



Research on the Spatial Evolution of the Coordination Degree Between Basic Public Services and Economic Development

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Abstract. With the in-depth development of intelligent society, providing high-quality public services has become an important topic in the modernization of national governance system and governance capacity. In order to investigate the quality of public services in China, this paper selects the relevant data of 31 provinces in China from 2011 to 2019 in the China Statistical Yearbook to study the coordination between basic public services and economic development. Firstly, the entropy method is used to calculate the comprehensive score. Secondly, the coordination degree is calculated by using the coupling coordination degree model. Thirdly, the global autocorrelation and spatial autocorrelation index are calculated by using the spatial autocorrelation model, and the spatial changes are displayed by ArcGIS. We found that: (1) the coordination level between basic public services and economic development has gradually improved. (2) The degree of coordination has obvious spatial differentiation. (3) The value gradually expanded from the Yangtze River Delta and the Pearl River Delta to the West. This study can provide reference for promoting the construction of basic public services and regional integration.

Keywords: Coupling coordination degree · Entropy method · Spatial autocorrelation model

1 Introduction

High quality public service is an important embodiment of the modernization of national governance system and governance capacity. With the continuous development of intelligent society, citizens put forward higher requirements for the improvement of public service quality. In this context, based on the integration and analysis of spatial information, thinking about how to improve the quality of basic public services, how to cross the isolated islands of public service information between regions, and how to strengthen the linkage and cooperation of public services between regions has become an important topic for the high-quality development of economy and society.

The existing studies mostly use the coupling coordination model to explore the interaction relationship or coordination difference between basic public service expenditure and economy development level or urbanization [2], mostly take a certain province or region as the research unit [1, 3, 4, 6], and the data are mostly the cross-sectional data of a certain year(3; 4; 5), while there are few studies on the spatial evolution of the coordination degree across the country. This paper constructs the coordination degree evaluation index system of basic public services and economic development, uses the coupling coordination degree analysis model, makes a quantitative study on the coordination relationship between them in 31 provinces from 2011 to 2019, and analyzes its temporal and spatial pattern characteristics.

2 Index and Data Source

This paper introduces the evaluation of coordinated development index to evaluate the coordination relationship. Firstly, this paper selects total GDP, per capita income of residents and proportion of secondary and tertiary industry to quantify the economic development subsystem. Secondly, this paper selects education, medical care, social security, culture and housing security in the list of National Basic Public Services in the 13th Five Year Plan, with a total of four indicators to quantify the basic public service subsystem. On this basis, this paper finally evaluates the coordination degree of the two subsystems. The data are from China Statistical Yearbook from 2012 to 2020 (Table 1).

Table 1. Evaluation Index of Coordination Relation

	<i>Index</i>	<i>Unit</i>
Basic public service	Education expenditure	Ten thousand yuan
	Social security expenditure	Ten thousand yuan
	Medical expenditure	Ten thousand yuan
	Cultural expenditure	Ten thousand yuan
	Housing security expenditure	Ten thousand yuan
Economic development	Total GDP	Billion yuan
	Per capita income of residents	Yuan
	Proportion of secondary and tertiary industries	%

3 Method

3.1 Data Pre-processing

In order to eliminate the influence of dimension and magnitude, the raw data need to be standardized using formulas (1), (2). For positive index

$$x'_{ij} = \frac{x_{ij} - \min_{1 \leq j \leq n} x_{ij}}{\max_{1 \leq j \leq n} x_{ij} - \min_{1 \leq j \leq n} x_{ij}} \quad (1)$$

while, for negative index

$$x'_{ij} = \frac{\max_{1 \leq j \leq n} x_{ij} - x_{ij}}{\max_{1 \leq j \leq n} x_{ij} - \min_{1 \leq j \leq n} x_{ij}} \quad (2)$$

where, x'_{ij} and x_{ij} represent the standardized value and the original value of index j in year i , respectively; $\max_{1 \leq j \leq n} x_{ij}$ and $\min_{1 \leq j \leq n} x_{ij}$ indicate the maximum and minimum value of index j among all years, respectively.

