Dynamic Features and Its Affecting Factors of Urbanization in the Middle of China: the Case of Hunan province

Jiayu Kang

College of Environment and Planning, Henan University, Kaifeng 475004, China

Kangjiayu2019@163.com

Abstract

In this paper, we see population urbanization rate as the measurement index, using the spatial econometric approaches to examine the temporal and spatial variation characteristics and the influence factors of county urbanization level in Hunan province from 2000 to 2015. The results are summarized as follows. From the calculation results of index, we find that the absolute and relative differences are gradually decreasing from 2000 to 2015 in Hunan province. From the spatial distribution characteristics, the whole spatial distribution characteristic is "west low and east high". From the spatial correlation pattern, county urbanization level in Hunan province exist the positive spatial auto-correlation effect and agglomeration phenomenon. With the quantitative results of spatial regression analysis, we find that economic development level, regional condition, urban grading, output in the secondary and tertiary sectors largely determines spatial differences of county urbanization. Population density, urban-rural income gap and output in the secondary and tertiary sectors have a larger difference between the eastern, northern, southern and western Hunan province in the county urbanization level. The other influence factors has no significant difference between the eastern, northern, southern and western Hunan province.

Keywords

County urbanization level; temporal and spatial pattern; reason analysis; Hunan province.

1. Introduction

Population urbanization rate is an important index to measure the degree of urbanization in a region. Since the reform and opening up, with the development of economy, China's urbanization has entered a period of rapid development[1-2]. China's urbanization level increased by more than 1% annually[3-5]. By 2015, China's population urbanization rate reached 56.1%, higher than the average level of urbanization in the world, about 1.2%. However, the level of urbanization in the central part of China shows a more obvious "central subsidence" situation. Taking Hunan Province as an example, the urbanization rate of population is 50.89%, which is lower than the national level of 5.8 percentage points, and it is in the lower reaches of the country.

China has a vast territory, a large population, the level of urbanization in various regions is unbalance, so Chinese studies on the development of urbanization in China is very rich, mainly on the level of urbanization measurement, differentiation characteristics, cause analysis. In the field of research, scholars pay more attention to the new urbanization in recent years, which mainly on the interpretation of the theoretical connotation of new urbanization[6-8] and empirical analysis of regional new urbanization[9-12]. From the perspective of regional research, there are more achievements in the evaluation and analysis of the level of urbanization in the whole country, but less achieve on the spatial and temporal characteristics of urbanization and influencing factors at the county level in central China. Generally speaking, the population proportion method can reflect the spatial and temporal evolution trend of urbanization more intuitively, exploratory spatial data analysis can find the spatial distribution correlation, regression analysis can find the influencing factors of population urbanization relatively intuitively, panel data analysis highlights the change of influence factors in time series.

Hunan province is located in the middle reaches of the Yangtze River in China. By 2015, the population urbanization rate of Hunan is 50.89%, but still lower than the national level of 5.8 percentage points which is in the lower reaches of China, the lower population urbanization of Hunan province is restricting its future economic development. Scholars' quantitative qualitative research on the spatial evolution pattern of urbanization in the central provinces is relatively few. Most of the research results are based on the study of city scale, the study of county scale is few. The study of city scale can not clearly reflect the evolution trend and influencing factors of urbanization in central provinces in the past 15 years. Thus, this paper takes Hunan Province as an example, using the coefficient of variation, Theil index, σ coefficient, Moran index, spatial autocorrelation and other research methods to analyze and summarize the distribution of urbanization level in Hunan Province, analyzes its spatial and temporal evolution law, in order to provide a theoretical support for the development of urbanization in central provinces.

2. Data sources and research methods

2.1 Data sources

This paper chooses the urbanization rate of the permanent population commonly used by the government as an index to measure the urbanization level of the county in Hunan Province, which is the ratio of the urban permanent population to the total permanent population. The data mainly come from the 2001-2015 China County and Municipal Statistical Yearbook of Socio-economic Statistics, 2001-2015 Hunan Statistical Yearbook, and the corresponding year Hunan County and Municipal Statistical Yearbook and Statistical Bulletin.

2.2 Research methods

2.2.1 Theil index and coefficient of variation

Theil index and coefficient of variation can be used to measure the relative difference of urbanization rate under different scales. The greater the value, the greater the level of dispersion.

