

Analysis on Spatiotemporal Pattern Evolution of Economic Development in Jiangsu Province

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Abstract

The balanced development of economy is an important requirement for regional sustainable development. Studying the evolution of the spatial and temporal pattern of regional economic development is conducive to providing scientific decision-making and basis for realizing regional sustainable development. Taking Jiangsu Province as an example and dividing it into three major regions: South of Jiangsu, North of Jiangsu and middle of Jiangsu according to its geographical location. Based on the global spatial autocorrelation and hot spot analysis, this paper analyzes the overall economic development in Jiangsu Province, coefficient of variation and Hirschman's index to measure the level of economic development in Jiangsu cities, and then use the methods of geography detector to analyze the impact factors of Jiangsu's economy. The results show that: (1) The overall economy in Jiangsu region steadily increased from 2006 to 2015; (2) The measurement of the economic development level difference between Jiangsu cities shows that the development difference shows a steady trend of decline over time, and the overall regional difference is dominated by the internal difference in Jiangsu; (3) Among the influencing factors of the economic development in each region: Number of health technicians, Number of employees, the level of industrialization, the distance to the provincial capital, the influence of four indicators on the economic development of Jiangsu as a whole on the upward trend.

Keywords

Regional economic difference; spatiotemporal pattern; Geodetector; Jiangsu Province.

1. Introduction

The provincial administrative region is the highest administrative region in China. Its economic development is often the epitome of China's macro economy and a bridge to the local microeconomics in the province. The unbalanced development of the province's economy is a common phenomenon of regional differences. Jiangsu Province, as a coastal province with rapid economic development and development, has similar problems and has attracted widespread attention. On the basis of ESDA global and local spatial autocorrelation analysis, Pu Yingxia made a preliminary exploration on the trends, characteristics and causes of the spatial and temporal differences of county economy in Jiangsu Province [1]. Through the four influencing factors of regional economic scale, development speed, development level and economic structure, Ou Xiangjun analyzed the regional economic differences in Jiangsu Province [2], and studied the development pattern and process of urbanization in Jiangsu Province [3]. Liu Zuolin's quantitative measurement of the regional economic development differences in Jiangsu Province, Jiangsu Province The regional differences, regional differences, and intra-regional differences and their evolutionary processes are comparatively analyzed [4].

We divided Jiangsu into three major regions, South of Jiangsu, North of Jiangsu, and middle of Jiangsu, to facilitate the exploration of Jiangsu's internal economic differences and regional economic development differences. The southern part of the city includes five prefecture-level

cities: Nanjing, Zhenjiang, Suzhou, Wuxi and Changzhou. The middle of Jiangsu area includes three prefecture-level cities: Nantong, Yangzhou and Taizhou, and North of Jiangsu is Xuzhou, Lianyungang, Suqian, Huai'an and Yancheng.

2. Data Sources and Research Methods

2.1. Data Source

The basic spatial data is based on the 2002 national county data provided by the National Geographic Information Center. The paper further collects the per capita GDP, the number of health technicians, the number of employees, the level of industrialization, and the distance to the provincial capital. The data mainly comes from the local statistical yearbooks of each year.

2.2. Research Methods

The measurement of regional economic development gap is commonly used by the coefficient of variation, the Herfindahl-Hirschman index and other methods.

2.2.1. Coefficient of Variation

The coefficient of variation is one of the commonly used indicators to measure the difference in data distribution. Because it eliminates the dimension, it can be compared between different data distributions. The calculation formula is:

$$CV = \frac{sd(y)}{\bar{y}} = \frac{\sqrt{\frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2}}{\bar{y}} \quad (1)$$

\bar{y} is the mean of the data distribution, $\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$ here for the level of economic development of each city, measured by GDP per capita. The larger the absolute value of the coefficient of variation, the greater the difference in data distribution.

2.2.2. Herfindahl-Hirschman Index

The calculation formula is

$$HHI = \sum_{i=1}^n S_i^2 \quad (2)$$

$$S_i = \frac{y_i}{Y} \quad (3)$$

$$Y = \sum_{i=1}^n y_i \quad (4)$$

The value of HHI is between 1/n and 1. If the regional economic development level is completely unbalanced, HHI is 1, and if it is completely balanced, HHI is 1/n. When n is large and the regional economic development level is balanced, HHI will tend to 0.

