

Study on Spatial Distribution Characteristics of Intra-City Agriculture Sub-sector Value-Added Growth Rates in Henan Province

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Abstract—Based on the value-added data of agricultural sub-sectors from 2011 to 2014, this paper utilizes spatial statistical analysis methods to study the spatial distribution characteristics, spatial correlations as well as the difference degrees of agricultural sub-sector value-added growth rates for cities in Henan province. The results show that there is a polarization feature of agricultural sub-sector value-added growth rates. The intra-city forestry value-added growth rates exist some positive correlations. Zhengzhou city has been becoming a growth pole. There are some negative correlations for the intra-city animal husbandry value-added growth rates, the eastern part of the province has been becoming a relatively weak developing area. In cities, the value-added growth rates for the different sub-sectors have a significant difference, there is a large space for adjustment of sub-sector developing policy. In the intra-cities, the value-added growth rates for the same sub-sectors have a large variation, the interactions are very weak and the coordinated developments are insufficient.

Keywords—*agricultural sub-sector growth rate; spatial statistical analysis; clustering analysis; global spatial auto-correlation; local auto-correlation; henan province*

I. INTRODUCTION

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Henan is a major agricultural province with agricultural economy playing a vital supporting role in the province's economy, meanwhile the development of agricultural economy is also an important livelihood basis for the province. In recent years, agricultural economy has considerably developed with extensive applications of agricultural science and technology, the proportion of agricultural economy in the national economy has gradually increased. However the problem in agricultural industry structure is growing more and more severe with time, which has seriously hindered the overall economic growth. It is a significant task for the province to adjust the structure of agricultural industry, to rationally utilize natural resources as well as to promote the healthy growth of agricultural economy and the whole national economy [1,2].

City regional economy with a certain geographical feature is an important part of regional economy. It takes a municipal

government as administrative body, administrative divisions as a geographical unit, forms a relatively complete functional economic form. It is vital to scientifically evaluate a city's economic development rate of industry, research the main driving forces of economic growth in cities, comprehensively to analyze and compare the differences among cities, to reveal weak links and development directions of economic growth in various cities [3-8].

Affected by spatial locations and natural resources distribution, there are certain geographical features in agricultural economic development, while the agricultural economic growth of one city and economic development of adjacent cities is closely linked. In the data, there are some spatial correlations in the spatial distribution of growth rate [4,9,10].

In this paper, spatial statistical analysis methods are utilized to analyze the agricultural sub-sector economic growth rates for 18 cities in Henan province in the last consecutive five years from 2010 to 2014. Based on the spatial relationships of statistical analysis results, study the spatial variation patterns and spatial relationships of sub-sector economic growth rates in agricultural economy for the province, to reveal their spatial differences and spatial correlations, and understand their spatial patterns, for unearthing the profound reasons, formulating the corresponding countermeasures, and maintaining the provincial agricultural economy equilibrium, rapid and sustainable development supply a scientific basis.

II. EASE OF USE RESEARCH METHODS

A. Data and Processing

According to the national economic industrial classification criteria, the indicators of this research includes five sub-sectors of agriculture, such as farming, forestry, animal husbandry, fishery and services for farming, forestry, animal husbandry, fishery (generally called as services). Following constant price in the year of 2010, the annual sub-sector value-added growth rates for all cities are calculated by using the sub-sector value-added data coming from the Henan statistical yearbook 2010~2014. The spatial maps used in the research come from Henan spatial map database [11,12].

B. Principal Component Analysis

Principal component analysis is a widely used analysis method in the data mining, which linearly combines the original variables to a few of new linearly independent variables in order to effectively eliminate overlapping information among the original variables. The data analysis carries out on the new variables [13].

C. Spatial Weight Matrix

Spatial weight matrix is a binary symmetric matrix describing the spatial adjacent relationships. In the topology, $w_{ij} = 1$ if and only if the polygon i and j have some common edges, otherwise $w_{ij} = 0$.

D. K-mean Clustering Analysis

K-mean clustering analysis is one of the most effective methods for spatial clustering. Firstly, the distance between samples and the criterion function is defined, the clustering number and the initial clustering centers are determined according to the prior knowledge. Secondly, the remaining samples are assigned to each group corresponding to the clustering centers, calculate the new clustering centers and criterion function until the change of criterion function fall in the setting allowable range.