The computational formula of Theil index and coefficient of variation are as follows.

$$T = \frac{1}{\mathrm{n}} \sum_{n=1}^{n} \frac{y_i}{\bar{y}} \log\left(\frac{y_i}{\bar{y}}\right) \tag{1}$$

$$C_{\mathrm{v}} = \frac{1}{y} \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(y_i - \bar{y}\right)^2} \tag{2}$$

In the formula, T is the Theil index; Cv is the coefficient of variation; n is the unit number; y_i is the urbanization rate of the unit i.

2.2.2 σ coefficient

The σ coefficient is used to measure the absolute difference of urbanization level among counties. The computational formula of σ coefficient are as follows.

$$\sigma = \sqrt{\sum_{n=1}^{n} \left(x_i - \bar{x}\right)^2 / N} \tag{3}$$

x_i represents the urbanization rate of Hunan research unit i, which represents the average urbanization rate of Hunan Research units, and N represents the number of research units in Hunan province。

2.2.3 Spatial classification and spatial correlation

According to the urbanization rate of each county in Hunan Province, it is divided into five grades (high level area, higher level area, middle level area, lower level area and low level area) by natural fracture rule, and then using Arc GIS 10.2 software to classify and characterize it.

Exploratory spatial data analysis is a method to analyze the spatial correlation of data. It can explain the spatial correlation characteristics of spatial variables and further explain the spatial distribution of spatial variables in the spatial structure.

2.2.4 Moran index

Local spatial autocorrelation summarizes the level of spatial dependence in a general spatial range, and its commonly used correlation index is Moran's *I*, The computational formula is as follows.

$$Moran'sI = \frac{\sum_{i=1}^{n}\sum_{i=1}^{n}\left(Y_i-\overline{Y}\right)\left(Y_j-\overline{Y}\right)}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}} \quad (4)$$

$S^2=\frac{1}{n}\sum_{i=1}^{n}\left(Y_i-\overline{Y}\right)$; $\overline{Y}=\frac{1}{n}\sum_{i=1}^{n}Y_i$, Y_i and Y_j indicate the observed values in areas *i* and *j*, *n* is the total number of research units, W_{ij} is the spatial weight matrix. The range of Moran's I is [-1,1], f the Moran's I value is closer to 1, it shows that the attributes of each research unit show a positive correlation, and vice versa. If the Moran's I value is 0, the attributes of each research unit are not related.

2.2.5 Space constant coefficient regression

(1) Spatial lag model

The model is mainly used to study the influence of variables in adjacent regions on the same variables in other regions of the whole system. The model is as follows.

$$y=\rho Wy+\beta X+\varepsilon \quad (5)$$

Parameter β reflects the influence of independent variable on dependent variable, Spatial lag dependent variable *Wy* is endogenous variable, *y* is a dependent variable vector of *n*×l order, *X* is the characteristic independent variable matrix of *n*×*n* order, β is a regression coefficient vector of *k*×l order, ε is an independent identically distributed random error vector of *n*×l order. ρ is a spatial correlation coefficient, with a value of [-1,1], indicating the degree of influence between adjacent regions.

(2) Spatial error model

The model is mainly used for spatial autocorrelation between residual items. The model is as follows.

$$y=\beta X+\varepsilon \qquad \varepsilon=\lambda W\varepsilon+\mu \quad (6)$$

ε is a random error vector, β is the coefficient of spatial error of vector variables of *n*×l order, μ is a random error vector with normal distribution, *W* is the spatial weight matrix λ, which is the residual coefficient of spatial regression.

3. Temporal and spatial pattern evolution

3.1 Temporal pattern evolution

Based on the county urbanization level index of Hunan Province, according to the calculation formulas of coefficient of variation, Theil index and σ coefficient, this paper analyzes the time variation of urbanization level in Hunan Province at County level, and the results are shown in Figure 1.

From the figure 1, we can see that the coefficient of variation and the Theil index of the county urbanization level in Hunan Province showed a significant downward trend, their change trend is similar, their numerical terms are from 43.47% and 3.49% in 2000 to 23.06% and 1.05% in 2015. The σ coefficient of county urbanization in Hunan shows a trend of first rising and then decreasing. First, the numerical changed from 8.24% in 2000 to 9.71% in 2008, then from 9.56% in 2009 to 9.58%

in 2012, and finally from 9.39% in 2013 to 9.09% in 2015. Among them, the σ coefficient in 2015 is greater than that in 2000.

