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Comprehensive Evaluation of Government Economic Management Performance Based on Multidimensional Data Mining

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Abstract The economic and social environment is constantly changing, the government's economic management functions are facing transformation, and the exploration and innovation of the construction of local government economic management performance system is necessary. This paper takes fairness and efficiency as the basic value orientation, selects key indicators from multiple dimensions, and constructs a set of scientific and feasible local government economic management performance evaluation indicators. Twenty provinces in China are selected as research objects, and the entropy method is adopted to determine the weights of each index, combined with the TOPSIS method to make a horizontal comparison of different provinces. And the kernel density estimation method and convergence model are used to analyze the dynamic evolution characteristics and convergence characteristics of the economic management performance level of the Chinese government. The experimental results show that although the average value of the Chinese government's economic management performance composite score has increased by 0.118 during the period of 2016-2021, there are still some differences in the government's economic management performance level in different provinces. Except for the Northeast region, all other regions in China have σ convergence and conditional β convergence. The research in this paper provides a scientific basis for the government to formulate targeted regional economic management strategies and helps to promote the coordinated development of regional economy.

Index Terms entropy method, TOPSIS method, kernel density estimation method, convergence model, government economic management performance evaluation

I. Introduction

All walks of life have been discussing the government's economic management function for a long time, and the correct handling of the relationship between the government and the market is of great significance to the construction of the socialist market economy, and how to make good use of this “visible hand” is a matter of concern to us [1]-[3]. Since the implementation of the reform of fiscal decentralization, the proportion of local government financial expenditure has continued to rise, and now has become the main part of the government's total financial expenditure [4], [5]. Over the past forty years of reform and opening up, China has created a miracle of economic development. Among them, the central government's support to localities and the local governments' implementation of the central government's policies in accordance with local conditions and differentiation have played a crucial role [6]-[8]. In the new era, China is turning to the high-quality stage of economic development, and at this critical moment it is even more necessary for local governments to accelerate the adjustment and improvement of their own economic management functions and improve their economic management capabilities [9]-[11].

With the transformation of the government's economic management functions, the government performance appraisal system is also changing [12]. At present, in the performance appraisal of the local government's economic level functions, there are fewer and fewer cases in which the appraisal method of local development is measured purely by GDP and GDP per capita [13], [14]. At the same time, the diversification of government functions, the connotation of enrichment, so that in the actual assessment process there are many achievements are difficult to quantitatively assess from the perspective of the results, and performance assessment in the “tracerism” of the problem is more and more prominent [15]-[17]. For this reason, it is necessary and urgent to establish a reasonable comprehensive performance evaluation system to guide local government cadres to establish a correct view of political performance for the construction of a strong socialist modernized country [18]-[20]. By building a scientific and perfect performance comprehensive evaluation system with distinctive characteristics of the times, clarifying the content of the economic management functions of the local government, helping the local government to

establish the work direction and work objectives, and helping officials and cadres to establish a scientific view of performance, so that the above problems can be effectively solved [21]-[24].

Literature [25] put forward the optimization design scheme of comprehensive evaluation of government economic management performance based on multidimensional data mining, and based on data mining technology, built an evaluation model combining subjective and objective criteria, which has good application prospects and practical value by comprehensively evaluating the effectiveness of government economic management. Literature [26] evaluates the economic development performance of local governments in China based on data envelopment analysis and hierarchical analysis, and the results point out that the economic performance of local governments shows a growing trend, and after deducting the advantages due to location and political connections, the economic performance of provinces in the eastern region is not better than that of other regions. Literature [27] examined the development of external government performance evaluation (EGPE) in China, and pointed out that the overall quality of EGPE in China is high, while there are some serious problems, which need to improve its independence, validity and reliability. Literature [28] applied multidimensional data mining techniques to the comprehensive evaluation modeling of economic management efficiency in smart cities, aiming to improve the quality of the comprehensive evaluation of economic management efficiency in smart cities, and demonstrated that the proposed method can ensure the efficiency and precision of the evaluation compared with the traditional evaluation methods. Literature [29] aimed at economic evaluation of the management of municipal corporations at the level of rural local self-government based on selected economic indicators and showed that the differences in the profitability of municipal corporations are not statistically significant based on the perspective of the area of operation and the number of employees. Literature [30] launched a comprehensive assessment of the local government management performance hypothesis based on literature review and stated that current research focuses importantly on the concepts of strategic content, planning, and employee quality, and the evidence suggests that employee quality, staff stability, and planning have a significant positive impact on performance.

This paper proposes a government economic management performance evaluation program based on multidimensional data mining to provide a basic basis for economic management policy formulation. The economic management performance of local governments in each province is evaluated from the perspectives of management equity and management efficiency. Twenty provinces in China are selected as the evaluation objects, and the study is based on six years of yearly data from 2016 to 2021. The objective data-driven entropy-based method is used to assign weights to each evaluation index, and the proximity of the government's economic management performance of each city is measured based on the TOPSIS method to further explore the differences in the level of different economic management performance of each city. The dynamic evolution characteristics and spatio-temporal convergence characteristics of the development of Chinese government's economic management performance level are also analyzed through kernel density estimation and convergence model, respectively.