E. Global Spatial Auto-Correlation Analysis

The global spatial auto-correlation analysis is based on Moran I index, which reflects the spatial difference degree and spatial similarity degree for the adjacent regions with a certain regular distribution samples.

$$I_i = (x_i - \bar{x}) \sum_{j=1}^n w_{ij} (x_j - \bar{x}) / s^2 \sum_{i=1}^n \sum_{j=1}^n w_{ij} \quad (1)$$

where, x_i , \bar{x} , s^2 respectively are the sample value, the mean and the variance. The test statistics, normalizing Z , describes the correlation degree between the regional samples, and for the corresponding significance level α . If α is less than the significant level set before (generally $\alpha = 0.05$), we believe the sample sequence is derived from a random distribution and there is no correlation. as $\alpha \geq 0.05$, the positive and negative values of Z respectively stand for the degree of aggregation and dispersion [14].

F. Local Spatial Auto-Correlation Analysis

Local spatial auto-correlation uses the Local Moran I index, which shows the space-related pattern on different spatial locations, describes the degree of aggregation and the degree of difference for one region which have some significant similarity with adjacent regions [14].

$$I_i = (x_i - \bar{x}) \sum_{j=1}^n w_{ij} (x_j - \bar{x}) / s^2 \sum_{i=1}^n \sum_{j=1}^n w_{ij} \quad (2)$$

III. 3 SPATIAL ANALYSIS ON AGRICULTURAL SUB-SECTOR VALUE-ADDED GROWTH RATES IN HENAN PROVINCE

A. The principal Component Analysis on Agricultural Sub-sector Value-Added Growth Rates in Henan Province

For a city region, the principal component analysis of sub-sector value-added growth rates is conducted, and three principal components are extracted under the confidence (90%). Then (3) is used to construct the vector of the sub-sector value-added growth rates for all cities.

$$V = \sum_{m=1}^3 \sqrt{\lambda_m} P_m \quad (3)$$

where, λ_m is an eigenvalue. P_m is the corresponding factor score coefficient vector. The calculation results are shown in Table1.

Table1 shows that there are different growth points of agriculture economy for different city, such as the forestry in Shangqiu is the mainly driving force for agriculture economy growth(1.57), animal husbandry value-added growth rate lagging behind (-1.23).

B. The Clustering Analysis on Agricultural Sub-sector Value-Added Growth Rates in Henan Province

The K-mean clustering analysis is carried out on vectors of the agricultural sub-sector value-added growth rates (Table1). The Euclidean distance is adopted as the distance between two samples, the sum of squares of deviations is used as the criterion function, and the clustering number is 3, The results are showed in Table 2.

