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Spatial Econometric Analysis of the Influencing Factors of Provincial Economic Growth in China

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Abstract. In order to explore the differences and driving factors of regional economic development in China, based on the panel data of 30 provinces in China from 2009 to 2018, by calculating Moran's I index, this paper analyzes the current imbalance and spatial agglomeration effect of regional economic development in China, and uses spatial econometric model to analyze the main factors affecting regional economic development. The results show that the economic development between provinces in China has a positive and significant spatial correlation in development. Industrial structure, urbanization level and population scale all have a significant positive impact on the economy. However, in terms of investment in science and technology, although it has a significant impact on the economic development in a short period of time, the impact degree is small; the impact of Efficiency of cargo circulation factors is not significant.

Keywords: regional economic development; science and technology investment; spatial correlation; spatial lag model;

1. Introduction

As the second largest economy in the world, China has undergone tremendous changes in economic volume, infrastructure and other construction in various provinces and cities in recent years. At the same time, with the continuous transformation of the global economic pattern, China's economic development has entered a new stage of innovation driven development. However, in terms of the development in recent years, China's industrial structure and economic power are in a stage of transformation and upgrading, with the constant adjustment of the development speed, it faces a great downward pressure on the economy.

From the national point of view, this new trend not only emphasizes the stable growth of economic structure, but also emphasizes the innovation driven development to realize the sustainable development of regional economy. However, in the node time of industrial change, how to adjust the structure and how to solve the bottleneck problem of current regional economic development are the current problems. In the same way as the economic transformation and development At the same time, the imbalance of economic development between provinces and cities, between urban and rural areas has become increasingly prominent. Based on these problems, we start with the main factors that affect the economic development at present, explore their impact on economic development, analyze the imbalance of regional development from the perspective of space, and provide theoretical suggestions for the comprehensive development of regional economy.

2. Spatial correlation analysis of provincial economic development in China

In spatial regression analysis, spatial effect refers to spatial dependence and spatial heterogeneity. Based on the requirements of spatial econometric model, it is necessary to judge whether there is spatial autocorrelation in the research variables. If there is spatial autocorrelation, then we can build a spatial econometric model. If there is no correlation, then there is no need to build the model.

In the relevant literature, the spatial autocorrelation test mainly uses global Moran's I index, local Moran's I index (LISA map), global Geary's C coefficient to measure the spatial correlation, among which, the global Moran's I index is the most widely used and most representative, so this paper selects the global Moran's I index as the measurement index.

Moran's I index is used to test whether the objects of study in the whole study area are similar, positive correlation, negative correlation or independent. The calculation formula of Moran's I index is as follows.

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

$S^2=\frac{1}{n}\sum_{i=1}^{n}\left(Y_i-\overline{Y}\right)^2$ is the sample variance, $\overline{Y}=\frac{1}{n}\sum_{i=1}^{n}Y_i$ where Y_i and Y_j represents the observed values of the study variables between regions, W_{ij} represents the spatial weight matrix. In this paper, we use 0-1 adjacency weight matrix to represent the adjacency relationship between spatial objects.

The Moran's I index is calculated with the GDP of 30 provinces and cities in China from 2009 to 2018 as sample data. We set the spatial weight matrix W as the (0-1) adjacency matrix, and get the global Moran's I index of the provincial GDP data in recent 10 years as follows

Table 1: Moran's I index with 0-1 adjacency matrix as weight matrix

year	2009	2010	2011	2012	2013
Moran' I	0.2513	0.2523	0.2483	0.2442	0.2448
year	2014	2015	2016	2017	2018
Moran' I	0.2461	0.2547	0.2717	0.2751	0.2749

It can be seen from table 1 that in the 10 years from 2009 to 2018, the Moran's I index of regional GDP data between provinces in China is positive, and the Moran's I index of adjacency matrix as spatial weight matrix passes the 5% test of significant water, which shows that the overall distribution pattern of regional GDP development in China is not random, but has a positive spatial correlation, which also shows that the regions with higher GDP usually have a kind of agglomeration phenomenon, and the regions with lower GDP also gather with the same type of regions, that is, high-high and low-low agglomeration phenomenon is obvious.