II. Realization of government performance evaluation management platform based on big data

II. A. Architecture of the Government Performance Evaluation Management Platform

The architecture of the government performance evaluation management platform based on big data is shown in Figure 1.

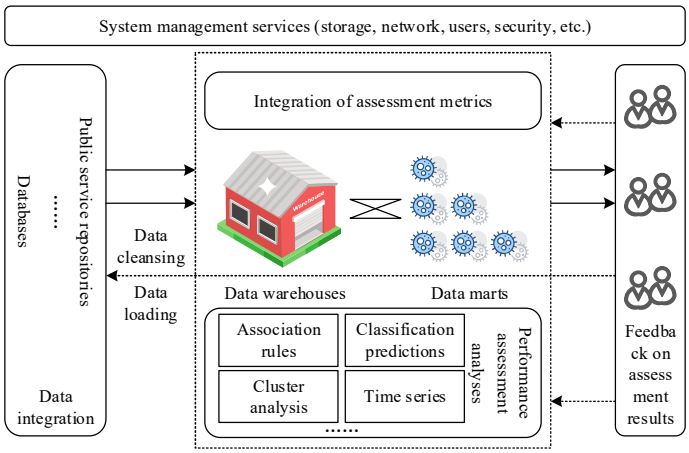

Figure 1: Government performance evaluation management platform

It consists of five layers: government dataset layer, evaluation index integration layer, performance evaluation analysis layer, evaluation result feedback layer, and system management service layer.

The government dataset layer is the basic data source for government performance assessment, which contains heterogeneous data sources distributed in various systems. After establishing the departure mechanism for heterogeneous data sources, the data required for government performance assessment can be incrementally integrated into the data warehouse to ensure the accuracy of the basic data. This layer contains data extraction, data conversion, data cleaning, and data loading. Heterogeneous data are integrated into structured data storage as much as possible, forming a new model to facilitate contact with the indicator system integration layer.

The integration layer of assessment indicators can split the unified government performance assessment indicator system and reconstruct personalized assessment indicators by theme association and data mart. Due to the complex structure of government assessment objects, assessment indicators are often composed of several indicators according to hierarchical relationships. Each indicator includes four aspects, including indicator connotation, assessment benchmark, weight and relevance, quantitative and qualitative modes, and so on. After the performance assessment analysis, the feedback on the personalized assessment indicators is obtained at the feedback layer of the assessment results, and is iteratively refined in turn.

The assessment results feedback layer not only contains feedback on the government performance assessment results, but also produces assessment results that contain feedback on the first three layers. The feedback layer identifies and analyzes the government's strengths, potentials, general government, and special government by visualizing the assessment results. The government construction is tracked over time to observe its development and progress. The feedback layer improves the application of each layer through iterative correction.

The system management service layer consists of 2 parts, platform management and data warehouse management. Platform management contains storage management, network management, user management and security management. This layer is relatively independent and provides information delivery services for the remaining 4 layers.

II. B.Government Performance Assessment Based on Big Data Mining

After completing the modeling of basic data and the modeling of assessment indicators, the fact table is used as the core, combined with dimension tables and data loading tools to provide data information to the data warehouse.

The performance evaluation management platform evaluates the performance of each government through different dimensions by using big data mining algorithms. Using classification prediction mining algorithms, a classification function is established to map governments that satisfy the conditions of the function to a given category to achieve the prediction goal. Decision tree algorithms, plain Bayesian algorithms, Bayesian network algorithms, neural network algorithms, etc. can be applied to make classification predictions.

Cluster analysis algorithm is used to divide the governments into clusters, where the performance of governments in the same cluster is similar and the performance of governments in different clusters varies widely. K-means algorithm based on division, BIRCH algorithm based on hierarchy, DB-SCAN algorithm based on density, STING algorithm based on lattice, etc. can be applied for cluster analysis. Association rule mining can be utilized to discover connections between different governments, promote cooperation between governments, and improve government performance. Apriori algorithm, FP-tree algorithm, etc. can be applied for association rule mining. Apply time series patterns to predict the development of government performance based on the trend of the underlying data over time.

III. Performance evaluation of local government economic management based on the TPOSIS method

III. A. Methodology for calculating indicators and description of data

Due to the large number of indicators, the overall indicator data loss is high. Among them, due to the limited access of individuals to information □ resources channels, to ensure the reliability of the empirical analysis results in the evaluation of the samples with missing indicator values were deleted. The lack of data on the built-up area of individual cities makes it impossible to standardize the caliber in the measurement of resource allocation efficiency, so the samples of these cities are deleted, and finally we get the complete evaluation index data of 30 cities in China.