3.2 Evaluation of the Subsystems

Suppose x_1, x_2, \dots, x_p represent the indexes of basic public service subsystem, and y_1, y_2, \dots, y_q represent the indexes of the economic development subsystem, then

$$b(x) = \sum_{b=1}^p \omega_b x'_b \quad (3)$$

$$e(y) = \sum_{e=1}^q \omega_e y'_e \quad (4)$$

where, $b(x)$ and $e(y)$ are the integration value of basic public service subsystem and the economic development subsystem, respectively; x'_b and y'_e are the standardized value of x_b and y_e respectively, which can be calculated by x_b and y_e described above; ω_b and ω_e are the weight of x_b and y_e respectively, which can be calculated by information entropy weight.

After unifying and standardizing the indicators, the entropy method is used to calculate the weight coefficient of each indicator, and the overall scores of basic public service expenditure and economic development are obtained respectively. On this basis, the coordinated development index is calculated. Considering the length limitation of the article, the specific calculation process will not be repeated. Please refer to the references for detailed steps [5].

3.3 Coupling Coordination Degree Model

The coupling coordination degree model is given in the following formulas:

$$D = \sqrt{C \times T} \quad (5)$$

$$C = \left\{ \frac{b(x) \times e(y)}{\left[\frac{b(x)+e(y)}{2} \right]^2} \right\}^{\frac{1}{2}} \quad (6)$$

$$T = \alpha \times b(x) + \beta \times e(y) \quad (7)$$

where, D represents the degree of coupling coordination, and $D \in [0, 1]$; C represents the degree of coupling between basic public service and economic development; T reflects the overall level of basic public service and economic development; α and β represent the contribution of basic public service and economic development, respectively. The values of α and β are equivalent, i.e. $\alpha = \beta = 0.5$.

3.4 Spatial Autocorrelation Model

The global Moran's I index mainly examines the spatial distribution of coordination degree as a whole, which is decentralized, clustered or random. If it is significantly positive, it indicates that a spatial agglomeration pattern in geographical distribution. If it is significantly negative, it indicates a spatial pattern of scattered distribution. The main formulas are as follows:

$$I = \frac{\sum_{i=1}^n \sum_{j \neq 1}^n w_{ij}(x_i - \bar{x})(x_j - \bar{x}) / S^2}{\sum_{i=1}^n \sum_{j \neq 1}^n w_{ij}} \quad (8)$$

$$S^2 = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2 \quad (9)$$

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \quad (10)$$

The local Moran's I index is used to identify whether there is spatial agglomeration in the local part of the coordination degree. If it is significantly positive, it indicates agglomeration. If it is significantly negative, it indicates distributions with large spatial differences. The main formulas are as follows:

$$I = n z_i \sum_j w_{ij} z_j / z_i^T z = z_i' \sum_j w_{ij} z_j' \quad (11)$$

$$z_i = (x_i - \bar{x}) / \sqrt{\sum_i (x_i - \bar{x})^2 / n} \quad (12)$$

4 Findings and Results

According to the coupling coordination degree evaluation model, the coupling coordination degree index of basic public services and economic development from 2011 to 2019 can be calculated.

4.1 Overall Analysis

According to the overall national data, from 2011 to 2019, the coordination showed a slight upward trend, as shown in Table 2. Referring to the commonly used median segmentation methods in academic circles, we respectively define 0–0.3, 0.3–0.5, 0.5–0.8 and 0.8–1 as low, medium, high and extreme coordination stages. Data show that from 2011 to 2015, the correlation degree has always been in a medium coordinated stage. After several years' steady maintenance, since 2016, the correlation degree has entered a highly coordinated stage and continuously improved.