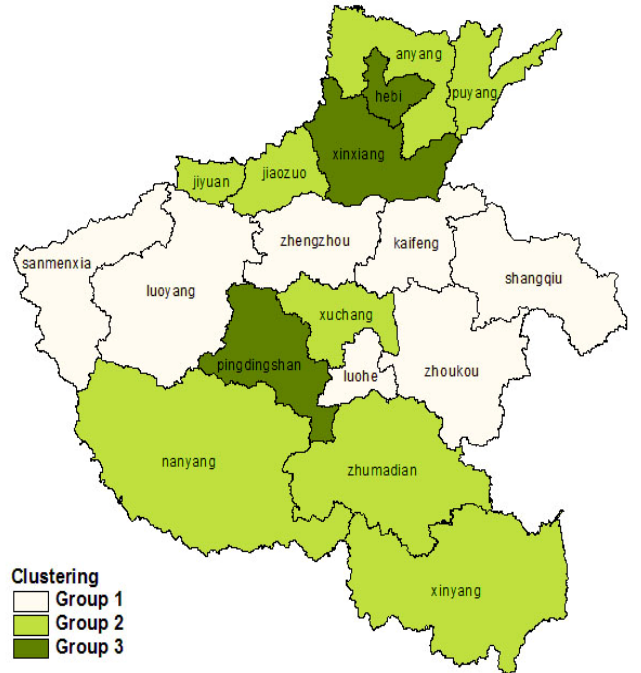


FIGURE I. THE CLUSTER ANALYSIS OF SUB-SECTOR VALUE-ADDED RELATIVE GROWTH RATES IN HENAN PROVINCE

When all city regions are divided into 3 groups, The first group is forestry driving type(1.31), the growth of animal husbandry are relative lag behind (-0.75), represented by Shangqiu, composed of Zhoukou, Luohe, Kaifeng, Zhengzhou, Luoyang, Sanmenxia. The second group, represented by Xinyang, includes eight cities as Puyang, Jiyuan, Jiaozuo, Anyang, Nanyang, Xuchang, Zhumadian, is services driving type(1.25), the development of forestry are their weaknesses (-0.31). Animal husbandry-driving type with low farming value-added growth rates is the characteristic of the third group, its representative is Xinxiang(1.42), including Pingdingshan and Jiaozuo.

TABLE I. THE AGRICULTURAL SUB-SECTOR VALUE-ADDED RELATIVE GROWTH RATES IN HENAN PROVINCE

City	Farming	Forestry	Husbandry	Fishery	Services
Zhengzhou	-0.57	1.36	-0.88	-0.46	1.36
Kaifeng	0.22	1.62	-0.42	-0.75	1.26
Luoyang	1.46	1.26	-0.58	0.83	-0.50
Pingdingshan	-0.31	1.03	1.35	-0.24	1.41
Anyang	1.35	-1.04	0.19	0.15	1.42
Hebi	-0.64	0.73	1.71	0.85	-0.65
Xinxiang	0.13	1.66	1.19	0.41	0.80
Jiaozuo	0.18	0.45	1.49	-1.08	1.18
Puyang	1.00	-1.05	0.92	0.05	1.43
Xuchang	-0.12	0.90	1.02	-1.37	1.12
Luohe	1.29	1.49	-0.69	0.79	-0.17
Sanmenxia	-1.07	0.88	-0.04	1.23	1.25
Nanyang	0.16	0.07	1.45	1.12	1.27
Shangqiu	0.27	1.57	-1.23	0.50	0.84
Xinyang	0.05	-0.81	1.27	-0.58	1.54
Zhoukou	0.86	1.00	-1.41	0.82	0.79
Zhumadian	1.25	-0.78	0.77	1.32	0.70
Jiyuan	0.31	-0.18	1.31	-1.18	1.32

In the view of geographical distribution, The first group is located in the central from the north to the south of the province (Figure 1), along with Longhai railway (G30 expressway), where has well-developed transportation network, and the first 4 cities are located in the eastern plain of the province. The second group is located in the northern end and the southern end of the province, where has relatively complex terrain and rich forestry resources. The forestry economy holds a larger share of the whole industry, but the forestry value-added growth has little contribution to the whole industry growth. The third group is located in the transitional zone between the former two groups, is adjacent to the region of ZhengBianLuo economic zone where are relatively provincial well-developed area, benefits from the developed tourism and scale cultivation.

C. The Global Spatial Auto-Correlation Analysis on Agricultural Sub-sector Value-Added Growth Rates in Henan Province

Using the global spatial auto-correlation analysis on the agricultural sub-sector value-added growth rates, the results are showed in Table 3. Under the significance level(0.05), there are some obviously positive correlations in the distributions of forestry, animal husbandry and fishery value-added growth rates, they demonstrate high-high and low-low aggregation characteristics, show that there are mutual influences among adjacent city regions, but obvious regional differences in the value-added growth rates for different city regions. There are little negative correlations in the distributions of farming and services value-added growth rates, which show that the development policy of adjacent city is relative closed, the value-added growth rates is relatively balanced.