Generally speaking, the relative regional differences of the urbanization level of counties in Hunan Province have shown a trend of obvious reduction during the study period, while the absolute regional differences change more complex, showing a trend of rising first and then declining, and finally the absolute regional differences in 2015 is greater than in 2000.

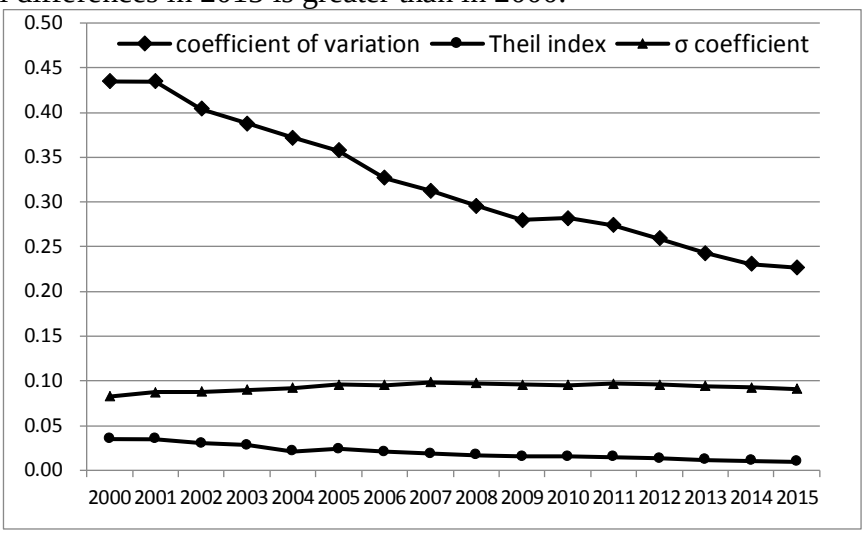

Fig.1 The index of urbanization level in Hunan province from 2000 to 2015

3.2 Spatial pattern evolution

3.2.1 Spatial pattern differentiation analysis

According to the division standard of urbanization level, the paper classifies the urbanization level of counties in Hunan Province by spatial visualization. The result is shown in Figure 2. From Figure 2, we can see that the spatial variation characteristics of urbanization in different counties of Hunan are quite different. From 2000 to 2015, the number of research units in the high urbanization level areas changed greatly, showing the characteristics of increasing first and then decreasing. The spatial distribution of research units in the high urbanization level areas showing the characteristics of dispersing to gathering, mainly distributed in central and eastern Hunan province until 2015. The number of research units in moderate urbanization level areas shows a downward trend, and the spatial distribution shows a process from agglomeration to dispersion and then to agglomeration. The number of research units in low urbanization level areas showed a steady upward trend, mainly distributed in the central and eastern parts and northwest of Hunan province.

In a word, from 2000 to 2015, the number of high level urbanization areas has a downward trend, from the eastern and northern parts of Hunan Province to the eastern part of Hunan Province. While the low level urbanization areas have an expanding trend, from the central and southwestern parts of Hunan Province to the central and western parts of Hunan Province forming a more obvious Eastern and central and western parts of Hunan Province. The spatial distribution of population urbanization rate in Hunan province has formed a more distinct pattern of eastern and Western regions, and the gap between eastern and western regions has been significantly widened.

3.2.2 Spatial association differentiation analysis

According to the ESDA analysis method, the data of population urbanization rate of Hunan county were brought into Geo-Da software for analysis, and the broken line map of Moran index from 2000 to 2015 was obtained, as shown in Figure 3. The Moran's *I* index of Hunan's urbanization level increased from 0.113 in 2000 to 0.169 in 2015. This shows that the urbanization level of each region in Hunan Province is not disorderly in spatial distribution, but has a certain relevance, and the correlation has increased significantly in recent years.

In order to analyze the spatial distribution law of county urbanization level better in Hunan province, the spatial distribution maps of Moran's *I* scatter points in 2000, 2005, 2010 and 2015 are drawn, as shown in Figure 4. From 2000-2015, the spatial correlation pattern of Hunan's urbanization level changed little. From 2000 to 2015, the number of High-High areas has a certain increasing trend, distributed from the north and northeast of Hunan Province to the entire eastern part of Hunan Province, which mainly along the Beijing-Guangzhou line. The number of Low-Low areas increased slightly and expanded to the whole western and central part of Hunan province and the south of Yongzhou by 2015. The number of Low-High and High-Low areas is relatively small, and their distribution is relatively discrete. Generally speaking, High-High areas and Low-Low areas are the main types of spatial correlation of urbanization level in Hunan province, which accounting for 75% of the total and has a increasing number. The number of Low-High and High-Low areas is small and the number is reduced. The unbalanced distribution of urbanization in Hunan is aggravated.

