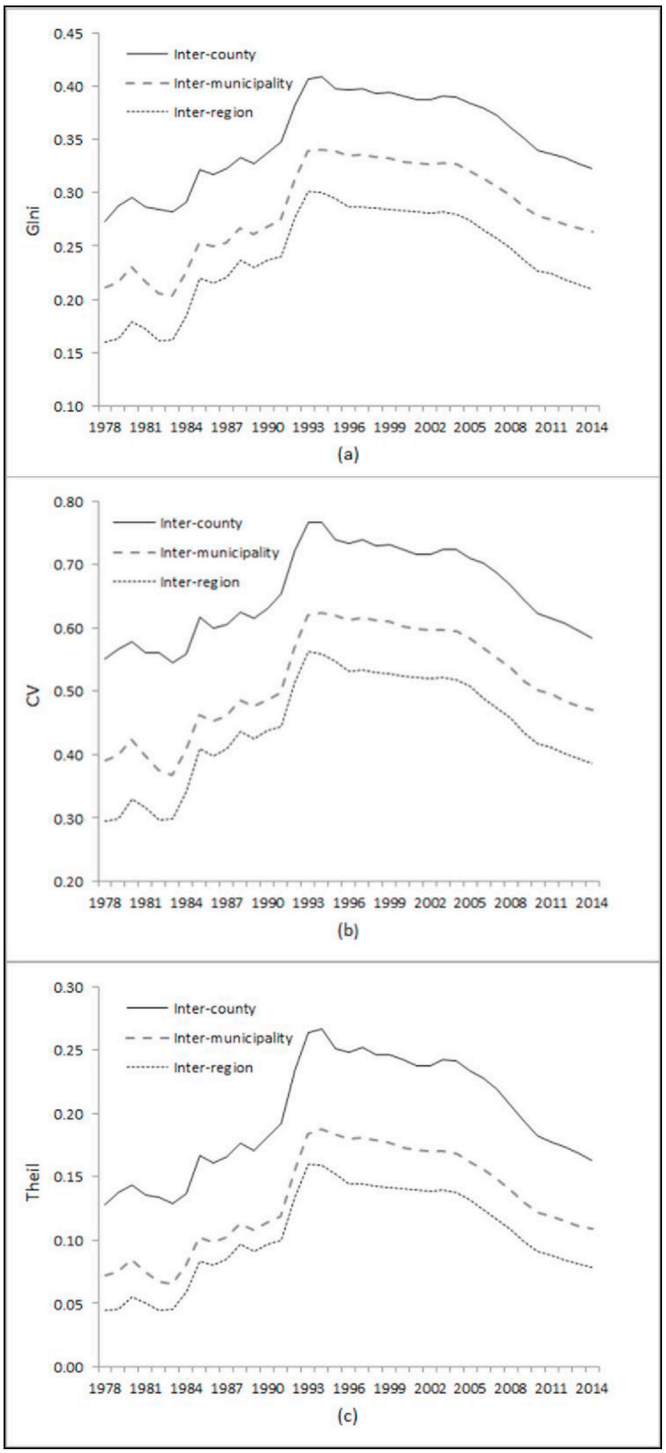


Fig. 2. Multi-scale regional inequality in Jiangsu, 1978–2014: (a) Gini; (b) CV; (c) Theil.

Thanks to the tax reform in 1994, the inequality stopped increasing, one of the main symbols of the decentralization process during China's economic transition. After that, regional inequality began steadily declining, continuing until 2014. Based on the trends of multi-scale regional inequality, we can divide the entire study period into three sub-periods: 1978–1993, 1993–2004, and 2004–2014. Over the thirty-seven years, regional inequality in Jiangsu shows an inverted-U shape. However, the turning points of regional inequality were more likely to be responsive to different stages of economic reform.

To investigate the relationship between regional inequalities of different scales, we first decompose the inter-county inequality into inequalities between three regions (Sunan, Suzhong, and Subei) and within them. Fig. 3 shows that a significant increase in the overall inequality from 1978 to 1993 was mainly because of a dramatic rise in the inter-region inequality (from 0.024 to 0.162). Inequality within three regions showed different evolution trends. Sunan had the lowest level of inequality and maintained a general declining trend, from 0.083 in 1978 to 0.042 in 2014. This trend indicates that compared to other regions, Sunan is more likely to be an integrated economic zone. Inequality in Suzhong fluctuated slightly and increased from 1978 to 1993 when it reached the peak value. It then maintained a declining trend unto 2014, which may be related to the tax reform. The fluctuation is very similar to the general inequality pattern in Jiangsu. Subei had the highest level of inequality at all times, which fluctuated dramatically since 1978, dropped to a relatively low level in 1988 before it steadily increased to its peak value in 1997. During these periods, inequality was at a relatively high level. Later it decreased gradually from 1998 to 2014, except for a small increase in 2003. The high level of inequality also implies that despite the fact that Subei is the poorest region in Jiangsu, it has higher variation and is less integrated than other regions. Moreover, the inter-region inequality has the same shape as the general inequality trend. The variation of inequality patterns is also because of the explicitly different development patterns of these regions. Subei and Sunan also have had historical segregations, which further result in the isolation problem in Jiangsu (Honig, 1990).

We then decompose the overall inter-county inequality into inequality between urban and rural areas and inequality within them. Fig. 4 reveals that a rapidly increasing inter-rural-county inequality is the major contributor to the overall inequality from 1978 to 1993. The urban-rural inequality has maintained a general declining trend except for some fluctuations in the 1990s. Rural inter-county inequality rose from 0.05 in 1978 to 0.27 in 1993 and increased more than five-fold, which may be attributable to the rapid development in rural Sunan. It decreased slightly from 1994 to 2001, registered a brief increase from 2002 to 2004 before it decreased again in 2005 and maintained this declining trend up to 2014. Inequality across urban districts fluctuated between 1978 and 1990 but increased rapidly from 1991 to 1993 and then decreased steadily from 1994 to 2006. Urban inequality has been stable since 2007. From these trends, we can find out that the urban-rural inequality is seldom a serious issue in Jiangsu. Instead, inequality among rural areas is more significant. While most rural areas in Sunan are well developed, many rural areas in Subei remain poor, troubled by poverty.

5.2. *Multi-dimensional regional polarization*

This section analyzes the changing trends of regional polarization, which exhibit different patterns from regional inequality. Fig. 5 presents the patterns of ER and Wolfson polarization indices and the Gini coefficient. ER and Wolfson indices show that regional polarization has increased since 1978. It is interesting to find that the polarization trends were similar to the inequality trend from 1978 to 1995. Nevertheless, they behaved differently after 1995. Wolfson index increased slightly from 1995 to 1999, decreased between 1999 and 2002 and then went up sharply from 2002 to 2003 but kept declining since 2004 and decreased rapidly between 2007 and 2011. ER index gradually increased from 1995 and reached its peak value in 2005, then decreased between 2006 and 2009 and remained stable since 2010. The Gini coefficient was relatively constant from 1995 to 2004 but decreased steadily since 2005.