(1) Gini coefficient of regional differences

Gini coefficient [31] is often used to measure the degree of equality of income distribution, and its essential idea is similar to the coefficient of variation, Herfindahl index, etc., which is to measure the variability of the distribution of a set of data and to make the results calculated based on different value vectors comparable. In order to get the difference of economic level between regions within provinces, this paper takes the data of China County Statistical Yearbook as the basis and the data of provincial statistical yearbooks as the supplement. Taking the districts and

counties included in cities above prefecture level as individuals, the GDP per capita data of each district and county are substituted into the direct measurement formula of Gini coefficient to get the Gini coefficient reflecting the regional differences, and the Gini coefficient value of the city is obtained. The direct measurement formula for the Gini coefficient is as follows:

$$G = \frac{1}{\mu N(N-1)} \cdot \sum_{i>j} \sum_{j} \left| y_i - y_j \right| \tag{1}$$

where G_n is the Gini coefficient of the n th city, μ is the expected value of the overall income of each equal subgroup, N is the number of observations, and y_i is the gross regional product of individual i.

(2) Thiel coefficient of urban-rural income gap

The Thiel index [32] first calculates the income shares of urban and rural residents and the ratio of rural residents' income, and then uses the ratio of urban and rural residents' income as weights to calculate the weight average. The data come from provincial statistical yearbooks, due to the missing values of urban population share or per capita income in some cities. The specific formulas are as follows:

$$\begin{aligned} dis &= \sum_{j=1}^{2} \left(\frac{P_j}{P} \right) \ln \left(\frac{P_j}{P} \Big/ \frac{Z_j}{Z} \right) \\ &= \frac{P_1}{P} \ln \left(\frac{P_1}{P} \Big/ \frac{Z_1}{Z} \right) + \frac{P_2}{P} \ln \left(\frac{P_2}{P} \Big/ \frac{Z_2}{Z} \right) \end{aligned} \tag{2}$$

(3) Resource allocation efficiency

Since there is no publicly available and reliable provincial-level data on resource allocation efficiency, this paper uses data from the China Urban Statistical Yearbook to measure this indicator. It is mainly divided into the following steps.

1) Model Selection

For the measurement of resource allocation efficiency, the commonly used methods include the traditional input-output method, data envelopment analysis (DEA) [33], stochastic frontier analysis (SFA), and evaluation methods based on the evaluation index system. Due to the limitations of provincial data acquisition, this paper uses the DEA model, a non-parametric method widely used in efficiency measurement, to calculate the local resource allocation efficiency of various factors such as capital, labor, land, etc., to obtain the local resource allocation efficiency data of each place, to analyze the differences in the quality of economic development of each place from the point of view of resource allocation, and to add it to the evaluation system to measure the effect of the intervention of the local government on the allocation of resources as an important indicator.

As the data required in this paper are applied in performance evaluation, the farthest distance to the frontier (SBM) in the super-efficient DEA model is selected. In the DEA model method is divided into input-oriented and output-oriented and non-oriented, according to the understanding of the local government economic management function of the optimal allocation of limited resources, this paper selects the non-oriented model.

2) Model description

The SBM model follows the basic idea of the DEA method, with the principle of “minimum” or “best fit”, using a convex sphere to wrap the original dataset, and manipulating the boundaries to obtain the “best practice technology frontier”.

Assuming that there are n decision unit DMUs, the SBM model uses ρ to denote the efficiency value of the evaluated decision unit, and s_i^- and s_r^+ to denote the input and output slacks, respectively, and the inefficiencies of the inputs and outputs of the SBM model are, respectively:

$$\frac{1}{m} \sum_{i=1}^{m} s_i^- / x_{ik} \quad \frac{1}{q} \sum_{r=1}^{q} s_r^+ / y_{rk} \tag{3}$$

If the validity of the SBM model is equal to 1, it indicates that the DMU is strongly valid. It is targeted:

$$\hat{x}_k = x_k - s^-, \hat{y}_k = y_k + s^+ \tag{4}$$

Step one:

$$\begin{aligned} t &= 1 / \left(1 + \frac{1}{q} \sum_{r=1}^{q} s_r^+ / y_{rk} \right) \\ \lambda, s^+, s^- &\geq 0 \end{aligned} \tag{5}$$

Second Step Order:

$$S^- = ts^-, S^+ = ts^+, \Lambda = t\lambda \tag{6}$$

$$\min \rho = t - \frac{1}{m}\sum_{i=1}^{m} S_i^- / x_{ik}$$
$$s.t. X\Lambda + S^- - tx_k = 0 \quad (7)$$
$$Y\Lambda - S^+ - ty_k = 0$$

$$t + \frac{1}{q}\sum_{r=1}^{q} S_r^+ / y_{rk} = 1 \quad (8)$$

The unguided SBM efficiency value is obtained as:

$$\min \rho = \frac{1 - \frac{1}{m}\sum_{i=1}^{m} \frac{s_i^-}{x_{ik}}}{1 + \frac{1}{q}\sum_{r=1}^{q} \frac{s_r^+}{y_{rk}}} \quad (9)$$

$$s.t. X\lambda + s^- = x_k$$
$$Y\lambda - s^+ = y_k \quad (10)$$
$$\lambda, s^+, s^- \geq 0$$

3) Indicator selection and data description

The resource allocation efficiency data required for indicator construction are mainly the allocation efficiency of land resources, labor resources and capital resources. Therefore, the input indicators of the model are composed of three elements: land, labor and capital. Output indicators are expressed in terms of gross local product and fiscal revenue.