In Fig. 1, the X-axis represents the year, and Y-axis represents the coordination degree between expenditure of different project and economic development, respectively. As shown in Fig. 1, the coordination degree between social security expenditure and economic development is the highest, better than that of other projects. In terms of grow speed, the ranking from high to low is: social security, medical care, culture, education and housing security. From the perspective of numerical changes, during 2011 to 2018, the coordination was in a moderate coordination stage; while when it comes to 2019, the coordination begins to enter a highly coordinated stage.

4.2 Curve Fitting Analysis

To further explore the regularity of coordination degree, this article selects basic public services as the independent variable and economic development as the dependent variable, and uses MATLAB to explore the trend. Assuming that there is a nonlinear interaction between them, the linear, quadratic, cubic, exponential and other models are selected for regression fitting by means of curve regression estimation. By comparing the fitting degree and sig value, it is finally found that the fitting effect of the quadratic term model is the best, and the fitting equation is (Tables 3 and 4):

$$y = Intercept + B_1 * x + B_2 * x^2 \quad (13)$$

Table 2. Annual coordination value

year	2011	2012	2013	2014	2015
value	0.38	0.41	0.43	0.46	0.49
year	2016	2017	2018	2019	
value	0.51	0.53	0.55	0.57	

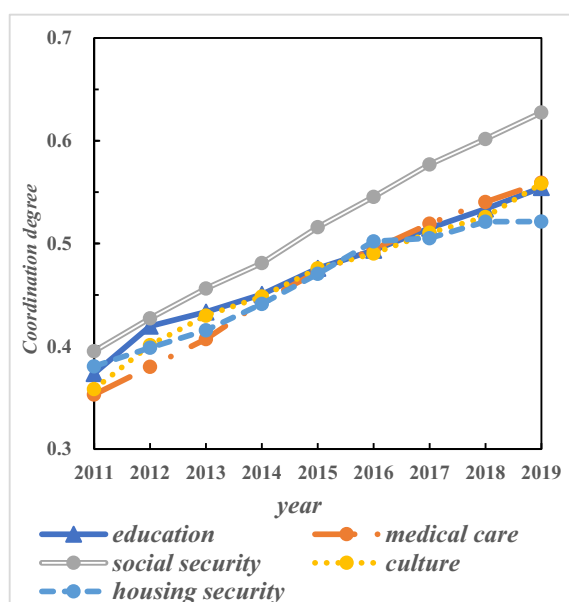


Fig. 1. Coordination degree between various expenditures and economy

Table 3. Model summary

R square	Adjusted R-square	F	Sig.
0.99273	0.9903	424.127	0.000

Table 4. Parameter estimate

Intercept	B ₁	Sig.	B ₂	Sig.
-0.21471	2.1421	0.003	-1.7339	0.077

In Fig. 2, the X-axis and Y-axis represent the composite scores of the level of economic development and the comprehensiveness of basic public services, respectively. According to the entropy method, the highest composite score is 1. It can be seen from the fitting curve that the coordination degree is a gradually rising curve from 2011 to 2019, indicating that the expenditure on basic public services is rising steadily with the improvement of economic development level.

4.3 Spatial Autocorrelation Analysis

In order to further explore the spatial pattern of coordinated development of public services and economy, this paper calculates the global Moran's I and local Moran's I