In Jiangsu, the similar trends of polarization indices and inequality index were only observed from 1978 to 1995. After 1995, they behaved differently, and ER was significantly different from either Wolfson or Gini. ER registered a decade of increasing polarization in Jiangsu from 1995 to 2005, while the Wolfson index fluctuated greatly during this period. The difference is contradicting previous findings, in which the trends of polarization and inequality were relatively similar to each

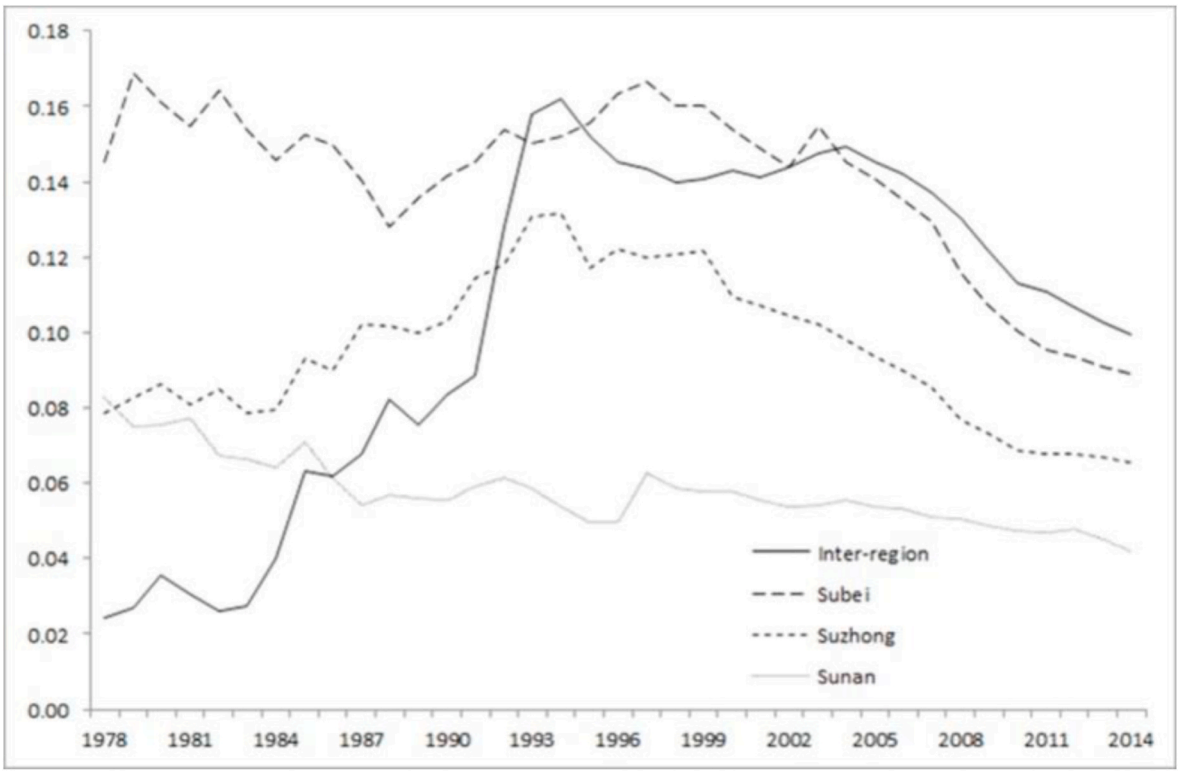


Fig. 3. Theil decomposition of overall inter-county inequality, 1978–2014: between and within three regions.

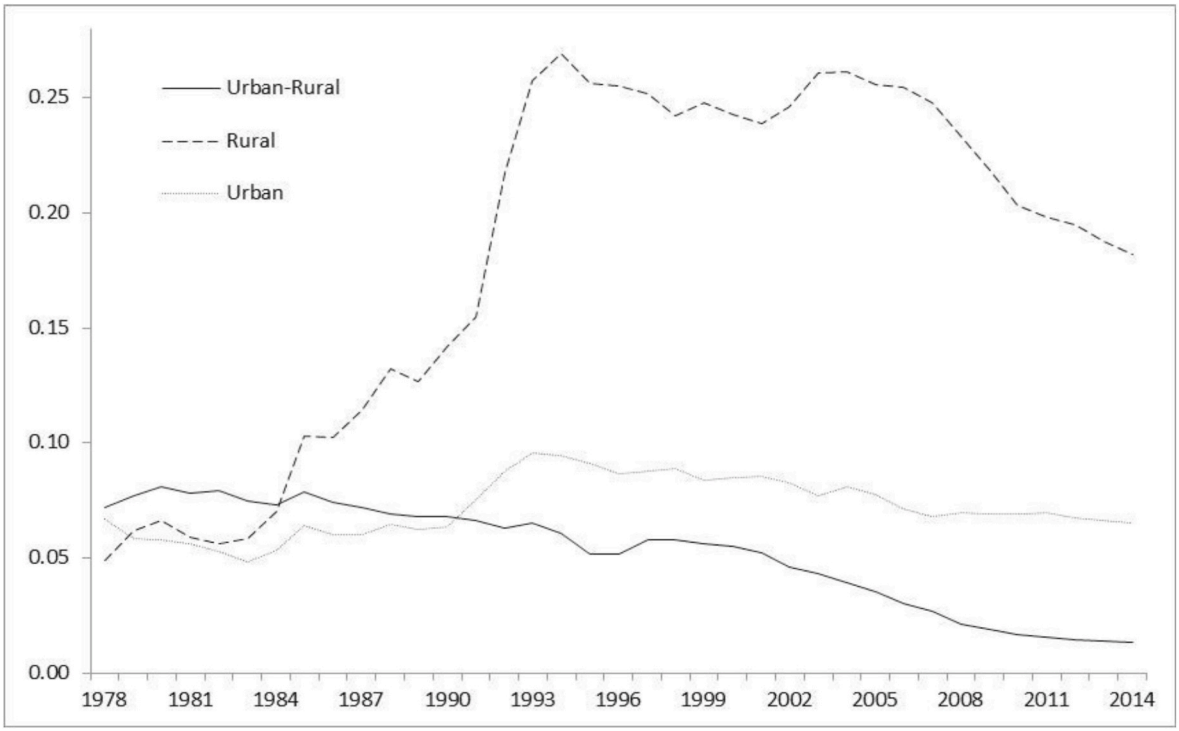


Fig. 4. Theil decomposition of overall inter-county inequality, 1978–2014: between and within urban and rural areas.

other for the entire study period (Ravallion & Chen, 1997; Zhang & Kanbur, 2001; Federov, 1999). As ER is more sensitive to top areas than Wolfson, it explains how concentrated the development is put on top of the main cities. Moreover, the ER index is adjusted by the weight of the local population, so the high polarization index also indicates that there is more population in the rich areas and increases the polarization gap.

ER and Wolfson indices can detect the presence of polarization. However, they are unable to identify the polarization taking place along which dimension. Therefore, we use the modified Kanbur-Zhang index to determine along which dimension these county-level units become

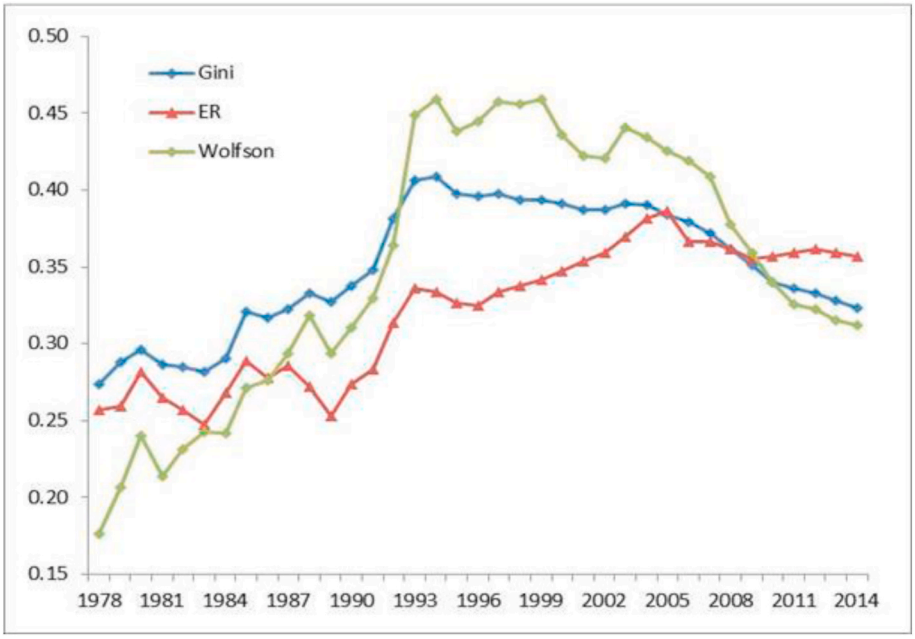


Fig. 5. Inequality and polarization indices for county level GDPPC, 1978–2014.

more polarized. Two dimensions of polarization are analyzed: in the "South-Central-North" dimension, county-level units are grouped into three groups (Sunan, Suzhong, and Subei) according to their geographic locations; in the "urban-rural" dimension, they are grouped into two groups, urban (urban districts) and rural (county-level cities and counties), according to their administrative level. Fig. 6 shows the trends of polarization along the two dimensions. While polarization along the "urban-rural" dimension constantly decreased from 1978 to 2014, polarization along the "South-Central-North" increased from 1978 to 1995, declined slightly between 1996 and 1999 but maintained at a high level since 2000. This suggests that the driving forces behind polarizations in Jiangsu have been more geographic (geographic regions) than structural (administrative division). The high-level of polarization maintained along the "South-Central-North" dimension indicates that the core-periphery pattern persists in Jiangsu and has become the major source of polarization.