(4) Industrial Structure Indicators

The Thiel index is redefined:

$$TL = \sum_{i=1}^{n} \left(\frac{Y_i}{Y}\right) \ln\left(\frac{Y_i / Y}{L_i / L}\right) \quad (11)$$

The index of advanced industrial structure here measures the results of transformation and upgrading of the industrial structure of a place. As the economy continues to grow, the proportion of the three industries rises along the order of the first, second and third industries. The GDP is divided into three parts according to the three industries, and the proportion of the added value of the three parts of the GDP as components constitutes a set of 3-dimensional vector $X_0 = (x_1, 0, x_2, 0, x_3, 0)$.

Then the angle θ_j between X_0 and the vectors $X_1 = (1,0,0)$, $X_2 = (0,1,0)$, and $X_3 = (0,0,1)$ is computed individually, where the vectors are ranked according to the industrial hierarchy, from low to high:

$$\theta_j = \arccos\left(\frac{\sum_{i=1}^{3}(x_{i,j} \cdot x_{i,0})}{\sum_{i=1}^{3}\left(x_{i,j}^2\right)^{\frac{1}{2}} \sum_{i=1}^{3}\left(x_{i,0}^2\right)^{\frac{1}{2}}}\right), j = 1,2,3 \quad (12)$$

The formula for calculating the value of advanced industrial structure W is as follows, where the larger the value indicates the higher the degree of advanced industrial structure:

$$W = \sum_{k=1}^{3}\sum_{j=1}^{k} \theta_j \quad (13)$$

(5) Fiscal self-sufficiency rate

Fiscal self-sufficiency rate is an important indicator of the state's fiscal balance, which reflects the local government's share of government expenditures. The lower the fiscal self-sufficiency rate is, the more it shows that the local government is more dependent on the central government's transfers, and the weaker it is in maintaining its fiscal balance.

III. B. Identification and screening of discriminatory capacity of evaluation indicators

First, the internal consistency index is used to measure the discriminatory power of different indices. The formula is as follows:

$$V_i = \frac{\overline{x}}{s_i} \quad (14)$$

$$S_i = \sqrt{\frac{\sum_{i=1}^{n}\left(\alpha_i - \bar{X}\right)}{n-1}} \tag{15}$$

In these assessment targets X_i, the average value of each assessment target X is shown, while the standard deviation of S_i is shown. When the value of V_i is larger, it indicates that the consistency of the index is better, i.e., the recognition ability of the index is worse, and vice versa. Based on the relevant experience, we chose the critical value of 10 for the consistency coefficient, and deleted the indexes in which the consistency coefficient is more than 10, and retained those less than 10. The indicators of full coverage of TV programs (%) and domestic waste disposal rate (%) were deleted.

The ratio of the tertiary industry and the secondary industry is used as a measure, thus highlighting the trend of service-oriented industrial structure. According to the specific connotation of the indicators, the established indicator system contains two categories of cost-type and benefit-type among the five types of attributes. For the cost-type indicators, this paper will carry out the positive treatment of the indicators according to the definition of the indicators in the subsequent evaluation process. The final established indicator system is shown in Table 1.

Table 1: Government economic management performance evaluation system

Angle	Primary indicator	Secondary indicator	Index attribute
Public	Market fairness	Government service	Effect type
		Government integrity	
		Business relations	
	Equal public service	The number of teachers per person in school	Effect type
		The number of teachers per person in school	
		Bed bed	
		Per capita doctor	
		The average number of public libraries in the public library	
	Fair distribution	Gini coefficient	
		Thie coefficient	
		The proportion of the insurance personnel of urban workers' old-age insurance	Effect type
		The proportion of medical insurance personnel of urban workers and workers	
Efficiency	Economic development efficiency	Resource allocation efficiency	Cost type
		Per capita GDP	Cost type
		GDP growth rate	Effect type
		Industrial structure height	
		Rationalization of industrial structure	
	Government agency	Financial rationing	
		Technology expenditure ratio	
		Government transparency	
	Public goods supply	Per capita road area	
		The density of the pipeline	
		The density of the drainage pipe	
		Sewage rate	
		Per capita park	
		Life disposal rate	

III. C. Methods for evaluating the performance of government economic management

III. C. 1) Entropy method

Entropy value method belongs to a kind of objective assignment method, which can avoid the subjective bias caused by the subjective method and make the evaluation results have a strong mathematical theoretical basis. The paper uses the entropy value method to assign weights to measure the performance evaluation, which can objectively derive the government economic management performance scores of different provinces and make the trend chart of each province, so that it is easier to make a longitudinal comparative analysis of the research object.

The basic calculation process of entropy value method:

(1) List the matrix of the original data.

Take panel data, need to include m indicators, r years, n provinces, $x_{\mu pq}$ indicates μ province in the p year of the q indicator value. Representing the matrix of raw data as X_{pq}, we have:

$$X_{pq} = \begin{bmatrix} x_{11} \cdots x_{1m} \\ x_{21} \cdots x_{2m} \\ \cdots\cdots \\ x_{r1} \cdots x_{rm} \end{bmatrix} \tag{16}$$

(2) Standardization of data.