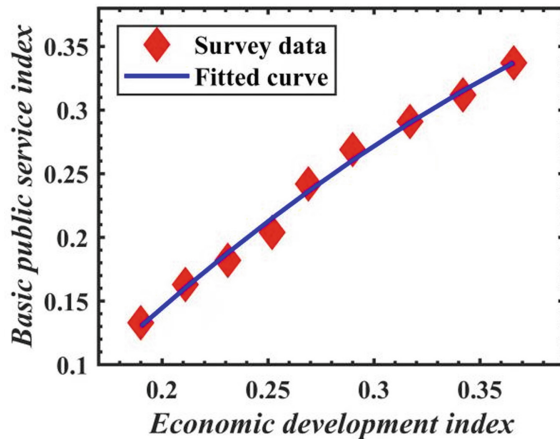


Fig. 2. Curve fitting of coordination degree

Table 5. Global autocorrelation Moran’s I

year	2011	2012	2013	2014	2015
Moran’s I	0.189	0.208	0.204	0.219	0.235
Z value	2.062	2.22	2.190	2.318	2.473
P value	0.039	0.026	0.029	0.020	0.013
year	2016	2017	2018	2019	
Moran’s I	0.221	0.232	0.240	0.249	
Z value	2.346	2.445	2.520	2.593	
P value	0.019	0.014	0.011	0.009	

from 2011 to 2019, and obtains the spatial distribution map based on GIS platform, as shown in Table 5.

According to the global autocorrelation analysis, the coordination relationship has been showing a strong spatial positive correlation from 2011 to 2019. According to the calculation, the global Moran’s I show an increasing trend. The Z values of the normal statistics pass the significance level test of 1%, and the P value is less than 0.05. This shows that in the past nine years, there are obvious spatial differences in the degree of coordination among provinces. High value areas and low value areas gather separately, and the trend of spatial differentiation is gradually deepening.

Through local autocorrelation analysis, it can also be verified that the coordination degree shows an obvious splitting form. This paper selects the spatial autocorrelation cross-sectional data of 2011, 2015 and 2019 to research the spatial trend, as shown in Fig. 3.

High-high clustered areas are mainly concentrated in the middle and lower reaches of the Yangtze River, with the number increasing from 6 in 2011 to 9 in 2019. Spatially,

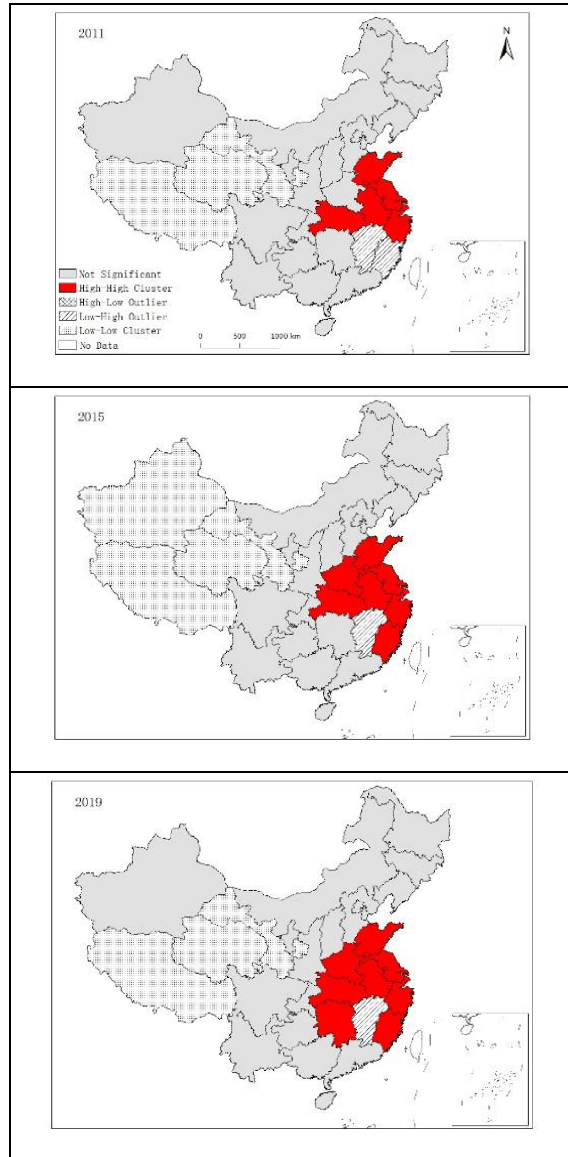


Fig. 3. Spatial agglomeration map. (Photo credit: Original)

they gradually spread from the Yangtze River Delta to the West and south. It shows that the Yangtze River Delta centered on Jiangsu, Zhejiang and Shanghai has indeed played a radiating and driving role in the development of basic public services and economic coordination of surrounding provinces, forming a good trend of large-scale agglomeration development.