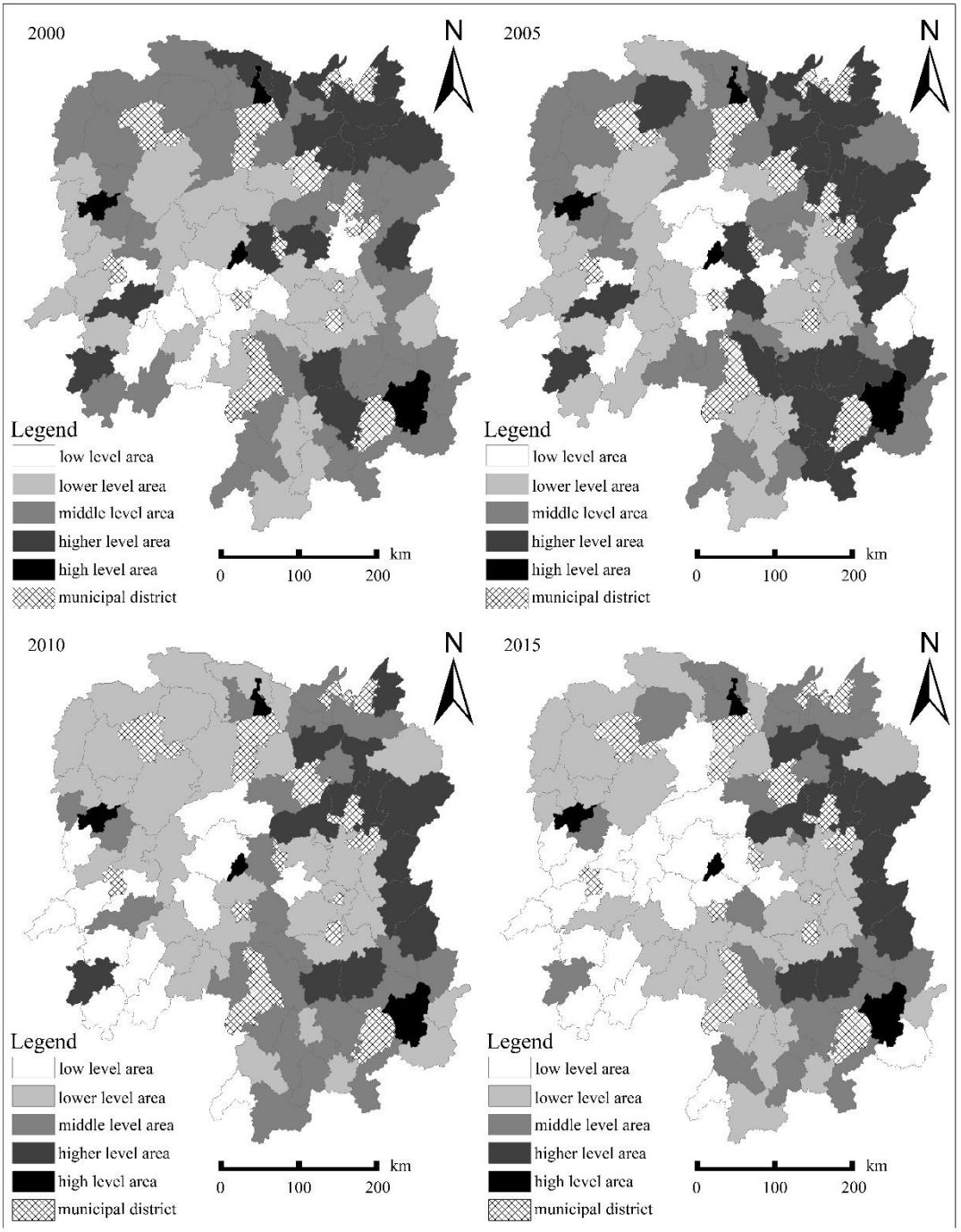

Fig.2 The spatial pattern of urbanization level in 2000, 2005, 2010, 2015

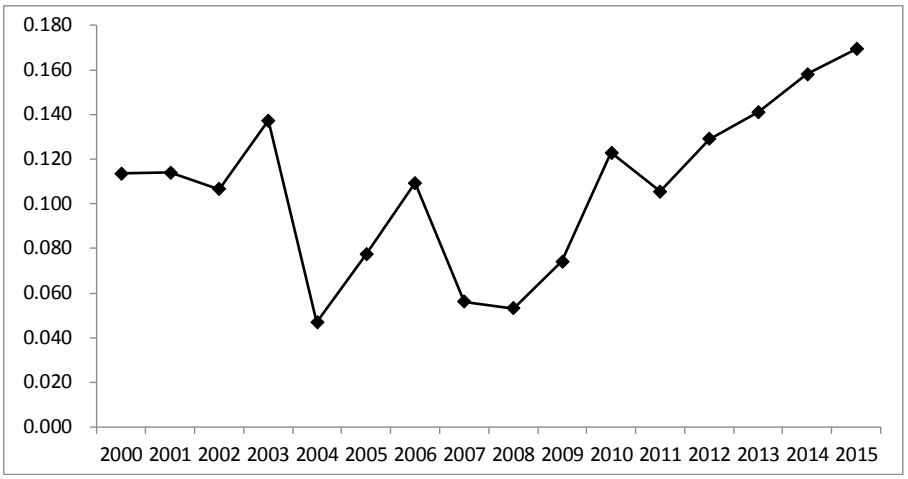

Fig.3 The Moran's I of county urbanization level in Hunan province from 2000 to 2015