As different indicators have different units and outlines, mainly divided into absolute and relative indicators, in order to carry out comparative analysis, it is necessary to do standardization and positive processing of the data of each indicator, and the common methods include minimum-maximum normalization, z-score normalization and so on. Then according to the characteristics of each indicator data, the negative indicator positive processing, generally using the inverse method. The data matrix after normalization can be expressed as $Z_{pq} = \dfrac{X_{pq}}{\sum_{p=1}^{m} X_{pq}}$.

(3) Calculate the entropy value of the q th indicator.

The entropy value of the q th government economic management performance evaluation indicator is expressed by e_q, which is expressed by the formula:

$$e_q = -\frac{1}{\ln r}\sum_{p=1}^{m} Z_{pq} \ln Z_{pq}, e_q \in [0,1] \tag{17}$$

(4) Measure the coefficient of variation of the q th indicator.

Due to the difference and negative correlation between e_q and the data matrix. So the coefficient of variation is denoted as g_q to indicate the degree of separation of the data, the larger the value of g_q, the greater the impact on the evaluation of the performance of the government's economic management, i.e.: $g_q = 1 - e_q$.

(5) Calculate the weight of each indicator.

The indicators to be evaluated are noted as w_q. The coefficient of variation g_q is used to describe the degree of importance of the q th indicator, therefore, to find its share of the total coefficient of variation is equivalent to the weight of each indicator.

(6) Calculate the score.

According to the weight of each indicator can be obtained in each year of the government's economic management performance of the impact layer of the evaluation of the situation, can be used to obtain the trend of the score of each layer of the impact layer more in-depth analysis of the impact of the performance of the government's economic management of each element of the history of the situation, to find a solution to the current problem.

$$F_l = \sum_{q=1}^{m} w_q Z_{pq} \tag{18}$$

(7) Calculate the comprehensive score.

The scores of all the indicators in the impact layer are summed up to finally get the overall situation of the economic management performance of each provincial and district government in each year.

$$F = \sum_{l=1}^{3} F_l \tag{19}$$

III. C. 2) TOPSIS method

The TOPSIS method [34] belongs to a kind of analytical evaluation method for multi-objective decision-making, which can make an evaluation of the strengths and weaknesses of the research object through the measured closeness. The thesis uses the TOPSIS method to measure the proximity of government economic management performance calculated from positive and negative ideal value distances to find the gap between cities with higher and lower performance levels.

A decision matrix is created and the data is normalized.

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{20}$$

The above equation R is the evaluation matrix after normalization, and r_{mn} is the standard value of the n th indicator in the m th year. Where m takes the value of $1,2,\cdots,m$, n is the evaluation year.

The standardized data R are weighted to obtain the weighted data matrix Y .

$$Y=\begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{bmatrix} = R*W = \begin{bmatrix} r_{11}w_{11} & r_{12}w_{12} & \cdots & r_{1n}w_{in} \\ r_{21}w_{21} & r_{22}w_{22} & \cdots & r_{2n}w_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1}w_{m1} & r_{m2}w_{m2} & \cdots & r_{mn}w_{mn} \end{bmatrix} \tag{21}$$

Calculate the ideal positive and negative solutions.

Ideal positive solution: $Y^{+}=\left\{\max y_{ij} \mid i=1,2,3,\cdots,n\right\}=\left\{y_1^{+},y_2^{+},\cdots,y_n^{+}\right\}$

Ideal negative solution: $Y^{-}=\left\{\min y_{ij} \mid i=1,2,3,\cdots,n\right\}=\left\{y_1^{-},y_2^{-},\cdots,y_n^{-}\right\}$

The ideal positive solution in the above formula means the maximum value of the i th indicator in the j th year of the selected data, i.e., the most preferred solution. The ideal negative solution is the minimum value of the i th indicator in the j th year of the selected data, i.e., the least preferred solution.

There are many common methods to calculate the distance, the main ones are: Euclidean distance, Markov distance, Manhattan distance, Chebyshev distance, etc. The formulas for calculating the distances are as follows: $d_{12}=\sqrt{(x_1-x_2)^2+(y_1-y_2)^2}$, $D(X)=\sqrt{(X-\mu)^T S^{-1}(X-mu)}$, $d_{12}=\mid x_1-x_2\mid+\mid y_1-y_2\mid$, $d_{12}=\max\left\{\mid x_1-x_2\mid,\mid y_1-y_2\mid\right\}$. The paper uses the simplest and most commonly used Euclidean distance applied to rational positive and negative solutions, which is $D^{+}=\sqrt{\sum_{j=1}^{n}(y_j^{+}-y_{ij})^2}$, $D^{-}=\sqrt{\sum_{j=1}^{n}(y_j^{-}-y_{ij})^2}$, where y_{ij} is the canonical value of the j th indicator weighted in the i th year, y_j^{+} is the most preferred solution value of the j th indicator taken in the n th year, and y_j^{-} is the least preferred solution value of the j th indicator taken in the n th year.