2.2.3. Moran's I Index

Spatial surface pattern analysis is commonly described by spatial autocorrelation analysis. There are many methods and indices to measure global spatial autocorrelation, and the Moran's I index is the most commonly used. Where W_{ij} is the weight between points i and j, and S is the variance of X.

$$I = \frac{\sum_{i=1}^n \sum_{j=1}^n W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{S^2 \sum_{i=1}^n \sum_{j=1}^n W_{ij}} \quad (5)$$

In order to better reflect the spatial aggregation degree of the cities in Jiangsu Province, the Getis-Ord $G_i^*(d)$ index is used to measure the high and low value clusters of GDP per capita. The calculation formula is as follows:

$$G_i^*(d) = \frac{\sum_{j=1}^n W_{ij}(d)X_j}{\sum_{j=1}^n X_j} \quad (6)$$

Where X_j is the per capita GDP of each region; $W_{ij}(d)$ is the spatial weight matrix; n is the number of study areas. The Z-score value of the G_i^* index reflects the significance of the cold hotspot area. The Z value is significantly positive, indicating that The area is a hotspot, and the Z value is significantly negative, indicating the cold spot area [5].

2.2.4. Geodetector

The research method was proposed by the research team of Wang Jinfeng and continuously improved (<http://geodetector.org/>), which should be used to detect the difference of geographic elements and its influencing factors on the spatial distribution of research objects [6]. This method is not only applied to the study of natural environment such as earthquake risk assessment, crop planting and environmental health [7-9], but also widely used in socio-economic research such as urbanization and human settlements [10-11].

The specific formula is as follows:

$$q = 1 - \frac{1}{N\sigma^2} \sum_{h=1}^L N_h \sigma_h^2 \quad (7)$$

Where: q is the detection force index of the spatial differentiation of per capita GDP; N_h is the number of sample units in the sub-region; N is the number of sample units in the whole region; L is the number of sub-regions; σ^2 is the variance of the per capita GDP of the whole region ; σ_h^2 is the variance of the sub-regions. The value interval of q is $[0, 1]$. $q = 0$, which indicates that the per capita GDP is randomly distributed, and the q larger, the greater the influence of the zoning factors on the per capita GDP distribution. This paper applies geo-detector to study the influence of various factors on the per capita GDP distribution.

3. Temporal and Spatial Differences of Regional Economic Development in Jiangsu Province

3.1. The Overall Economic Characteristics of Jiangsu Province

From table 1 to compare the per capita GDP of 13 cities in Jiangsu Province during the 10 years from 2006 to 2015, it can be found that with the growth of time, the per capita GDP of each city has increased significantly, and in south of Jiangsu, middle of Jiangsu, and north of Jiangsu, in southern Jiangsu, Suzhou is significantly higher. In Zhenjiang, there is not much difference between the three cities in the north of Jiangsu. The comparison of the highest and lowest findings narrowed from the original nearly five-fold gap to double the gap, indicating that the gap is also gradually decreasing. The biggest change is in northern Jiangsu, which is nearly three times more than in 2007. The per capita GDP of several cities in southern Jiangsu has doubled. In the past ten years, the per capita GDP of Jiangsu cities has increased significantly.

Table 1. Per capita GDP of cities in Jiangsu Province (2006-2015)