5.3. Spatial measurements of regional inequality and development

Spatial dimensions and trajectories of regional development can provide new insights into the understanding of regional inequality and development. We use Moran's *I* index to reflect the spatial inequality of regional development in Jiangsu (Fig. 7). We find out that spatial inequality continues to grow. In the beginning, namely before 1984, the spatial inequality at the county level and the municipality level was similar at a low level. Then the inequality of both increased rapidly, and the county level Moran's *I* grew at a much higher level of the municipality level. The difference implies that there is cross-border and intra-municipality inequality in Jiangsu, which may be a result of regional integration and unbalanced development.

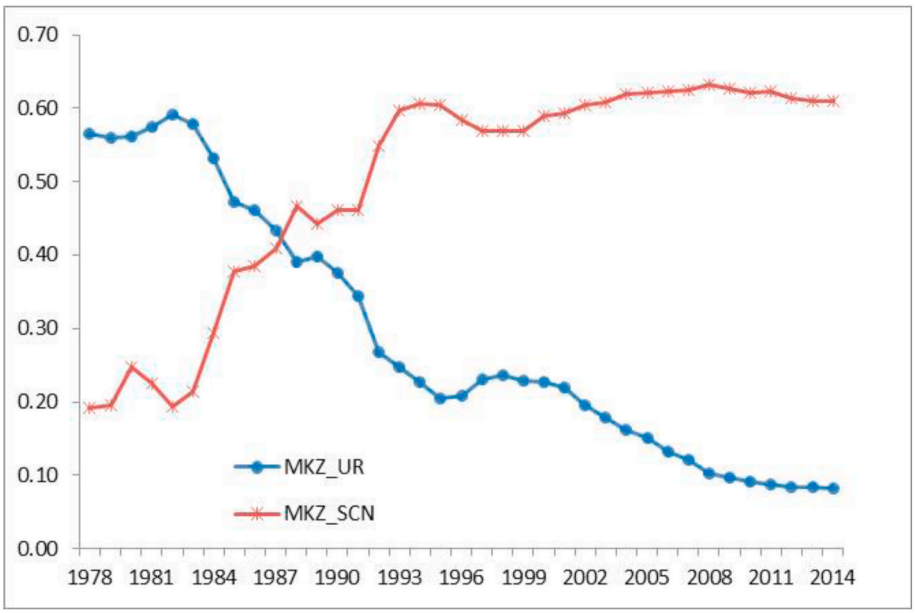


Fig. 6. Modified Kanbur-Zhang index for polarization along urban-rural and south-central-north dimensions, 1978–2014.

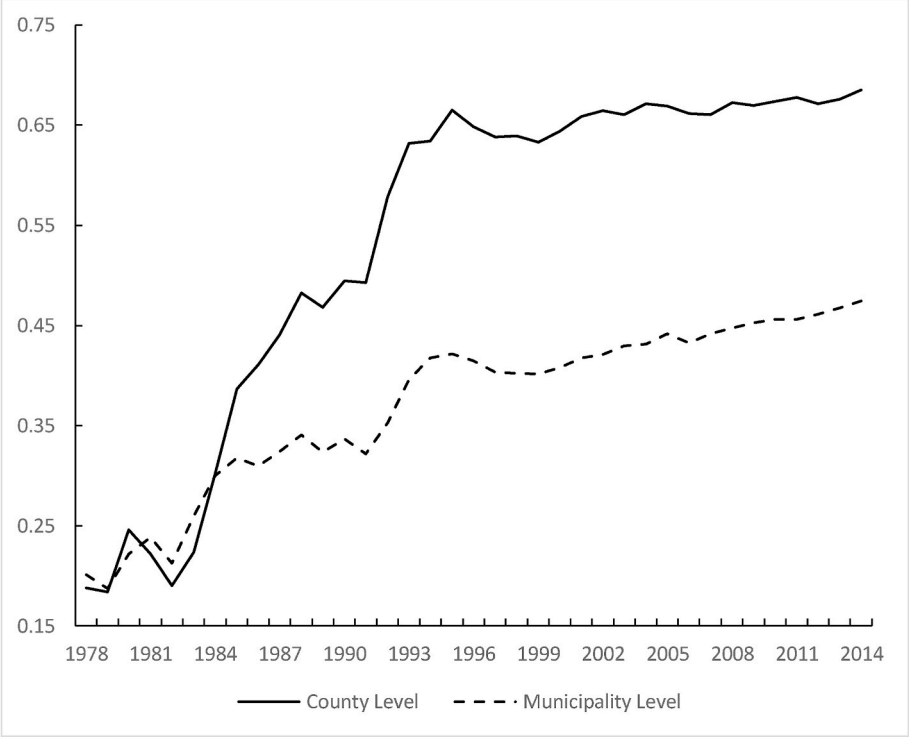


Fig. 7. Global Moran's *I* of county level GDPPC in Jiangsu, 1978–2014

The growth pattern is further confirmed by the Local Moran's *I* index. Fig. 8 shows the LISA map of county-level GDPPC in 1978, 1993, 2004, and 2014. In 1978, there were two spatial clusters and two outliers in Jiangsu's regional development pattern: a high-high cluster of three municipal districts of Suzhou, Wuxi and Changzhou in central Sunan, a low-low cluster of several counties in central Subei, and two high-low outliers of Lianyungang and Suqian municipal districts in Subei. The map reveals the original core-periphery structure in Jiangsu: Suzhou-Wuxi-Changzhou is the core, while Subei is the periphery area with its own cores (Lianyungang and Suqian). In 1993, the high-high cluster in Sunan expanded west and east to include the entire Suzhou municipality and Wuxi municipality and expanded northwestern to include municipal districts of Zhenjiang and Yangzhou, Danyang City and Yangzhong City. The low-low cluster in Subei expanded to include Huai'an municipal district and some counties that were to the west or southeast of the original cluster. As both the low-low cluster and high-high cluster expand, the former two core areas in Subei disappear, which implies the declining competitiveness of Subei. From 1993 to 2004, Yangzhou municipal district dropped from the high-high cluster while Nantong municipal district joined in. The low-low cluster expanded and encroached onto more counties in Subei. From 2004 to 2014, Suzhou municipal district fell off the high-high cluster, Jingjiang City joined in, and Yangzhou municipal district came back, while the low-low cluster in Subei did not change at all. A new low-high outlier of Rubu City emerged in Suzhong. Over the thirty-seven years, the persistent and expanding low-low cluster in Subei and the high-high cluster in Sunan and southern Suzhong well corresponded with the maintained high-level of polarization along the South-Central-North dimension in Jiangsu (see Fig. 6). Both the clusters expand due to the development process, indicating the emergence of regional integration, unbalanced development, and a more significant and explicit core-periphery structure.

6. Spatial-temporal dynamics of regional inequality and place mobility

An analysis of the spatial-temporal dynamics of regional inequality can provide more insights into the evolution of regional inequality in Jiangsu. Fig. 9 shows that the south-north gradient trend of regional development did not change much from 1978 to 2014. County-level units in the rich and developed classes are mostly located in Sunan and Suzhong. Counties in Subei are mostly in the less developed or poor classes. Compared with the map in 1978, the 2014 map showed that the poor class was exclusively concentrated in Subei. The boundary of the rich class moved north, dropped Suzhou municipal district and Wujiang City, and incorporated Haimen City in the northeast and Danyang City in the northwest. The obvious and intensifying South-North divide indicates the club effect in regional development. Several adjacent county-level units in northern Sunan and southern Suzhong formed a developed club while some neighboring counties in central Subei formed a backward club.

