Spatial and temporal difference of county economy development level in Jiangsu Province during 2005-2015

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Abstract. The evolvement of regional economic disparity of Jiangsu province in this paper is analyzed from spatial and time perspective using counties economic development level indicators from 2005 to 2015. The research methods combine the ESDA-GIS(exploratory spatial data analysis method in GIS) with traditional statistical analysis method including standard deviation coefficient of variation and spatial auto-correlation model. The research conclusion indicates the absolute and relative difference of county economic development level is expending and there exists strong spatial auto-correlation that counties with similar economic development level tend to be concentrated. There is a significant difference between the southern and northern Jiangsu province, which indicates county economy development is unbalanced in Jiangsu.

1. Introduction
County is the basic administrative unit of a country. The county economy is an important element to measure regional economic development differences, and plays an important role in government decision-making and macro-control. Luo et al.(2014) and Zhang (2010) regarded it is of great practical significance to promote the coordinated development of county economy by the spatial econometric analysis of the differences and agglomeration of county economic growth and its influencing factors. Guan et al.(2004) studied the regional spatial structure changes in Jiangsu Province since the reform and opening up. Xiong et al.(2011) studied the spatial and time evolution of county economic differences in Jiangsu province using traditional mathematical statistics method. In the present study, we combine GIS spatial statistical method with traditional mathematical method to get a more comprehensive evaluation result.

2. Data source and research method
2.1. Data source
The economy development level index consist by GDP,GIP(gross industrial product),CA(car amount) and PTBV(post and telecommunications business volume), which come from the statistical yearbook of Jiangsu province.

2.2. Index processing
Because of the different measurement unit of the four indexes, so it is import to make the unit of measurement consistent. Standard value is calculated using the following equation :

\[
\text{Standard value} = \frac{\text{index} - \min (\text{value})}{\max (\text{value}) - \min (\text{value})}
\]  

(1)
Where index is the current value, min(value) is the minimal value in current column, max(value) is the maximum value in current column.

Then determine the weight of each index by expert scoring method. In this paper the weight of production level and quality of life are 70% and 30% (see table 1).

| Production Level | Life Quality |
|------------------|--------------|
| GDP              | GIP          |
| 35%              | 35%          |
| CA               | CA           |
| 15%              | 15%          |
| PTBV             | PTBV         |
| 15%              | 15%          |

2.3. Research method

2.3.1. Traditional method
Standard deviation is a common measurement for absolute economic difference. The larger the standard deviation, the greater the difference in the absolute difference between the county economy.

Coefficient of variation is used to represent the relative quantity of the standard deviation and average value, which reflects the relative difference of economic development.

Coefficient of skewness can describe the distribution of county economy.
First degree reflects the economic situation of the county scale distribution.

2.3.2. Spatial auto-correlation
The spatial auto-correlation is the degree of correlation of a geographical phenomenon or attribute value on a regional unit and the same phenomenon or attribute value on the adjacent region. It is divided into global spatial auto-correlation and local spatial auto-correlation.

We use Moran index to test the spatial correlation of unit values in spatial adjacent regions, which can reflect the spatial difference trend about the whole region.

The local spatial variation is only reflected by the Moran's I index, since the global Moran index is only an overall average statistical index. Therefore, the local Moran index and Getis-Ord $G^*_i$ index are used to analyze the local spatial correlation pattern and attribute differentiation characteristics (Yang 2013).

The global Moran exponents and local Moran exponents are calculated by the following equations:

$$1=\frac{\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}(X_i - \bar{X})(X_j - \bar{X})}{S^2 \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}}$$  \hspace{1cm} (2)

$$I_i = \frac{(X_i - \bar{X})}{S^2} \sum_{j} W_{ij} (X_j - \bar{X})$$  \hspace{1cm} (3)

Where n is the total number of samples, $S^2$ is sample variance, $X_i$ and $X_j$ stand the observed value, $W_{ij}$ is the binary spatial weight matrix, when I is connected to j, $W_{ij}$ is 1, Else $W_{ij}$ is 0.