Cities	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Suqian	8618	10217	12289	15381	22525	27839	31722	29830	39963	43853
Lianyungang	11084	12857	15458	19229	26987	32119	36470	34335	44277	48416
Huai'an	12278	14347	17104	20946	28861	35181	39992	38985	50736	56460
Yancheng	14647	16987	19775	23607	31640	38222	43172	42178	53115	58299
Xuzhou	15363	17909	21367	25100	34084	41407	46877	44050	57655	61511
Taizhou	19933	23933	27843	33166	44118	52395	58378	59191	72706	79479
Nantong	22826	27500	32815	37642	47419	56005	62506	65696	77457	84236
Yangzhou	24048	28585	34238	40418	49786	58950	65692	70696	82654	89674
Zhenjiang	38088	44894	52391	62084	63280	73981	83650	107621	102652	110351
Changzhou	44440	52840	61503	70138	67327	77485	85039	119151	104423	112221
Nanjing	46114	53639	60808	67455	64037	76263	88525	124600	107545	118171
Wuxi	72489	83923	95460	107365	92166	107437	117357	170978	126389	130938
Suzhou	78801	91911	106863	122565	93043	102129	114029	199017	129925	136702

3.2. The Change of Moran's I Index

Table 2. The changes in the Moran's I index for 2006-2015

Years	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Moran's I	0.62	0.629	0.63	0.6271	0.691	0.694	0.6837	0.626	0.712	0.711

The Moran's I index of GDP per capita is above 0.6 every year, and the Moran's I index of the spatial distribution of per capita GDP in each city is generally on the rise, indicating that the spatial correlation of economic development levels in Jiangsu is getting stronger and stronger.

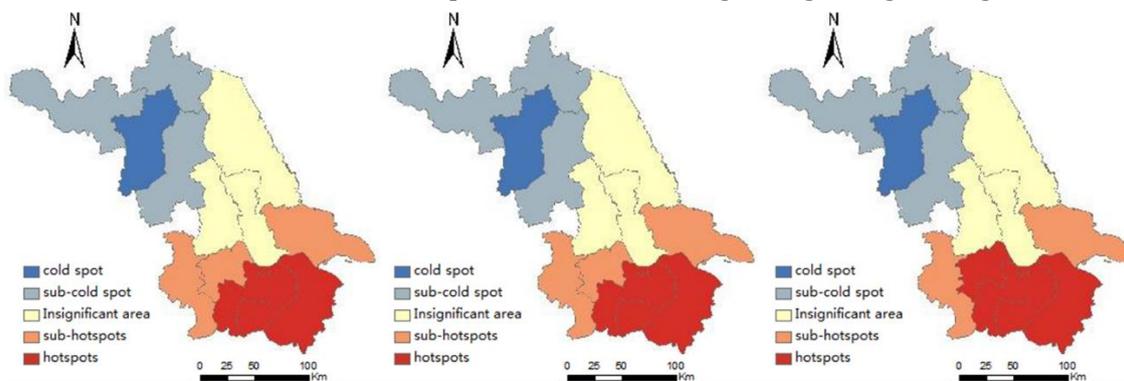


Figure 1. Hotspot analysis results in 2006, 2010 and 2015

In order to probe the distribution of cold hotspots in the cities of Jiangsu Province in more detail, by conducting statistical analysis of spatial hotspots, hot and cold spots can be obtained at different levels of significance. The results were classified into hotspots, sub-hotspots, insignificant domains, sub-cold spots, and cold spots by natural discontinuous point classification (Fig. 1). The results show that the results have not obvious changed in 2006-2010. The hotspots are mainly concentrated in Suzhou, Changzhou and Wuxi in southern Jiangsu. The sub-hotspots are located outside the hotspots, concentrated in Nanjing, Zhenjiang, and Nantong. The cold spot area is mainly concentrated in Suqian, and the sub-cold area is mainly distributed on the outer side of the cold spot area, which is distributed in the center-outer, concentrated in Xuzhou, Lianyungang, Huai'an, The non-significant cold hot spots are mainly located in the transition zone between cold spots and hot spots. It is distributed in Yangzhou, Taizhou and Yancheng, which belongs to northern Jiangsu. In 2015, there was a change, and Zhenjiang had the original sub-hot spot to become a hot spot. In terms of quantity, there were 3 hotspots, 3

sub-hotspots, 3 insignificant area, 3 sub-cold spot, and 1 cold spot in 2007 and 2010. In 2015, there were 4 hotspots and 2 hotspots. The hotspots and sub-hot spots were mainly located in southern Jiangsu. The cold spots and sub-cold spots were mainly located in northern Jiangsu. The hotspots and sub-hot spots, cold spots and sub-cold spots gather more obvious.