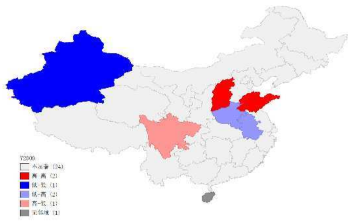

Figure 1: Lisa map of 2009

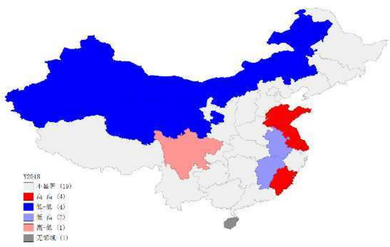

Figure 2: Lisa map of 2018

Compared with the Lisa significant image of GDP in 2009, the number of high-value clusters increased from 2 in 2009 to 4 in 2018, and Fujian Province changed from low-high (L-H) type clusters in 2009 to high-value clusters. The number of low-value clusters increased from 1 in 2009 to 5 in 2018, in which Inner Mongolia autonomous region appeared.

From the spatial change and distribution of GDP in recent 10 years, the development of regional GDP in China presents a spatial agglomeration phenomenon. Through Moran's I index, we can see that the differences in economic development between provinces and regions will become more and more obvious over time. From the current trend, China's low value agglomeration areas continue to spread in the northwest of China, while the high value agglomeration areas continue to spread in the northwest of China The gathering area is in the southeast coastal area of China, especially in Zhejiang and Guangdong.

3. Empirical analysis on the influencing factors of GDP

3.1. Variable selection

According to the theory of regional economic development and the availability of data, this paper takes the level of regional economic development as the measurement index, and takes five aspects of population scale, industrial structure, science and technology expenditure, urbanization level and regional circulation efficiency as influencing factors.

Table 2: Definition of panel data variables

Variable	symbol	Variable calculation	Unit
Economic development level	GDP	Regional GDP	Billion yuan
Population size	POP	Regional population	ten thousand people
Industrialization	IND	Proportion of secondary industry	%
Science investment	SCP	Government expenditure on science	Billion yuan
Urbanization	IND	Proportion of urban population	%
Circulation efficiency	VOT	Regional freight volume	Ten thousand tons

In order to eliminate the heteroscedasticity of data between provinces, in the following modeling process, all data are processed by taking natural logarithm, which is helpful to eliminate some heteroscedasticity and make the model results more significant.

3.2. Selection of spatial econometric model

We have proved that 30 provinces in China are related to each other from global Moran's I and local autocorrelation. In order to judge whether the current spatial econometric model is better than the traditional model and find out the specific model that should be used, we need to carry out the Lagrange multiplier (LM) test and robustness Lagrange multiplier test on the model. LM error is to test that the original hypothesis is that there is no spatial autocorrelation in error; the alternative is that the model should be a spatial error model. LM lag test is that the original hypothesis is that spatial lag variables do not have spatial autocorrelation; the alternative hypothesis is that this model is spatial lag model. The correlation test of spatial lag and spatial error is carried out between the extracted variables and each model, and the statistics and P value are shown in the table:

Table 2: Lagrange model test

	LM test	Value	P
SEM	LM	7.078	0.008
	Robust LM	6.415	0.011
SLM	LM	10.259	0.001
	Robust LM	9.595	0.002

It can be seen from the results in Table 2 that the statistics of the spatial error model is 7.078, and the statistics of the spatial lag model is 10.259, which passed the test under the condition of 1% significance level, but the significance of robust LM lag is slightly lower, P value is 0.011,. From the statistics level and significance level test results, the spatial lag model is more suitable for this model, but the LM of error model passed the significance test too, so we can also consider to build two models at the same time, and determine the final model by the final maximum likelihood ratio.

3.3. Empirical research on spatial econometric model

According to the previous LM test results, space lag model and space error model are used to model respectively. In order to better measure the goodness of fit of different models, the maximum likelihood estimation Log L value is used to represent the goodness of fit of the model. Since the selected variables are all eliminated heteroscedasticity by taking logarithm, the larger the log likelihood function, the better the fitting effect.