A comparison of regional inequality in 1990 and 2014 identifies different mobility of county-level units. Fig. 10 presents the spatial pattern of development status change (for example, a county moved upward from poor to less developed) from 1990 to 2014. Ten county-level units moved up: Yixing, Haimen, and Danyang moved from developed to rich; Liyang, Gaochun, Lishui, Jurong, and Dongtai moved from less developed to developed; Xinghua and Baoying moved from poor to less developed. Except for Dongtai in Subei, all the others are located in Sunan and Suzhong. This indicates that upward mobility was almost impossible for counties in Subei. Nine county-level units moved down: Lianyungang municipal district moved downward two classes from rich to less-developed; Suzhou municipal district and Wujiang City from rich to developed; Yancheng municipal district and Rudong, Yizheng, Jinhu from developed to less developed; Donghai and Hongze from less developed to poor. The downward trend of the Suzhou municipal district is worth noting. This municipal district used to be the richest county-level unit in the 1980s, 1990s, and early 2000s. However, in recent years its development has slowed down due to the concern of environmental protection of the Taihu Lake and the old city. With rapid economic development, county-level-cities in Sunan and Suzhong (e.g., Jiangyin and Kunshan) already surpassed Suzhong in the mid-2000s.

The temporal dynamics underlying regional inequality in Jiangsu are

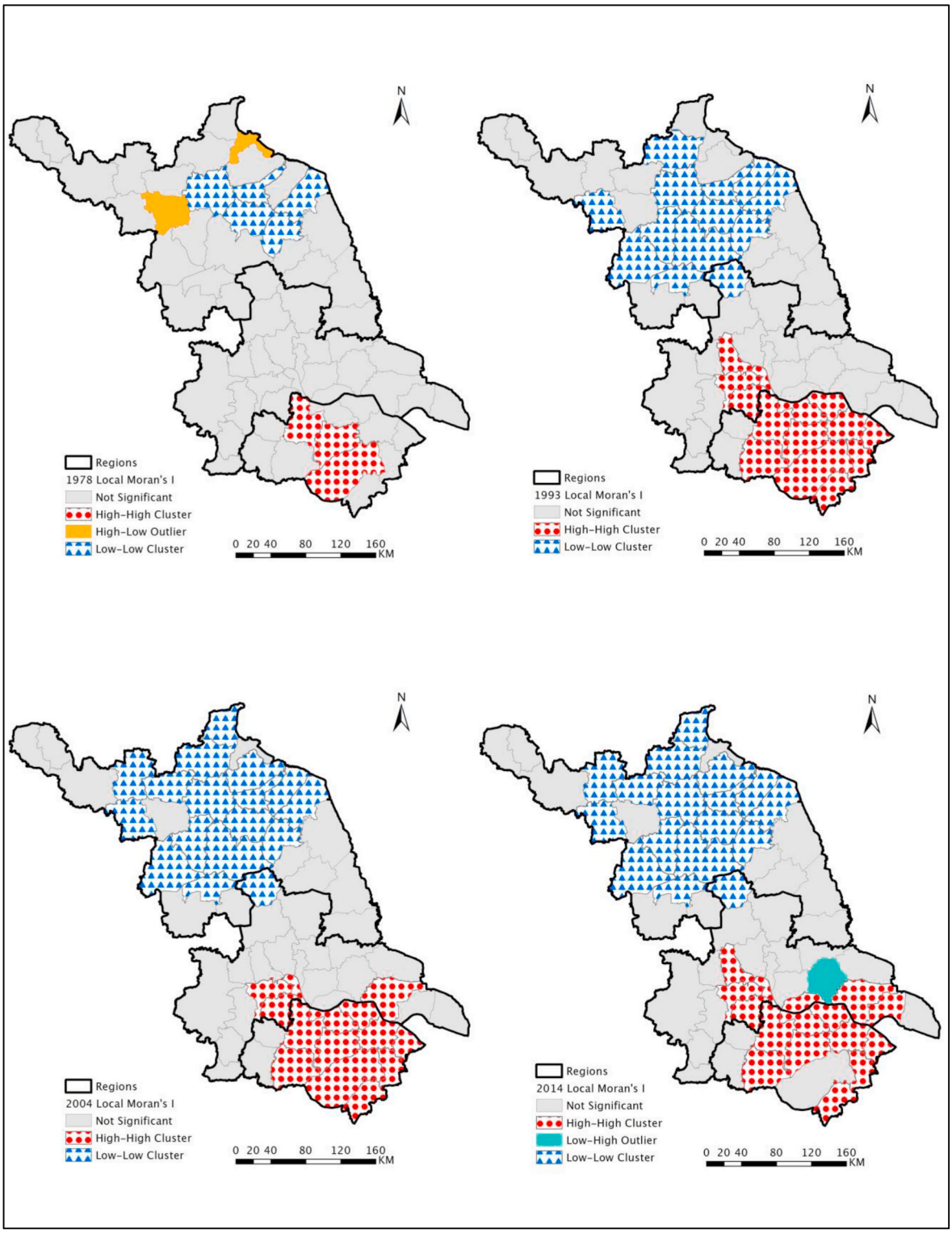


Fig. 8. LISA map of county level GDPPC in Jiangsu, 1978, 1993, 2004 and 2014 P = poor; L = less developed; D = developed, R = rich.

analyzed within the Markov chain framework. Table 2 presents the transition probability matrices in the entire study period and three sub-periods. The non-diagonal numbers are usually much smaller than the diagonal numbers, indicating that it is more likely for a county-level unit to stay in its original category. For the first sub-period, the diagonal numbers range from 0.806 to 0.957, which indicates that there is at least 80.6 percent of the possibility that a unit will stay in the same category. The highest transitional possibility was 12.8 percent, indicating an active regional development system from 1978 to 1993. More detailed observation indicates relatively high mobility of county-level units in the first sub-period because 4.8 percent of them moved upward, and 6.8 percent moved downward. During the second sub-period (1993–2004), the highest transitional possibility decreased to 2.9 percent; the upward mobility was 1.1 percent, and the downward mobility 1.4 percent. In the third sub-period (2004–2014), the highest transitional possibility was 3.7 percent, the upward mobility 1.6 percent, and the downward