The fit between the assessment object and the ideal solution is calculated, so that T_i is the level of government economic management performance level close to the optimal utilization in the i th year, often referred to as the fit, taking the value range of $[0,1]$, and the larger the T_i, the higher the level of the city's government economic management performance is indicated. When $T_i=1$, the city's government economic management performance level reaches the maximum value. When $T_i=0$, the city's government economic management performance level reaches the minimum value. The formula is as follows:

$$T_i=\frac{D^{-}}{D_i^{-}+D_i^{+}} \tag{22}$$

IV. Analysis of the results of the evaluation of the Government's economic management performance

IV. A. Data sources

Due to data availability, the study population is 20 provinces in China (excluding Tibet, Hong Kong, Macao and Taiwan), and the study year is 2016-2021. The data come from the China Statistical Yearbook and the statistical yearbooks of each province, etc., as well as the bulletin of the economic management status of each province, and the data of some indicators are obtained by secondary calculations, and the missing data are supplemented by using the linear interpolation method or utilizing the data of similar years.

In this paper, the entropy weight TOPSIS method is used to make a comprehensive evaluation of the government economic management performance of each province.TOPSIS method utilizes the distance between each evaluation object and the ideal point to make a comprehensive evaluation of the evaluation object. Entropy weight method borrows the information entropy in information theory to determine the index weights, which is a kind of objective assignment method. The entropy weight TOPSIS method uses the entropy value method to determine the weights of the dimensions in the TOPSIS method, further eliminating the arbitrariness in the process of the TOPSIS method. The indicator weights are determined as shown in Table 2.

Table 2: Index weight

Angle	Primary indicator	Secondary indicator	Index weight
Public	Market fairness	Government service	0.0411
		Government integrity	0.0652
		Business relations	0.0059
	Equal public service	The number of teachers per person in school	0.0415
		The number of teachers per person in school	0.0459
		Bed bed	0.0512
		Per capita doctor	0.0065
		The average number of public libraries in the public library	0.0098
	Fair distribution	Gini coefficient	0.0123
		Thie coefficient	0.0158
		The proportion of the insurance personnel of urban workers' old-age insurance	0.0122
		The proportion of medical insurance personnel of urban workers and workers	0.0321
Efficiency	Economic development efficiency	Resource allocation efficiency	0.0684
		Per capita GDP	0.0621
		GDP growth rate	0.0411
		Industrial structure height	0.0489
		Rationalization of industrial structure	0.0122
	Government agency	Financial rationing	0.1065
		Technology expenditure ratio	0.0053
		Government transparency	0.0213
	Public goods supply	Per capita road area	0.0223
		The density of the pipeline	0.1145
		The density of the drainage pipe	0.0593
		Sewage rate	0.0142
		Per capita park	0.0412
		Life disposal rate	0.0432

IV. B. Overall situation analysis

The government economic management performance score is shown in Figure 2, numbered 1-20 represent 20 Chinese cities in Xinjiang, Ningxia, Gansu, Heilongjiang, Inner Mongolia, Qinghai, Guangxi, Guizhou, Hebei, Shanxi, Hubei, Shaanxi, Chongqing, Fujian, Tianjin, Jiangsu, Guangdong, Beijing, Shanghai, Zhejiang, etc., and the composite scores of all the provinces have been improved from 2016 to 2021 or basically the same, the average value of the government's economic management performance composite score improves from 0.321 in 2016 to 0.439 in 2021, with an average increase of 0.118, the government's economic management performance level continues to improve, and the construction of economic management performance has obvious results. The province with the highest comprehensive score improvement is Zhejiang Province, with an improvement of 0.319.

The quadrant diagram of government economic management performance in 2016 and 2021 is shown in Figure 3 and Figure 4 respectively. It is worth noting that the improvement in the fairness aspect of government economic management performance nationwide is more obvious compared with the improvement in the efficiency aspect, and 70% of the provinces' scores on the fairness aspect have improved more than the efficiency scores have improved, reflecting the transformation of China's relationship between economic management fairness and economic management efficiency to a coordinated win-win situation. The performance of government economic management has made comprehensive progress as a key task in the current period, with remarkable results.

The ranking of government economic management performance evaluation results in 2021 is shown in Figure 5, which shows that there are large differences in the level of government economic management performance among the 20 provinces in the country. In 2021, the top three provinces in the overall rankings are Zhejiang, Shanghai, and Beijing, and the bottom three provinces in the overall rankings are Gansu, Ningxia, and Xinjiang.