Low-low clustered areas are mainly concentrated in the northwest and southwest, which is still a depression for public service development and economic development. From the change trend within 9 years, the western provinces are still concentrated with low value, indicating that the radiation driving effect between the provinces is weak. It also shows that the western region has failed to form a linkage pattern of coordinated progress and common development of public services.

4.4 Spatial Distribution and Evolution

In order to further clarify the spatial distribution and evolution trend of the coordination degree between public services and economy, this paper uses GIS platform to draw the provincial distribution map of the coordination degree, and selects the cross-sectional data of 2011, 2015 and 2019, as shown in Fig. 4.

In terms of quantity, the coordination level of public services and economy in all provinces has maintained an upward trend. The number of provinces and regions with extreme and high coordination increased from 3 in 2011 to 18 in 2019, and the number of provinces and regions with moderate and low coordination gradually decreased. Until 2019, all 31 provinces entered the stage of moderate coordination.

From the perspective of spatial distribution, the degree of coordination gradually forms an obvious circle structure in each province. The eastern coastal provinces represented by Shandong, Jiangsu, Zhejiang and Guangdong have formed a high-level core circle of coordination. The central and western provinces represented by Shanxi, Henan, Hubei, Hunan and Sichuan form a sub core circle. Remote provinces and regions represented by Heilongjiang, Jilin, Xinjiang, Qinghai and Tibet have formed peripheral circles. There is an obvious degree of coordination gradient difference between each circle.

From the perspective of pattern evolution, the provinces with high coordination degree gradually spread from east to west, and gradually spread from the Yangtze River Delta to the vast central region. Highly coordinated provinces and regions are distributed in scattered points at first, then in clusters and blocks, and finally form a cluster distribution form, which is concentrated in the middle and lower reaches of the Yangtze River. However, remote areas such as northeast, northwest and southwest have not yet entered the radiation range of high-value areas.

4.5 Reasons for Spatial Pattern

From the above analysis, it can be seen that the coordination degree of basic public services and economy shows obvious spatial differentiation nationwide. The reasons are as follows.

The circle differentiation of coordination degree is affected by the spatial pattern of regional economy. The eastern coastal area represented by the Yangtze River Delta has always been an economically developed area. Relying on its superior geographical location and transportation advantages, it has formed a good economic foundation and realized the rapid promotion of basic public services. At the same time, the improvement of the level of basic public services has accelerated the construction of regional soft environment, rapidly gathered production factors such as talents, capital and technology,