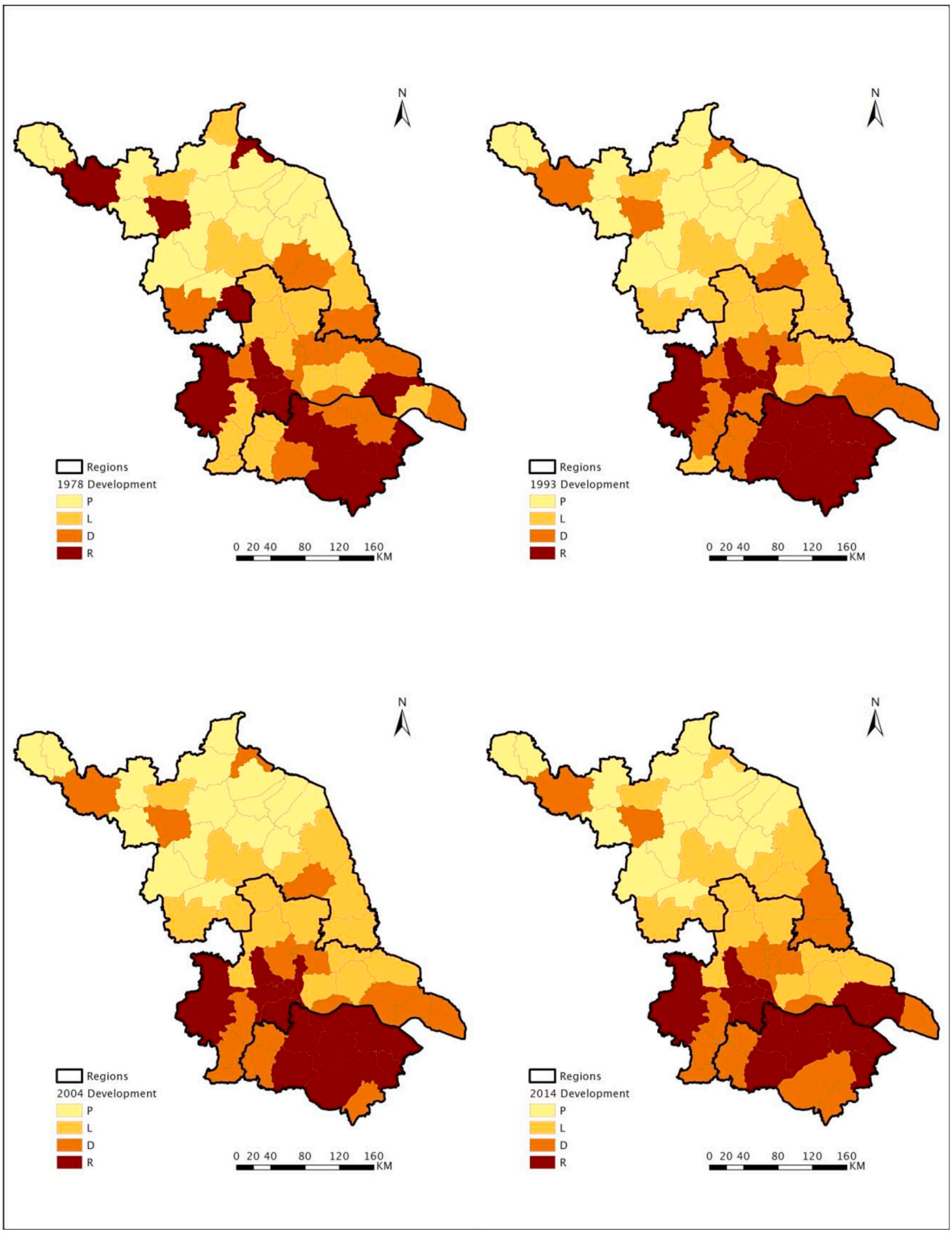


Fig. 9. Spatial patterns of regional development in Jiangsu, 1978, 1993, 2004 and 2014.

mobility 0.6 percent. The results indicate that the mobility of county-level units, both upward and downward, decreased over the years. It became very difficult, if not impossible, for a county-level unit to jump out of or fall off its original development level. The regional development system had become more stable in Jiangsu. The results also point out that transitions could only take place between adjacent categories. It is impossible for a county-level unit to jump from a lower category to a higher category while skipping an intermediate one.

The spatial Markov chain method identifies that a particular county-level unit's development is inevitably influenced by the development

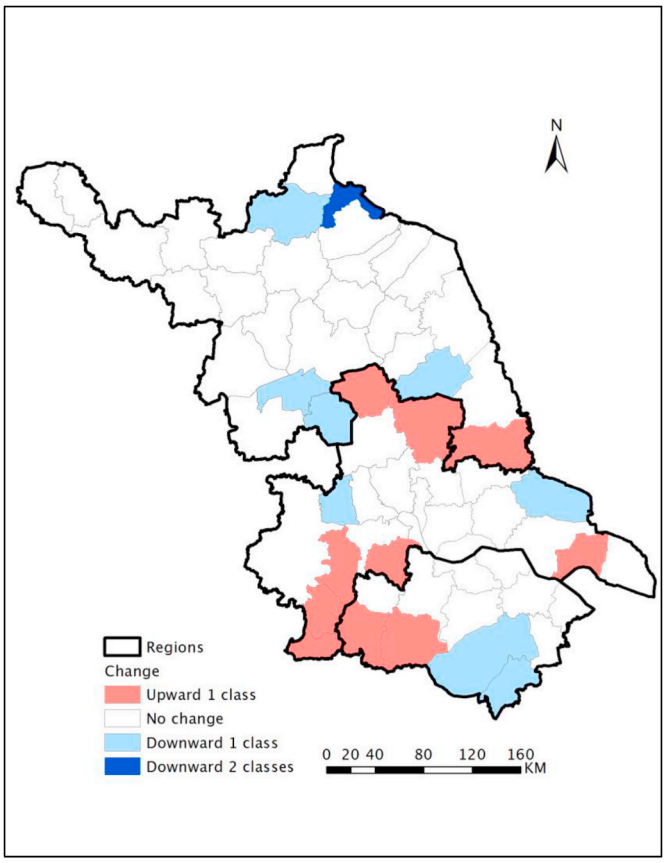


Fig. 10. The spatial pattern of regional development status change in Jiangsu, 1990–2014

Table 2
Markov chain transitional matrices for county level GDPPC, 1978–2014.

1978–2014					
Category	No.	P	L	D	R
P	568	0.958	0.042	0	0
L	571	0.060	0.888	0.053	0
D	242	0	0.059	0.906	0.036
R	234	0	0	0.030	0.970
1978–1993					
Category	No.	P	L	D	R
P	227	0.956	0.044	0	0
L	242	0.099	0.818	0.083	0
D	242	0	0.128	0.806	0.066
R	234	0	0	0.043	0.957
1993–2004					
Category	No.	P	L	D	R
P	174	0.971	0.029	0	0
L	173	0.023	0.954	0.023	0
D	173	0	0.017	0.971	0.012
R	173	0	0	0.017	0.983
2004–2014					
Category	No.	P	L	D	R
P	161	0.963	0.037	0	0
L	156	0	0.981	0.019	0
D	154	0	0	0.994	0.006
R	159	0	0	0.025	0.975

status of its neighboring geographical units. For example, rich county-level units had a possibility of 3 percent of moving downward during the entire study period from 1978 to 2014 (Table 3). However, if they were surrounded by less developed or poorer neighbors, such a possibility would increase to 16.2 percent or 14.7 percent. The possibility for a poor county to move out of the bottom category was 4.2 percent. Nevertheless, if the poor county was surrounded by developed or rich county-level units, that possibility would increase to 11.3 percent or 8.3 percent. Tables 4–6 present the transition probability matrices of spatial Markov chain analysis for the three sub-periods. Comparing Table 4 with Tables 5 and 6, we find that the neighborhood effect became less obvious in the last two sub-periods, indicating the influence of neighboring geographical units' development status decreased over time. For instance, during 1978–1993, if a developed county was surrounded by rich counties, it had a possibility of 13 percent of moving upward. However, such a possibility would decrease to 2.1 percent during 2004–2014. This confirms again that the regional development system has become more stable, the regional mobility gap has been intensifying, and the overall mobility of county-level units has decreased in recent years.

Spearman's ρ rank correlation coefficient described similar trends of the relationship between county-level units' previous rank and their subsequent rank, which is widely applied in mobility studies (Fig. 11). The positive correlation between them has increased over the years, and the correlation is nearly 1 in recent years. Thus, the historical mobility of county-level units decreased. Most of them stayed in the same category, or even the same position after 1995 without moving upward or downward. Fig. 12 illustrates the ranks of each county-level unit based on their GDPPC in 1978, 1993, 2004, and 2014. In this figure, a county-level unit that had the highest GDPPC was ranked 63rd, while the county that had the lowest was ranked the first. This ranking method is different from the one we use in everyday life but conforms with that of the rank correlation analysis. A downward line between two years in Fig. 11 indicates a county-level unit moved downward in terms of GDPPC. Fig. 12 also presents a more active regional system in the first sub-period as we can observe many county-level units dramatically moved upward or downward between 1978 and 1993. Nevertheless, their mobility decreased in the second sub-period, and many of them stayed unchanged in the third sub-period. This confirms again that the regional development system has become more stable.

As both spatial Markov chain and Spearman's ρ rank correlation reflect the place mobility based on historical accumulation, we further apply intergenerational income elasticity (IGE) to explore the future potential of place mobility. The trend of IGE is shown in Fig. 13. Before 1994, the IGE index fluctuated dramatically, and after 1994 the index remains below or just around 1, which indicates that the place mobility is more stable and higher than most years in the previous period. The mobility increased during 2003–2009, which may be mainly because China joined the WTO, however, then decreased after 2009, which may be a reaction to the recent financial crisis. By comparing the non-spatial

Table 3
Spatial Markov chain transitional matrices for county level GDPPC, 1978–2014.