3.3. Measurement of the Gap in Economic Development Level of Various Cities in Jiangsu

By calculating the coefficient of variation (CV) and the Herfindahl index (HHI) of per capita GDP data of various cities in Jiangsu Province over the years to characterize the gap in economic development level, the results can be listed as follows:

Table 3. Changes of the coefficient of variation and the Herfindahl index of various cities in Jiangsu Province from 2006 to 2015

Years	CV	HHI
2006	0.738	0.116
2007	0.731	0.115
2008	0.717	0.113
2009	0.694	0.111
2010	0.46	0.092
2011	0.434	0.0903
2012	0.425	0.0898
2013	0.645	0.106
2014	0.384	0.0874
2015	0.369	0.0866

Judging from the calculation results of the coefficient of variation and the Herfindahl index, the economic development level of each city in Jiangsu Province shows a certain degree of difference every year. In general, there is a downward trend, which indicates that there may be a convergence trend in the economic development level of Jiangsu Province.

4. Analysis of Influencing Factors

We use geodetectors to analyze the impact of the factors of economic development in Jiangsu Province. Factor detectors are used to detect the relative importance of impact factors. The per capita GDP of each city directly reflects the degree of economic development, and it can be used as a variable of economic development. According to 2015 statistics: the number of health technicians, the number of employees, the industrialization level, distance to the provincial capital, the influence of the four factors gradually increases. Per capita GDP represents the level of economic development, practitioners represent the region's ability to absorb employment, and industrialization represents the industrial structure and development stage. With the continuous improvement of the level of science and technology, people's ability to transform and adapt to the natural environment has been significantly enhanced, and the market has gradually become the main force that dominates economic activities. The improvement of the economic level will also cause changes in the social structure, which make the main factors and driving forces that affect the economic differences of different cities in Jiangsu province constantly change.

5. Conclusions and Discussion

With the development of Jiangsu's economy, the balanced development of the regional economy has become an important factor affecting the sustained and steady growth of the economy. Based on the per capita GDP data of 13 prefecture-level cities in Jiangsu from 2006 to 2015, this paper uses the coefficient of variation and the Herfindahl index to evaluate the non-equilibrium of regional development, and combines the structure of various regions in Jiangsu to explore the law of regional economic development. According to the analysis results, it is concluded that:

From 2006 to 2015, the overall economic disparity in Jiangsu Province showed a steady downward trend. Jiangsu showed a regional economic pattern of south of Jiangsu > middle of Jiangsu > north of Jiangsu, and the differences between regions in Jiangsu were shrinking with time. Among the influencing factors, the number of health technicians, the number of employees, the level of industrialization, and the distance to the provincial capital, the influence is gradually increasing.

South of Jiangsu, middle of Jiangsu and North of Jiangsu are not only the three new political areas divided by geography and space in Jiangsu Province, but also the three economic regions with obvious gradients. South of Jiangsu is the leader of Jiangsu's economic development and an important pillar for ensuring the economic development of the North and middle of Jiangsu and the narrowing of regional differences. Regional differences in economic development will inevitably lead to regional differences. To a certain extent, the gaps can stimulate the policies and paths for actively seeking development in various regions. However, if imbalances increase, regional differences will continue to expand, which will seriously affect people's lives. and it is easy to cause the backward areas to lose the power of further development, and it is difficult to realize the maximization of the overall interests of Jiangsu. Therefore, in implementing the regional coordinated development strategy, we should stabilize the economic development momentum of southern Jiangsu, introduce advanced technologies to Suzhou and Northern Jiangsu, learn successful experiences and industrial radiation, focus on the coordination of regional economic development in northern Jiangsu, and accelerate the various places in Jiangsu. Accelerate the industrial upgrading and economic transformation of the northern Jiangsu and the middle of Jiangsu, and promote Jiangsu's formation of a new pattern of sustainable development in southern Jiangsu, the accelerated rise of middle of Jiangsu, and the rapid revitalization of northern Jiangsu.

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