3. Time characteristics of economic differences
Based on the 2005-2015 comprehensive value of county economy of Jiangsu Province, we calculate each county's standard deviation, coefficient of variation, skewness and first degree (see table 2).

In table 2, SD is standard deviation, VC is variation coefficient, SC is skewness coefficient, FD is first degree.
From this table, we get the follow results:

· The standard deviation decreased from 0.1981 to 0.1864 in 2005 and 2008, then gradually increased to 0.2059 in 2014 and finally to 0.2017 in 2015. This suggests the difference of the county economy shows a general trend of decline first and then increase.

· The variation coefficient indicates a slow decreasing trend, which is divided into three stages. The relative difference of the county level economic development from 1.25 to 1.32 form 2005 to 2008, which indicates the economic development difference has been widened; 2009 to 2015, the relative economic development of the county shows a decline trend, whose growth rate is -0.02. The above data show that the relative difference of county economy in Jiangsu Province basically conforms to the "V" curve, and the economic development is convergent.

· Skewness coefficient is positive and shows a tendency to rise first and then decrease, indicating that the number of counties below the average level of economic development is the majority, but the number is decreasing.

· The first degree shows a decreasing trend during the study period, indicating that the county with the highest level of economic development is shrinking its relative advantage.

4. Global spatial auto-correlation analysis

The Moran's I index and the test values from 2005 to 2015 are calculated using GeoDa software. The results shows in Table 3.

| Year | Moran's I | Z   | P   |
|------|-----------|-----|-----|
| 2005 | 0.665177  | 8.5461 | 0.01|
| 2006 | 0.6607    | 8.7241 | 0.01|
| 2007 | 0.6559    | 8.4245 | 0.01|
| 2008 | 0.6351    | 8.6116 | 0.01|
| 2009 | 0.6945    | 8.4263 | 0.01|
| 2010 | 0.7113    | 8.7918 | 0.01|
| 2011 | 0.721     | 8.7776 | 0.01|
| 2012 | 0.7155    | 7.7126 | 0.01|
| 2013 | 0.7227    | 8.0441 | 0.01|
| 2014 | 0.7318    | 9.395  | 0.01|
| 2015 | 0.7342    | 9.4551 | 0.01|

The Moran's I index is higher than 95% (P <0.01), and the critical value of Z is 1.96. The Moran's I
index of economic development level in 2005-2015 is greater than 0, indicating that there are significant space in county economic development Agglomeration. The Moran index showed a trend of decreasing first and then rising. In 2008, the Moran index decreased to 0.6351, and the spatial agglomeration of this stage (2005 to 2008) decreased, indicating that the spatial correlation of the county-level economy was weakened and the difference of economic development between neighboring counties was widened. From 2008 to 2015, the Moran index is expanding expect 2011 to 2012, which has a slight decline. This indicates that the spatial correlation of the county economy has strengthened and the difference of the neighbor counties have narrowed.

5. Local spatial auto-correlation analysis

5.1. Moran scatter plot
In order to study the spatial heterogeneity and agglomeration characteristics of Jiangsu province, GeoDa software is used to create the spatial weight matrix using Queen adjacency to calculate the Moran scatter gram of economic development level in 2005, 2010 and 2015 (see in figure 1). The four quadrants in Figure 1 represent the local spatial auto-correlation different between a county and its adjacent county. The first to fourth quadrant are respectively HH, LH, LL, HL type. The abscissa stands for standardized value of the county economic development level, and the ordinate represents the spatial lag vector. In order to reflect the local spatial agglomeration characteristics and spatial evolution of the county economy more intuitively, Moran scatter plot is visualized in ArcGIS software (see in figure 2).

From figure 1, the discrete degree of Moran scatter plot has been increasing, indicating that local differences of economic development level in Jiangsu Province is expanding.