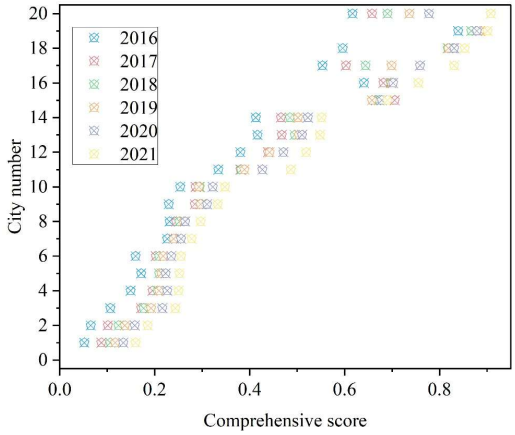

Figure 2: Overall performance of economic management performance

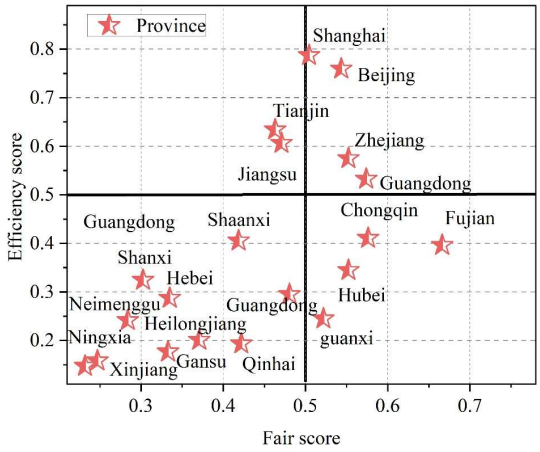

Figure 3: 2016 government economic management performance quadrant

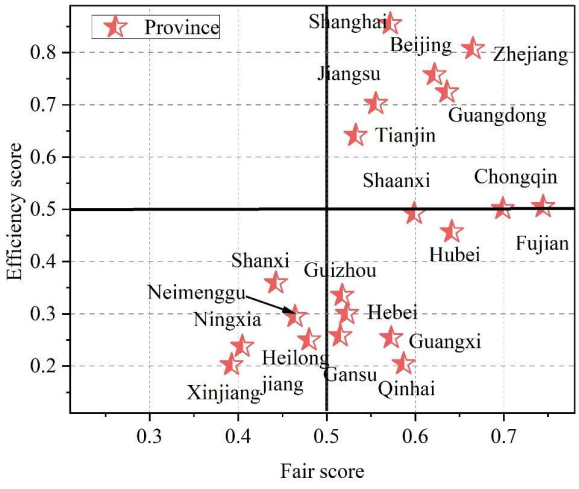

Figure 4: 2021 government economic management performance quadrant

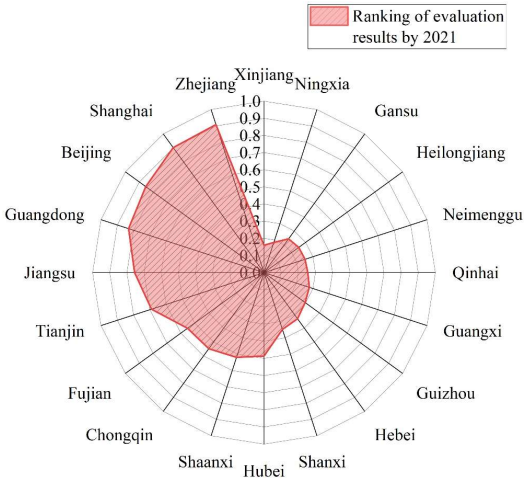

Figure 5: The ranking of the evaluation results in 2021

V. Characterization of the evolution and convergence of economic management performance levels

V. A. Characteristics of the dynamic evolution of the level of performance of government economic management

Kernel density estimation is an effective tool for measuring spatial disequilibrium by constructing a kernel density function and utilizing kernel density curves. The method is able to reflect the trend of spatial and temporal variations of quantitative indicators, polarization phenomena and so on. The specific formulas are as follows:

$$f(x)=\frac{1}{Nh}\sum_{i=1}^{n}\left(\frac{y_i-y}{h}\right) \tag{23}$$

where N is the number of observations, y_i is the green wealth of the i th province, y is the mean value of the indicator, and h is the bandwidth. The Gaussian kernel density function is:

$$K(x)=\frac{1}{\sqrt{2\pi}}\exp\left(-\frac{x^2}{2}\right) \tag{24}$$

Figure 6 demonstrates the three-dimensional kernel density plot of government economic management performance level in China from 2016 to 2021. First, from the distribution location, the center of the kernel density function curves of China as a whole all show different degrees of rightward shifting trends, which indicates that the overall government economic management performance level of the country as a whole has been improving with the passage of time. Second, from the evolution of the main peak, the width of the main peak gradually expands, indicating that the economic management performance of the government in each region tends to be more and more decentralized during the observation period, and the absolute difference shows a tendency to expand.

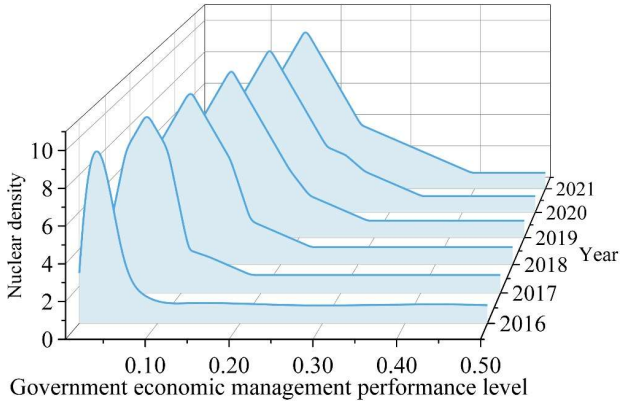

Figure 6: National nuclear density curve distribution

V. B. Convergence analysis of the level of performance of government economic management

(1) σ convergence. In order to reflect the trend of the deviation of the level of economic management performance of regional governments over time, the coefficient of variation measure σ convergence is used, the specific formula is:

$$\sigma = \frac{\sqrt{\sum_{i=1}^{N_j}\left(GW_{ij} - \overline{GW}\right)^2 / N_j}}{\overline{GW}} \tag{25}$$

where GW_{ij} refers to the performance level of government economic management of i provinces in the j region, $\overline{GW}$ is the mean value of the performance level of government economic management of the provinces in the j region, and N_j denotes the number of provinces in the j region.