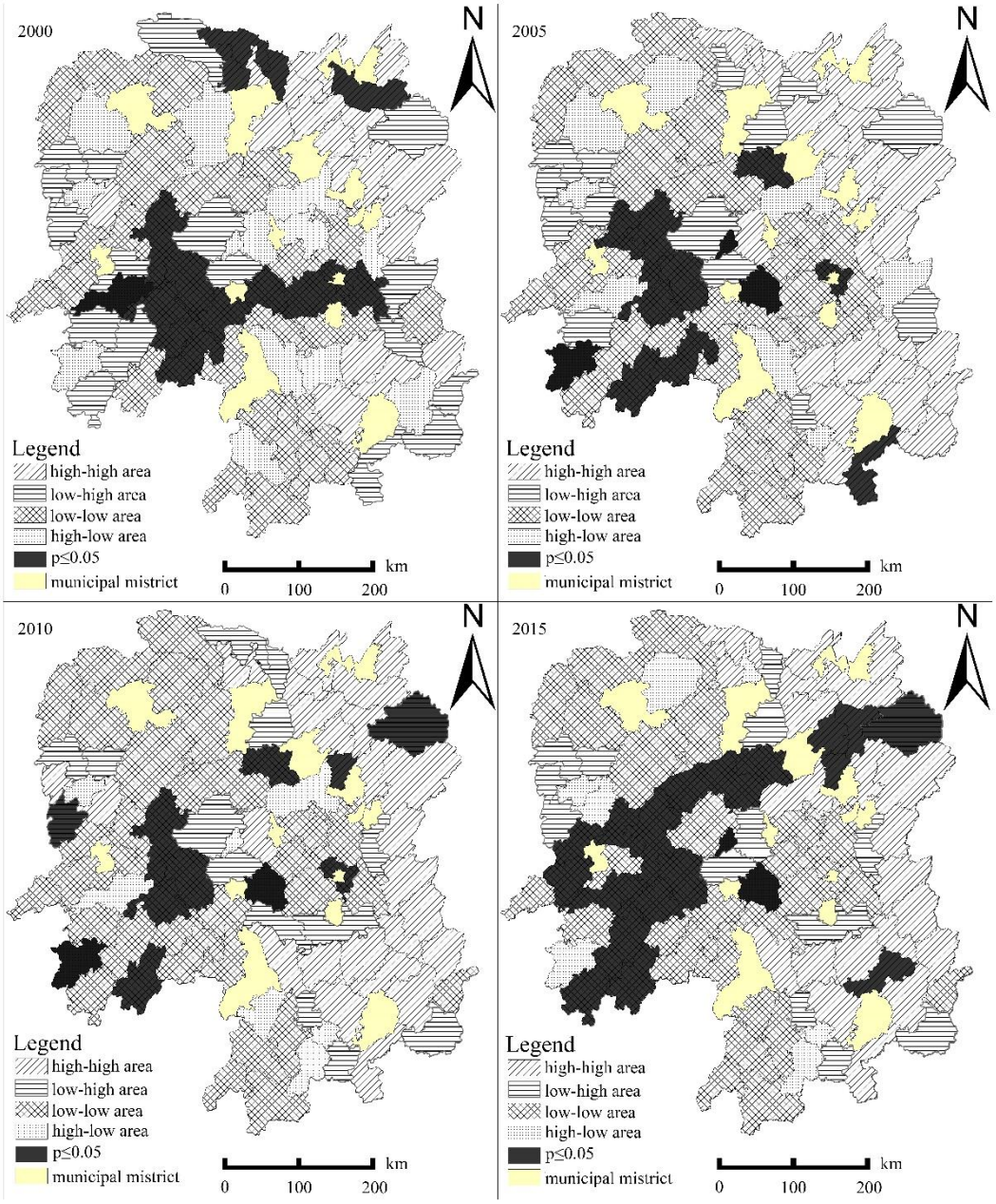

Fig.4 The spatial correlation pattern of county urbanization level in 2000, 2005, 2010, 2015

4. Analysis of influencing factors

4.1 Selection of influencing factors and explanation of variables

Based on the analysis of the influencing factors of population urbanization by previous scholars and the availability of county data in Hunan province, this paper selects per capita GDP, per capita investment in fixed assets, per capita local fiscal revenue, population density, fictitious variables of county-level cities, distance from central cities and towns, distance from Changsha city, urban and rural income gap and proportion of output value of two or three industries as independent variables.

Tab.1 Definition of Variables

Variables	Symbol	Definition
economic development	X1	per capita GDP (yuan)
investment scale	X2	per capita investment in fixed assets (yuan)
local fiscal revenue	X3	per capita local fiscal revenue (yuan)
population density	X4	man / square kilometers
virtual variables in county level cities	X5	is it a county-level city (take 1, take 0)
distance from central town	X6	the distance from county to urban area (km)
distance from Changsha city	X7	county to Changsha City distance (km)
urban and rural income gap	X8	per capita disposable income of urban residents/per capita income of rural residents (%)
proportion of output value of two or three industries	X9	the two or three industry output accounts for GDP /%.

4.2 Regression analysis of spatial coefficients of influencing factors

Considering the comprehensiveness of regression analysis, the data of population urbanization rate and nine influencing factors of each research unit in Hunan province in the past 16 years were averaged. Then, the OLS model, the spatial lag model and the spatial error model are used to estimate the parameters of the indicators in Hunan province. The results are shown in Table 2.