Spatial Lag	Category	No.	P	L	D	R
P	P	320	0.969	0.031	0	0
	L	81	0.123	0.827	0.049	0
	D	131	0	0.031	0.947	0.023
	R	34	0	0	0.147	0.853
L	P	183	0.962	0.038	0	0
	L	234	0.060	0.897	0.043	0
	D	114	0	0.132	0.833	0.035
	R	37	0	0	0.162	0.838
D	P	53	0.887	0.113	0.000	0
	L	179	0.050	0.872	0.078	0
	D	171	0	0.070	0.889	0.041
	R	163	0	0	0.025	0.975
R	P	12	0.917	0.083	0.000	0
	L	77	0.013	0.961	0.026	0
	D	145	0	0.014	0.945	0.041
	R	334	0	0	0.006	0.994

Notes: P = poor; L = less developed; D = developed, R = rich; No. is the number of transactions.

Table 4
Spatial Markov chain transitional matrices for county level GDPPC, 1978–1993.

Spatial Lag	Category	No.	P	L	D	R
P	P	102	0.980	0.020	0	0
	L	43	0.116	0.791	0.093	0
	D	47	0	0.170	0.809	0.021
	R	31	0	0	0.065	0.935
L	P	70	0.914	0.086	0	0
	L	73	0.164	0.781	0.055	0
	D	62	0	0.177	0.758	0.065
	R	42	0	0	0.095	0.905
D	P	51	0.980	0.020	0	0
	L	77	0.065	0.831	0.104	0
	D	64	0	0.156	0.813	0.031
	R	51	0	0	0	1
R	P	4	0.75	0.25	0	0
	L	49	0.040	0.878	0.082	0
	D	69	0	0.029	0.841	0.130
	R	110	0	0	0.036	0.964

Notes: P = poor; L = less developed; D = developed, R = rich; No. is the number of transactions.

Table 5
Spatial Markov chain transitional matrices for county level GDPPC, 1993–2004.

Spatial Lag	Category	No.	P	L	D	R
P	P	86	0.965	0.035	0	0
	L	36	0.056	0.917	0.028	0
	D	51	0	0	1	0
	R	0	0	0	0	0
L	P	82	0.976	0.024	0	0
	L	69	0.029	0.942	0.029	0
	D	22	0	0.045	0.955	0
	R	0	0	0	0	0
D	P	6	1	0	0	0
	L	46	0	0.978	0.022	0
	D	69	0	0.014	0.972	0.014
	R	53	0	0	0.019	0.981
R	P	0	0	0	0	0
	L	22	0	1	0	0
	D	31	0	0.032	0.936	0.032
	R	120	0	0	0	1

Notes: P = poor; L = less developed; D = developed, R = rich; No. is the number of transactions.

Table 6
Spatial Markov chain transitional matrices for county level GDPPC, 2004–2014.

Spatial Lag	Category	No.	P	L	D	R
P	P	86	0.965	0.035	0	0
	L	26	0	1	0	0
	D	47	0	0	1	0
	R	0	0	0	0	0
L	P	70	0.972	0.028	0	0
	L	64	0	0.969	0.031	0
	D	22	0	0	1	0
	R	1	0	0	1	0
D	P	5	0.800	0.200	0	0
	L	46	0	0.978	0.022	0
	D	48	0	0	0.979	0.021
	R	57	0	0	0.035	0.965
R	P	0	0	0	0	0
	L	20	0	1	0	0
	D	37	0	0	1	0
	R	101	0	0	0.010	0.990

Notes: P = poor; L = less developed; D = developed, R = rich; No. is the number of transactions.

and spatial-corrected IGE index, we find that the role of spatial clustering is tremendous before 1995. After 1995, the two indices barely have a significant difference. Thus, unbalanced regional development mostly happened before 1995, which is consistent with our findings from the spatial Markov chain.

7. Trajectories of diverse regional development patterns

To further understand the changing status of regions and the nature of mobility, we used the clustering of SOM to classify the trajectories of diverse regional development patterns in Jiangsu. This analysis focuses on the dynamics of changing the development status and growth rate of the 63 county-level units during each sub-period rather than snapshots of them in certain years. Fig. 14 shows the classification results in the three sub-periods. According to the trend of each cluster's mean, they were classified into different groups in each sub-period. We need to note that the classification standard changes because of the GDPPC and growth rate vary in different sub-periods. Thus, the categories of counties are not consistent in different sub-periods. SOM clustering aims to identify different development trajectories and the spatial patterns in the sub-periods, but not compare the group of particular cities between sub-periods.

From 1978 to 1993, it is hard to identify the counties by mobility as all the counties have a tremendous fluctuating growth rate. Thus, it is a period of high dynamics, and we can only identify three groups because there are so many outliers and noises which affect the clustering result. Because of the unstable grouping of growth rate, we can only judge the characteristics of each group by its GDPPC. From the map, we find that while there is a stable spatial core-periphery structure (south-north), the "mid-class," namely the semi-core/semi-periphery group, does not have a significant spatial cluster. These phenomena indicate that at the beginning of the open-up stage in Jiangsu, the development is highly unstable, and the spatial clustering trend is not that significant, especially in the distribution of "mid-class."

During 1993–2004, the core group mostly remains stable, and the most significant change is that the three counties in Subei fall into semi-core. Similar to the clustering result of 1978–1993, the semi-core group still scatter in the province, and the semi-periphery and periphery group stay in the north. The main difference between this sub-period and the previous one is that one group is identified because of high mobility but not GDPPC. The periphery group is divided into two groups, namely a high mobility group and a low mobility group. The high mobility group has an average growth rate higher than the other one. Interestingly, most counties in the periphery with high mobility group are adjacent to local cores or in the north area of Subei, as the low mobility group is mostly located in the very north. The phenomenon confirms the existence of the effects of spatial spillover the diffusional development.

After 2004, all the groups are identified by both GDPPC and growth rate. Interestingly, the rank of the growth rate of each group is inversed rank of GDPPC, as cores have lower growth rates, and peripheries have higher growth rates. The semi-core splits into two groups because of mobility, as one group has a stable high growth rate, and the other group has a lower growth rate, especially before 2011. Compared to the map of 1993–2004, we find a more significant spatial division of south-middle-north. However, except for the core group, the growth rate of other groups gradually converge into a similar level in 2014, raising the concern of sustainable long-term development.

In sum, through SOM clustering, we find that after 2004, a very clear and stable spatial core-periphery structure, and a mobility structure form, which are not significant enough to be identified in previous sub-periods.

8. Discussion and conclusion

This study investigates regional inequality and polarization in China's Jiangsu province, following a multi-scale and multi-dimensional