Table 3: SLM and SEM modeling results

	Random effects		**Time fixed**		**Spatial fixed**		**Time and space double fixed effect**	
	SLM	**SEM**	**SLM**	**SEM**	**SLM**	**SEM**	**SLM**	**SEM**
Ln POP	0.786^{***}	0.965^{***}	0.916^{***}	0.885^{***}	0.649^{***}	0.612^{***}	0.518^{***}	0.603^{***}
	(10.049)	(21.999)	(33.447)	(35.844)	(5.195)	(3.639)	(4.312)	(4.270)
Ln IND	0.133^{***}	0.202^{***}	0.233^{***}	0.299^{***}	0.135^{***}	0.219^{***}	0.265^{***}	0.261^{***}
	(4.392)	(5.357)	(5.883)	(7.713)	(4.684)	(6.139)	(6.882)	(6.888)
Ln SCP	0.136^{***}	0.093^{***}	0.117^{***}	0.138^{***}	0.128^{***}	0.082^{***}	0.099^{***}	0.091^{***}
	(9.050)	(6.340)	(6.167)	(8.809)	(9.119)	(5.920)	(6.813)	(6.152)
Ln UBL	0.585^{***}	1.068^{***}	1.483^{***}	1.466^{***}	0.505^{***}	0.716^{***}	0.487^{***}	0.679^{***}
	(6.362)	(10.374)	(21.730)	(28.310)	(5.675)	(6.737)	(5.470)	(7.091)
Ln VOT	0.015	-0.058^{***}	-0.001	-0.004	0.004	-0.059^{***}	-0.001	-0.023
	(0.623)	(-2.874)	(-0.063)	(-0.232)	(0.188)	(-3.037)	(-0.031)	(-1.038)
α	0.641^{***}		-0.006		0.688^{***}		0.366^{***}	
	(22.192)		(-0.390)		(25.089)		(6.960)	
β		0.960^{***}		-0.475^{***}		0.970^{***}		0.429^{***}
		(96.476)		(-5.732)		(128.971)		(6.231
Log L	631.6615	613.7633	442.4599	457.5335	745.4254	701.5643	779.4904	773.2812

*** means passing the test with 1% significance level, ** means passing the 5% significance test, * means passing the test with 10% significance level, α means the spatial lag term, β means the spatial error term, and t value in brackets

From the results in Table 3, under these four effect modes, the spatial error model (SLM) is more effective, which also verifies the correctness of the previous Lagrange multiplier (LM) test

According to the four different effect modes in SLM model, from the log likelihood coefficient value, the fitting degree is the best under the spatiotemporal fixed effect model, whose log L value is 779.4904. Therefore, this paper selects the special lag model (SLM) based on spatiotemporal fixed effect as the model result for analysis.

The coefficients of the final fitting model show that: the population scale, industrial structure, investment in science and technology and urbanization level of the province are all positive and significant, so these four factors have a positive correlation with the level of regional economic development. However, from the fitting results of these eight models, we can see that more than half of the factors of regional internal cargo circulation efficiency are not obvious. Therefore, we remove it from the model and re fit the spatial lag model (SLM) based on the fixed effect of time and space. The results are shown in Table 4

Table 4: Results of spatial lag model under fixed effect of time and space

Variable	Coef.	Z	P
Ln POP	0.5186	6.96	0.0000
Ln IND	0.2646	6.83	0.0000
Ln SCP	0.0991	4.32	0.0000
Ln UBL	0.4864	5.70	0.0000
A	0.3655	7.05	0.0000
R2	0.9194		
Mean of fixed-effects	-0.1335		
sigma2_e	0.0003		
Log Likelihood	779.4901		

It can be seen from the spatial lag model (SLM) of fixed effect of time and space that the population scale, industrial structure, investment in science and technology and urbanization level all play a significant role in the development of regional economy, among which α = 0.3655 and pass the 1% significance level test, it can be seen that the spatial lag does have a certain impact on the model, and the results show that from the perspective of space, The improvement of China's regional economy is affected by many factors, and there is a strong interregional correlation in its development. The expansion expression of the specific model is as follows:

$$LnGDP_{it} = 0.5186 LnPOP_{it} + 0.2646 LnIND_{it} + \\ 0.0991 LnSCP_{it} + 0.4864 LnUBL_{it} + 0.3655 \sum_{j=1}^{30} W_{ij} LnGDP_{jt} + \mu_i$$

Finally, the fitting results show the population size, science and technology input, industrial structure and urbanization level coefficient of each province are all positive, so these four factors are positively related to the GDP.