The total number of counties among the first and third quadrants in 2005, 2010 and 2015 are respectively 48, 51 and 50, accounting for 87.2%, 92.7% and 90.9% of the all counties respectively. This shows that the county economy has strong spatial positive correlation Relationship and the spatial duality of county economic development is remarkable.

Figure 1. Moran scatter plot of Jiangsu Province counties economic development level

The number of counties in the third quadrant is 34, 32, 31, accounting for 61.8%, 58.2% and 56.4% of the all counties respectively, and the county economy is mostly in low level.

In 2010, the number in the first quadrant increased 5 counties compared with 2005, and the third quadrant decreased 2, indicating that county economic development level tends to high level. High level development areas have great influence to low level development areas. However the local differences are still expanding.

In 2015, the number of counties in the first and third quadrants is unchanged compared with that in
2010, indicating that the relative differences of county economic development are stable and unchanged.

At 2005, 2010 and 2015, the total number of counties in quadrants 2 and 4 is 7, 4 and 5 respectively, accounting for 12.7%, 7.3% and 9.1% of the total number. In general, the negative correlation area of spatial development of county economy has been reduced.

Figure 2. Space display of Moran scatter plot

Follows are some results getting from figure 2:
· The number of LH-type county decreases 3 during 2005 to 2010, which mainly distribute at the junction area of HH-type and LL-type counties in the northern area of southern Jiangsu. In 2005, HH-type counties mainly distribute in Yizheng, Jurong, Taixing, Jingjiang, Rugao, Nantong and Haimen. In 2010 these distribute in Rugao, Taixing, Qidong and Jurong. These cities whose economy development rapidly, drawing the surrounding counties’ talent, material, technology and other resources into the HH-type counties, which turns the surrounding counties into economic development depression city.
· HH-type county exist in southern Jiangsu, and the number increased 5 from 2005 to 2010, forming a economic development high-value zone. It has a tendency expanding to the northern districts. This indicates the urban economy in southern Jiangsu has developed rapidly and has a diffusion effect on the surrounding areas.
· LL-type counties are mainly distributed in northern Jiangsu and its Junction cities with central Jiangsu. These areas’ economic base is weak and far away from the Yangtze river delta.
· HL county counties appear only in 2015, with a certain randomness. The county which has advantage in economic development is higher than its surrounding areas in economical level obviously. It shows a spatial polarization phenomenon of economic growth on a spatial scale. When the economic development advantage weakened or the surrounding counties’ economy level developed, it maybe transforms into other types.

5.2. LISA clusters map
In order to further explore the auto-correlation of economic development in neighborhood counties, the LISA index is used to detect the similarity or difference in attributes between the unit and its neighbor units. The LISA value of the economic development level in 2005, 2010 and 2015 is calculated by GeoDa software, and the LISA agglomeration diagram is drawn based on Z test (P < 0.05) (see figure 3).

From figure 3, we can get the follow results.
From the perspective of amount, the HH-type significant aggregation county number increased gradually. At 2005, 2010, 2015, the number is 8, 11, 12 respectively. LL-type county number is nearly unchanged. Each stage only one increase showing a slight expansion situation. LH-type county number in three time points is 3, 1, 2 respectively, which can be disregard.

In the perspective of space, HH-type significant gathering counties are mainly distributed in the Suzhou-Wuxi-Changzhou economic circle, that is, the southern Jiangsu province; In 2010, HH-type significant aggregation of county areas expanded, which adds Nantong, Zhangjiagang, Jingjiang. Danyang city is added in 2015 indicating the driven effect is obvious. LL-type counties are mainly distributed in northern Jiangsu, which number and spatial changes are not obvious. During the three stages, only two counties increased showing a weak expansion tendency.

LH-type counties are mainly distributed in northern districts of southern Jiangsu, experienced from narrow to expansion of distribution process. LH-type significant areas are Haimen, Jingjiang and Nantong in 2015.