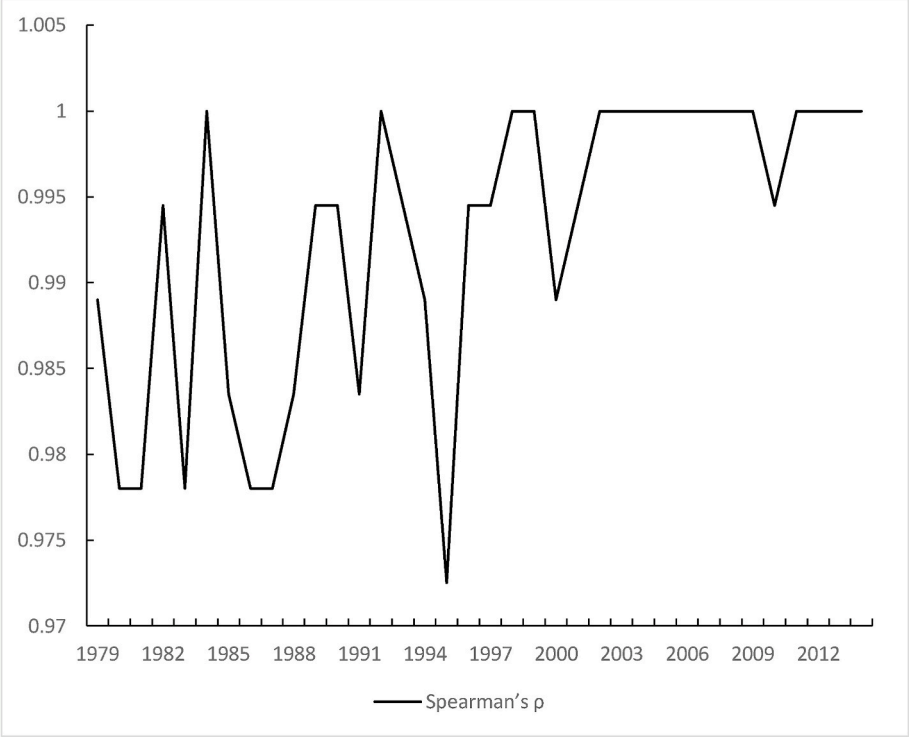


Fig. 11. Spearman's ρ rank correlation coefficient in Jiangsu, 1990–2014

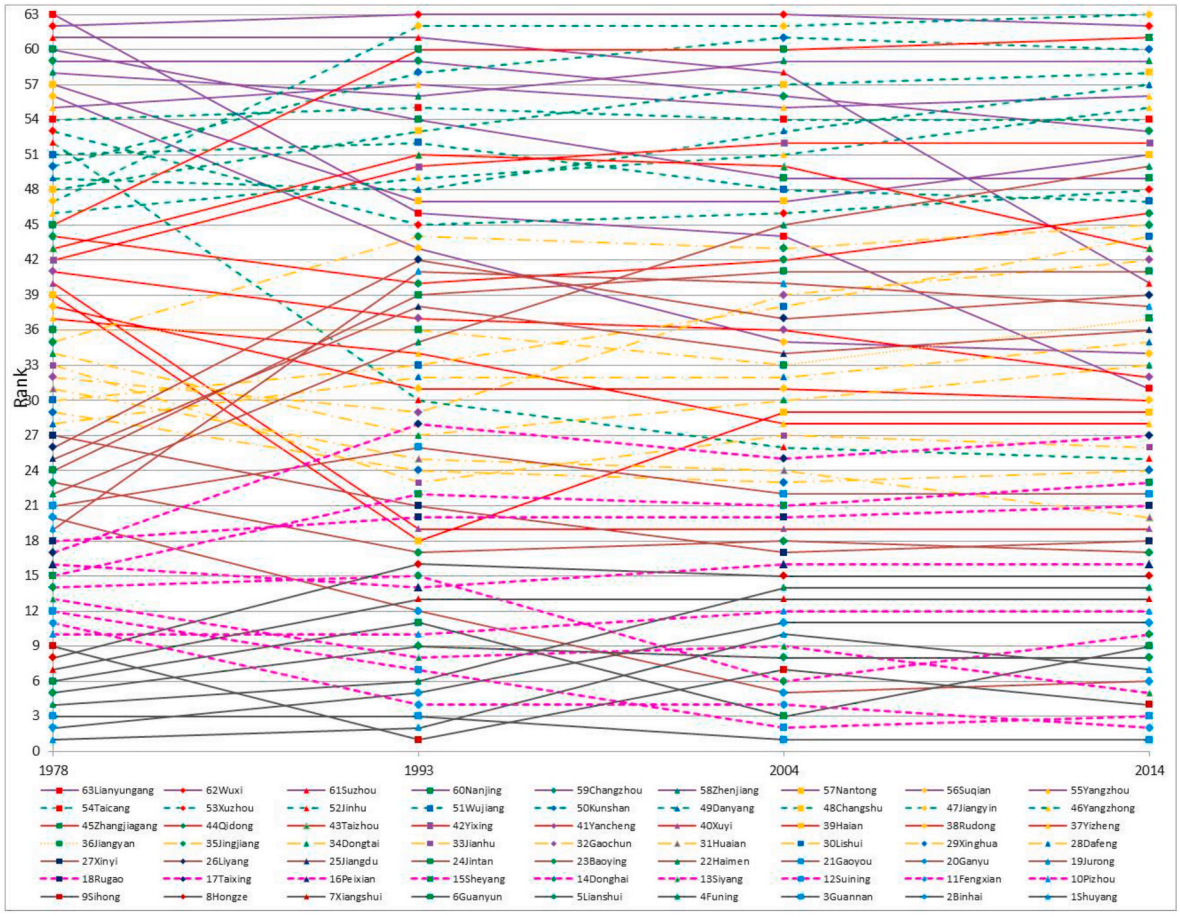


Fig. 12. Rank of county-level units based on GDPPC in 1978, 1993, 2004 and 2014.

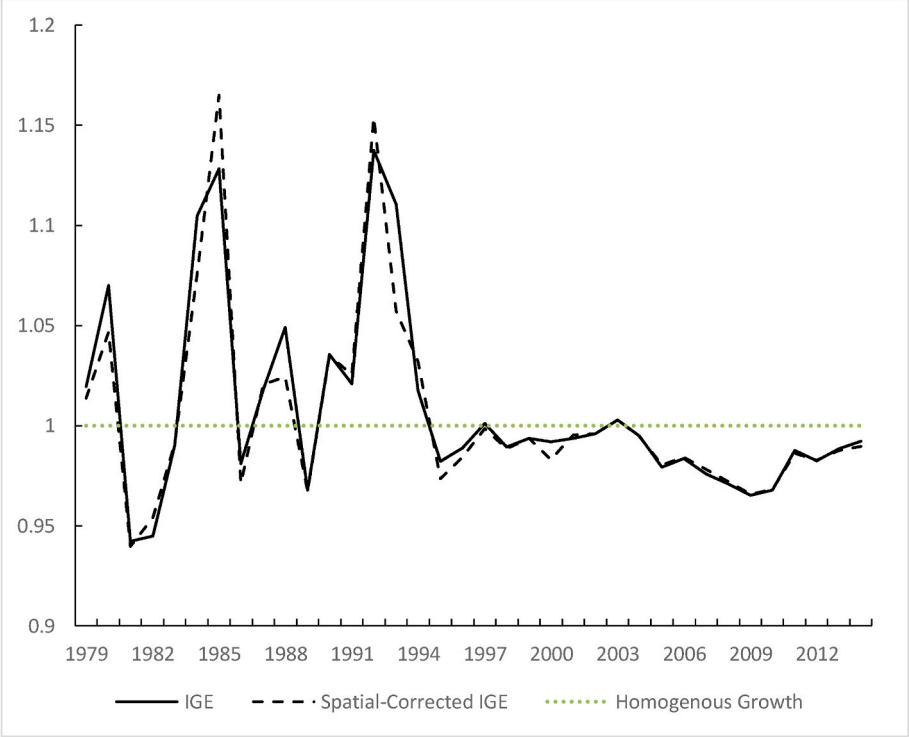
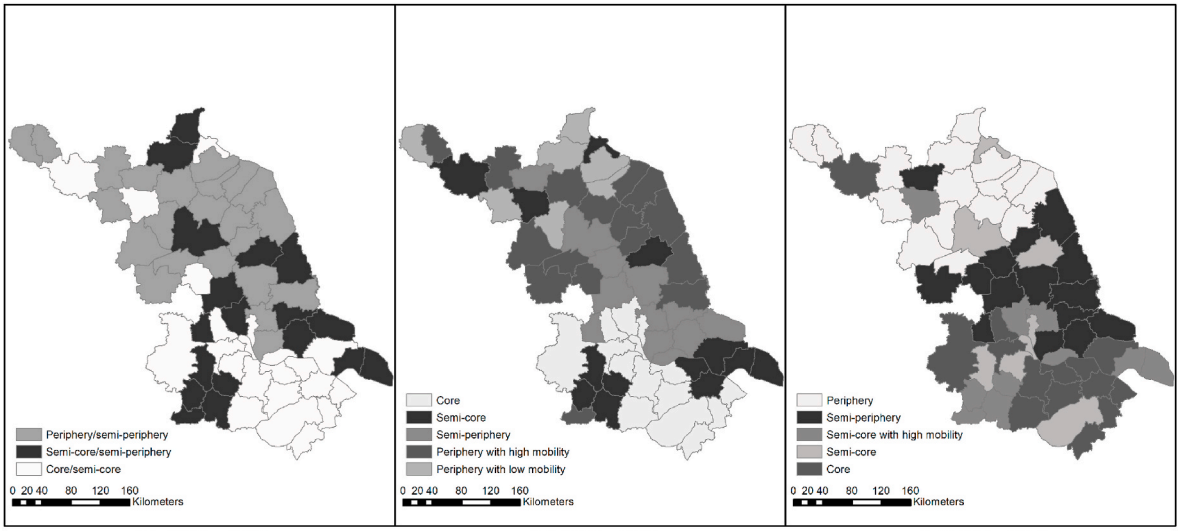