(1) the coefficient of the total population of each province (Ln POP) is 0.518, and it passes the significance level test of 1%, which indicates that it is not considered. Under the influence of other factors, for every 1% increase in regional population, the average GDP will increase by 0.518%. In the case of rapid economic development, the size of population means the potential of regional economic development. Generally speaking, the larger the population, the greater the total economic output.

(2) the coefficient of industrial structure (Ln IND) of each province is 0.265, passing the test of 1% significance level, which shows that under the condition of remaining unchanged in other situations, every 1% increase in the proportion of the secondary industry will bring about an increase of 0.265% of the GDP. The level of industrialization reflects the regional production and manufacturing capacity, which plays a certain role in promoting the regional economic development. However, with the continuous rise of the tertiary industry in China, the impact of the secondary industry on the economy will be reduced.

(3) the coefficient of government expenditure on science and Technology (Ln SCP) is 0.099, which means that every 1% increase in government expenditure on science and technology will generate an increase of 0.099% in GDP, and passes the test of 1% significance level. At present, China has changed it stage from "made in China" to "create in China". The development of science and technology is conducive to promoting the transformation and upgrading of China's industrial structure, reducing the consumption rate of resources per unit of GDP, improving energy intensity and expanding output, to realize the continuous development of economy. However, there is a certain lag quality in science and technology, which makes it difficult to convert it into social productivity immediately. Which indicates that the government's input in science and technology has a limited impact on social and economic development in a relatively short period of time.

(4) the coefficient of urbanization level (Ln UBL) is 0.487, which is a positive number. passes the test of 1% significance level, the level of urbanization between provinces and cities is positively related to the level of economic development. For every 1% increase of urbanization level, the regional GDP increases by 0.487% on average. As a developing country, with the continuous development of social economy in recent years, China's urbanization level is also constantly improving, among which, one of the most important factors affecting the economy is infrastructure construction. Sound infrastructure can improve the ability of urban development and services and provide adequate guarantee for economic development.

4. Conclusions

From the perspective of space, this paper discusses the influencing factors and functions of regional economic development in China. Firstly, by calculating Moran's I index, this paper analyzes the spatial correlation of economic development level among 30 provinces in China from 2009 to 2018. The results show that there is a significant positive spatial correlation between regional economic development in China, that is, there are a large number of H-H and L-L agglomeration regions. Then through the establishment of spatial lag model, the paper mainly focuses on the analysis of the four main influencing factors facing the current social development. The regional population scale, urbanization level and industrial structure are the main factors affecting the regional economic development, while the government's investment in science and technology is not so obvious in promoting the economic development.

In recent years, although the regional economy of China is constantly developing, the Moran’s I index is also showing a rising trend, which means that the spatial correlation of the economic development of all provinces and cities is increasing. On the one hand, the spatial spillover effect of the more developed regions promotes the development of the adjacent regions, but on the other hand, it also shows that the imbalance of regional economic development makes the economic gap between different regions bigger and bigger. Based on the above conclusions, we propose the following suggestions for the future development of provinces:

In view of the imbalance of regional economic development, except of the optimization of resource allocation by the state from macro-control and other aspects, provinces can make full use of administrative and legal means, formulate and improve regional economic development and productivity distribution policies, and provide guarantee for the market mechanism to play a role in the normal economic and technological links between regions and the flow of production factors. On the other hand, we should also speed up the pace of urbanization, increase the overall planning and construction of major infrastructure such as road traffic and production services, and provide the basis for cross regional economic ties.

Pay attention to the strategic adjustment of economic structure. Different provinces and regions should comprehensively investigate the industrial development of themselves and their neighboring regions, take the comprehensive market as the guide, promote the coordinated development of the whole region, actively develop the high-tech industries that have a breakthrough role in economic growth, cultivate and support new economic growth, and improve the integration of industrial structure, accelerate the pace of its transformation from an advanced form.

Under the influence of policies such as environmental protection and industrial structure upgrading, the government should increase investment in science and technology, accelerate the implementation of innovation driven development strategy, build a high-tech cooperation platform, improve the transformation efficiency between science and technology and productivity, shorten the development cycle, minimize the impact of location factors, with scientific and technological innovation as its support point, form an industrial pattern with high-tech industries as the guide, basic industries and manufacturing as the support, and the service industry developing in an all-round way.

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