TABLE II. THE FINAL CLUSTER CENTERS

Group	Farming	Forestry	Husbandry	Fishery	Services
1	0.35	1.31	-0.75	0.42	0.69
2	0.52	-0.31	1.05	-0.2	1.25
3	-0.27	1.14	1.42	0.34	0.52

TABLE III. GLOBAL SPATIAL AUTOCORRELATION ANALYSIS

	Farming	Forestry	Husbandry	Fishery	Services
Moran	-0.23	0.51	0.35	0.27	-0.32
Pvalue	-0.92	4.00	2.95	2.42	-1.53
Pvalue	0.15	0.02	0.04	0.05	0.10

D. The local Spatial Auto-Correlation Analysis on Agricultural Sub-sector Value-Added Growth Rates in Henan Province

Carry out local spatial autocorrelation analysis on the 6 sub-sector value-added growth rates in Henan province, under the significance level (0.05) Moran scatter plots are showed as Figure 2.

In the view of spatial distribution, there is a significant high aggregation regions for forestry and fishery value-added growth rates, where are the faster value-added growth rate areas for the two sub-sectors, while the low aggregation areas for animal husbandry and fishery value-added growth rates are the slower value-added growth rate areas.

In the view of spatial location interactions, according to the theories of regional economic, the regions with fast growing rates have radiation and leading role on adjacent areas through information exchange and cooperation to form a pattern of common development. For example, the provincial capital city, Zhengzhou, which is also the most developed city in the province, leads to the forestry rapid value-added growth in adjacent cities as Kaifeng and Xuchang, due to its increasing demand for flowers and trees in urban greening, but the radiation influence to Luoyang is relatively weak for the terrain factors. Shangqiu and Kaifeng form a low-lying area of animal husbandry value-added growth rates for geographical factors.

Luoyang is not only a high-low aggregation region of farming value-added growth rates, but also a low-high aggregation region of services, Xuchang is not only a aggregation region of forestry value-added growth rate, but also a high-low aggregation region of animal husbandry, which mean that the sub-sector value-added growth rates in the two regions are very imbalanced, and there is a large space for policy adjustment. The low-high aggregation region of animal husbandry value-added growth rate, Anyang, located in the most northern part of the province, is affected by the provincial capital, Zhengzhou, and JingJinJi region, but the role is not very obvious. Xinyang is the only one region in the north of the country, has relatively rich water resources, but the fishery value-add growth rate is relatively slow, forms a low-high accumulation area.

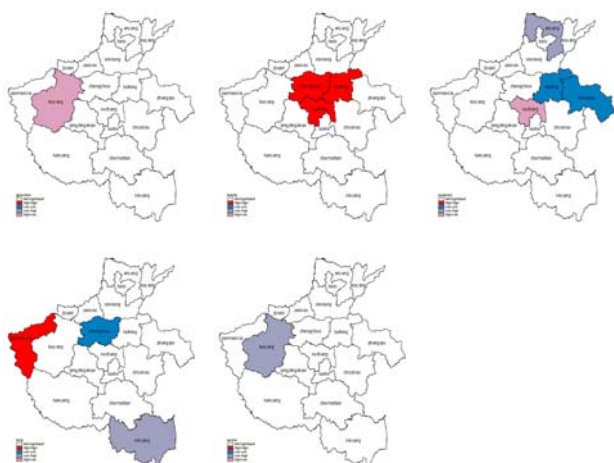


FIGURE II. THE LOCAL SPATIAL AUTOCORRELATION DISTRIBUTION OF SUB-SECTOR VALUE-ADDED GROWTH RATES IN HENAN PROVINCE

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IV. CONCLUSIONS

This paper utilizes spatial statistical analysis methods to study the spatial distribution characteristics, spatial correlations as well as the different degrees of agricultural sub-sector economic growth rates of cities in Henan province. The results show that: (1) The agricultural sub-sector value-added growth rates in Henan province can be divided into three groups as the forestry-driving type, the services driving type and the animal husbandry driving type. (2) There is an obvious positive correlation in forestry value-added growth rates, the provincial capital Zhengzhou, has been gradually becoming the growth pole. There is a negative correction in the animal husbandry value-added growth rates, the eastern part of the province has been becoming a relatively weak developing area. (3) There is an obvious space for policy adjustment because of the agricultural sub-sector value-added growth rates in the cities of the province. (4) The differences of the agricultural sub-sector value-added growth rates between the different cities are relatively obvious, the interactions between adjacent cities are very weak and the coordinated developments are insufficient.

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