Fig. 13. Intergenerational elasticity of places in Jiangsu, 1990–2014



(a) 1978 – 1993 (b) 1993 – 2004 (c) 2004 - 2014

Fig. 14. Classification of regional development trajectories based on GDPPC, 1978–2014.

framework. The multi-scalar inequality analyses indicate that regional inequality in Jiangsu has experienced three stages: increasing from the onset of economic reform in 1978–1993, staying relatively stable from 1993 to 2004, and decreasing from 2004 to 2014. Decomposition of Theil index has yielded important findings: the overall inter-county inequality was primarily because of the difference between Subei, Suzhong, and Sunan; intra-region inequality tended to be small in Sunan, moderate in Suzhong, and large in Subei; urban-rural (city-county) inequality kept decreasing, but rural inter-county inequality kept intensifying. Not all of Jiangsu's counties are necessarily poorer than cities; especially those in Sunan are, in fact, more dynamic and experience faster growth. Our study has shown the complexity of regional inequality, manifested by differences based on scale and dimensions (e.g., polarization and inequality).

Polarization indices have behaved significantly differently from inequality measures since 1995. The results indicate that polarization and inequality do reveal different aspects of regional disparity. ER index registered a decade of increasing polarization from 1995 to 2005, and Wolfson index fluctuated greatly, whereas inequality stayed relatively stable at the same time. One main reason between the differences is that we apply population adjusting to the ER index; thus, the ER index reflects the population proportion. As more populations are concentrated in the rich region, adding the weight of the population amplifies the degree of polarization. The modified Kanbur-Zhang polarization index further reveals that regional polarization decreased along the urban-rural dimension but increased along the South-Central-North

dimension from 1978 to 1996 and maintained at a high level. Therefore, the polarization concern in Jiangsu has multiple dimensions, while the county-level and urban-rural polarization has been relieved, the polarization based on population and geographical core-periphery structure persist at a higher level.

Global and local Moran's *I* have been used to demonstrate the significance of spatial autocorrelation and self-reinforcing clustering in Jiangsu's regional development. The persistent and expanding low-low cluster in Subei and the high-high cluster in Sunan and southern Suzhong indicate the club effect in regional development and correspond with polarization along the South-Central-North dimension. Unlike the non-spatial inequality measurements, the global Moran's *I* does not show a declining trend after the 2000s. Instead, it flatulates with a minor increase. Thus, researchers should be careful on not only the core-periphery structure on the non-spatial aspect but also on the spatial aspect. Moreover, as Moran's *I* index of city-level is highly similar to the county level before 1984, the county-level index grows much faster than the city level. The difference implies that the development clustering trend is not limited to administrative borders, which may be a result of regional integration and development diffusion. Interestingly, after the Moran's *I* stay stable at a high level, non-spatial inequality measurements start to decline, which indicates that a clear and stable spatial core-periphery structure may be necessary for resolve regional inequality problems. Nonetheless, it also raises the concern of spatial exclusion in economic development.

The finding of spatial inequality and polarization in Jiangsu province is consistent with the findings of studies in Guangdong (Liao & Wei, 2012) and Zhejiang (Yue et al., 2014). Our study has therefore provided strong evidence for the existence and even intensification of the core-periphery structure, as well as spatial polarization in China, which is not only in Jiangsu province but also widely, exists in most of the provinces in China. Spatial polarization has become the most critical dimension of regional inequality in provincial China and has to draw more attention from policymakers. Moreover, while orthodox inequality indices start to decline, especially after 2004, spatial inequality continues to increase, and the polarization indices vary. The variation indicates that regional inequality in Jiangsu has become more complicated than before, especially from the perspective of place mobility.

The results of the Markov chain and rank correlation analyses reveal that the regional system in Jiangsu has become more stable. Spatial Markov chain has demonstrated the importance of spatial dependence in regional development. This indicates the core-peripheral structure has become stable over time in Jiangsu, and even more concerning is the declining upward mobility of poorer regions. The poorest regions have largely remained the poorest, and their chance of moving up has even declined over time. As the Markov chain and rank correlation is highly based on development accumulation, the IGE index gives us a new insight into the "potential" place mobility. Before 1994, the general place mobility is extremely unstable, but mostly at a low level. After 1994, the place mobility stays at a higher level and even higher during 2002–2008, which may be the result of globalization, but recently it declines a little, which may be because of the financial crisis. We can also link the IGE index to the dynamics of regional inequality. In the years when the IGE index is higher than 1 (which means low mobility), regional inequality level increases, and when the IGE index is lower than 1, regional inequality declines. Thus, place mobility should be stressed as an essential factor in regional inequality. The spatial-corrected IGE further reveals the role of spatial lag in regional mobility. It shows that before 1994, geographically concentration largely affects place mobility, and after 1994 it is less critical, which is also consistent with the finding of spatial Markov chain.

These findings are further validated by the SOM analysis, which focuses on the dynamics of the changing development status of county-level units and is able to classify the trajectories of diverse regions in their development patterns. The classification results indicate that the relative decline of several urban districts and the rise of many county-level cities and counties, especially in Sunan. Competition in development has also become more intense in more developed regions, where suburban counties, with more land and labor for development, have competed successfully with some city districts. However, changes in development status are more likely to take place in Sunan and Suzhong rather than Subei. The clustering result also shows a clear dynamic of the formation of the spatial core-periphery structure and the spatial diffusion of economic development. It also shows the emergence of the convergence pattern in Jiangsu after 2004: richer groups grow slower than the poorer group.

While regional inequality began to decline in recent years, regional polarization persists in Jiangsu, which is inseparable from the triple process of economic transition (i.e., decentralization, marketization, and globalization) (Wei, 2000; Wei et al., 2011; Wei & Fan, 2000). Due to the proactive local state in fiscal and investment reforms, Sunan has improved its development conditions and known for the Sunan model of development centered on TVEs and local state corporatism (Wei, 2002, 2010). Recent years have witnessed the restructuring of the original Sunan model, particularly driven by deepening globalization with the infusion of FDI and the flourishing development of private enterprises (Yuan, Wei, & Chen, 2014). As the majority of investments and economic activities are more concentrated in Sunan (Table 1), the core-periphery structure has been reinforced in Jiangsu. The core-periphery structure further leads to the improvement of regional inequality and polarization; however, some problems are not solved, such as spatial exclusion, resulting in the high polarization between regions and among the population. These findings are critical to policymakers, and the polarization issue should be addressed.

Moreover, the lack of accumulative place mobility, especially in the Subei region, is a big concern. Surely the provincial government of Jiangsu has implemented several policies in recent years, such as the North-South City-to-City cooperation to promote economic development and mobilize the undeveloped regions in Subei (Xian, Chan, & Qi, 2015). Partly as a result, in recent years, the Subei and Suzhong areas have high growth rates. However, the accumulative economic gap is too large to fill. More importantly, the recent growth trend shows that the potential high mobility of the poorer region is impacted by the financial crisis. It also raises the concern that most of these spatial development policies are tied to changing national and regional political contexts and may not sustain over the long run (Lim & Horesh, 2017).

Geography is playing an important role in the fortune of regions and the development trajectories of places. After 2004, while regional inequality decreases, spatial polarization is intensified, which indicates the economic agglomeration and the existence of geographical barriers. Thus, overcoming geographical barriers, such as the development of transportation and communication, remain a top instrument in the policy agenda of regional development in provincial China. It should be noted that recent industrial relocation of labor- and pollution-intensive industries within Jiangsu, largely driven by rising production and labor costs and more strict environmental regulation in the core region, might have provided new opportunities for regional development in the periphery and semi-core areas (Wu, Wei, Li, & Yuan, 2018).

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CRediT authorship contribution statement

Yehua Dennis Wei: Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Visualization. **Yangyi Wu:** Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Felix Haifeng Liao:** Conceptualization, Writing - review & editing. **Ling Zhang:** Writing - original draft.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.apgeog.2020.102296.

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