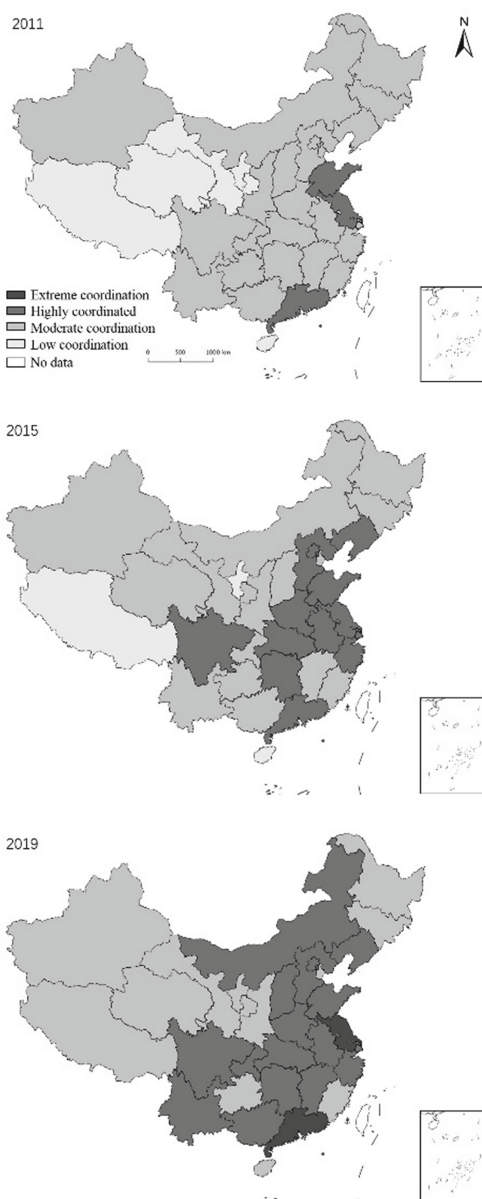


Fig. 4. Coordination degree distribution map. (Photo credit: Original)

and further promoted the rapid development of local economy. Moreover, due to the existence of circular cumulative effect, economic development and basic public services form a benign coupling interaction.

The spatial pattern evolution of national policy for coordination degree forms an external action mechanism. In order to balance the economy and basic public services

between national and local governments through the introduction of regional policies to promote economic development and corresponding planning and improve the supply of basic public services. The corresponding measures of capacity, increase the support for backward areas, and improve the economic development and basic public services of backward areas to a certain extent coordination ability.

The radiation driving effect between provinces and regions affects the formation of high-value and low-value aggregation patterns. Highly coordinated provinces not only drive the economic development of surrounding provinces and regions through the flow and transfer of economic factors such as capital, talents, technology and market, but also play an exemplary and leading role in neighboring areas through the dissemination of basic public service policies and ruling ideas. Therefore, the highly coordinated province produces the welfare overflow of economic factors and public policies, radiating and driving the coordinated development of basic public services and economy in the region.

5 Conclusions

BY constructing the coordination degree evaluation index system of basic public services and economy, selecting the data from 2011 to 2019, using the coordination degree evaluation model, this paper makes a quantitative study on the coordination relationship between basic public services and economic development in 31 provinces, and research its temporal and spatial pattern characteristics. The conclusions are as follows:

The coordination level of basic public services and economy in 31 provinces has gradually improved, and gradually crossed from moderate coordination to high coordination, indicating that the balanced development relationship between basic public services and economic development has been improved day by day. From the perspective of specific projects, the level of coordination between social security construction and economic development is the highest.

The fitting law between public services and economy is that the degree of coordination between them increases gradually, that is, with the improvement of economic development level, the expenditure on basic public services increases steadily. After the degree of coordination reaches a certain peak, the growth rate will slow down.

There are obvious regional differences in the coordination degree between basic public services and economy, and the provinces with high coordinated dispatching and the provinces with low coordinated dispatching gather respectively. In terms of spatial evolution, high cooperative scheduling has gradually evolved from point distribution to cluster pattern in space, and the spatial agglomeration effect is still strengthening.

The coordination degree gradually presents a typical circle structure in space, and there is an obvious gradient difference of coordination degree between circles. The coordination degree of the eastern coastal area is significantly higher than that of the western inland area and Northeast China. In terms of spatial evolution, the highly coordinated area shows an obvious trend of gradually spreading from the Yangtze River Delta and the Pearl River Delta to the West, as shown in Fig. 4. It is proved that there is spatial correlation between adjacent provinces, that is, high-value provinces play a radiation effect to drive the coordinated development of surrounding provinces.

Based on the above conclusions, this paper puts forward the following suggestions. Firstly, Expand the leading role of core provinces by improving digital means such as

regional transportation and information technology networks. Secondly, establish cross-provincial and regional counterpart cooperation and assistance mechanism and build a regional basic public service sharing platform.

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