5.3. Spatial evolution of county economic hotspots
According to the size and significance level of the index, the natural economic disparity method is used to divide the spatial pattern of the county economy into hotpot, sub-hotpot, warm, sub-warm spot and cold spot (see figure 4).

In general, the spatial pattern of Jiangsu province county economic development has a great evolution, mainly reflected in the non-hot spots. The spatial distribution of hot spots is described as follow:

- The hot spots mainly distributed in the Suzhou-Wuxi-Changzhou area, and the number are 6, 7, 9
in 2005, 2010 and 2015, showing an increasing trend. Zhangjiagang, Jingjiang and Changzhou gradually turned into core areas of economic development in Jiangsu province from sub hot spots.

- The county number in hot spots area increased from 5 in 2005 to 15 in 2015, mainly due to the rapid economic development in southern Jiangsu and the fact that many sub-hot spots evolved into hot spots, and then pulled the surrounding cities economy up. By the end of 2015, nearly the whole southern Jiangsu have become hot and sub-hot region and plays a lead role in developing Jiangsu economy.

- Driven by Nanjing, Yangzhou, Taizhou and Nantong, the warm spots gradually changed from southern regions to central Jiangsu. However Xuzhou, which locates in northern Jiangsu and totally separates with the hot and sub-hot spots, is a special case. The reason why it can transform from a sub-warm spot to warm spot is that Xuzhou has advantages in traffic, location and the foundation of heavy industry.

- The number of economy sub-warm regions reduced from 16 in 2005 to 9 in 2015. Its spatial distribution gradually changed from central to northern Jiangsu. In 2015 sub-warm spots mainly distributed in the surrounding counties of Xuzhou and part of the northern counties that close to central Jiangsu.

- The cold spots cut down from 17 in 2005 to 13 in 2015, which locate in northern Jiangsu totally. Economic cold area spread over Pizhou, Suining, Huai'an and Hongze. One reason for the change is that the Xuzhou’s development led to economic Growth of the two counties under its jurisdiction. Huai’an and Hongze nearing the central Jiangsu province can gain technology and capital supports from the high level counties of economic.

6. Conclusion

Based on the ESDA-GIS method, we study the spatial, time evolution and spatial differentiation characteristics of the Jiangsu province county economy of development level. Research results indicate:

- In 2005-2015, the trend of county economic absolute difference of is decreasing at first and then decreasing. The relative difference meets the law of "V" type economic development trend, and the number of counties which are lower than the average level is decreasing.

- From the perspective of global spatial auto-correlation, the county economy of Jiangsu Province shows a high agglomeration degree, with a significant difference between the northern and southern area.

- From the perspective of local spatial auto-correlation, the Moran scatter diagram shows that the regional disparity of the county economy in Jiangsu province has been expanding. The number of HH-type counties spread from southern to northern region, showing a certain spatial diffusion effect; The result indicates there are significant spatial differences in economic development between northern and southern Jiangsu, and northern Jiangsu has always been the economic cold region. According to the index analysis, the spatial pattern of Jiangsu province’s regional economic development has evolved to a large extent. Su-xi-Chang economic circle as the core of the hot spots and other types of regional development, according to the order of heat from south to north in order to weaken by strip.

The economic differences between southern and northern Jiangsu have existed for a long time. The Yangtze River Delta region is far from northern Jiangsu, which can not be pulled up by the economic development hot regions. With the continuous policy support recent years, we can see the northern areas’ economy has grown up, but the rate is still slow, which don’t match the southern development speed. Therefore, it is suggested that the government give more favorable policy in education, technology, capital, and administrative, and give full play to the role of the Huaihai economic circle. As can be seen from the example of Xuzhou, its economic level is obviously higher than the surrounding cities, indicating the economic circle of Huaihai will inevitably lead to a qualitative leap in northern Jiangsu and promote the harmonious and healthy development over all province.
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