Tab.2 The parameter estimated result of influencing factors in urbanization level of Hunan province

index	OLS	SLM	SEM
constant	-6	-8	-4
X1	0.001***	0.001***	0.001***
X2	-2.00E-04	-2.00E-04	-0.0002
X3	0.006**	0.005**	0.005**
X4	0.007	0.007	0.0068
X5	9***	9***	9***
X6	-0.01	-0.01	-0.01
X7	-0.01**	-0.02**	-0.02**
X8	0.7	0.54	0.14
X9	25**	24**	23**
R-squared	0.606	0.608	0.614
AIC	573	574	571
SC	597	601	596
LogL	-276	-276	-276
space lag term		0.4	
space error term			0.18

Note:*, **, *** represents the significant level of 10%, 5% and 1% respectively.

From the test results in Table 2, after comparing the R-square value, AIC value, SC value and various test values, SEM regression model is most suitable to explain the county urbanization level in Hunan Province as a dependent variable. Therefore, based on the SEM regression model, the main influencing factors of the spatial distribution pattern of urbanization level can be analyzed.

From the main parameters of SEM regression model, X1, X3, X5, X7, X9 are the significant factors affecting the urbanization of county population in Hunan province. Among them, X7 is a negative parameter value, this independent variable is negatively correlated with the urbanization rate of Hunan county; the other five significant independent variables are positive; X2, X4, X6, X8 parameters are not significant.

In order to further analyze the influencing factors of county urbanization level in Hunan province, this paper uses Geo-Da software to analyze the influencing factors in Changsha-Zhuzhou-Xiangtan region (A), Dongting Lake region (B), southern Hunan region (C) and western Hunan region (D). After comparison, the SEM model is selected. The results are shown in Table 3.