(2) β convergence. In view of the actual situation of the study, the conditional β convergence theory in neoclassical economic theory is used to analyze the convergence mechanism of the Chinese government's economic management performance level, and the conditional β convergence model is:

$$\ln\left(\frac{GW_{i,t+1}}{GW_{it}}\right) = \alpha + \beta \ln GW_{it} + \delta X_{it} + \varepsilon_{it} \tag{26}$$

where i and t denote province and time, respectively. $\ln\left(\frac{GW_{i,t+1}}{GW_{it}}\right)$ denotes the annual growth rate. To eliminate the problem of incomparability and heteroskedasticity between indicators, some of the control variables are logarithmized. ε denotes the random error term. β is the convergence coefficient, if $\beta < 0$ and passes the significance test, it indicates that the level of government economic management performance is in a convergent trend, otherwise it indicates that the level of government economic management performance is in a divergent state.

According to the σ convergence model established above, the convergence results can be obtained as shown in Table 3. On the whole, although the coefficient of variation fluctuates in the whole country and the eastern, central and western regions in a few occasional years, the overall coefficient of variation shows a clear downward trend, with decreases as high as 5.43%, 6.62%, 11.54% and 34.23%, respectively. Therefore, σ-convergence exists in the whole country and in the eastern, central and western regions, but not in the northeastern region.

Table 3: σ convergence test results

	2016	2017	2018	2019	2020	2021
Whole country	0.681	0.622	0.642	0.577	0.638	0.644
East	0.785	0.735	0.773	0.698	0.768	0.733
Middle	0.442	0.441	0.465	0.431	0.411	0.391
West	0.815	0.694	0.635	0.511	0.594	0.536
Northeast	0.183	0.154	0.135	0.162	0.204	0.277

Changes in the level of government economic management performance are usually influenced by a variety of factors, so it is necessary to further explore the conditional β convergence characteristics of the level of government economic management performance while controlling for other variables. Table 4 shows the results of conditional β convergence after adding control variables.

The β values of the country as a whole, the eastern region, the central region and the western region are all negative and pass the significance test, which indicates that the level of government economic management performance in the above regions can converge to the equilibrium level after considering the control variables. However, the results in the Northeast region are consistent with the results of absolute β convergence and do not pass the significance test, which indicates that there is conditional β convergence in the country as a whole, in the eastern region, in the central region and in the western region, and there is no conditional β convergence in the Northeast region. From the speed of convergence, the four regions present the pattern of east > central > west > national > northeast, and the east has the fastest speed of convergence, 0.0522, which indicates that there is an impact of the control variables selected in this paper on the speed of convergence of the government's economic management performance level.

Table 4: Conditional β convergence test results

	Whole country	East	Middle	West	Northeast
β	-0.2065***	-0.3741**	-0.2698***	-0.2511***	-0.1876
	-5.85	-2.25	-3.84	-5.36	-0.44
Control variable	Yes	Yes	Yes	Yes	Yes
cons	1.1168*	4.8954*	-0.2254*	0.4745*	5.5361*
	1.55	1.71	-0.15	0.33	0.46
Convergence rate	0.0255	0.0522	0.0345	0.0325	0.0233
Half life cycle	26.95	12.35	19.56	21.56	30.02
R^2	0.415	0.275	0.741	0.645	0.549

VI. Conclusion

This paper finds that, from 2016 to 2021, government performance management in China's provinces improved significantly, with both the management fairness aspect and the management efficiency aspect improving significantly, and the average of the performance composite scores increased from 0.321 to 0.439, or 0.118, between 2016 and 2021.China's nationwide government economic management performance fairness aspect improved more effectively than the The effect of the improvement in management efficiency is more obvious. However, there are still regional differences in the level of economic management performance of the Chinese government.

Except for the Northeast region, there is σ-convergence and conditional β-convergence in China as a whole, in the eastern region, in the central region and in the western region. In terms of the speed of convergence, the conditional β convergence speed in the eastern region is 0.0522, which is much higher than that in other regions.

In order to break the uneven development and limitations of government performance management level among local regions in China, and to promote economic cooperation and exchange among regions. This can be realized through resource sharing, industrial synergy and market integration in order to narrow the gap in economic management performance between regions. In addition, it should also increase support for emerging industries, encourage innovation and entrepreneurship, strengthen investment in scientific and technological research and development in regions with weaker levels of government performance management, promote the transformation of scientific and technological achievements into real productivity, and promote the development of emerging industries.

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