Tab.3 The parameter estimated result of influencing factors in urbanization level of four region

index	A	B	C	D
constant	146***	-68**	11	-11
X1	0.002***	0.003**	0.0001	0.002***
X2	0.001***	7.00E-05	0.0007*	0.001**
X3	0.013***	0.04**	0.002	0.01**
X4	0.02***	0.03***	0.003	-0.01
X5	2.82***	17***	`10***	15***
X6	-0.24***	-0.04	-0.02*	-0.03
X7	-0.46***	-0.009	-0.02***	-0.013*
X8	-23***	18*	-0.27	2
X9	152***	27	8	39**
R-squared	0.99	0.89	0.94	0.81
AIC	21	109	120	223
SC	26	117	132	238
LogL	-0.66	-44	-50	-101
space error term	-1.14***	-0.95***	-0.85***	-0.37*

Note:*, **, *** represents the significant level of 10%, 5% and 1% respectively

Table 3 shows that all the influencing factors in Changsha-Zhuzhou-Xiangtan region are the significant factors affecting the urbanization of county population in Changsha-Zhuzhou-Xiangtan region. Among them, the parameters of X6, X7 and X8 are negative. The parameters of X6, X7 and X8 independent variables are negatively correlated with the urbanization rate of Changsha- Zhuzhou-Xiangtan region; the other six significant independent variables are positive.

X1, X3, X4, X5 and X8 are the significant factors that affect the urbanization of counties in the Dongting Lake area. All significant independent variables are positive values.

X2, X5, X6 and X7 are the significant factors that affect the urbanization level of county population in southern Hunan. The parameter values of X6 and X7 are negative, and the other 2 significant independent variables are positive values.

X1, X2, X3, X5, X7 and X9 are the significant factors that affect the level of population urbanization in the western Hunan region. The parameter values from X7 are negative, and the remaining 5 significant independent variables are positive values.

Through comparison, the results show that the economic level of Changsha-Zhuzhou-Xiangtan region, the Dongting Lake region, the western Hunan region effect their population urbanization level far

greater than the southern Hunan region, and all of them are positively correlated. . Fixed assets investment has a great impact on the urbanization level of population in Changsha- Zhuzhou-Xiangtan region, southern Hunan region and western Hunan region, and all of them are positively correlated. Population density has a positive and significant correlation with the urbanization level of population in Changsha-Zhuzhou-Xiangtan area and Dongting Lake area.

The impact of urban hierarchy on urbanization of county population is positively correlated in Changsha-Zhuzhou-Xiangtan region, Dongting Lake region, southern Hunan region and western Hunan region. While the impact of location conditions on urbanization of county population is more obvious in Changsha-Zhuzhou-Xiangtan region and southern Hunan region, but not in other regions. The narrowing of the income gap between urban and rural areas promotes the urbanization of Changsha-Zhuzhou-Xiangtan area, but hinders the urbanization development of Dongting Lake area. The proportion of output value of secondary and tertiary industries has a great influence on the urbanization level of population in Changsha-Zhuzhou-Xiangtan region and Western Hunan region, and both are positively correlated.

5. Conclusion

In this paper, the spatial and temporal patterns of urbanization level in Hunan province from 2000 to 2015 are analyzed at the county level by various measurement methods. The main conclusions are as follows: (1) The relative difference and absolute difference of the county population urbanization rate in Hunan province are obviously reduced. (2) The spatial distribution of county-level urbanization in Hunan Province shows obvious characteristics of "low in the West and high in the east", and has a trend of polarization. The number of High-High and Low-L ow regions is similar, and there is a slight increase. Both of them are absolute majority. The distribution of Low-High and High-Low regions is scattered, and the spatial distribution heterogeneity is enhanced. Per capita GDP (X1), per capita fiscal revenue (X3), county-level city virtual variable (X5), distance from Changsha (X7), the proportion of secondary and tertiary industries (X9) are the significant factors affecting the urbanization of county population in Hunan province. The influence of population density (X4), urban-rural income ratio (X8) and output value ratio of secondary and tertiary industries (X9) on the level of urbanization is obviously different in the east and west and north and south of Hunan Province, but there is no significant difference in economic level, fixed assets investment, location conditions and urban grade.

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